

*diagnostics, point mechanism,
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MODEL OF REMOTE DIAGNOSTICS SYSTEM OF POINT MACHINES WITH USAGE OF SHORT DISTANCE WIRELESS NETWORKS

The paper deals with a proposal of a diagnostic device to measure the point machine technical parameters using a short distance wireless network. The device will allow providing online diagnostics, what makes such a complicated diagnostic process of the point machine much easier and improves safety at the same time. That is so because the information about incoming failure symptoms will reach the staff much earlier.

MODEL SYSTEMU ZDALNEJ DIAGNOSTYKI NAPĘDÓW ZWROTNICOWYCH Z WYKORZYSTANIEM SIECI BEZPRZEWODOWYCH KRÓTKIEGO ZASIĘGU

W referacie przedstawiono propozycje urządzenia diagnostycznego do pomiaru parametrów technicznych napędu zwrotnicowego z wykorzystaniem sieci bezprzewodowej krótkiego zasięgu. Urządzenie to pozwoli na prowadzenie diagnostyki on-line, co znacznie uprości skomplikowany proces diagnostyczny napędu zwrotnicowego przy jednoczesnym podwyższeniu bezpieczeństwa, ponieważ informacja o symptomach zbliżającej się usterki będzie docierała do personelu utrzymania wcześniej.

1. INTRODUCTION

In conjunction with the increase of maximal speed on the railway lines, at the same time of modernizing the appliances for automatic train operation there is a need of development the diagnostics' systems- both whole systems and the single elements.

The diagnostics of point mechanisms and point switches is especially important for safety of traffic guidance.

In the article the proposal of complex system is presented to diagnose of the point mechanism.

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2. CONCEPTION

The main assumption in planning diagnostic system is the remote measurement as many parameters of working in the point mechanism in the remote way as possible.

During the concept works connected with the appliance the following matters should have been taken into consideration:

- type and range of measuring parameters;
- choice of measurement sensors taking the natural conditions into account;
- communication way with the superior appliances (recording, analysis, visualization);
- way of the system feeding;
- overall dimensions of the appliance taking these kinds of drives into account.

3. WAY AND RANGE OF MEASURED PARAMETERS

For definition parameters and system qualities it essential is

- Measurement of humidity and temperature;
- Vibrations' measurement;
- Set currents' measurement;
- Control currents' measurement;
- Voltage measurement.

3.1. TEMPERATURE AND HUMIDITY MEASUREMENT

According to notes contenting in [1], the temperature range inside the point mechanism should be $-30[^\circ\text{C}]$ to $+70[^\circ\text{C}]$ and the humidity range 0 to 90[%]. In result in the situation of choice the measured sensor the following ranges should be taken into consideration:

- For temperature: $-40[^\circ\text{C}]$ to $+80[^\circ\text{C}]$
- For humidity: 0 to 100[%]

Taking these demands into account the sensor SHT7x from Sensirion Co. was chosen. This sensor ensures the humidity measurement in the range of 0 do 100[%] accurate to $\pm 2\%[\text{RH}]$; temperature measurement from $-40[^\circ\text{C}]$ to $120[^\circ\text{C}]$ accurate to $\pm 0.5[^\circ\text{C}]$. Advantages for this sensors are:

- Possibility of exchange the measured tip without necessity of the next calibration,
- Time of set reaction $<3[\text{s}]$,
- Moreover the set posses comfortable introduction to the assembly. Sensor's set SHT7x assures the whole reading with the help of digital 2-line exit.

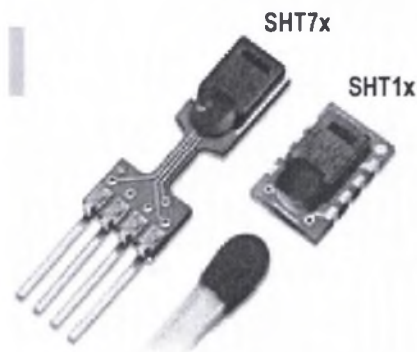


Fig.1. SHT7x set for temperature and humidity measurement

3.2. VIBRATION MEASUREMENT

The vibrations are very important parameter, defining the point mechanism state, point switch and the whole set of drive.

