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Analysis of research on smart rail circuits

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Abstract. The purpose of the article is to study intelligent continuous-type rail circuits with current receivers, respectively, to identify the possibility of determining the unit located on the rail lines with a standard shunt prescribed in the operating rules, as well as monitoring for breakage of a continuous-type rail circuit. To study smart railway circuits, it is necessary to take into account the circuit diagram of this track circuit and its operation with various factors influencing it. One of the points of the study is to determine the maximum and minimum resistance at the beginning and at the end of this rail line and also taking into account the worst influencing parameters on an intelligent rail circuit of unlimited length, carry out calculations and determine on the graphs the probability of failure-free operation in all modes. The study took into account fluctuations in temperature decline, both during the seasons, winter, summer, etc., and sharp continental changes within an hour in operating mode. When conducting the study, we also took into account the insulating resistance that affects the power supply of the composition determination sensor, which leads to a dependence on the length of the smart sensor. The parameters of changes in the sensor supply voltage, its variability from the supplier and the resistance of the rails and their fluctuations were taken. For this purpose, the requirements for the length of the intelligent rail circuit, shunt resistance and insulation resistance used on the road were applied, as well as determining the influence of all unfavorable conditions.

1 Introduction

When researching intelligent endless track circuits, take into account a number of existing differences. Namely, the parameters of rail lines may have the worst conditions, which do not coincide with the sensors currently used in train sections [1]. When calculating shunt and normal modes, simultaneous calculations must occur [2]. The important task of increasing the parameters for changing the power source of track circuits is inextricably linked with the use of new types and determining the parameters for them [3]. The use of voltage in track circuits of voice-frequency complicates the following factors: short-circuiting of the power source due to asymmetry of the control signal, the need to switch precise circuits with frequency power [3, 4-12]. However, unlike the currently used frequency rail circuit circuits with a capacitive limiter, the rail circuit has a specific feature that must be taken into account when calculating the main operating modes [12-16]. At the input and output ends of each track section, due to the difference in the lengths of the sections, we take the least permissible

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insulation resistance and equate it with the resistance values of the rail line at the input and output [1, 2, 3, 4, 17-20].

2 Research methodology

The method in which it is necessary to determine the required parameter is to set several values of the highest insulation resistance from 0.35 to 0.20 Ohm km and apply a shunt composition along moving coordinates until precipitation falls in the form of rain. It should be noted that the necessary method was made in order to clearly demonstrate the process of determining the desired parameter and allows you to change the data for the optimal search for the desired parameter along the route section, taking into account all external factors, such as the intensity of rain and snow, sudden changes in ambient temperature and pollution by chemicals, etc. At the beginning of movement along the first coordinate of the train approach, the range of change in insulation resistance is set to 0.35 Ohm*km and the train maneuvering point where the rain begins has a distance of 2 km. In Figure 1 shows curves red and blue, where the voltage change is observed at the input end of the third railway line. Dotted line 2 reflects the reference voltage, which is used to determine the on and off threshold voltage. In Fig. 1 – 4 show curves showing an example of determining the smallest specific insulation resistance. This research determining includes the lowest insulation resistance at which all sections or block sections of the track will be reliably guided. To determine the lowest insulation resistance at the inputs and outputs of the sensor, you need to set the frequency of the signal current and the conditional values.

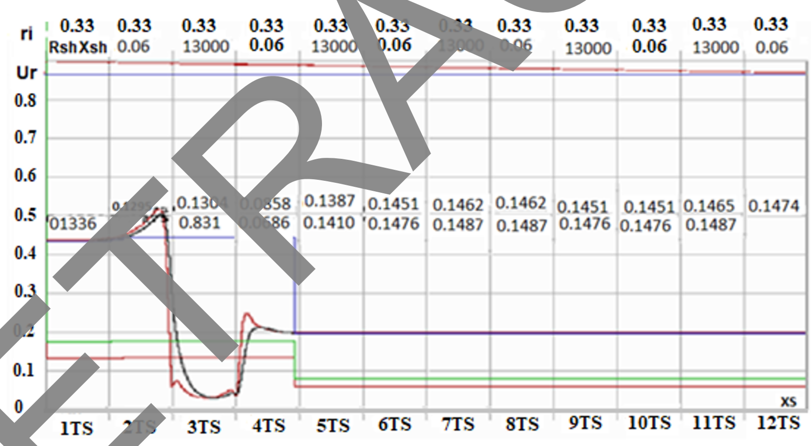

Fig. 1. Graphs of the movement of the train in the third section, when the insulation resistance changes to 0.35 ohm*km, taking into account the second train from the origin at a length of 2 km.

