# A New Approach on The Diagnosis of Automatic Block Signaling Installations

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*Abstract*— **This work presents a new vision on the diagnosis of railroad Automatic Block Signal Installations (ABS), using the current modern technologies that involve mobile devices or personal computers. The ABS installation is the system of signals between two consecutive railroad stations, stations centralized either electrodynamically (with electromagnetic relays) or electronically (using computers). The system of signals ensure the command and control of traffic train. Currently, failure diagnosis of such installations is done by the staff working in the Signals, Centralizations, Block (SCB) department of the railroad company. The diagnosis time depends on the professional qualifications of the staff (detailed knowledge of the installation's functioning principles, of the electrical diagrams and related installations), on the practical diagnosis and recovery competencies. A long diagnosis time causes train traffic delays which, in turn, cause passenger discomfort and losses for the transporter companies. In this work we present diagnosis charts for two types of failures of the ABS installation: Failures of the 220 V power circuits in the ABS boxes, and failures of the Transmitting Relays (TR or T) power circuits. The diagnosis charts and their software implementation assist the maintenance staff in quick detection the failure causes for these types of ABS installations. This solution leads to shorter train delays, higher rail traffic security, and to the optimization of the transport services.**

## I. Introduction

The command and control of train traffic between two consecutive train stations (electrodynamically or electromechanically synchronized) is done with the Automatic Block Signal (ABS) installations. Fig. 1 shows the basic diagram of an ABS installation [1,2].

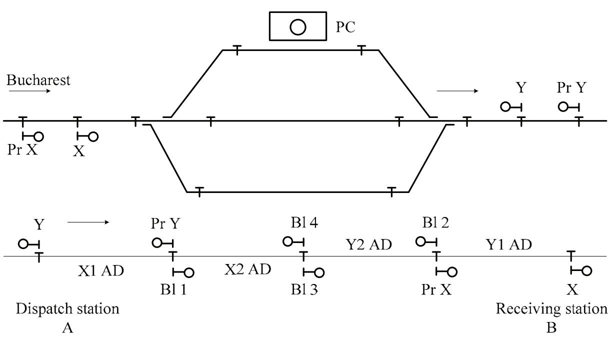


Fig. 1. Simplified station and ABS electric wiring.

We can identify on this figure:

- The central command post, PC;
- The dispatch station A;
- The receiving station B;
- The return conductors (X1AD, X2AD, Y2AD, Y1AD) which control the 'free' or 'occupied' line state, and check the line integrity;
- Light signals, which allow or forbid the train access on the line controlled by the signal.

All ABS installation diagrams are conceived for the X traffic direction, that is train dispatch from Bucharest towards a further station [1,3]. The signals seen by the train dispatched from the station closer to Bucharest are marked with X, those for the return direction are marked with Y. In the previous figure, we have 4 return conductors covered by luminous signals.

The ABS installation is controlled by the Electrodynamic or Electromechanic Centralization Installation (CED or CEM – abbreviating the Romanian appellation).

One or more failures of the ABS installation's circuits will make train traffic at normal speed impossible. During such a failure, it is also impossible to normally reverse the ABS installation, which requires the use of a forced reverse circuit. We recall that a normal orientation reversion, or normal reverse, of the ABS installation changes the state of the dispatch station into receiving station and the receiving station becomes a dispatch station.

The ABS signals are displayed on the station's controller panel as an arrangement of lights (Fig. 2) [4] as follows:

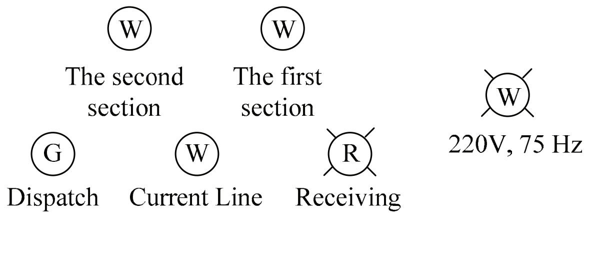


Fig. 2. ABS installation signals.

