Computerized diagnosis of electric diesel locomotive type 060 DA 2100 HP using the TATUNG TX-2000 WebPAd

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Abstract: The current focus is on efficient solutions for reducing rail vehicle costs. Thus, diesel-electric locomotives equipped with modern surveillance and control equipment have been built, leading to lower operating and maintenance costs. This paper presents an electronic device that was developed within the Iasi depot for computerized diagnosis of equipment on railway vehicles in the CFR park. A computerized diagnostic method, a 060 DA 2100 hp electric diesel locomotive, was used using this device.

1. Introduction
Rail transport has been particularly successful since its emergence, as it has several advantages that other types of transport do not have. We could say that it is one of the most environmentally friendly, economical and safe means of transport. One of the great preoccupations of railway operators is to reduce the costs of operating and maintaining railway vehicles used for the carriage of passengers and freight.

In the specialized works, the maintenance term usually defines repairs and maintenance. Maintenance is not only a name, a new term, but a superior approach to specific activities that aim to maintain the performance of the asset used, complemented by specific methods and integrated into a systemic logistic, administrative and managerial approach so that economic efficiency is constantly improved. Systems with failures lead to unexpected and unwanted results, which, even if they are not catastrophic, create discomfort, induce inconvenience and generate a loss that ultimately materializes in additional costs that are not negligible.

Maintenance is a set of activities designed to conserve equipment and property, provided that they enable the enterprise to properly meet its objectives. In most cases maintenance is perceived as a preventive maintenance system that minimizes the cost of these activities in the long run, but maintenance must also meet very complex mixed objectives: ensuring system security and reliability, eliminating or reducing operating risks, stability of functional features in the system life cycle, continuity and motivation of employees' activity, economic survival and competitiveness of the enterprise by controlling the expenditures related to the respective activities.

The main objectives of the maintenance activities are:
• minimizing economic losses due to interruptions and optimizing maintenance and repair costs;
• maximizing the performance of endowment equipment in a continuous and efficient manner;
• preventing accidental interruptions and their consequences on the rhythm and continuity of productive activities.

The defect represents the state of the system where they obtained performance is not the accepted standard.

Specialty literature mentions several ways to increase the safety of system operation:
1. Increase the operational safety of system components.
2. Ensuring redundancy in the system.
3. Design and implementation of a preventive maintenance system.
4. Using the history inventory to identify the status of the system and the types of probable events.
5. Sizing maintenance capacities and reducing stagnation times.
6. Use in the maintenance of rapid and effective diagnosis; computerized diagnosis of system equipment.

Need to improve the quality of maintenance by making quick diagnoses and finding results. One of the modern diagnoses is computerized diagnosis, which is, the evaluation of the state of maintenance equipment with the help of a computer and specialized software.

In this paper, mini-computer equipment has been adapted for use in medical diagnosis (hospitals, medical centers, polyclinics, etc.). The TATUNG TX-2000 WebPad, with small hardware and software modifications, can be used successfully in computerized rail diagnostics on locomotives, motorcars, etc.

2. Short presentation of electric diesel locomotives 060 DA 2100 HP

The electric diesel locomotive 060 DA modernized 2100 hp appeared in the Romanian railway landscape in 1959 as a necessity to replace the steam traction to make rail transport more efficient. Their acquisition was a successful operation, being one of the most modern at that time. It achieves a high pulling force, with low fuel consumption, reduced axle load and low noise. This locomotive, after the transfer of technology, has been manufactured in Romania since 1960, being successfully introduced in the national and international rail transport.

About 2300 units were built, being the type of locomotive with the largest number of models manufactured in Europe [1]. With the introduction of this type of locomotive, the towing capacities and, in particular, the autonomy in the hauling of freight and passenger trains has improved. Experience has shown that this type of locomotive has been imposed on the Romanian Railways, being a reliable locomotive with easy maintenance. In this way, in most of the depots, proper formation schools have been created, the experience being passed from one generation to the next. The needs imposed the design and development of electronic equipment for command, signaling and diagnosis of electric diesel locomotive 060 DA.

Modern electronic equipment for command, signaling and diagnostics used on the locomotive 060 Modernized DA.

The use of computing systems in the locomotive structure has led to improved performance, increased reliability and easier maintenance. These things have also been achieved by removing the subjective human factor in conducting certain processes.

Microprocessor equipment used to drive various processes in a locomotive is generally made up of the following parts:

- central computing unit;
- RAM;
- interfaces for input / output signals;
- transducers;
- displays.

Such a block diagram can be seen in Figure 1.

Types of equipment used on the upgraded 060-DA diesel locomotive

On the partially upgraded diesel-electric diesel locomotive 060-DA one of the following three types of electronic control, signaling and diagnosis equipment can be found:

- electronic system for measuring, controlling and monitoring speed and fuel consumption [2];
- ISDC surveillance, diagnosis and control installation, manufactured by SC Softronic SRL Craiova[3];
- protection and signaling system INDA EPSAI 02, manufactured by SC INDA SRL Craiova[4];
- PROMAT type control, protection and diagnosis system, manufactured by SC PROMAT SRL Craiova [5];
- the GM-EMD surveillance, diagnosis and control facility, manufactured by EMD - USA[6].
3. Description of the TATUNG TX-2000 WebPad Computerized Diagnostic Device

Figure 2 shows the device adapted to diagnose the equipment mounted on the electric diesel locomotive 060 DA 2100 hp.

