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DIAGNOSTICS OF POINTS DRIVE WITH PLC CONTROLLER APPLICATION

У роботі проведені дослідження струмових характеристик електроприводів. У результаті аналізу даних характеристик запропонована методика дистанційної діагностики електроприводів, запропонована також модель діагностичного обладнання для вимірювання струму.

В работе проведены исследования токовых характеристик электроприводов. В результате анализа данных характеристик предложена методика дистанционной диагностики электроприводов, предложена также модель диагностического оборудования для измерения установившегося тока.

In work the researches of current characteristics of points drive have been executed. As a result of analysis these characteristics a concept of remote diagnostics of points drive has been offered, a model of diagnostic equipment for measurement of setting current value has been offered also.

Introduction

Safety of trains movement in the great deal depends from the reliable work of the railway traffic control systems, and consequently from efficiency of diagnostic these systems. PKP recently started to employ station equipment status recorders and diagnostic systems for line blocks. However, presently in PKP there is no diagnostic equipment that could serve for creation of diagnostic models for railway traffic systems.

The aim of this work is the development of concept of remote diagnostics of point drive on the basis of research of their current characteristics.

The paper proposes application of a PLC-based diagnostic equipment for point drives. The setting current would serve as a diagnostic information for this controller. In the course of looking for an appropriate technical solution point drive current characteristics have been performed.

Measurement of current characteristics for EEA-4 point drive

Measurements of setting current and turnout setting time values in the function of turnout switching resistance have been performed using EEA-4 type drive provided with a three-phase drive. The measurements have been performed in the circuit as shown in Fig. 1. In this circuit, voltage control takes place by way of an autotransformer, whereas change of resistance of supply lines was achieved by using rheostats. Change of switching resistance was performed using test bench. Switching time of a drive was measured using a HIOKI 8833 recording device.

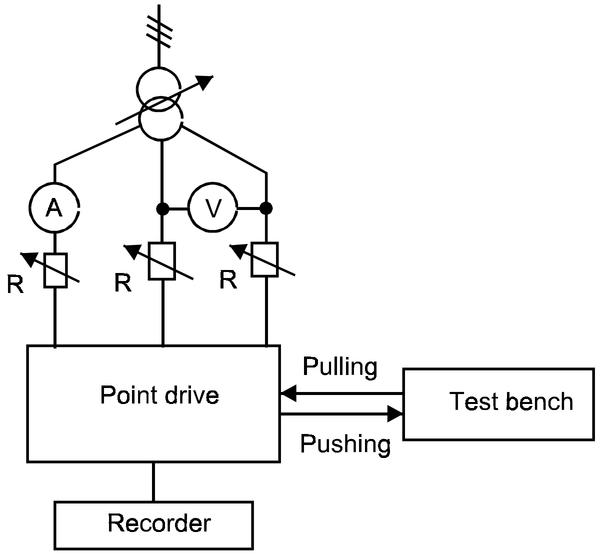

Fig. 1. Measurement circuit diagram

Fig. 2. shows dependence of setting current of EEA-4 in the function of turnout switching resistance. Measurements have been performed with switching resistance from <0÷7> [kN], at power supply 340, 380, 410 [V]. Supply cable resistance was assumed at 0 [Ω]. The chart shows that in the range of assumed loads, at fixed voltage, the value of setting current changes in the range <0,84÷3,01> [A].

Fig. 3 shows dependence of point drive switching time as the function of switching resistance at the power supply cable resistance 0 [Ω]. This test was carried out at supply voltage 380 [V] and power supply cable resistance equal to 0 [Ω]. This chart shows that in the range < 0÷2> [kN] the switching time is of fixed value, whereas above 2 [kN] the switching timer grows till 4 [s] for 7 [kN].