a) The Current Line is signaled as Occupied (OCL 'blocked') either in the receiving station or in both stations by a whitely lit light bulb (Current Line – W in Fig. 2) when an exit signal is set on 'proceed' or when an ABS return conductor is occupied;

b) The 'dispatch' signal is a green light (Dispatch – G in Fig. 2) when the station is dispatch oriented. When the

D relay circuit is interrupted, the same light will be blinking red (signaling a defect);

c) The 'receive' signal is displayed by a red light when the station is receive oriented (Receiving – R in Fig, 2), This light is on also when the ABS installation operates on the forced reverse circuit;

d) The correct function of the Static Contactor Plug (SCP) circuit. When the feeding is c.c. 60÷80 V, insured by a d.c. 220 V/75 Hz source, the white light is continuously on (this being the normal case). When the power feed us insured by the c.c. 24 V source, the white light blinks, signalling a malfunction;

e) First and second close sections, signaled by two white lights, one for each section, signaling the occupation of their return conductors.

## II. ABS Command and Control

The main circuits commanded and controlled by the ABS installation are [2,4]:

1) The Transmitting Relays (TR) feeding circuits, powered at d.c. 110V, by the dispatch station. The relays powered by this circuit are used to command and control the ABS return conductors. Figure 3 shows how this circuit is powered, and the 220V 75Hz power circuits for the ABS apparatus boxes along the line [2,3].

2) The a.c. 220V feeding circuit of the ABS boxes (to each pair of insulating joints an apparatus box is placed). Each adjacent station powers half of the boxes placed on the ABS track between them.

3) The Occupied Line (OL) and Control Line (KL) relay circuits are powered up by the dispatching station at d.c. (60÷80) V. These circuits control and signal, in both stations, the Occupied Current Line (OCL) when the 'proceed' signal is set in one of the stations, as well as the 'occupied' signal of a ABS circuit [2], [4], [5]. The OL and KL circuits control the train dispatch operation as well as block the receiving station from performing dispatch operations, avoiding a train dispatch towards the one just sent on the current line by the dispatch station. When one or more ABS return circuits show the occupied line state, these relays de-energize and signal in the both adjacent stations the Occupied Current Line state (Current Line – A on Fig. 2). The feeding of this circuit and of the forced reverse circuit are shown in Fig. 4.

4) The forced reverse circuit, powered the same as the OL-KL circuit, allows reversing the ABS's orientation when one or more return conductors falsely signals 'blocked', or when the OL-KL circuit is failing.

5) The Directing relay circuit (D) fed by c.c. (60÷80)V from the receiving station. This circuit concatenates the D relays in each ABS apparatus box with the D relay in the dispatch station. It is used to power the ABS track and the signal circuits. Fig. 5 shows the powering of this circuit which uses relays of type KF1-80 with two 40 Ω windings, connected serially for the station relays, and parallel for the relays along the ABS [2], [6].

6) The proximity (close/far) circuit relays (1A2D, 2A3D) powered with ± 24V from the ABS adjacent stations. This relays' terminals send signals about the occupancy of each return conductor of the ABS.