The vibration sensors afford to definite of what kind of vibrations operate on the point mechanism during the mismatching of point switch and during the equipment passage.

The information about changes of vibration amplitude will be shown by the drive condition, its component parts such as motor, gear, set of drive transfer and point switch condition.

The measurement should comprise 3 axes and the range of recorded vibrations should be in the range 0 to 30[G] (on the basis of instructions contended in [1] admissible vibrations should be 0 to 200[G] – according to the authors this volume is exceeded about order in magnitude).



Fig.2. OEM sensors to the vibration measurements

To the usage in the set the sensor TO-5 from PCB Piezotronics was chosen. This sensor ensures the measurement in the range of accelerations from 0 to 50[G] at the frequency from 0,32[Hz] to 10[kHz] and work temperature from -54°C to $+85^{\circ}\text{C}$.

Next researches let determine the optimal number of measurement sensors and the measured places depending on the drive type.

3.3. CURRENT AND VOLTAGE MEASUREMENT

Voltage measurement in the delivery circuit and current running during the drive mismatch is very important parameter talking about the point switch and drive state. It is important to conduct a lot of tests, which let for the creation the model current characteristics of the point mechanism. Earlier researches [3] proved, that it is possible to use the current value of set current as diagnostic information about mismatch resistance and eventually about the state of cable connections.

In the proposed solution the possibilities of the diagnostic appliance were broaden about the measurement the other parameters.

In the figures 3 and 4 the example current characteristics for point mechanism EEA-4 i EEA-5 were presented.

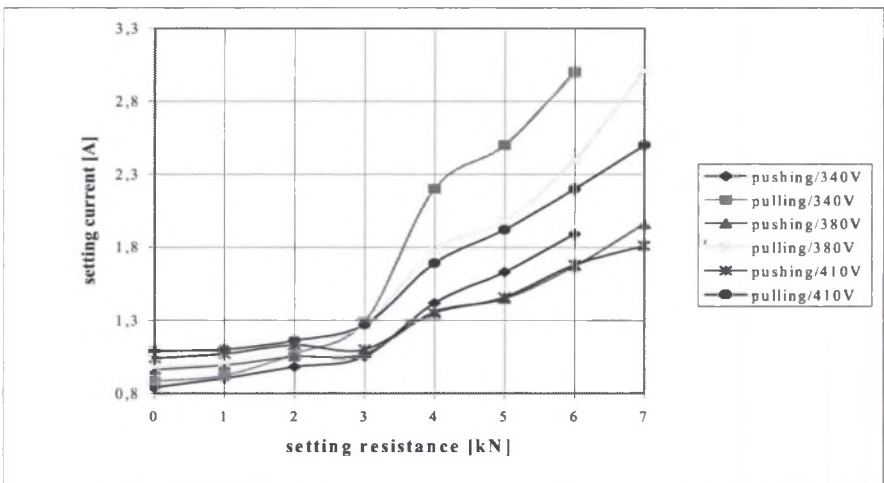


Fig.3. Value of set current in the function of resistance mismatch for the EEA-4 drive