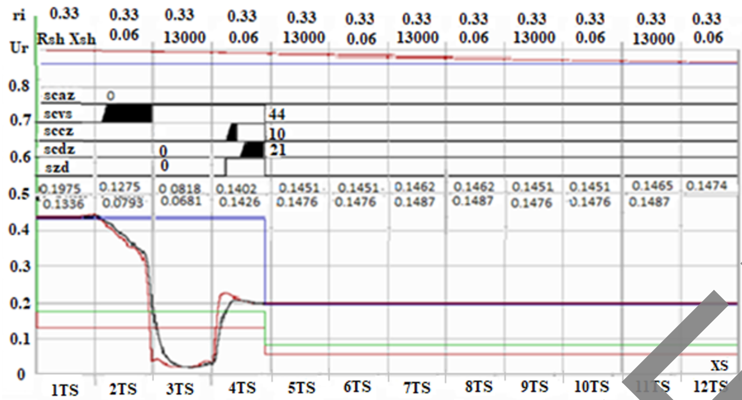

Fig. 2. Graphs of the movement of the train in the third section, when the insulation resistance changes to 0.35 ohm*km, taking into account the second train from the origin at a length of 1 km.

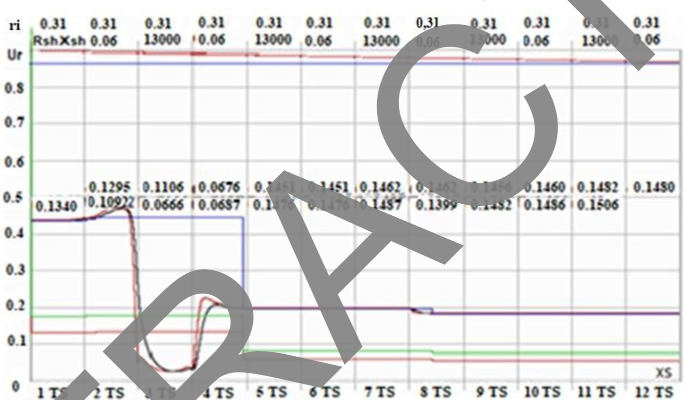

Fig. 3. Graphs of the movement of the train in the third section, when the insulation resistance changes to 0.34 ohm*km, taking into account the second train from the origin at a length of 1,5 km.

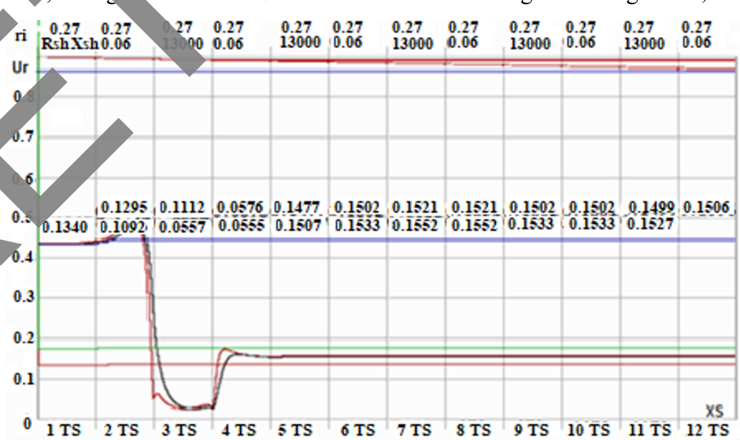

Fig. 4. Graphs of the movement of the train in the third section, when the insulation resistance changes to 0.20 ohm*km, taking into account the second train from the origin at a length of 1,5 km

