OVERVIEW OF AUTOMATIC IDENTIFICATION SYSTEMS FOR ROLLING STOCK

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Annotation: *With a long railway line, the time it takes to deliver cargo from the point of departure to the point of destination can be significant. Naturally, the shipper would like to constantly know where his cargo is at the moment. The automatic identification system of rolling stock of railway transport allows you to quickly and objectively receive data on the time and location of each car and locomotive. With the help of this system, you can monitor the movement of trains in real time, see at what point a specific car is coupled or uncoupled, etc.*

In addition, the automatic identification system gives a lot to the road itself - there is no need for inefficient manual labor of car number listers, it is known exactly where and in what condition the locomotives needed for train movement are located.

Keywords: *system, rolling stock, identification, code, system control, automation, telemechanics.*

Purpose of the automatic identification system of rolling stock (ASI)

The system provides prompt receipt of data on the location of each car and locomotive at any given time, allowing real-time determination of not only the location of trains, but also their condition (for example, at what point a specific car is coupled or uncoupled, etc.).

The operational information received is used to solve problems of management, analysis, accounting, mutual settlements for the use of wagons, and informing railway clients.

The use of AIS allows for:

- increasing the intensity of freight transportation by reducing downtime and empty runs;
- improving traffic safety and cargo security;
- increasing the period between repairs of units and parts due to specific control of their service life, eliminating unjustified replacement (or substitution) during the repair of wagons and locomotives;
- increasing the throughput capacity at customs and checkpoints on highways and railways between states;
- reduction of low-skilled railway workers - car number listers, office workers, repair workers;

- reduction of the empty run coefficient (by 2.4%);
- development of additional transportation by 1.6%;
- reduction of costs for wagon repairs (during mileage-based repairs) by 2.5%;

Basic principles of operation of the Palma AIS system

All rolling stock is equipped with coded on-board sensors KBD-2, which carry information about each moving object, and at checkpoints (border crossings, road boundaries, entrances and exits of marshalling, section, large freight stations, boundaries of train sections, checkpoints of locomotive and wagon depots) reading points (RPS) are installed, upon passing which information about the state of a given object is automatically taken.

The received information about the identifier, the PSC number, the time of the rolling stock passing the checkpoint, the direction of movement at fixed time intervals is transmitted to the linear level concentrator, which collects it from all reading points of the given railway junction. The number of PSC and their placement must ensure tracking of the rolling stock transition at all entry and exit points of the allocated control objects without exception (network control - border crossings, road - road boundaries, department - interdepartment junction points, allocated station (marshalling, section, large freight) - station boundaries at all entry and exit points).

The final message contains identification data of the rolling stock (8-digit rolling stock code), station code and reading point code, direction of travel and travel time, as well as a list of rolling stock in the train.

The Palma system allows you to determine the serial number of a vehicle in a train, which makes it possible to identify cars or locomotives with faulty on-board sensors. If the on-board sensors on the cars fail or are missing, the automated transportation management system (ASOUP) will receive data on the number of vehicles passing through the reading point in the train, and when a message about the train's passage is generated, the read identification numbers of the cars are correlated with the serial numbers of the rolling stock in the train.

At the next maintenance station (section station), information about the identifiers of rolling stock whose CBDs are temporarily missing or faulty must be entered into the system. This information must be supported by software until the end point of the train, and after arrival at the destination (unloading), the wagon or locomotive must not be used in transportation until the fault is corrected according to the CBD.

