MONITORING OF COMPOUND STANDARD OBJECTS OF RAILWAY AUTOMATION

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ABSTRACT

Modern systems of continuous monitoring of railway automation and telemechanics devices receive a large set of discrete and analog diagnostic information that is difficult to be analyzed during maintenance and troubleshooting. For centralization of information and its convenience for an end user, it is offered within the system «Hardware-software complex of dispatch control» (APK-DK) to group data from typical objects of automation and to output them into separate technological windows. The article describes APK-DK measuring controllers, as well as the order of output of information about such compound objects of railway automation as power supply units, control computers of microprocessor centralization systems and signaling points of automatic blocking.

Keywords: railways, automation and telemechanics, continuous monitoring, typical objects, analysis of diagnostic information.

Background. *Systems of continuous monitoring of technical condition allow to quickly detect deviations from standard critical parameters of devices that ensure quality and safety of responsible technological processes, which in turn helps maintenance personnel to prevent evolving malfunctions in time [1–3].*

On the railway transport, however, not all technically complex objects involved in transportation process are equipped with monitoring tools. As a rule, only periodic monitoring of the technical condition of infrastructure facilities is widespread, which is related to geographical distribution of monitoring objects, their location, direct interaction with rolling stock, etc. [4–13].

Devices and systems of railway automatics and telemechanics (RAT) are fully equipped with continuous monitoring tools at present [14]. Measuring controllers are connected to specially selected circuit nodes of RAT both on electric centralization posts and in localization places of decentralized objects (relays and moving points of automatic interlocks). Measured data are transferred to line posts via the cable network (in exceptional cases – using cellular communication [15]) for processing and delivering results to the technical personnel of signaling, centralization and blocking distances/sections (SCB). The information is broadcast to central posts located in buildings of SCB distances, as well as to the upper level of the hierarchy – to network monitoring centers [16].

The article considers features of monitoring of complex typical objects of RAT and centralization of processing and delivery of diagnostic information to servicing personnel by means of system of technical diagnosing and monitoring «Hardware-software complex of dispatching control» (APK-DK STDM).

Objective. *The objective of the author is to consider monitoring of compound standard objects of railway automation.*

Methods. *The author uses general scientific, engineering and electrical engineering methods, comparative analysis, evaluation method, simulation, IT tools.*

Results.

1. A variety of diagnostic information

In APK-DK STDM system, diagnostic information is obtained by connecting specialized measuring controllers, working mainly with electrical values, to the circuit nodes of RAT and relay boxes. Controllers are distinguished by the number of sensors and different operating ranges of the measured values. They are connected to electrical circuits in compliance with safety conditions – they should not affect operation of the main automation devices. For this purpose, various design measures are envisaged in measuring devices: galvanic isolation (transformer or optical isolation), protective and limiting resistors and diodes, and devices for measuring the strength of the magnetic field (Hall sensors) [17–19].

Measuring controllers receive either only discrete or only analog information, or they are devices of a combined data type. For some objects, only one type of data is defined (for example, discrete states of technological units of the remote control panels of station duty officers), and for others, an extended set (for example, discrete and analog parameters of power supply devices of the centralization system of switches and signaling).