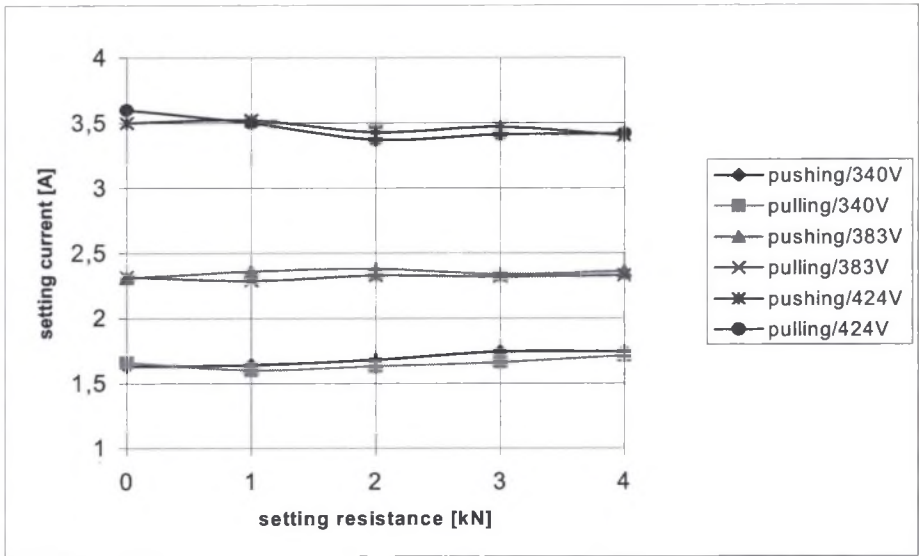


Fig.4. Value of set current in the function of resistance mismatch for EEA-4 drive

In order to collect the whole information about voltage and currents in the control circuit, 3 current transformers and 2 voltage transformers will be used and in the control circuit will be 1 current transformer and 1 voltage transformer.

Expected admissible currents and voltage of control circuit is 20[A] and 380[V]. Expected admissible current and voltage in the control circuit is <1[A] and 24[V]. With the purpose of use in this set the transformers from Feryster company were chosen, which for the sake of little dimensions are customized.

4. SET OF CONVERSION

Chosen measurement sensors require the service of 2 digital entrances (measurement of the temperature and humidity) and 10 analog entrances (measurement of the vibrations, currents and voltages).

Depending on the central unit it is required the usage of external converters a/c and / or the analog multiplexers. Bigger influence on the choice of the central unit has the applied transmission system.

4.1. DATA TRANSMISSION SYSTEM

In the presented case the data transmission from the telemetry appliances doesn't need the usage of data protective mechanisms against the falsehood (coding), not updating (time punch) or sequence breach (sequence numbers).

High level of the reliability isn't needed on the level of transmission medium- for the sake of time unlimited of data delivery from the measured appliances, reliability can be realized by the repeated transfer with the confirmation till to the obtain the right information.

In the case of designed telemetry system the cabling can have the considerable share. It comes directly from the size of the place on which this system has to act.

In order to this for the data transmission the digital radio communication is used. This kind of approach except the reduction of introduce costs and set maintenance increases its flexibility- Switching on the new appliance needs only the giving of unique address, simultaneously it identifies the appliance- doesn't need the immediate engagement of time and costs to the infrastructure development.

According to [2] to the data transmission goals 2 ranges of frequency were chosen 430,00-433,05[MHz] and 433,05-434,79[MHz]. The first range is dedicated to amateur application, the second is the one of ranges dedicated to the telemetry goals.

Transmitter power in 2 strips is limited by the rules to 10[mW] (it is measured from 10[m] distance from the transmitter), with the channel about width of 25[kHz], with the possibility of usage the associate antennas.

According to the small range- with the power limited according the rules, the transmission with the maximum speed can be on the distance 50[m], and the maximum distance with the central diagnostic computer between among transceivers can be 2[km] – communication with the central diagnostic computer should be by the cumulative points, which are responsible for information collecting from local diagnostic appliances and transfer them to the diagnostic computer.

Communication between the cumulative points and diagnostic computer can be by the telecommunication cable or by the mobile network and SMS standard or with the usage GPRS.

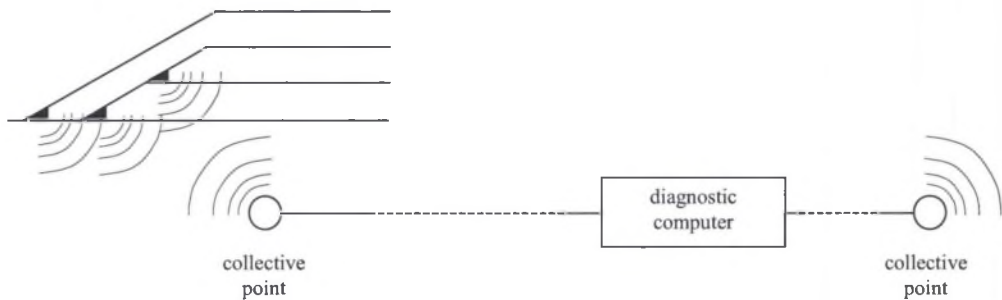


Fig.5. Diagram of diagnostic scheme

The choice of the means of communication between collective points and the diagnostic computer will be the issue of the next consideration.

