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The “Engineer” publishes the most significant results of scientific and applied research carried out in universities of transport profile, as well as other higher educational institutions, research institutes, and centers of the Republic of Uzbekistan and foreign countries.

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Functions of the Operation of Continuous Automatic Locomotive Signaling in Rail Transport (ALSN)

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Abstract: Automatic locomotive signaling continuous type of action - a system of traffic safety on railway transport, performing continuous data about signal indication traffic light standing in front of train in form of coded signals from ground devices of automation and telemechanic to control post of rolling stock.The continuous automatic locomotive signalling system (ALSN) is a type of cab signalling systems that provides track status information to the train cab and uses the rails as a continuous communication channel between track and train.

Keywords: rail transportation, computational modeling, signalling system, signal disturbances, function blocks, simulation, MATLAB&Simulink

1. Introduction

ALSN is used on almost 100 thousand kilometres in the countries of former Soviet Union or more than 10 percent of the world's railways. This system is installed on main lines but applied basically as additional equipment which supplements, and not replaces trackside signals in most cases[1]. If there is a disagreement between trackside and cab signals, the driver has to obey the trackside signal. Systems such as auto-blocking, electrical centralization of arrows and signals, and dispatch centralization use information received from rail circuits to determine whether sections of track can be used in the train route [2]. Automatic locomotive signaling is a means of regulating the movement of trains using locomotive traffic lights that reflect the train situation in the block section located in front. Automatic locomotive signaling devices transmit to the driver's cabin the readings of the passing and station traffic lights that the train is approaching. Automatic locomotive signaling is complemented by hitchhiking with devices for checking the driver's vigilance and controlling the speed of the train. Automatic locomotive signalling with hitchhiking is a combination of track and locomotive devices. ALS track devices are equipped not only with the transfer routes, but also all the main tracks at the stations, as well as the receiving and sending routes along which non-stop passage of trains is provided. Continuous type ALS devices (ALSN) ensure the transmission of signal readings of floor-mounted auto-locking traffic lights continuously when the train is moving along the stage and station. The ALSN system is used in areas equipped with single- or double-track auto-blocking[3].

2. Research Methodology

Automatic locomotive signaling is characterized by the quantity and quality of signal readings transmitted from the track to the locomotive. Along with the signal indications of the locomotive traffic light, high-speed (digital) signaling is also used in newly developed systems, which increases the functionality of the train traffic control system using ALS. Along with signaling and speed readings, locomotive signaling systems are complemented by means of monitoring the set and actual speeds of movement, as well as devices for monitoring the vigilance of the driver. The driver's vigilance is checked once or periodically[4]. The driver confirms his vigilance by pressing the vigilance handle in response to the warning whistle of the electropneumatic valve (EPC). If, in necessary cases (when it is necessary for the driver to take measures to exclude the passage of a forbidding signal), the vigilance handle is not pressed within 7 seconds after the whistle warning, then this is regarded by the devices as a loss of the driver's ability to drive the train and the train brakes and stops.

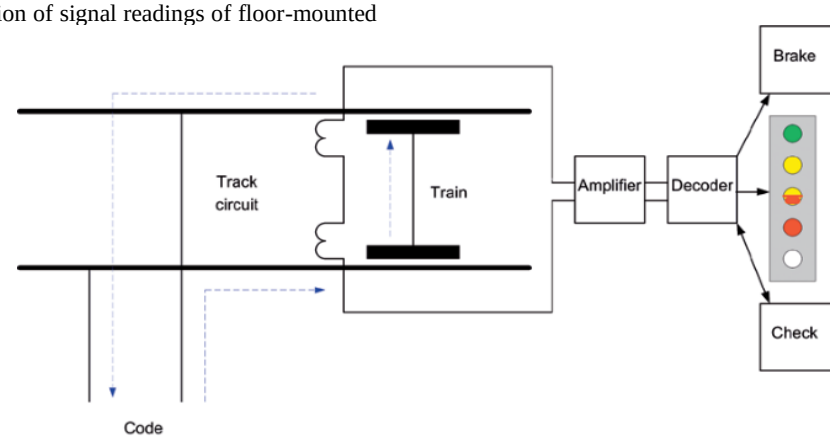

Figure 1. Code transmission from track circuits to the locomotive equipment

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There are three codes displayed in the cab signal corresponding with the aspect of the trackside signal ahead. In case of three-aspect-signalling these codes are (figure 1):

– red signal ahead (results in cab signal red-yellow)
– yellow signal ahead (results in cab signal yellow)
– green signal ahead (results in cab signal green)

The section beyond a signal at Stop is not coded, therefore the train will be emergency stopped (cab signal red). This is in accordance with the fail-safe-principle. Passage of a Stop signal can be authorised with driver's special action at the maximum speed 20 km/h (figure 2).