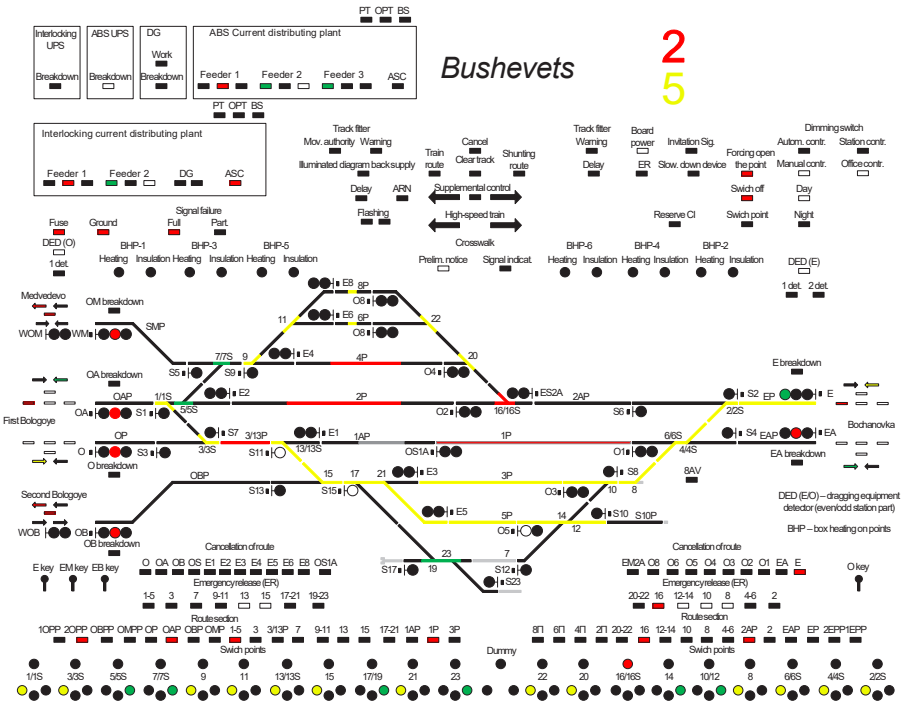
2. Control of typical compound objects

Even at a small station (up to 30 switches), the volume of diagnostic information is very significant: telesignalization tables and telemetry contain more than a thousand discrete and analog parameters of various automation devices. In view of this, it is important to centralize presentation of diagnostic information in the technological windows of automated workstations (AWS) of APK-DK system.

Discrete information about the main floor objects of RAT is displayed in the technological window of the console display of the station (or haul). In Pic. 1 there is such a window for one of stations of Oktyabrskaya railway, automation devices of which are controlled by means of APK-DK. Information is displayed in a specialized color scheme, and analogues of colors in black and white are shown in Pic. 2 (color schemes are available in e-version of the journal at elibrary.ru). Data are provided, as actually collected from the console of the station duty officer in case of relay control system, or obtained by interfacing with the control computer complex (CCC) of the microprocessor centralization system. The data reflect the discrete states of rail circuits (free, occupied, closed, open), traffic lights (presence of permissive or prohibitive indication, or malfunction), switches (position control), and technological cells. If necessary, monitoring results of analog parameters (for example, voltage of rail circuits supply) can be output to the relevant objects. The presence of critical deviations from the norms is indicated by blinking of the measured parameter (yellow in the pre-fault state and red in the failure state).

From Pic. 1 it is clear that even discrete data is quite abundant in the system and that their presentation in one technological window makes the analysis of information by the technical personnel of SCB distances and monitoring centers extremely difficult.

In order to centralize the diagnostic information from the complex typical objects of RAT, the developers



Pic. 1. General view of the display window about the train situations at the station.

of APK-DK system decided to introduce special additional technological windows, including all monitoring data for typical objects. These technological windows (the so-called «fourth views») are displayed on AWS screen by double clicking on a grouped object located in a rectangular shape in the upper left corner of the main process window (see Pic. 1).

Typical objects in APK-DK system are a power supply unit (Pic. 2), an uninterruptible power supply (UPS) (Pic. 3), a diesel generator set (DGS) (Pic. 4), supervisory computer control system (SCCC) devices of microprocessor centralization (Pic. 5), objects of an autolock signal point (Pic. 6), as well as self-diagnostics in the monitoring system (Pic. 7).

Several power windows are provided for controlling power supply devices. In the feeder, the symbols show the paths of currents – green lines can identify objects from which power is supplied (for example, in Pic. 2 this is the feeder 2, voltage in the feeders 1 and 3 is (see analogues of green lines in the power input device of feeders VUF1 and VUF3.) In the display window of the power supply unit, a transformer shield (TS) is displayed separately, where the power poles are output. If necessary, a technologist can turn on the mode of viewing the measuring information on any object. Hovering the mouse cursor over the measuring field displays a hint about which particular parameter is being measured.