Range 430,00-433,05[MHz] is chosen for the preliminary test of the system- frequency 433[MHz] is operated by many factory modules of transceivers, which are ready to work without complicated procedures for tuning.

The range 433,05-434,79[MHz] should be treated as terminal – it is a range destined to the telemetry goals and it is not loaded as 430,00-433,05[MHz] – after preliminary system

tests in this range the transmission should be taken place. According to these frequency ranges the set CC1010 from Chipcon company were chosen by the connecting the single set microcomputer and universal transceiver.

4.2. CENTRAL UNIT

CC1010 set from Chipcon company has following features:

- Transceiver integration with the single set microcomputer set (group 8051);
- Possibility of settlement the frequency of transceiver work in the range of 300-1000[MHz];
- Manufacturing modules according to the set with the frequency 315/433/868/915[MHz];
- Equipment cryptologic module (DES algorithm);
- 3-channels converter A/C with the resolution of 10 bits;
- 4 timer- counters;
- clock of real time RTC;
- watchdog;
- 26 universal lines I/O;
- low voltage of feeding 2,7 - 3,6[V] and small current consumption;
- possibility of working in the range of temperature from -40 to +85[°C];
- storage capacity of program 32[kB] Flash type;
- data capacity 2 [kB].

The construction of typical appliance working on the frequency 433[MHz] will be based on the manufacturing module. To the proper work of transceiver and conversion set the usage of additional peripheral set will be needed.

4.3. PERIPHERAL SET

Additionally there were applied popular analogue self-contained multi/demultiplexer series 4051, because the application of 4 current transformers and 3 voltage transformers and 3 vibration sensors require more quantity of analogue inputs than the system CC1010 offers. The analogue self-contained multi/demultiplexer series 4051 permit on easy switching eight sources of signal to one analogue input through addressing with using 3 digital inputs.

In order to improve the range it is necessary to abandon a wire antenna and antenna SMT (Surface Mount), which are typical for devices working in band 433[MHz], and replace them by stub antenna. It permits on contain larger area under the supervision of the device.

5. SUMMARY

At present the prototype device, working in the band 433[MHz], is constructed. It permits on verification the correctness of made construction assumptions and it determine the range of possible realization of the conceptual set study.

Designing device permits on:

- increasing of the security level of traffic conducting
- improving of diagnostic and exploitation processes
- enlarging of the measured parameters range

So far, the researches [3],[4] in this area demonstrated the purposefulness of improving the diagnosis of point machine, and lack of complex solutions in world-wide scale is important argument for construction of described device.

BIBLIOGRAPHY

- [1] „Wymagania bezpieczeństwa dla urządzeń sterowania ruchem kolejowym”, CNTK, Warszawa 1998
- [2] Rozporządzenie ministra infrastruktury z dnia 6 sierpnia 2002 roku (Dz.Ust. nr 138) „w sprawie urządzeń radiowych nadawczych lub nadawczo-odbiorczych, które mogą być używane bez pozwolenia”
- [3] MIKULSKI J., MŁYŃCZAK J., „Drive Points Remote Control”, I Międzynarodowa konferencja Telematyka Systemów Transportowych, Ustroń 2001
- [4] MIKULSKI J., MŁYŃCZAK J., „Komputerowa diagnostyka napędu zwrotnicowego”, Zeszyty Naukowe Politechniki Śląskiej, Nr 43, Seria Transport, Gliwice 2001

Reviewer: Prof. Zbigniew Ginalski