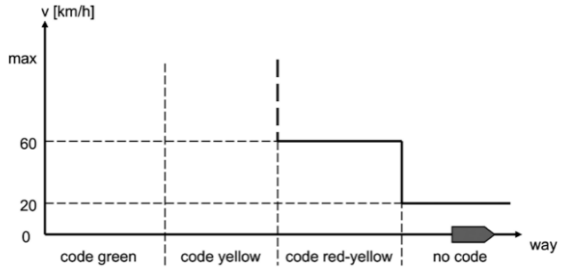

Figure 2. Braking supervision in ALSN

As the number of signal aspects in and near stations is usually higher than three, there is a simple rule[5]. If the train approximates a signal indicating the diverging route (the speed restriction for which can be between 25 and 80 km/h depending on the geometry of movable track elements) or to a yellow signal (straight route, but only one block section is clear, the speed restriction after the signal is 60 km/h), the train receives the code yellow and driver has to select the proper speed according to the trackside signal[6]. If two or more block sections are clear and the first section has the straight route, the train receives the code green. If the following signal is red or an auxiliary signal, the train receives the code red-yellow[7].

3. Analysis and Results

In the ALSN numerical code system, coding equipment is installed at the automatic blocking traffic light in the form of a KPT code waypoint transmitter and a transmitter relay T (Fig. 2.1). The signal code is selected depending on the traffic light reading by an encoding scheme: in DC autoblocking using linear relay contacts L, and in AC autoblocking using signal contacts relay G and 3. The transmitter relay Operates in the mode of the code currently generated by the KPT transmitter, depending on the indication of the passing traffic light[8]. By switching the contact in the circuit of the CT code transformer, the relay T transmits a numerical signal code in the form of alternating current pulses to the rail circuit.

The period of the code transmitted by the track circuit is 1.60 or 1.86 seconds (figure 3). The carrier frequency depends on traction power supply and is 50 Hz or 25 Hz. As external influences with low frequency often occur, the reaction time of the system is three code periods[9]. This means that the new cab signal becomes effective five seconds after a code change.

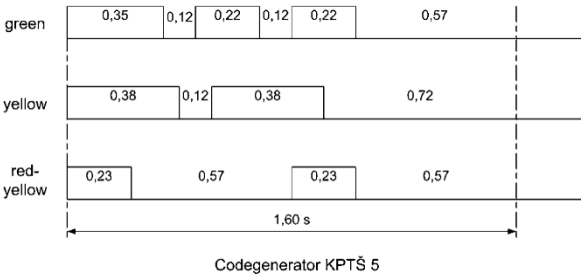

Figure 3. Code generator

System ALSN itself (without the additional systems) cannot transmit information about distance to the signal ahead[10]. The distance between signals varies from 1000 to 2600 meters depending on local conditions. Therefore the supervision curve in system ALSN (without any additional transmission) is only staircase, but the frequency of driver's acknowledgement check by the codes yellow and red-yellow depends on train speed. Moreover, the change of a cab signal to lower speed is accompanied by a bell and the driver is obliged to confirm this by an acknowledgement[11]. If the train receives the code red-yellow, its speed is limited to 60 km/h.

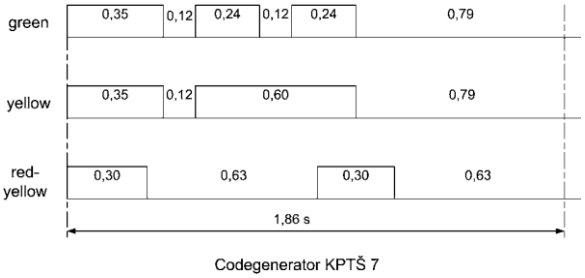

Figure 4. Code generator

4. Conclusion

According to new technical requirements, stations and open lines will have high frequency track circuits. This implies new functions for ALSN. When the track section is clear, the track circuit carries no code and serves for track clear detection only[12]. Only in these sections where a train is detected or expected soon, the code is applied. On open lines, jointless track circuits, whose areas of efficacy overlap by some tens of metres, are used. When the train is in this overlapping area, the coding is shifted from one track circuit to the next. Therefore, only one track circuit carries the coding at any given time. But in stations, insulated rail joints are still applied and track circuits do not overlap. To transfer the coding upon entering a new track could cause failures due to inertia of the detectors and transmitters. Therefore in stations the codes are given in two track circuits at the same time: the one which is currently occupied and the one ahead. As soon as the train occupied a new section, the coding in the previous section is switched off. Likewise generally in ALSN, only these station tracks which are provided for non-stop train passage are coded.

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