

## AUTOMATIC INTERLOCKING TRAIN MOVEMENT: SAFETY, EFFICIENCY AND DIGITAL CONTROL APPROACHES

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**Abstract:** Automatic blocking of trains is one of the important technological solutions for organizing traffic in railway transport.

This article analyzes the principles of operation of the automatic blocking system, its safety level, throughput capabilities, and integration with digital control technologies. Also, based on the advanced experiences of countries such as Germany, Japan, and Russia, practical proposals for the railway system of Uzbekistan are developed.

**Keywords:** Automatic blocking, traffic safety, train dispatching, signaling system, railway control, real-time monitoring, ERTMS, digital systems

### Enter

Signaling and control systems play a key role in ensuring the safety and continuity of rail transport. The Automatic Block System (ABS) divides train traffic into sections, allowing only one train to travel in each block. This system reduces human error, increases throughput, and improves safety.

The principle of operation of the automatic blocking system

Block sections are the division of a railway line into certain distances.

Current transmission through track relays - a moving train sends information to the signaling system through the rails.

Automatic traffic lights - determine whether there is a train on the block.

Integration with train braking systems ensures automatic braking in the event of danger.

International experience

Germany (DB Netz AG)

More than 70% of the lines are covered by automatic blocking.

Integration with the ETCS Level 2 system.

Japan (JR East)

Intercity high-speed lines (Shinkansen) are fully automated.

In each block, the movement is controlled for 3-5 seconds.

Russia (RZhD)

A combination of ABS and semi-automatic locks.

For medium-distance lines, ABS has increased efficiency.

The situation in the railway system of Uzbekistan

Most routes have a semi-automatic control system.

Limited blockade sections in the Fergana Valley, Tashkent-Samarkand routes.

Traffic signal and dispatching systems need to be updated.

Offers and digital integration opportunities

Problem Suggested solution

Multi-hand control IoT based rail monitoring system

Delays Block Section Reduction and Automation

Phased introduction of ERTMS/ETCS systems with low to do

Resource consumption Energy-saving signal and traffic light systems

Technical architecture of automatic blocking system

Detectors (axial counters or rail contacts) determine the location of the train.

Traffic lights and signal transmitters - indicate the block status (empty / busy).

Centralized control point - real-time monitoring and management is performed.

Automatic braking system - in case of danger, the system stops the movement independently.

> When illustrated with diagrams or graphs (in the PDF version), the relationship between these blocks can also be given in a visual form.

Traffic safety algorithms

The following algorithms are used to ensure traffic safety in the automatic blocking system:

Boolean logic algorithms for determining block occupancy

Anti-collision remote braking function

Pre-scanning of blocks in high-speed motion

Predicting block volatility through artificial intelligence

International experience: integrated solutions

Country System Features

Sweden ATC-2 (Automatic Train Control) automatically analyzes block status

France TVM430 (TGV lines) Each block is 1.5 km, speed 300+ km/h

China CTCS-3 Real-time control via GPS, AI and 5G

Russia ABT-CE Equipped with energy-saving and signal-receiving sensors

Prospects for implementation in Uzbekistan

Semi-automatic systems need to be fully automated

Selective phased integration of ERTMS/ETCS Level 1 or 2 technologies

Forecasting the real load of blocking sections using an artificial intelligence analysis platform

Testing the "Digital Twin" concept

### Summary

Automatic blocking systems are an important factor for modern railway transport infrastructure. International experience shows that these systems not only increase safety, but also significantly expand the capacity of the line. By gradually modernizing automatic blocking systems on the railway networks of Uzbekistan, it is possible to adapt to world standards.

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