THE ON BOARD MICROPROCESSOR SYSTEM FOR THE METRO TRAINS ELECTRO POWER EQUIPMENT DIAGNOSTICS

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ABSTRACT

The urgency of an evaluation (in rate of movement) of the equipment of coaches of metro is justified with the purpose to give recommendations to machinist on failures liquidation (as they appear) when train moves. The perspective of microprocessor on board systems of diagnostics (OSD) is shown as the automated machinist adviser. Indicated the special significance of OSD when out-of-date trains work for a long time on paths with a complicated structure of lines.

The structure of inspected equipment is updated. The principles of system construction are considered, the choice of bus-magistral structure with a centralized control and with open architecture is justified. The problems of increase of reliability of OSD operation are considered, the algorithm of its work and features of tests are described. The perspective and universality of purpose is shown.

Keywords: electro power equipment, diagnostics, metro trains, board microprocessor system, diagnostics

I. INTRODUCTION

Improvement of transport service of population is an actual problem. For its solution on railways the complex automation of transportation process with introduction of modern methods and control facilities is carried out: systems of automatic driving of trains, automatic signaling and regulation of velocity, remote control by traffic lights, power supply etc. In underground they should ensure such major requirements, as safety of passengers and trains traffic, high through put of stations, through put of lines and operational velocity of trains movement during, but short stops [1].

The urgency of the problem increases when takes place a long operation of out-of-date trains which make half of the acting park of rolling-stock (RS) in countries of former USSR. In this case the larger sloped and complicated profile of paths result to big loads on engine and brake parts and, as a result, bring to overloading of the worn out equipment of trains. The indicated reasons reduce reliability of RS work, create threat of safety of passengers, that requires continuos remote monitoring of the dispersed equipment of RS coaches.

The successful solution of these problems is impossible without application of remote information computer systems of an evaluation (in rate of traffic) of condition of the equipment of RS coaches. They will allow to undertake emergency measures for preventing the growth of accident when failures occur, some of which are found out only during movement. Furthermore, the registration of failures for each type of the equipment will allow to generate an appropriate data base and predict failures.

II. STATEMENT OF THE PROBLEM

The application of microprocessor on board systems of diagnostics (OSD) is most perspective as the automated machinist adviser. They can give in rate of movement information not only about failures appearance, but also give recommendation for their removal during movement, and about mode of further operation of the RS. During development of OSD (because of its operation at RS) should be taken into account specify of object and environmental conditions of its operation (humidity, constant vibrations and shock loads, significant impulse interference from sparks from current pick up device, switching of aggregation of the equipment of coaches, etc.).

Existing OSD give information about extreme situations during movement of RS (exceed of allowable values of parameters, overheating the motor compressor, locomotive engine, etc.) [2]. However, they only signal about malfunction and do not allow to eliminate them during operation of RS. Therefore it is important the availability of automated built-in OSD (in structure of regular equipment of RS), which function in the mode of the automatic machinist adviser for the elimination of appearing failures and extreme situations in rate of movement.

III. STRUCTURE OF THE DIAGNOSTICS EQUIPMENT

According to statistics of failures of equipment parts of RS coaches, to monitoring were subjected: operation of protective devices (fuses, automations, relays); work of devices for current pick up, electrical and pneumatic brakes, reserve control, lighting, door and other equipment. They are incorporated in subsystems of the power equipment, automatics (control circuits) and pneumatic equipment characterized by its set of control points. During clarification of the list of control points, and also texts of recommendations on elevation of appearing failures with an evaluation of possibilities of further RS operation the experience of work of underground in Moscow and Baku cities was used.

The system carries out control of 22 kinds of malfunctions in head and 14 kinds – in intermediate coaches. The malfunctions are determined by means of analysis of condition of 28 control points in head and 21 points – in intermediate RS coaches. Because of the byte by byte processing of information on the micro-computer, all complex of diagnosed parameters is broken on groups will 8 control points. It allowed to generate codes of malfunctions (concrete combination of control points) with corresponding to them, numbers of messages.

IV. OSD STRUCTURE

The consideration of principles of OSD construction (ring-shaped, star-shaped, etc.) revealed, perspective of bus-magistral structure with a centralized control. The length of communication lines (CL) of the magistral (MB) is least, serviceability of OSD is not distributed on the case of for want of failure of any module of pick up and transfer (MPT) of information, the repair of replacement MPT without the interrupt in a system work [3] is possible.