This TATUNG TX-2000 WebPad was taken over from the field of medicine. The software has been modified to be used in the rail field for the diagnosis of railway vehicles. Microprocessor equipment used to drive a variety of processes in a locomotive is generally made up of the following parts: central computing unit, RAM, interfaces for input / output signals, transducers, displays.

The use:
- In all railway areas where computerized diagnosis can be done;
- Modernized railway vehicles;
- Special railway vehicles;
- Various railroad automation (railway signaling installations, railway heating installations, brake installations, etc).

The device thus adapted was successfully used to diagnose the equipment of the following vehicles:
- 1250KW hydraulic diesel engine equipped with control and control systems with EPSAl electronic control and control system;
• Diesel - electric locomotive type 060 DA, equipped with ISDC SOFRONIC surveillance and control equipment;
• Diesel - electric locomotive type 060 DA, equipped with EPSIDE - INDA surveillance and control equipment;
• Diesel - electric locomotive type 060 DA CARPATHIA, equipped with PROMAT equipment;
• 5100 KW electric locomotive, equipped with PROMAT equipment;
• 5100 KW electric locomotive, equipped with ICOL SOFRONIC equipment.

4. Experimental study - Diagnosis of diesel-electric locomotive 060-DA 2100 HP
In the present paper a computer diagnosis was made with the TATUNG TX-2000 WebPad device adapted to the electronic system for measurement, control and monitoring of the speed and fuel consumption, type IVMS - built by SOTRONIC SRL CRAIOVA [7], locomotive 060 YES. This IVMS (Softronic) type installation is currently found on all types of locomotives in the CFR Park.

Computerized diagnosis can be used by any engineer or technician who has medium-level computer usage knowledge. It is very important for the specialist to know the equipment of the locomotive very well.

Operations for diagnosis preparation:
• Start the locomotive's electronic equipment (energized);
• The device shall be started by the Railway Diagnostic Equipment (EDF);
• Install the transfer cable between the train diagnosis equipment and the locomotive computer.

After the equipment is connected to the locomotive, the transfer cables between the locomotive and the machine, the data collection is collected.

The IVMS variant was used (without INDUSI and DVS) [7]. This is a program that measures and records the travel speed of a railway traction vehicle, space, time, and binary signals, providing speed limits information, and counting the distance traveled. The IVMS program also has a safety and vigilance function, such as the speed control function, depending on the indications of the track signals and the programmed initial data. If the driver does not follow tracking specifications, the program automatically executes the emergency brake.

The adapted device can successfully complete a computer with the above configuration. In the following figures there are stages of diagnosis of the IVMS installation of the 060 DA diesel locomotive.

![Figure 3. The graphic form of the IVMS program.](image-url)
So, on the left side of the screen, we find the following buttons: „Files”, „Display”, „Band”, „Find”, „Options”, „Informations”. The working window is presented as a roll that can be rolled on which the speed curve is drawn. The maximum speed that can be displayed on the tape is 160 km / h. Also, at the bottom of the window (strip), information is displayed on the operation of the induced installation: the recording of the 500, 1000 and 2000 Hz frequency frequencies. There is also information about the operation of the Attention button and the brake controls due to the system.

Figure 3 shows the graphical working format of the IVMS program. In this window of the program you can see in the bar the buttons that allow the execution of various diagnostic actions.

Figure 4 shows the selection of experimental data and the obtaining of graphical results. In this window you can analyze the data collected by diagnosis. The graphical results of the IVMS program are presented in the figure below (Figure 5).

Figure 4. Selecting data for graphical results.

As the chart parabola in the picture (Figure 5) increases, the speed of travel of the railway vehicle, the distance traveled and the time also increase.

Figure 5. Graphic results of the IVMS program.
It is possible to analyze the movement according to the service schedule of the railway vehicle, both in normal and in special conditions. Besides the speed and time information, we also find information on the energy consumption of the vehicle. The analyzed files are then archived into device memory or nonvolatile media (CDs, sticks, hard drives).

Figure 6 shows that with the help of the TATUNG TX-2000 WebPad, a computerized diagnosis can be carried out on several types of electronic equipment of the diesel locomotive type 060 DA. This is done by the diagram in the figure, using a serial adapter.

5. Conclusions
A barrier-free route is based on a preventive computerized diagnosis before the vehicle starts on the road. This can be done with the smart device presented in the paper. This can be done with the smart device developed by the author and presented in the paper. This diagnosis is very important at the beginning and during the technical revisions as it helps overcome the unpleasant moments and be also aware of the state of the system.

The paper itself presents an electronic device developed and used in the Iasi locomotive depot to check the technical condition of some systems on the diesel Diesel locomotive 060 DA of 2100 hp, namely the electronic system for measuring, controlling and monitoring the speed and consumption of fuel type IVMS (SOFTRONIC), EPSAI control and signaling system, ISDC control and signaling system, PROMAT signaling and control system.

The author presented in the paper an IVMS type diagnostics model (SOFTRONIC) specifying the advantages of using the developed electronic disposer. The aim in this paper is to find advanced, cheap, and accessible technologies for everyone to help control the technical condition and smooth operation of existing systems on railway vehicles. With the help of these technologies we could prevent early wear of the elements of the railway vehicle systems.

6. References
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