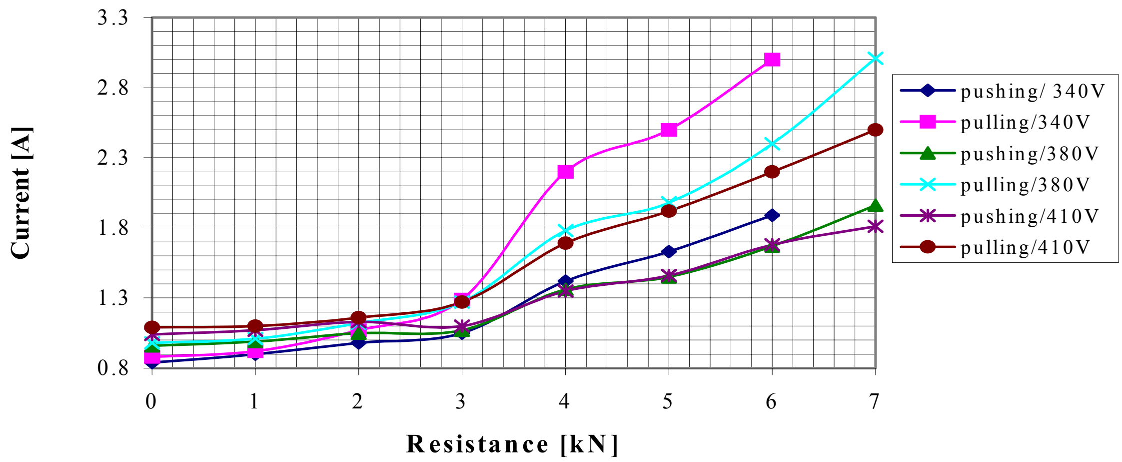

Fig. 2. Chart of setting current values as a function of switching resistance EEA-4 drive

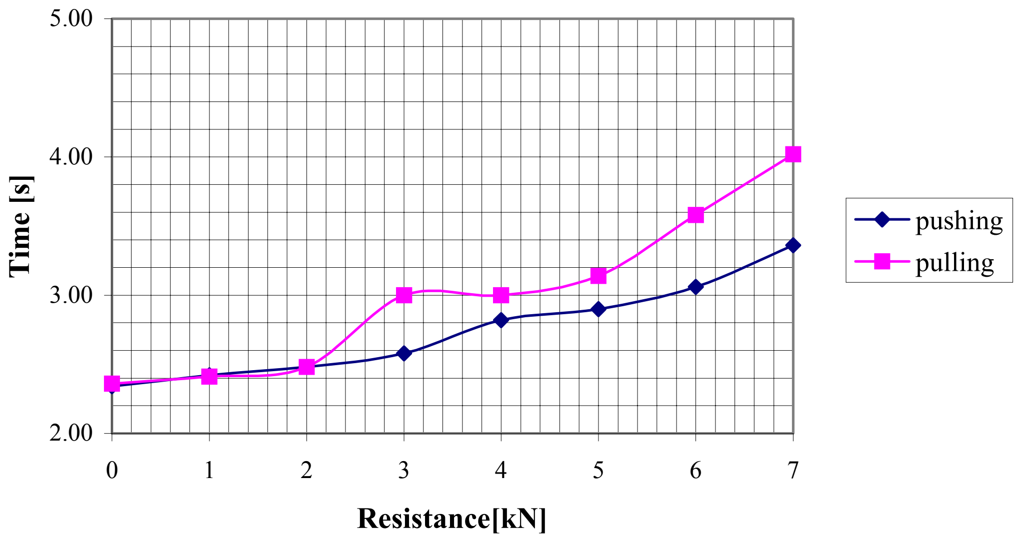

Fig. 3. Chart of dependence of switching time of a EEA-4 points drive as a function of switching resistance at the power supply cable resistance equal to 0 [Ω]

The above mentioned data and characteristics allow to draw the following conclusion that could be useful for the needs of EEA-4 drive diagnostics purposes:

1) as the value of setting current is a value depending of turnout switching resistance we may assume that when the value of setting current falls into the range <1,6÷3,5> [A] (at supply voltage from the range <340÷424> [V]) the drive in question is operational;

2) as the value of turnout switching time, at the worst condition where switching is still possible, amounted to 4,02 [s], the switching time equal to 4,30 [s] should be deemed as maximum. Exceeding this value shall be treated as malfunction;

3) assuming that the value of setting current depends only of supply voltage and supply cable, it is possible to determine: the resistance of power supply cable and condition of engine winding, as well as connections in cable boxes and in the relay room (in certain specific conditions). As in the performed analysis the value of engine winding resistance was treated as a fixed value, we may assume that the value of setting current in the function of power supply should fall into the range <0,8÷3,3> [A];

In the case of real measurements it is necessary to „cut" the startup current value, because it amounts to ca. 8 [A] resulting in error in the diagnostic program.

Model of diagnostic equipment for measurement of setting current value

Block diagram of the diagnostic device is similar to the measurement workstand presented on Fig 1. The difference consists in the fact that the measuring devices are not metering instruments but a programmable logic controller provided with analog to digital converters. A drawback of such a solution is a necessity to use current and voltage transformers with the goal to reduce the values of measured parameters to the standard measurement values of current and voltage. However, this solution features the following:

– a relatively low cost;

– easy communication with the diagnostic stand (a PC);

– continuous character of measurements;

– a preliminary calculation of requested characteristics;

– ability to perform self-tests on its own modules.

The block diagram of the diagnostic device is shown in Fig 4.