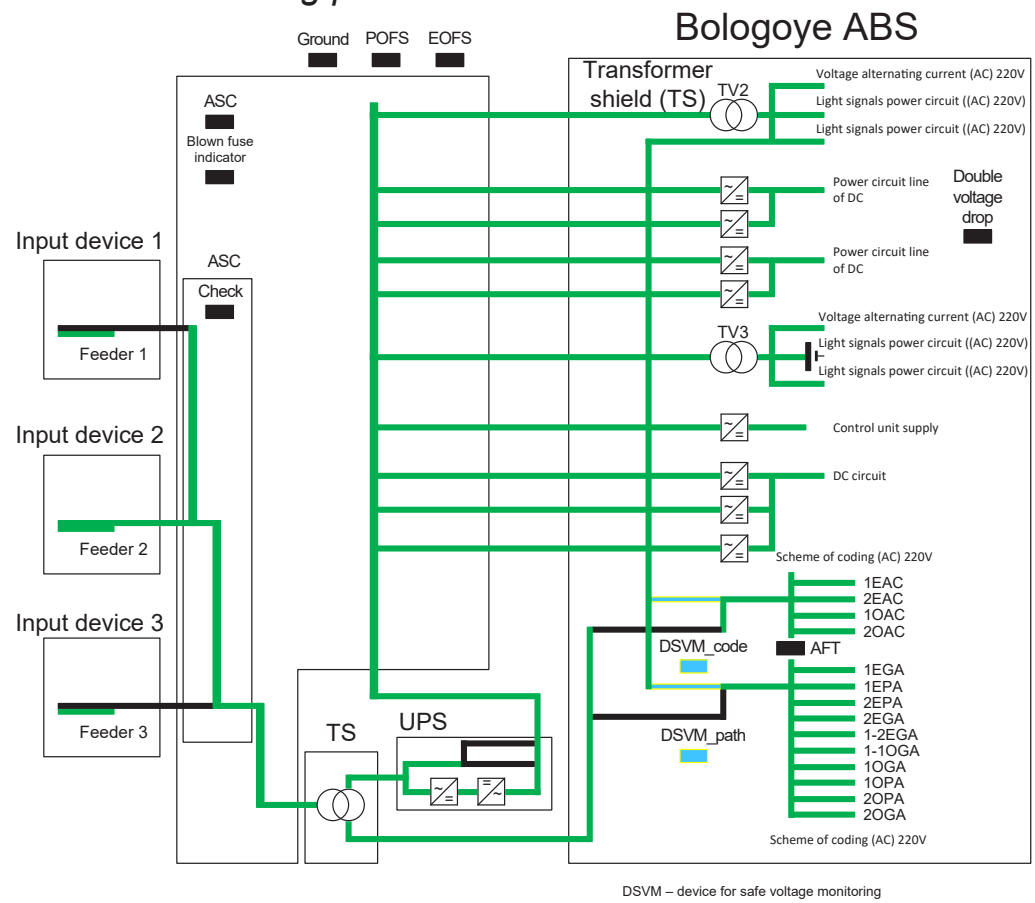
Separately, APK-DK system displays information on the state of SCC of microprocessor centralization. For example, Pic. 5 shows a functional scheme of CCC of the system of microprocessor centralization of EC-EM. Three workstations of the station duty officer (WS) are connected to each other and to the blocks of signal box center equipment (SBE). In good condition, all communication lines are highlighted in green, the red signaling corresponds to the occurrence of disturbances in operation. To control triads of information retrieval units (IRU), output modules (OM), and also correction modules (CM), cells are provided, if each of the objects is in good condition, in green, and in case of failures, the lights are red.

To monitor the state of objects of signaling points of automatic blocking, a specialized device (controller ADSU [18]) is used, and data is also output to a typical technological window (Pic. 6). In the equipment window of signal points, the principle of operation of a rail chain is shown in the form of a structure. Here the green color indicates the flow of currents with the set even and odd directions of train movement (for depersonalized tracks of hauls). In comparison with the previous displays, there are unique indicators of the state of track plug-in coding relay (TPCR). The relay arrow points upwards and lights up green when the relay is on, otherwise the arrow points down. The TPCR indicator shows the color corresponding to the code it generates.

To organize the output of the results of self-diagnosis of the monitoring system, a technological window was developed, shown in Pic. 7. Here, the indicators show the states of all diagnostic information retrieval devices within the same distance of SCB, as well as the relationship between the data concentrators. In the normal state (when all the controllers and communication between the devices are working) all the indicators are lit in black. In case of loss of operability by one of the devices for obtaining diagnostic data, the cell next to the name of the station lights up in yellow. If all measuring controllers fail on the station or the information concentrator, the cell lights up red. To control the state of the server, a separate field is provided: the status of the server itself and of AWS APK-DK software is displayed here.