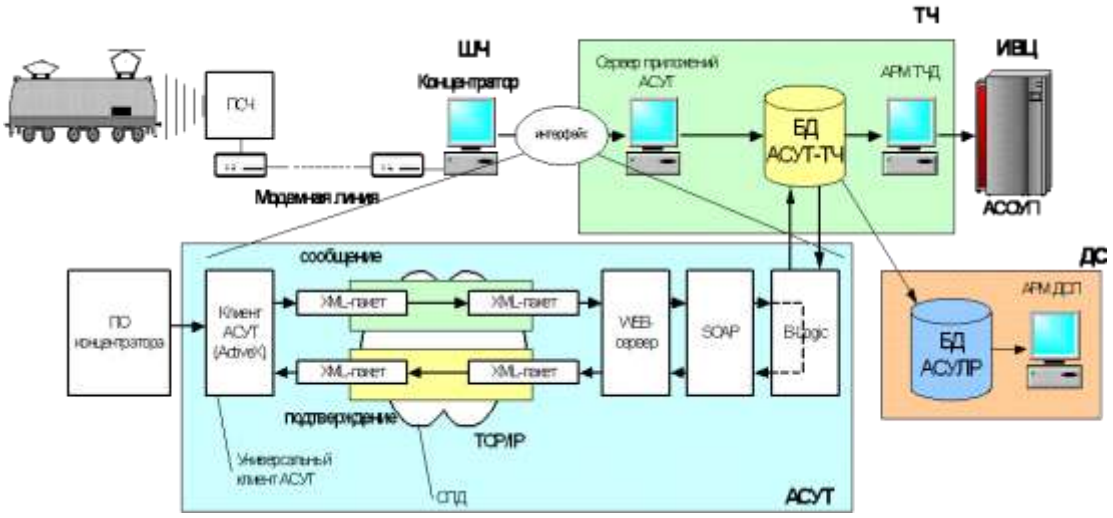

Fig.1 - Technology and methodology of using the SAI "PALMA"

The message about the passage of a vehicle includes:

• information about the date and time of passage of a train or shunting train through the reading point;

• the serial number of the rolling stock in the train and the information linked to this number, read from the code on-board sensor.

The information read from the rolling stock by radio frequency means is linked with the information received from the railway automation means and transmitted from the PSCH to the linear level concentrator KSAI-L. From this concentrator, the processed and presented in the form of standard messages data is sent to the road level concentrator KSAI-D or to the automated workplaces of linear enterprises. At the KSAI-D level, logical control of the correctness of the read information is carried out, and then the received data replenishes the information arrays of control tasks. The structure of the SAI allows, with minimal costs, to promptly convey the reading results to the complexes of tasks solved in the ASOUP (traffic control, freight operations, wagon economy, service maintenance of rail transport clientele, etc.).

Functions of the Automatic Identification System for Rolling Stock

Identification system with its comprehensive implementation:

- fully implements the functions of train composition control, which allows to reduce the number of employees controlling train compositions;

- ensures the implementation of paperless information technologies;

- increases the reliability and efficiency of reporting on the condition of wagon and locomotive fleets;

- provides a high level of information service in domestic and international transit transportation;

- increases the efficiency of tasks solved as part of the automated control system of railway transport.

Means and technical requirements of the SAI "Palma" system

The Palma automatic identification system (AIS) operates on the basis of microwave technology using frequencies of 865, 867 and 869 MHz, which allows

reading information at large distances and at high speeds. The basic level of the system is formed by the irradiating reading equipment. It includes a reader with an antenna and a code on-board sensor. The sensor is a passive element that does not contain a power source; the energy required for its operation comes from the reader in the form of an electromagnetic signal. The operating range directly depends on the power of the reader. The advantage of passive code on-board sensors over active ones with a power source is a virtually unlimited service life - no need to replace the power source. The KBD-2 code on-board sensor belongs to the category of RW sensors (with the ability to repeatedly record and read information).

The KBD-2 sensor installed on railcars has a 128-bit memory, sufficient for recording a 12-digit number of a rolling stock. It interacts with the antenna at a distance of up to 5 meters. It ensures data safety in the temperature range from -60°C to +100°C, functions normally at an ambient temperature from -50°C to +70°C, at a relative humidity of up to 100%, in rain and fog, with icing up to 3 mm, when covered with a layer of soot, oil or fuel oil up to 1 mm thick. The sensor is protected from vibrations and impacts.

It is possible to rewrite data up to five times, but to prevent unauthorized recoding, measures are provided that do not allow re-writing. This is achieved thanks to the special design of the sensor, which allows it to be installed on board a vehicle only once. When attempting to remove the sensor, which is necessary for recoding, its internal elements are destroyed.

Radio frequency identification (microwave technology) has the following advantages over other technical solutions (optical reading - visual recognition of the on-board number applied to the vehicle; use of surface acoustic waves; bar coding, etc.): much more data can be recorded in a radio frequency sensor, and much faster; such sensors are durable (average service life of at least 10 years); the location of the sensor is not particularly important for the reader; the sensor is better protected from environmental influences.

The system parameters in terms of the reliability of reading and transmitting information are close to the requirements of the technical specifications.