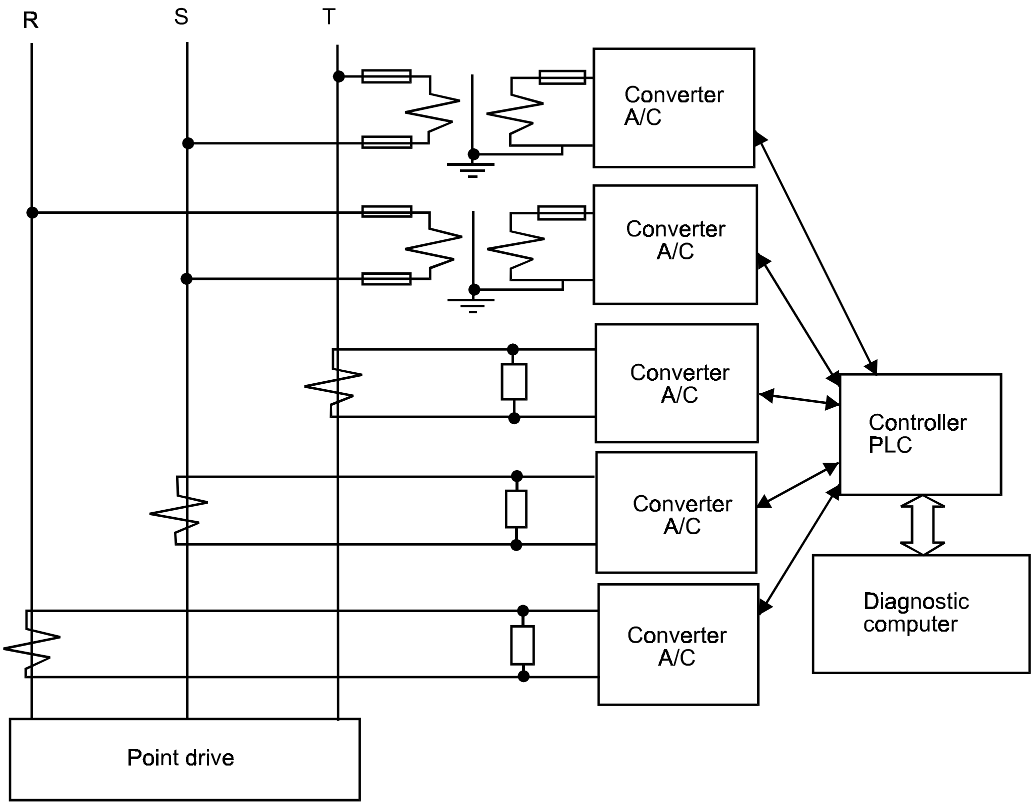

Fig. 4. Block diagram of a diagnostic device

An important issue is that the current value obtained from a measurement transformer ranges around 5 [A], the maximum current of a converter is 20 [mA], thus the proposed solution is to connect a resistor of predetermined parameters into the current transformer circuit and then measure the voltage drop on this resistor. With the known basic parameters of measurement transformers and the resistor it is possible to calculate the real value of setting current already in the controller. The measurement of setting voltage may be performed at two locations (for example, between phase R and S and phase S and T), whereas the current should be measured for each phase separately in order to detect the irregularities in the supply circuit and cable routing. As the railway traffic control systems used in the PKP lines have all their point drives powered from common terminals, only one measurement system is necessary for one station. Moreover we can assume that with hybrid equipment and with computer control panel only one turnout is switched at a time.

As a real measurement system a PLC controlled of Bernecker & Rainer (B&R) manufacturing series 2003 was proposed together with analog-digital converters (A/C). As a CPU was proposed a CP470, the intermediary module between CPU and analog inputs will be AF101 module. As analog inputs AI354 modules have been proposed.

Each component ii shown on Fig. 5.

The proposed solution features a low power consumption and modular construction. An important advantage of a modular construction is easy replacement of damaged components. The system is supplied with 24 [V DC]. Analog inputs may measure voltages up to 10 [V].

Operating cycle of a diagnostic controller

The task of a diagnostic controller consists in measurement of setting voltage and current. These are parameters whose deviation from normal constitutes an indication of irregularities of drive operation or power supply decay. First of all the controller checks the presence of setting voltage, and in the case of its decay the controller informs the diagnostic computer about this fact. If the setting voltage U_n is present the controller goes to the next cycle of operation – it checks presence of setting current I_n. If the current I_n is presetn, the controller measures its value, if it stops flowing, the controller sends information about the values of setting currents to the diagnostic computer. Upon sending the information about values of currents to the computer, the controller returns to the beginning of cycle (checks the setting voltage). The time of drive switching is equal to the time of flowing of setting current. The operating cycle of a diagnostic controller is shown on Fig. 6.

