Semi-Automatic Block System with Fiber Optic Chanel Data Transmission

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Abstract – **A device developed by DISSY Company is reviewed in the paper. It allows SAB regimes implementation by securing trains operation between two neighboring stations using an optic transmission medium.**

Keywords – **Telemechanic system, Semi-automatic blocking Stepanov, linean line circuit, local circuit, optic connection channel.**

I. Introduction

The semi-automatic blocking (SAB) known under the name Stepanov is a telemechanic system providing safe trains operation between two neighboring stations with a broad application in the railway system of our country. When SAB is installed, a train is allowed to enter an open line only at a permissible indicator of the starting signal given by the operation manager on duty, provided that there is not a train in the open line and a blocking permission is received from the reception station. It is closed automatically by the train leaving the station. After the opening of any exit signals in the departure station, all the rest (signals that could permit entering into the open line from one side, as well as from the other side) are closed, while the receiving station sends a blocking signal for train arrival to the departure station. The blocking signal confirming train arrival is given by the operation manager on duty, but only after an objective check of the actual arrival. In case of emergency the operational managers on duty use stamp buttons and take entirely or partially care of safety conditions keeping.

Information between two neighboring stations is exchanged through a polar compact direct current linear circuit with combined linear receiver in both stations. The linear circuit is two-conductive – cable (mainly in electrified sections) or an air circuit. One-conductive line is used in some scheme decisions and “earth” is used for a second conduit. The most common case is simulation of two-conductive telephone line between stations through differential transformers for the operation of the direct conductor and “earth” is the reverse conductor. A new regime for operation of the linear circuit shall be created for transmission of a subsequent command.

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The more frequent burglaries of copper cables in open lines make impossible SAB application. In this case the train operation is managed by telephones, but lots of disadvantages arise from this method.

The availability of optic fiber cable (NRIC property) between two neighboring stations and the fact that this cable is not a subject of burglaries allow SAB regimes implementation by securing trains operation between two neighboring stations using an optic transmission medium.

In accordance with NRIC Terms of Reference, DISSY Ltd. Company developed and introduced a device under the name DISIM-SAB [1], allowing classical SAB - Stepanov regimes implementation. The connection between its parts in both neighboring stations is fulfilled by a fiber optic cable. The device does not change the functional sequence of work with SAB.

DISIM-SAB got permission for commissioning by the Ministry of Transport, Railway Administration Executive Agency № BG-01-CCS-S and since 19.12.2007 it has been put in regular operation along Alexandar Dimitrov – Zemen section. At the end of 2008, due to introduction of this device, SAB was restored also along Radomir - Alexandar Dimitrov, Zemen – Razhdavitza and Razhdavitza – Kopilovtzi sections.

II. Changes in Classical SAB – Stepanov Schemes

Change in the existing linear circuit scheme has been done for interaction between SAB semi- parts in both neighboring stations by a fiber optic cable, as follows:

- The necessity of transformer drops out;
- The linear relay scheme is changed in such a way that it could be managed by code combinations in “Received Consent” – RC regime and „Track Arrival” – TA;
- Possibility for setting the relay into motion is foreseen in the scheme of TDR relay, when a code combination “Received Departure” – RD is received from the neighboring station;
- GAR relay scheme is changed in such a way that it is set into motion when „Track Arrival” – TA command is received, after a verification of the conditions necessary for regime fulfillment.

The scheme of local circuit relays connection is unchanged. Repeaters of some relays are supplemented.

The structural scheme of modified SAB-Stepanov is shown on Fig. 1, where:

1-given consent, 11-received consent,

2-given departure, 22-received departure,

3-track arrival.