Prospects for using the Palma AIS

1. Application of the AIS with wagon weighing systems.

2. To obtain data on large-capacity cargo containers, on the operation of wagons and vehicles (transport volumes, mileage, repairs, etc.).

3. Identification of component units of railway and automobile objects (using electronic tags installed on these units and read during operational control both in a stationary position and during movement by means of automated information systems).

Automatic identification system for rolling stock "Transtelekart"

The automatic rolling stock identification system SAI "Transtelekart" is designed for automatic recording of railway rolling stock units that have passed through pre-set

reading points, determining their type, individual number and other parameters (freight and passenger cars, locomotives, heavy-duty containers installed on platforms, etc.).

To implement automatic identification, information on-board coded sensors (ID) are installed on the rolling stock, into which information is recorded that characterizes the rolling stock in accordance with the adopted international standard ISO 10374. The information recorded in the ID is automatically read at reading points, processed and transmitted to the automated railway transportation management system.

Information is read from vehicles moving at speeds up to 140 km/h, and ID is also carried out automatically at real speeds. The system identifies the number of vehicles in the train, determines their type (car, locomotive), the presence of information sensors, and records the time of passage through the reading point.

The operating principle of the Transtelekart AIS is based on the use of microwave radio signals, which are used to irradiate a sensor installed on a vehicle, receive a signal reflected from the sensor, decode it and transmit it to the automated control system of railway freight carriers.

Composition of the Automatic Identification System for Rolling Stock "Transtelekart"

The automated identification system of rolling stock SAI "Transtelekart" consists of the following components.

The coding point of on-board information (ID) sensors is a component of the automatic identification system of rolling stock and heavy-duty containers "Transtelekart" (AI "Transtelekart") and is designed to record and read information from the on-board information coded type ID sensor. It includes:

- on-board information coded sensor – for identification of rolling stock. Structurally it is an electronic unit with a built-in antenna, enclosed in a sealed shockproof case; provides reading of information in the frequency range from 860 to 880 MHz. Provides recording, storage and reading of information with a capacity of 128 bits.

- the sensor programming device is designed for programming information sensors before their installation on a vehicle;

- a portable reading device (terminal) is designed to read data recorded in the ID by the operator.

It is possible to use a terminal that rewrites the variable (commercial) part of the information.

The automatic identification system reading point (AISP) is an integral part of the automatic identification system for rolling stock and heavy-duty containers "Transtelekart" (hereinafter referred to as the AIS "Transtelekart") and is designed to combine all of its components. It ensures the formation of the necessary control signals, supply voltages, and communicates with the information concentrator. AISP is installed in specially selected locations in close proximity to railway tracks while

maintaining the clearance for approaching buildings. AISP consists of a high-frequency reading device (HFRD) for reading data from onboard IDs. HFRD as part of the AIS "Transtelekart" can operate in the frequency range from 865 to 869 MHz. The probability of erroneous reading of information in the ID is no more than one undetected error per 1 million reading episodes.

Main parameters of the USV:

- frequency range from 865 to 869 MHz;
- the power emitted by the US antenna in the entire frequency range is from 1.8 to 2.2 W;
- information transmission from the control system is carried out via the RS232 interface;
- the power supply of the control unit is carried out from a 24 V DC source; - power consumption is no more than 50 W.;
- axle pass detection sensor (APDS) for recording the moment a wheel pair of a railway vehicle passes through the reading zone.

The PSCh cabinet receives data from the US, read from the on-board information sensors (ID), determines the number and type of vehicles in the train at speeds of up to 140 km/h and transmits information via a two-wire dedicated line using a modem. The PSCh switches to power from the backup line when the voltage on the main line disappears. Switches to power from the battery when the voltage on the main and backup lines disappears.

The PSCH cabinet is designed for use in areas with moderate and cold climates outdoors:

- ambient temperature from - 50°C to + 70°C;
- relative humidity of the environment 100% at 25°C;
- protection class IP 64.

In terms of data exchange parameters, the Transtelekart AIS is compatible with information sensors of similar systems used in Russia (Palma), Poland (SSD) and other countries, and corresponding to the international standard ISO 10374.

