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telecommunication wire lines,
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USING OF NOISE LIKE SIGNAL FOR MEASUREMENT OF FREQUENCY PARAMETERS OF WIRE TELECOMMUNICATION LINES

A railway transport complex is the difficult territorial dispersed system with the generous amount of technological subdivisions and technical systems of process control of the transportations, organized on principle of centralization controller's services. The reliable and effective work of railway transport in the great deal relies on authenticity and timeliness of information transfer, which at the physical level is determined by quality of lines transmission.

WYKORZYSTANIE HAŁASU JAKO SYGNAŁU DO MIERZENIA PARAMETRÓW CZĘSTOTLIWOŚCIOWYCH PRZEWODOWYCH LINII TELEKOMUNIKACYJNYCH

Kompleks transportu kolejowego to skomplikowany, terytorialnie rozproszony system z dużą ilością technologicznych podziałów i systemów sterowania procesami transportowymi, zorganizowany na zasadach centralizacji usług kontrolera. Niezawodny i sprawny przebieg pracy transportu kolejowego w dużej mierze zależy od prawdziwości i punktualności przekazu informacji, która na poziomie fizycznym określona jest poprzez jakość linii transmisyjnych.

1. INTRODUCTION

The distortions at the transmission of harmonic signals in the wire lines of automation and communication characterize by such parameters: Own or working fading, relative phase changes, own (characteristic) and working phase coefficients, absolute and relative group time of passing.

Of the real work development is a target of automatic device for the control and diagnosing of communication channels and automation with the use of noise signal.

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For achievement of the put target a checking feature is considered and measuring parameters of communication channels on the basis method of authentication, the mathematical ground is resulted method of spectral analysis, methods are considered of forming noise signal and method of organization device control and diagnosing of channels railway automation and communication.

2. MATHEMATIC MODEL

For measuring a testing signal is used, given in the communication channel. A noise signal comes forward as a measuring signal, as a result the least influencing is achieved of measuring signal on the informative signal.

Signal y(t) on the return of object control it is possible to write down through the entrance signal of u(t) and impulsive description of object g(t) in kind:

$$Y(t) = \int_0^{\infty} g(\theta)u(t-\theta)d\theta \cdot \tag{1}$$

At imposition on y(t) noise a n(t) signal on the entrance of line will have a kind:

$$z(t) = y(t) + n(t) \tag{2}$$

where n(t) - centered noise, I.e. stationary accidental signal with the zero expected value.

A correlation function of entrance and output signals of object authentication has a kind:

$$\begin{aligned} R_{uz}(\tau) &= E \cdot \{u(t-\tau) \cdot z(t)\} = \\ &= \int_0^{\infty} E\{u(t-\tau) \cdot u(t-\theta)\} g(\theta) d(\theta) + \\ &+ E\{n(t) \cdot u(t-\tau)\}. \end{aligned} \tag{3}$$

The expression (3) can be simplified thanks to independence to the signal of u(t) from the noise of n(t) as follows:

$$E\{n(t) \cdot u(t-\tau)\} = E\{n(t)\} \cdot E\{u(t-\tau)\} = 0. \tag{4}$$

In addition:

$$E\{u(t-\tau) \cdot u(t-\theta)\} = R_{uu}(\tau-\theta), \tag{5}$$

where $R_{uu}(\tau-\theta)$ – correlation function of signal u(t), which is considered stationary accidental process.

Expression (3) taking into account equalities (4) and (5) signs kind:

$$R_{uz}(\tau) = \int_0^{\infty} R_{uu}(\tau-\theta) g(\theta) d\theta = R_{uy}(\tau) \cdot \tag{6}$$

If an identification signal of u(t) is a white noise with power σ:

$$R_{uu}(\tau-\theta) = \sigma^2 \cdot \delta(\tau-\theta), \tag{7}$$

from where:

$$R_{uz}(\tau)=\int_{0}^{\infty}\sigma^{2}\cdot\delta(\tau-\theta)\cdot g(\theta)d\theta=\sigma_{k}^{2}\cdot g(\tau). \tag{8}$$

Taking the integral Fure from two parts of expression (3), will get:

$$\dot{S}_{xy}(\omega)=\dot{S}_{xx}(\omega)\cdot\dot{W}(\omega), \tag{9}$$

where – one-sided spectral closeness power of output signal y(t), – one-sided spectral closeness power of the tested signal x(t).