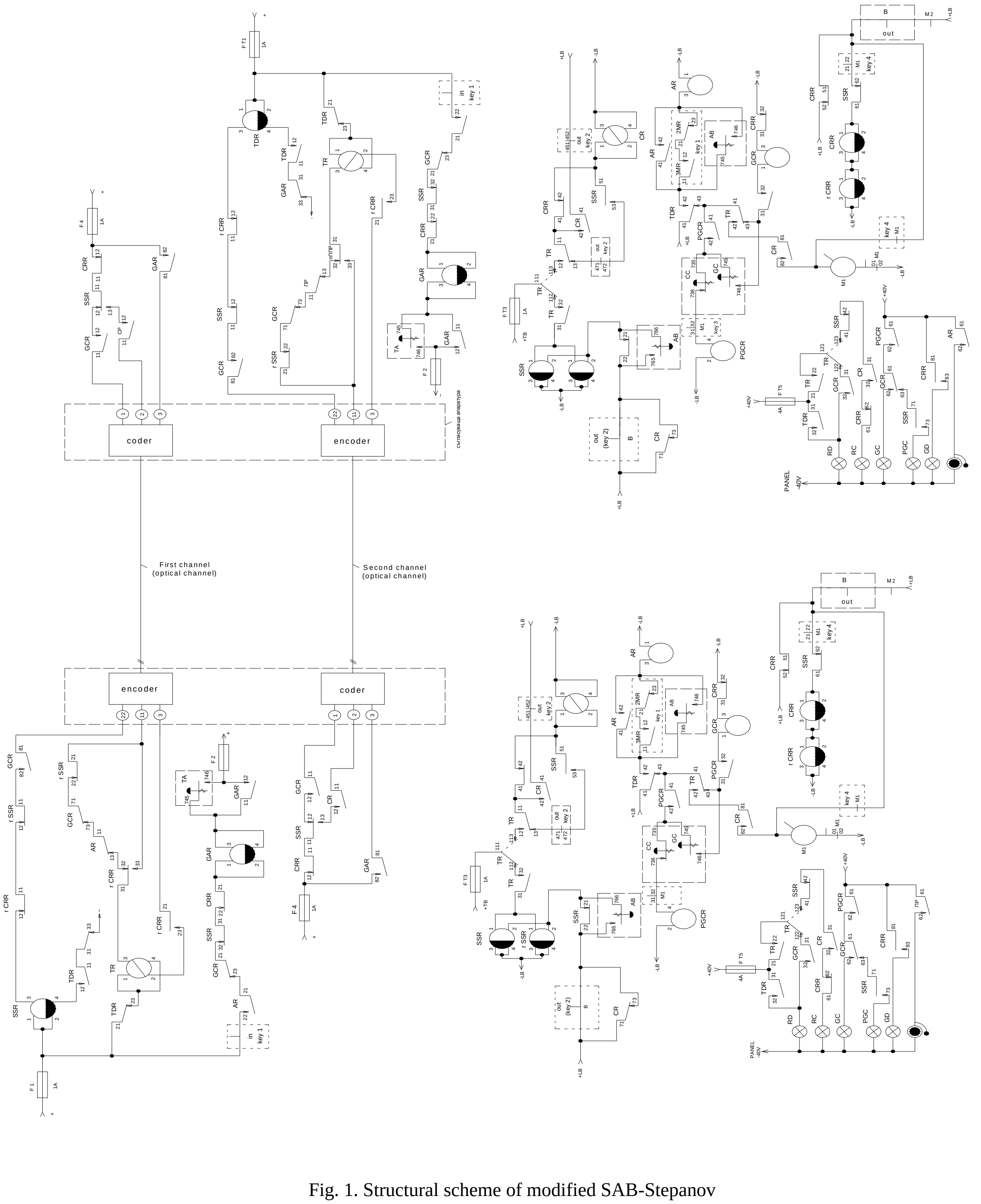

Fig. 1. Structural scheme of modified SAB-Stepanov

III. DISIM-SAB WORKING PRINCIPLE AND STRUCTURAL SCHEME

The signals arriving for connection into the optic channel are encoded, using 8-digit Heming code with Heming distance 4 between the different code combinations, i.e. a simultaneous transition $0 \rightarrow 1$ or $1 \rightarrow 0$ is necessary for the transformation of one code combination into another. The allowed code combinations responding to the condition for Heming distance 4 are shown in Table I.

TABLE I
ALLOWED CODE COMBINATIONS

№	Possible combinations	Function
1.	0000 0000	Standard status of decoding relays
2.	0001 0111	**GC (RC)**
3.	0010 1011	**GD (RD)**
4.	0011 1100	**TA**
5.	0100 1011	not applied
6.	0101 1010	not applied
7.	0111 0001	not applied
8.	1000 1110	not applied
9.	1010 0101	not applied
10.	1011 0010	not applied
11.	1100 0011	not applied
12.	1101 0100	not applied
13.	1110 1000	not applied

Code combinations (2) ÷ (4) from Table I are used for “given consent” (respectively “received consent”) and “given departure” (respectively “received departure”) and “track arrival” regimes implementation.

DISIM-SAB consists of:

- Coder;
- Encoder;
- Operating processor controller.

The block scheme of the device is shown on Fig. 2.

Contacts’ reading from SAB relay apparatuses is done through a coder (diode matrix), that codes the entering analog signals into 8 digit code combinations (words).

The code combinations enter into the controller, which verifies their correctness, i.e. verifies the validity of the respective combination. If the result from the verification is positive, the respective key word is transmitted to the optic equipping of the channel for connection. If the code combination is invalid, it is not transmitted to the channel for connection.

Encoding of the accepted code combination is fulfilled with 8 receiving relays.

The encoder transforms coded signals for connection entering the channel into analog ones in a way acceptable for the interlocking relay apparatuses.

Encoding has to be completed (front and back contacts of all the 8 relays are included).

In case of a standard status, the encoder’s relays perform the first code combination (1) in Table I.

When a coded signal arrives at the channel for connection, the processor controller sends the received signal to the encoder, if the following conditions are fulfilled:

- Triple subsequent full coincidence of the received code words information bits;
- Availability of continuous communication. The power supply of the encoder’s relays will be stopped if the communication is interrupted for more than 100ms. The encoder’s relays perform the first code combination (1) in Table I and doing so the transmission of an analog signal to SAB is interrupted.

Only a correctly set combination of the relay encoder is transferred to SAB set. The combination correctness is checked by a reverse reading of the contacts of the encoder’s relays. The command is kept only if there is coincidence of the reverse reading and availability of continuous communication.