In this situation, the shunting effect of the first train decreases with a decrease in the distance XS1 of the first and XS2 of the second train from the current track receiver and the insulation resistance is 0.35 ohm * km, an increase in the resistance of the shunt of the first train and a decrease in the resistance of the shunt of the second train. When two trains are located near the current track receiver, the shunt sensitivity of the control sensor will be practically equal to zero. In this case, the occupancy control of the control sensor disappears and the tail of the train will not be protected by the red light of the track traffic light, which is dangerous for the movement of trains. Thus, the worst-case conditions for the shunt mode of a control sensor with a current track receiver include the presence of a second train shunt at the end of an adjacent section with a resistance Rsh2 = 0.12 ohms. Therefore, to use monitoring sensors with a current path receiver, it is necessary to use special technical solutions that eliminate the possibility of hazardous situations due to the presence in monitoring sensors without insulating joints of a zone of insensitivity to the standard shunt. To eliminate this drawback, within the insensitivity zone to the standard shunt, you can use a special control sensor, which can be used to check the vacancy of a section of a rail line of length lznsh near the current track receiver, but this method is not very effective, since it requires large economic costs. The values of the occupancy and release coefficients in this example are taken to be 0.3, respectively. On lines red and black from Fig. Figure 1 shows the coefficients of occupancy and vacancy by the composition of the block site.

The state of change of block sections is determined reliably, as can be seen in Fig. 1. The beginning of precipitation corresponds to the location of the composition at a distance of 1 km, shown in Fig. 2 and from the curves shown we are also convinced that the state of the block sections of the track is reliably recorded. Examining Figure 3, we see the place where the rains began in the block section, which corresponds to the situation when the train is located on the block section at a distance of 1.5 km from the place of rainfall and at the same time, the condition of the block sections of the track segment is reliably monitored. The use of an upper occupancy factor significantly reduces the likelihood of monitoring the false freeness of a rail line due to the influence of interference. A faulty track circuit can be detected when there is a significant change in the current voltage and provided that none of the adjacent rail lines is occupied by a train and the voltage on each of them remains stable.

When the insulation resistance changes to 0.20 ohm*km, a situation arises that erroneously shows the occupation of block sections of track 3 and the following block section 4 (Fig. 4).

3 Result

In the above researcher, we saw that by changing the value of where the rain starts, the lowest insulation resistance was determined. To study and determine the maximum length of the block section of the smart sensor, calculated at the input and output ends of the resistance of an endless seamless rail line and the signal frequency of the current, we came to the conclusion that at the lowest value of insulating resistance, we find the following parameters, changing several for each parameter of the variables being studied. If you change the signal frequency of the current and the insulation resistance, then the length of the block section of the smart sensor will change. And the sensitivity of determining the composition by a shunt already depends on the length of the block section and, accordingly, the insulation resistance, the signal frequency of the current and the input and output resistances of the path lines.

4 Conclusion

The analyses and syntes of the operation of intelligent sensors of continuous rail lines indicates that reliable provision of readings in the operation of sensors occurs at the lowest insulation resistance of up to 0.55 ohm*km and below up to 0.35 ohm*km, with a standard of 1 ohm*km, this indicates that that the sudden influence of any external factors on the sensor still ensures reliable control, and therefore operation

With a negative argument of the input resistance, the receiving and transmitting ends of the control sensor, the sensitivity criterion increased, but at the same time the current of the supply end increased. From the results of the research, we can conclude that when synthesizing control sensors with an adaptive receiver, it is recommended to select a negative argument of the input resistance of the receiving end of the control sensor. The most significant drawback identified during the research was that during long-term occupation of the rail line and intense precipitation, cases of control of false occupation of track sections were observed. As subsequent studies have shown, this drawback is easily removable, and intelligent rail circuits seem to be the most promising devices among other sensors for monitoring the condition of track sections. Currently, previously known and significantly modified axle counters, devices for reading car numbers (or other marks), as well as the use of tail car inductors are proposed to monitor the condition of the rail line. The listed devices have a fatal drawback - the lack of control over the integrity of the rail thread. Every year, on most railways, there are from one to five cases of rail bend inspection. Thanks to the use of track chains, this does not lead to dangerous situations. The use of track chains makes it possible to monitor the condition of track sections in almost any climatic conditions, which significantly increases the safety and uninterrupted operation of trains.

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