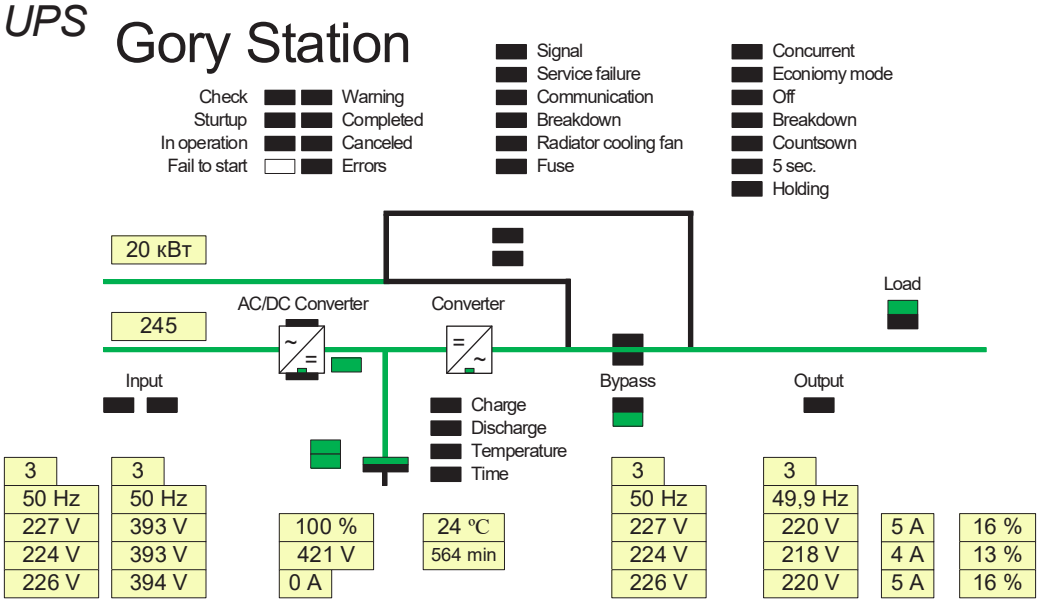
Conclusion. *The types of technological windows developed with participation of the author passed the procedure of approbation, testing and adaptation and*