DISIM-SAB creates Events Protocol, i.e. it makes an archive in chronological order of the events arisen in DISIM-SAB. If it is necessary the Events Protocol could be downloaded using a portable computer and subsequently printed. When the computer memory is filled up, the record starts from the beginning, as the oldest records are firstly erased.

The available events for DISIM-SAB are shown in Table II.

A light-emitting diode indicating panel is foreseen for timely diagnostics of the different DISIM-SAB states. The panel is visible through the transparent cabin door.

DISIM-SAB works on two single mode optic fibers. Depending on the kind of the receiver-transmitter (Table III), the device works reliably in open lines with length of up to 35 km. Its working temperature interval is from - 5°C to +45°C.

The device allows a direct telephone connection of “local battery” type for implementation of “interstation connection”. It is supplied by a station battery 24V (-10% +20%) with insulated terminals and works reliably in the presence of power supply pulsations up to 40%. When the supply voltage goes down to the lower limit, DISIM-SAB starts running in protective state and when it enters into the working zone, it proceeds to working state.

The device does not produce harmonious components and does not disrupt the normal work of the telecommunication and radio equipment.

DISIM-SAB operates under conditions responding to II climate group requirements in compliance with Bulgarian standart 17165-90. It keeps its working state and appearance under the following environmental parameters impact:

- Temperature of the ambient air: from 5 to 40°C;
- Air relative humidity at temperature of 28°C: from 5% to 85%;
- Atmospheric pressure: from 70 to 106 кPa;
- Air dustiness: not more than 0,75 mg/m3;

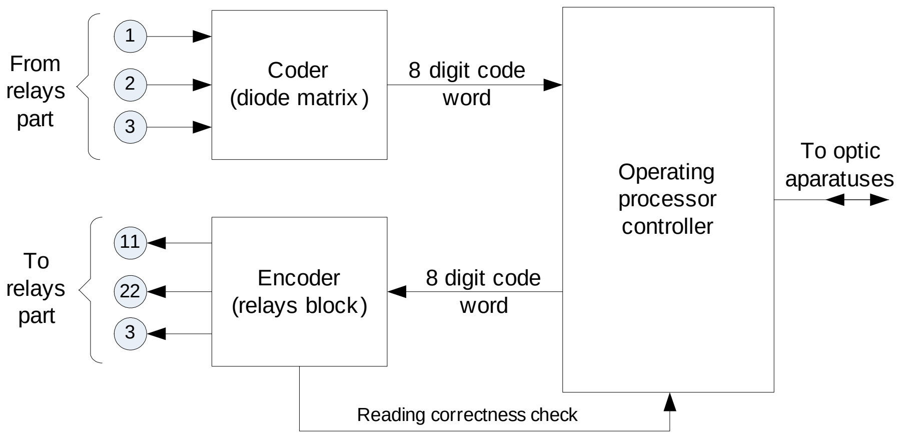

Fig. 2. Block scheme of DISIM-SAB

- Floor vibrations: with an amplitude not more than 0,1 mm, at frequency not more than from 10 to 25 Hz;
- Electrical component of disturbances electromagnetic field: not more than 0,3V/m;
- Absence of aggressive admixtures in the surrounding atmosphere.

TABLE II
EVENTS PROTOCOL

№	Event
1.	Power supply plugged in DISIM-SAB
2.	Fulfilled communication
3.	GC/ДС at the coder entrance
4.	GD/ДЗ at the coder entrance
5.	TA/ПП at the coder entrance
6.	RC/ПС at the encoder exit
7.	RD/ПЗ at the encoder exit
8.	TA/ПП at the encoder exit
9.	Business information
10.	Reset due to a system mistake
11.	Reset due to transfer mistake
12.	Reset due to acceptance mistake
13.	Protocol mistake – head of the telegram
14.	Protocol mistake – control amount of the telegram
15.	Invalid command of the encoder exit
16.	Invalid command of the coder entrance
17.	Reverse reading mistake
18.	U battery normal
19.	U battery low
20.	U battery high

TABLE III
TECHNICAL SPECIFICATIONS OF USED RECEIVER-TRANSMITTERS

Standard Compliance	IEEE 802.3z
Data Rate Gigabit	1.25Gbd
Data Rate Fiber Channel	1.0625Gbd
Media	SMF
Optical Receiver Sensitivity	-24dBm
Optical Transmission Power	0 ~5.0dBm
Power Budget	23.0dB
Center Wave Length	1550nm
Transmission Range	9/125um (up to 80km)
Connector	LC type

IV. CONCLUSION

The unusual operational conditions produce unusual technical decisions. This applies fully for the elaboration of semi-automatic block system with fiber optic channel data transmission. Along with modern technologies and elements usage, old and already rejected systems are returned and put into real operation. DISIM-SAB design, elaboration and introduction increased the product range of DISSY Company and strengthened the company’s positions with innovative view and perspective developments.

To our great satisfaction, SAB with fiber optic channel data transmission has been working flawlessly from its installation for experimental operation until today and has positive references from NRIC employees working along Radomir – Kustendil section.

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