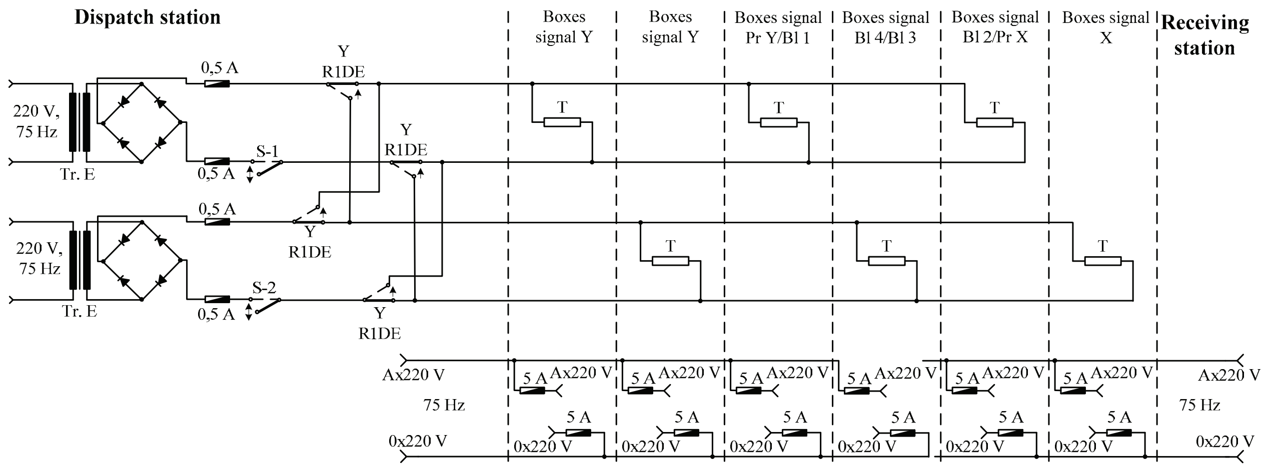


Fig. 3. The transmitting relays feeding circuits and a.c. 220V feeding circuit of the ABS boxes.

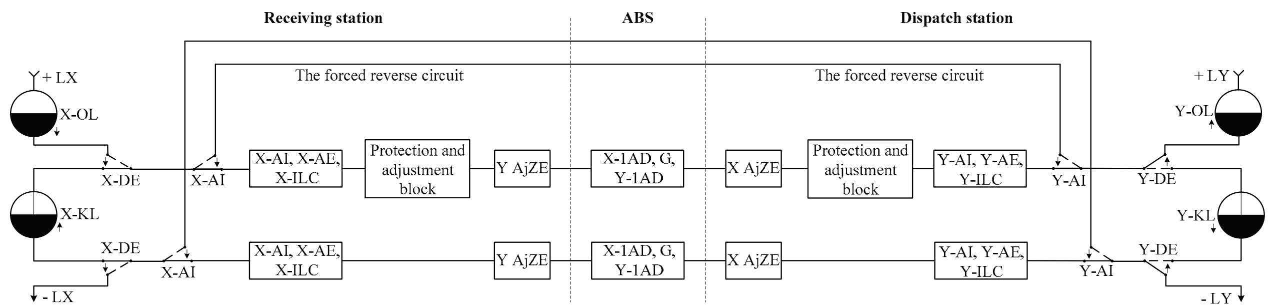

Fig. 4. The Occupied Line (OL), Control Line (KL) and the forced reverse circuits.

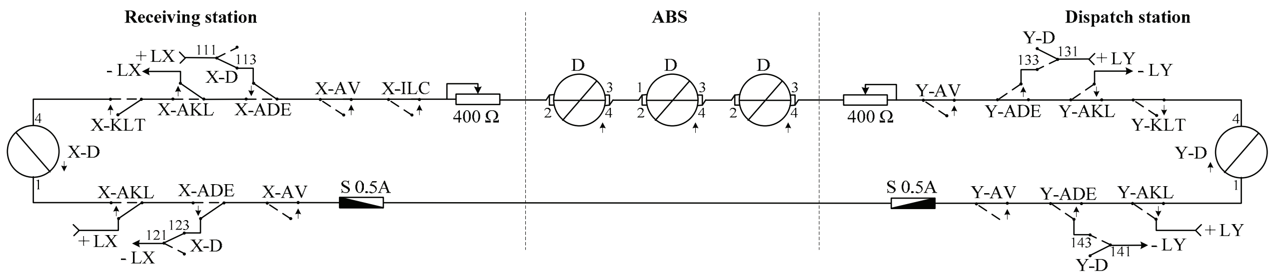


Fig. 5. The Directing (D) relay circuits.

Along these main ABS circuits, there are several secondary circuits which either influence or are influenced by the ABS installation:

a) Power feed circuits for the ABS return conductors, which control their ‘occupied’ or ‘free’ state;

b) Power feed circuits for the light signals that allow or forbid the line occupancy for the return conductors they cover;

c) Power feed circuits for the inductive train control system, which control the train speed on the ABS length.

## III. Diagnosis Charts For 220V Power Interruptions

For the ABS installation to function failure-free, it is necessary that the ABS boxes are powered at 220 V/75 Hz by the CED or CE inverters.