Figure 2 - Scheme of information flow in the system"Transtelekart"

Main parameters of the Automatic Identification System for Rolling Stock "Transtelekart"

1. Operating frequency range 865 – 869 MHz;
2. Information capacity of the sensor is 128 bits;
3. Reading information from IDs moving at speeds from 0 to 140 km/h;
4. Reading information from the ID at a distance from the track axis of no more than 5.8m;
5. Storing information on at least 1000 IDs read last in a row;
6. Information transfer speed from 300 to 115200 baud;
7. The equipment is powered from an alternating current network of 220V+10%, -15% with a frequency of 50±1 Hz;
8. Maximum power consumption is not more than 50 W;
9. Overall dimensions 1697x650x542 mm;
10. Weight no more than 120 kg.

"ARSCIS" - a system for identifying wagons, tanks, platforms

The automated optical-electronic system for reading numbers of wagons of railway rolling stock "ARSCIS" is designed for recognition, registration (reading) and automatic verification of identification numbers of freight wagons of railway rolling stock against the natural sheet. The system can be expanded with additional functions of commercial inspection of freight wagons (checking the presence or absence of cargo), and also perform the function of a security system at a control section of the railway (automatic detection, registration and classification of foreign objects on railway tracks). The system is related to automated means of information processing and is designed to operate in conditions of a continuous technological process.

The use of the system allows for the acceleration of the wagon processing process (thereby increasing their throughput capacity), reduction of associated operating costs, automation of the identification of freight rolling stock, and the receipt and long-term storage of information on the passage of trains through the control zone.

Scope of application of the ARSCIS system:

· oil refineries;
· metallurgical, mining and processing plants;
· fuel filling stations;
· sorting stations;
· food storage;
· industrial enterprises;
· customs terminals.

Main functional capabilities of "ARSCIS"

· formation and input into the computer of a video sequence of images of the working scene (television signal from the camera);

· automated diagnostics of the appearance of a train in the control zone (when a train appears, video signal recording is automatically turned on and numbers are recognized);

· localization, tracking and counting of rolling stock cars;

· identification and recognition of wagon numbers;

· formation of a list of rolling stock cars;

· verification of wagon numbers against the list of goods;

· notification of the operator in the event of a discrepancy between the recognition results and the data on the natural list and provision of images with unrecognized or missing numbers to the operator for decision-making;

· manual and automatic verification mode;

· recording and long-term storage of information about past trains;

· storage of video fragments of past trains, with the possibility of subsequent viewing;

· maintaining a database of past trains with information on the time and date of passage, the results of the inspection, the employee who carried out the inspection, images with the numbers of all cars of the corresponding rolling stock;

· providing additional functions for working with data: archiving, viewing, printing, generating reports;

· protection of information from unauthorized access, changing parameters and access to the system is carried out through a password system with access rights delimitation;

· keeping a log of work with the system;

· time and date of system switching on and off;

· change of employee performing control;

· registration of actions performed in the system;

· alarm and voice notification system;

· interaction with other modules and programs used within the integrated automated control system of station technologies.

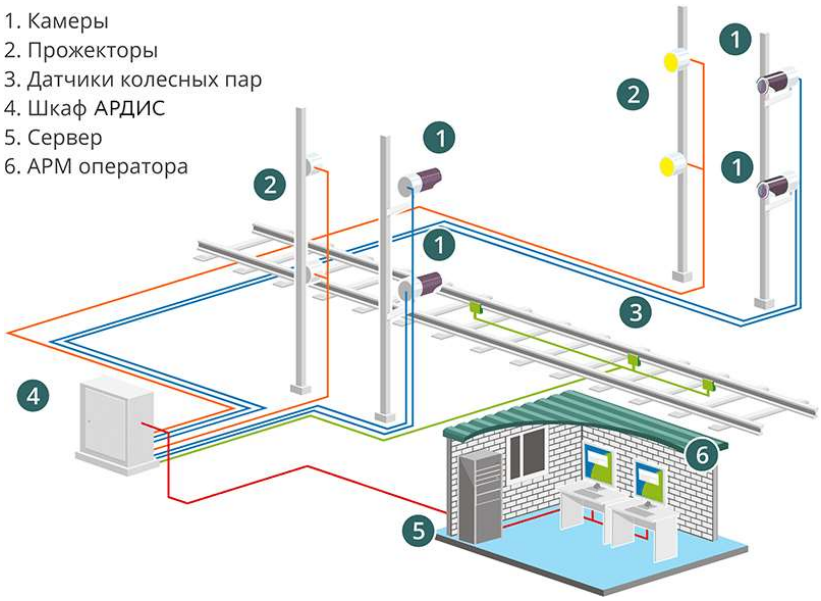

Figure 3 - Composition of the ARDIS number plate recognition system

Automated systems for identification of rolling stock in other countries

In North America, the Amtech automatic radio frequency identification system for rail vehicles, ISO 10374 standard, is used. The system is manufactured by Amtech Systems Division, a division of Intermec Technologies (USA).