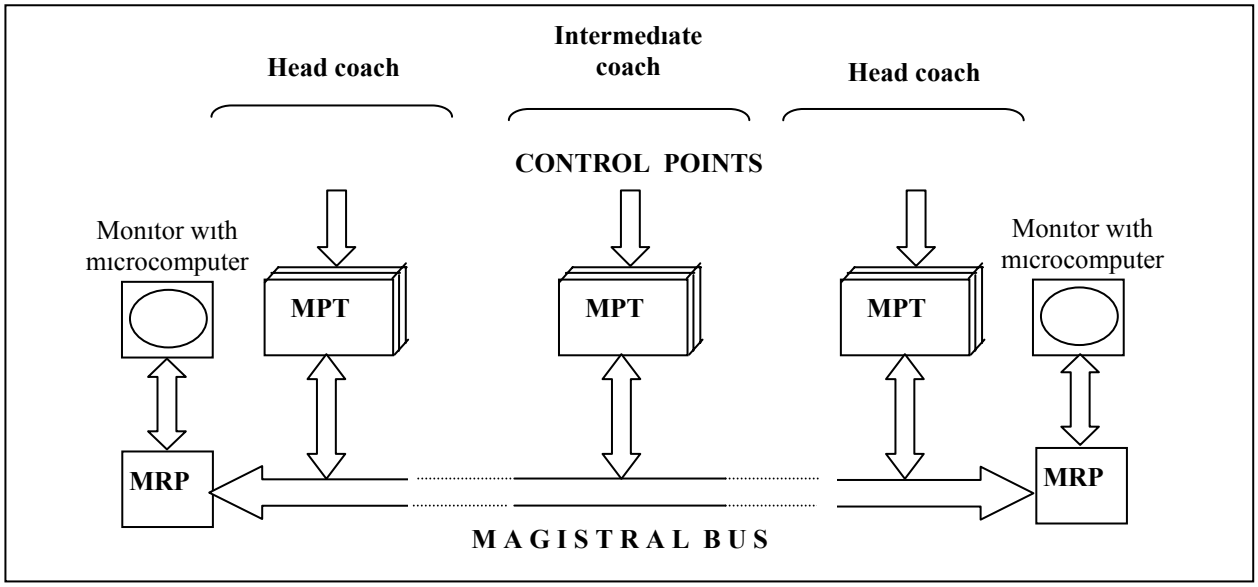

Fig. Block diagram of developed OSD is indicated

On Figure the block diagram of developed OSD is indicated. On a lower layer all control points are radially connected to unified (for convenience of mounting and adjustment) MPT, the number of which in head and intermediate coaches is different (because of different amount of control points). All MPT are connected in parallel to MB. As MB taken three-cable CL, on which byte by byte information interchange is carried out. At the following level the module of a reception and processing (MRP) of information carries out sequential inquiry, reception and preparation of data from MPT for a top level – micro-computer. The latter ensured data processing and displaying of appropriate information at monitor [4].

V. INCREASE OF RELIABILITY

During transfer of code-impulse (CI) signals under effect of interferences takes place a distortion and modification of number of impulses. It can bring to making false recommendations. For their elimination the noise stability of data transfer is increased due to devices of galvanic bracing by options of MPT and MRP from CL. The simplification of the protocols of information interchange is ensured with a rigid regulation of code sequences of transmitted signals on two simplex CL ("Inquiry", "Answer"), third wire – "Common". It allowed to divide CI signals in time and in space and to ensure reliable operation of OSD.

The question of a protection from interference in transmitting CI signals when providing, accepted in practice, word transfer error probability $P_{error}=10^{-6}$ and known transport probability error (on the chosen telephone cable channel) of one digit p = (2-5) x (10^{-4} …

10^{-5}) [5]. The researches have shown, that protection from interference OSD is provided by simply made retransmission with probability of code reception P^*_{error}= (n/2) x p^2, where n – number of transmitting categories (when byte = 8). In this case the condition of reliability of information transfer ($P^*_{error} \leq P_{error}$) is provided even with worst characteristics of a data channel.

VI. ALGORITHM OF OSD WORK

When RS is at line, MPR in all of coaches work constantly. The display, micro-computer and MRP are turned on in that head coaches, in which is machinist. The work of OSD is carried out by cycles, in each of which MRP transmits at CL "Inquiry" address code and 8 clock pulses. MPT, adjusted (by installation of cross connection on the plug of a printed circuits board) on the given address, transmits by clock pulses data on CL "Answer" in MRP. After termination of sending MRP gives a signal, after which micro-computer reads out MPT number and code sending for the analysis. When data coincided at monitor screen displayed corresponding message and formed a signal for MRP with the purpose of giving up the next address and so on [4].

VII. REALIZATION AND TESTS

The instrument means of OSD are developed on the base of modern integrated elements, also the basis of micro-computer is made from the one-crystalline microprocessor and memory chip. As the monitor the device for information output is used on the basis of liquid-crystal indicators stable against vibration. The software, the codes of malfunctions are stores in memory chip.

The bench and onboard tests, program cycle of MZPT inquiry (till 3 seconds), imitation of appropriate malfunction have proved algorithmic and systematic and technical solutions. This system is successfully used on RS of the Baku underground.

VIII. PERSPECTIVE

The distributed system with open architecture provides broad possibilities:

- when the number of inspected equipment increases (by means of bus topology) and increases the number of controlling points (by means of algorithm of transfer of three-cable CL);
- when they are used for solution of problems of control of objects of fuel-energy complex [6].

IX. CONCLUSION

Thus, as the machinist automated adviser OSD:

- improves safety of passengers transportation (by means of elimination of originating failures in rate of movement);
- reduces number of off-schedule comings to depot (a by means of evaluation of possibilities of further operation of RS);
- accelerates coming of RS on a line (by means of fast preventive maintenance of coaches' equipment in depot).

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