The 220 V/75 Hz ABS power feed circuit is separated from the other station circuits powered at the same voltage. The separation is realized by means of galvanic insulated transformers, while voltage control is realized by two ammeters and two relays (ACBY, ACBX), one for each station end feeding the ABS installation, mounted on the entry and distribution panel (EDP).

Any damage of the 220V/75Hz power feed circuit in the ABS installation causes:

- Malfunctioning of the return conductors;
- Light signal malfunctions;
- Signals of Occupied Current Line, making any further train dispatches with a ‘free’ signal impossible [4];
- Signals of occupied return conductors;
- Impossible normal or forced reversion of the ABS installation [6].

During such damage, on the command panel the signals that occur are:

- Occupied Current Line;
- At least the first two approach/departure sections signal an occupied state;
- The green dispatch light is blinking (when the station is dispatch oriented);
- The white light indicating the static plug converter AV (alternative voltage) is blinking.

Fig. 6 shows the diagnosis chart for this type of failures.

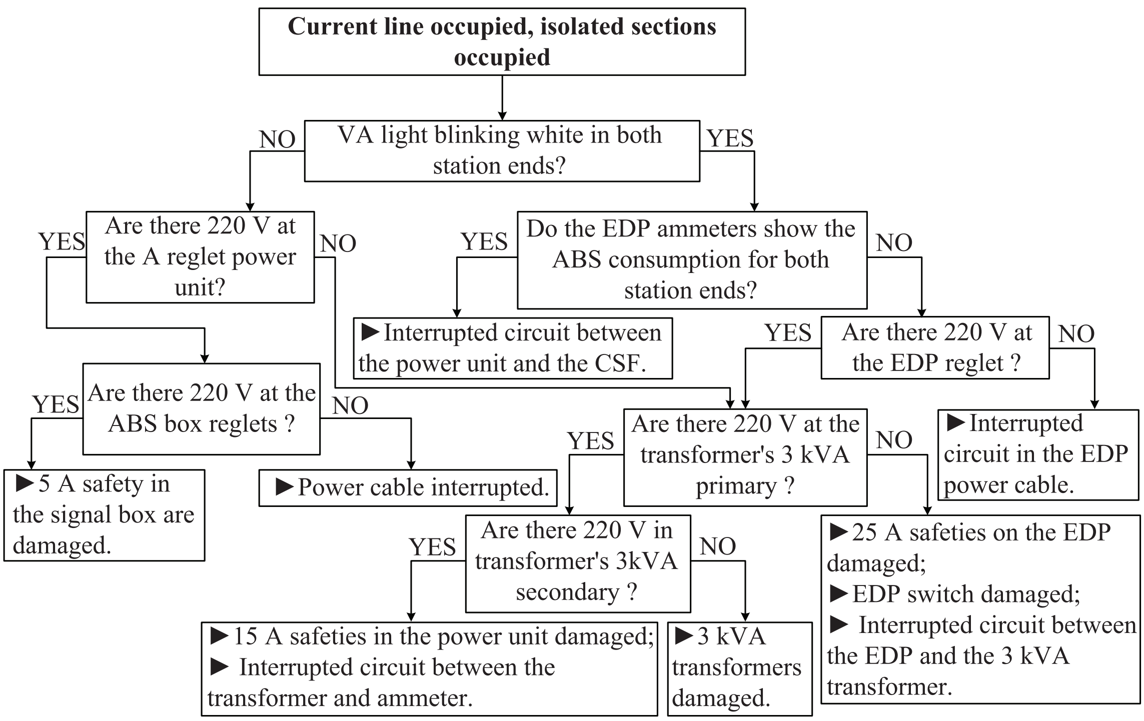

Fig. 6. Failure diagnosis chart for damaged 220V/75Hz power feed circuit.

## IV. Diagnosis Charts for Transmitting Relays Power Failures

The T transmitting relays pulse-feeds the return conductors. For each ABS box, one transmitting relay is used (Fig. 3), the relay contacts being used also in decoding the pulses.

How the T relays interconnect within the return conductor diagrams, and their failure diagnosis will be detailed in another article. The present work focuses on the diagnosis of the transmitting relays power failures along the ABS installation only.