Current distributing plant

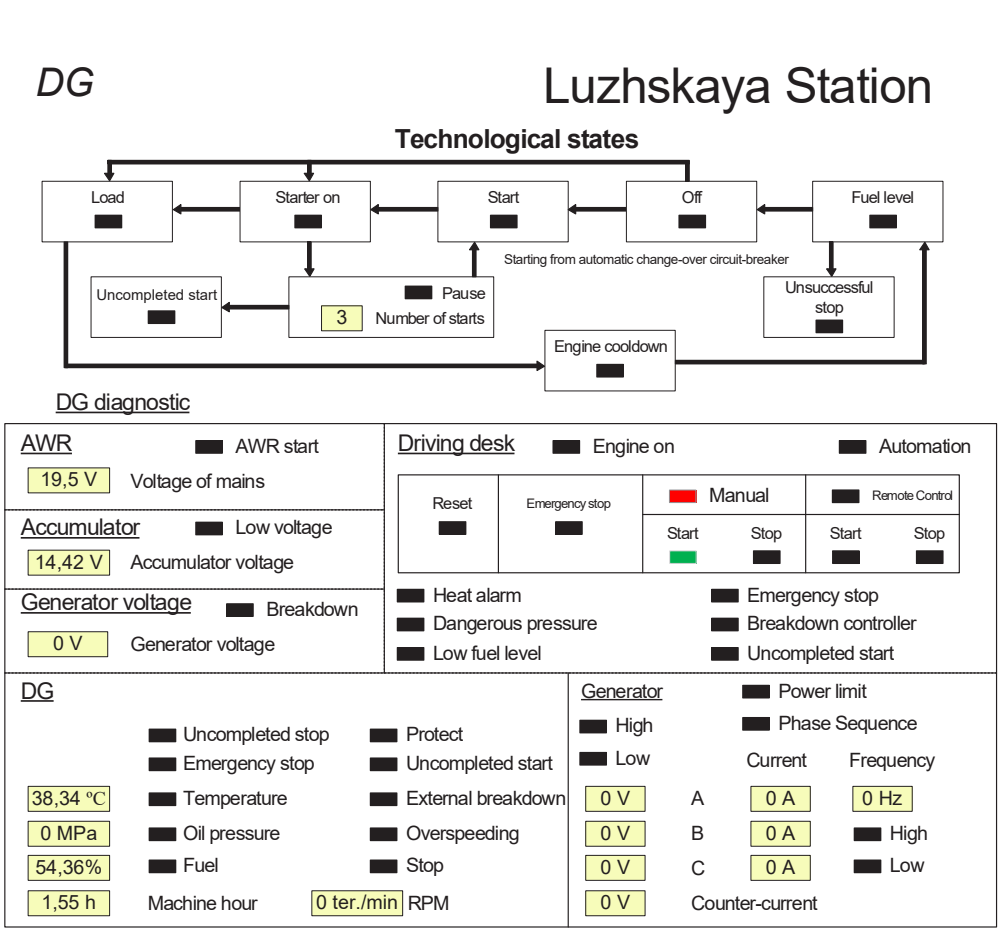


Pic. 2. General view of the display window of the technical state of the elements of power supply units.

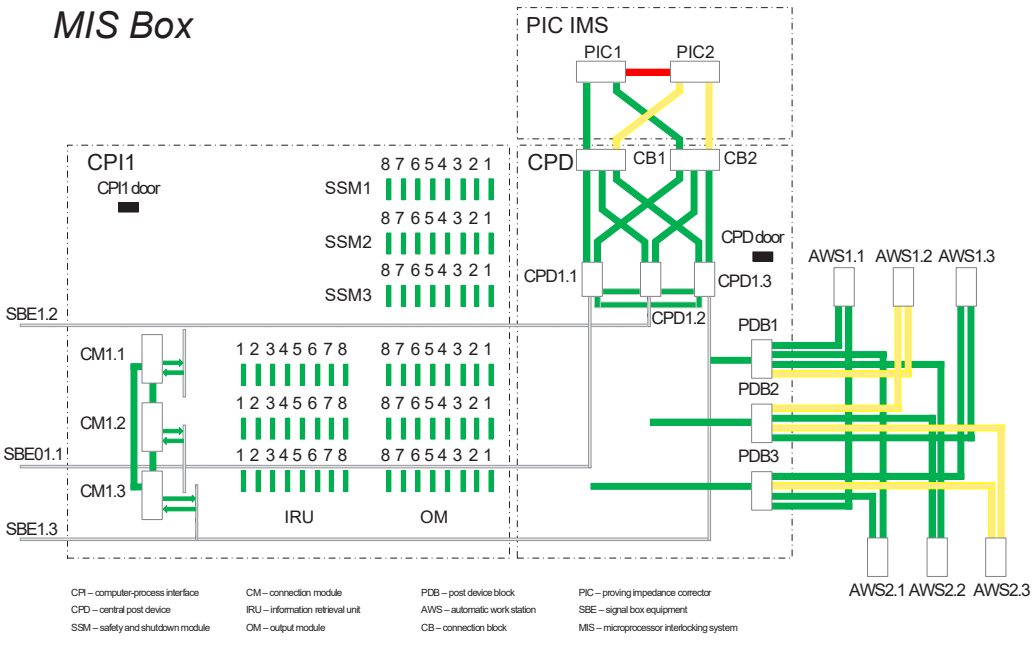
UPS



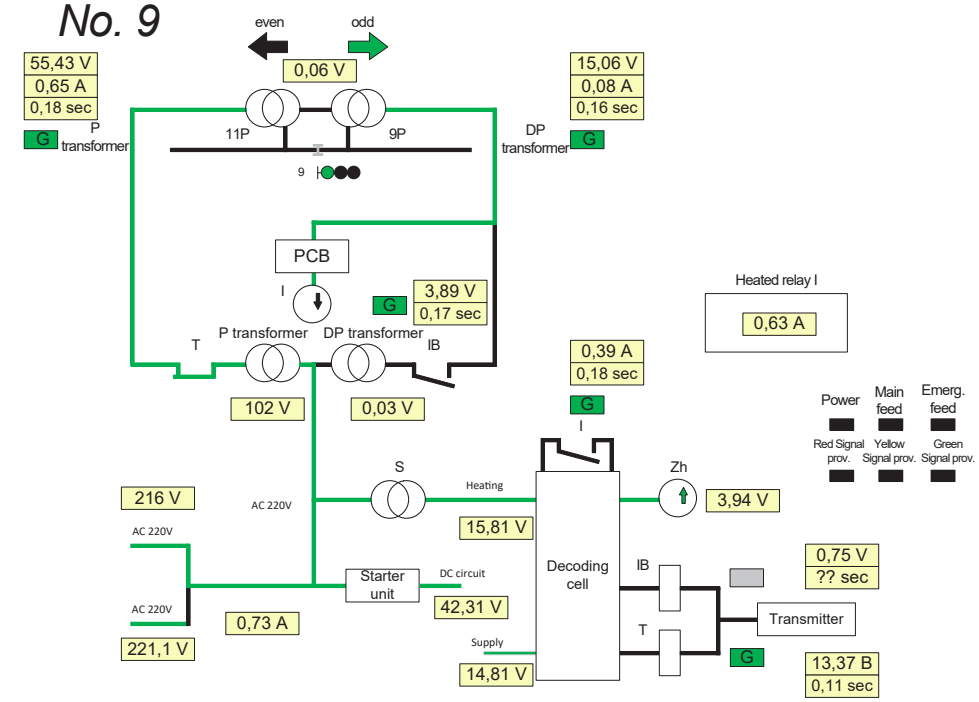
Pic. 3. General view of the display window of the technical state of UPS.