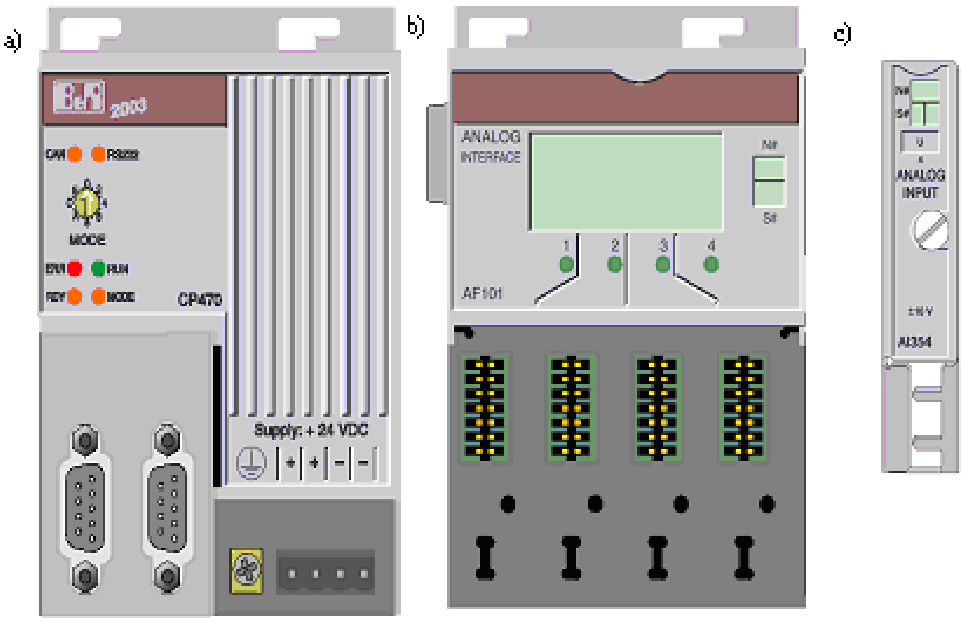

Fig. 5. Elements composing a diagnostic device: *a* – central unit module CP740; *b* – analog input module AF101; *c* – analog input AI354

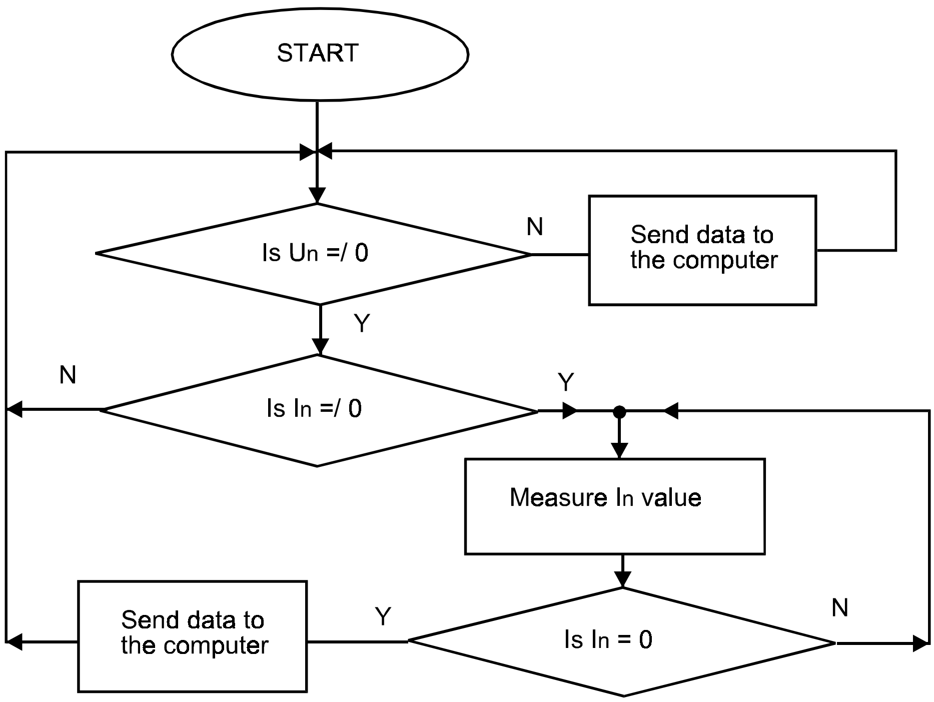

Fig. 6. Block diagram of diagnostic controller operating cycle

Conclusions

The paper presents the results of investigation of current characteristics of an EEA-4 point drive. A measurement of setting current was proposed in order to establish turnout switching resistance value. The current measurement will enable obtaining of diagnostic information with each switching of drive. Results of these data constitute a basis for construction of a diagnostic device model serving the purpose of diagnostics of point drives using their current characteristics. It is worth to remark (assuming that at one moment of time only one point drive is switched-over), that the proposed diagnostic device is “sufficient” for the entire control room (thus for the entire station in many cases). The proposed solution of diagnostic device may be used in various applications of railway traffic control systems.

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