Powering the transmitting relays on the ABS, relays of type TR 2000 CR, is done from the dispatch station, with a c.c. 110 V voltage provided by the rectifier bridge and the S1 and S2 transmitting relays in the CED station. S1 and S2 are transmitting relays of type TR 3B. Any failures of this circuit causes the current line and the ABS's return conductors to be signaled as occupied.

Fig. 7 shows the diagnosis charts for ABS transmitting relays T power circuit failures. These diagrams have been implemented in two software components, called ALIMBla and TRBla. The two software components are implemented using Visual Basic and can be used both on a personal computer (PC), or a mobile device. Using these software packages, the maintenance staff can quickly and securely establish the failure causes.

The two software components are not described in this work. They are, however, built on the same interface and design principles as the LCOBla tool [5] and the INVBla tool [6].

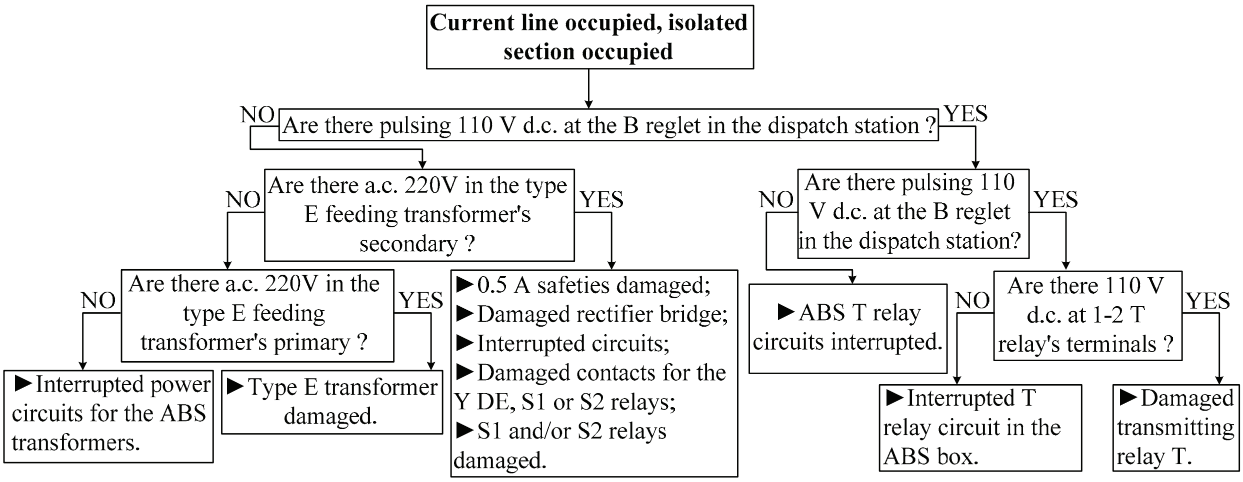


Fig. 7. Diagnosis chart for failures of the TR relay power circuits.

## V. Conclusions

This work describes the elements on which the failure diagnosis charts for power interruptions are based. The power interruptions considered are interruptions in the 220 V/75 Hz power feed and interruptions in the power feeds of the relays along the ABS installation.

The failures we focus on in this work are rather frequent and cause the most train delays, because on the whole distance of the affected ABS the trains may travel with at most 20 km/h.

The diagnosis charts designed by the authors of this work are especially useful during ABS installation maintenance work, which is done by SCB maintenance staff. The charts help to optimize the activity of this maintenance staff.

The diagrams have been used as a basis for the implementation of specialized diagnosis software (ALIMBla and TRBla, not described here but similar in concept and design with LCOBla and INVBla [5,6]) which contribute to drastic time improvements in failure diagnosis and remedy, and improve train traffic security.

Maintenance staff using the diagnosis charts and/or the diagnosis software provide answers to the shown questions by validating or invalidating the measurement results and on-field observations. Based on the answers chosen by the staff the failure causes can be quickly and securely detected.

This work, together with the work described in [4], [5], [6] opens new horizons in the diagnosis of train traffic security installations, being based on the modern technology.

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