In 1991, the Association of American Railroads made it mandatory to install Amtech coded onboard sensors on all rail cars and locomotives in the United States. The economic effect of implementing the system is to reduce the number of errors in calculating transportation fees, promptly transmit information to customers, reduce the cost of finding cars, load cars exactly on schedule, create conditions for precise regulation of the rolling stock fleet, expand railroad services, process data end-to-end, and improve the quality of transportation.

The system allows automatic tracking of the arrival of wagons at destination or unloading stations, access roads of enterprises, marshalling yards, as well as their departure. It also allows control over the use of locomotives.

In Europe, the Dynicom system, a joint development of Amtech and Alcatel, is used to identify vehicles. It differs from the North American system in its performance characteristics and the location of the reader and sensor. The reader is placed in the track between the rails, and the onboard sensor is attached to the car body from below. Radio frequencies in the range of 2400 - 2500 MHz are used. The maximum speed of a train past the reading point reaches 400 km/h. In rail transport, the Dynicom system is used in France, Switzerland, Poland, and Spain. It is also used in the metros of Brussels, Paris, and Hamburg.

Conclusions.The development of computer control systems, the introduction of information technologies, including the Automatic Identification System for Rolling Stock, make it possible to gradually eliminate existing shortcomings in the organization of the transportation process, make it completely deterministic, improve the safety of rolling stock, thereby ensuring greater transportation safety.

Information coming from the AIS will not only improve the efficiency and quality of solving existing problems, but also solve completely new technological tasks. The main goal of implementing the automatic identification system of rolling stock is to optimize the management of the transportation process.

The automated system for identifying rolling stock in railway transport Dynicom allows solving the following tasks:

- monitoring of traffic flows, rolling stock and cargo in real time;
- increasing the efficiency of using rolling stock by reducing downtime and repair times;
- improving the quality of cargo transportation;
- strengthening control over the condition of highways;
- strengthening control over the operating conditions of rolling stock;
- integration into the pan-European automated system for identifying rolling stock;
- elimination of sources of errors associated with manual input of initial data.

ЛИТЕРАТУРА:

1)ISO 10374:1991. Freight containers — Automatic identification. Geneva: International Organization for Standardization, 1991. 28 p. ISOISO

2)Система автоматической идентификации подвижного состава (САИПС) «Пальма». Техническое описание. М., 2021. 32 с. s-emf.ru

3)Mallenom Systems. АРСИС: аппаратно-программный комплекс оптоэлектронной идентификации вагонов. Рабочая документация. Ярославль, 2020. 64 с. mallenom.ruControl Engineering Russia

4)TransCore. RFID Rail & Intermodal Solutions [Электронный ресурс]. URL: https://transcore.com/rfid/rail-intermodal (дата обращения 24.04.2025). transcore.com

5)Crandall S. “Amtech Tag Lets RFID Ride the Rails.” EE Times, 05 Jul 2006. EE Times

6)UIC Leaflet 928. Identification Marking of Freight Wagons. Paris: International Union of Railways, 2012. UIC - International union of railways

7)EN 15877-1:2018. Railway applications — Marking on railway vehicles — Part 1: Freight wagons. Brussels: CEN, 2018. UIC - International union of railways

8)European Union Agency for Railways. Combined Transport Guide GUI/CCT-TD/2023. Valenciennes, 2023. European Union Agency for Railways

9)UNIDROIT. Protocol to the Convention on International Interests in Mobile Equipment on Matters Specific to Railway Rolling Stock (Luxembourg Protocol). Luxembourg, 2007. UNIDROIT

10)Mitu J., Kumar A. “RFID in Railway Logistics: A Review.” International Journal of Railway Technology, vol. 11, no. 3, 2022, pp. 45-70.