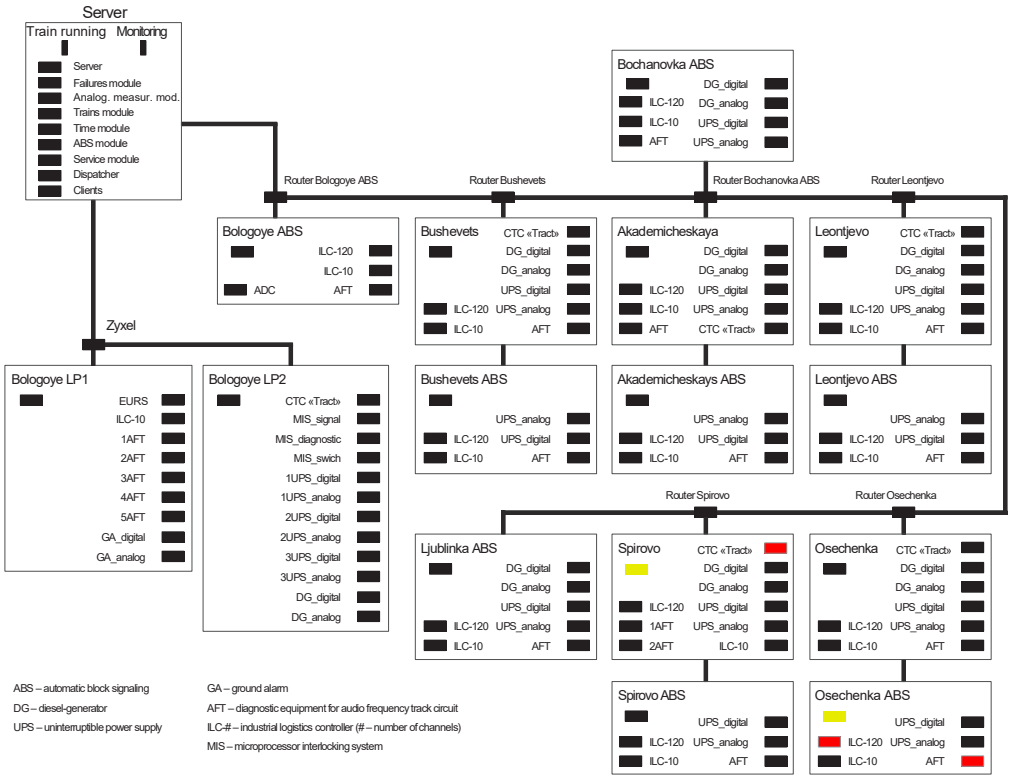
Pic. 4. General view of the display window of the technical state of DGS.



Pic. 5. General view of the display window of the technical state of CCC of microprocessor centralization.



Pic. 6. General view of the display window of the technical state of an autolock signaling point.



Pic. 7. General view of the self-diagnosis display window of the monitoring system.

are integrated into AWS of the upper level of APK-DK system. The use of a centralized representation of diagnostic information greatly facilitates the work of the technical personnel of SCB distances and situational monitoring centers both in maintenance of automation devices and in search for emerging faults.

At the same time, it should be noted that the use of continuous monitoring tools of both RAT devices and railway infrastructure facilities as a whole allows not only to improve maintenance technologies, but also creates opportunities for transition to a smart railway complex.

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