From expression (9) will get:

$$\dot{W}(\omega)=\dot{S}_{xy}(\omega)/\dot{S}_{xx}(\omega). \tag{10}$$

A spectral closeness of the white noise, used in the given method for authentication, is permanent on all frequency region. As a result, from expression (10) get, that mutually a spectral closeness $\dot{S}_{xy}(\omega)$ within the permanent multiplier corresponds to the frequency transmission function of the identified object.

In practice it is comfortably to realize a method on the basis of the following expressions:

$$\dot{W}(f_k)=\dot{S}_{xy}(f_k)/\dot{S}_{xx}(f_k), f_k=kf_1, \tag{11}$$

where f_1 – the Fundamental frequency of spectrum, which is a discrete analogue of basic formula of spectral method.

$$\dot{S}_{xy}(f_k)=\frac{2}{NT}X^*(f_k)\cdot Y(f_k); \tag{12}$$

$$\dot{S}_{xx}(f_k)=\frac{2}{NT}X^*(f_k)\cdot X(f_k); \tag{13}$$

$$X(f_k)=T\sum_{n=0}^{N-1}x(nT)\cdot\exp(-j2\pi kn/N); \tag{14}$$

$$Y(f_k)=T\sum_{n=0}^{N-1}y(nT)\cdot\exp(-j2\pi kn/N). \tag{15}$$

$S_{xy}(f_k)$ and $S_{xx}(f_k)$ – one-sided spectral closeness's; $x(f_k)$ and $y(f_k)$ – discrete spectrums of functions $x(nT)$ and $y(nT)$ on the period NT, got the discrete transformation Fure; $f_k=kf_1$ – the first frequency of discrete signal; $f_1=1/NT=F/N$ – fundamental frequency, F – frequency of transformation in the discrete signal. On the basis of the got discrete transmission function of object measuring, it is possible to get its frequency descriptions.

A flow diagram of device control and diagnosing of communication channels and railway automation with the use for testing of noise signal is resulted on Fig.1 and works as follows. The signal $X(s)$ acts in from generator 1 on the entrance of object control, on the return of which a signal appears $Y(s)$. Thus on the return of the block 3 get the value of discrete spectrums of entrance S_x and signal on return S_y. From the returns of devices increase get a spectral closeness of entrance S_{xx} and signal on return S_{xy}. Signals, and on the return of block 6 – discrete transmission function $W(s)$.

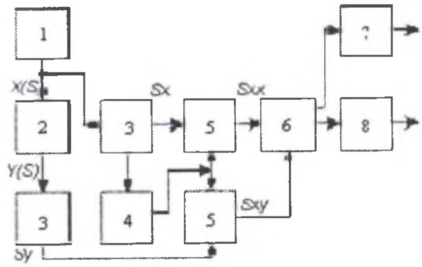

Fig.1. Flow diagram devices of control communication channels with the use of noise signal:
1 – generator of noise signal; 2 – object of measuring; 3 – block of the discrete transformation Fure;
4 – block calculation of the attended value complex number; 5 – block of increase; 6 – divisor;
7 – block of calculation the module of complex number; 8 – block of calculation argument

For the receipt of transmission function it is necessary to take advantage of the discrete transformation Fure, through which get a spectrum of signal. On the spectrums of entrance and output signals will get a spectral closeness of power the signal S_{xy}, S_{xx}. For the receipt of transmission function of object measuring it is enough to divide a spectral closeness power of output signal on the spectral closeness of power entrance signal.

3. PRINCIPLE FORMING OF NOISE SIGNAL

A noise signal is formed on the basis of pseudo accidental sequence, which is generated through the cyclic moved register. Dependences of quantity of cells and number of forming elements of register from length of the formed pseudo accidental sequence are resulted in tab. 1 and 2.

Table 1

Dependence of quantity cells of register from length of pseudo accidental sequence

	Length of pseudo accidental sequence					
	256	512	1024	2048	4096	8192
Quantity of cells of register	8	9	10	11	12	13

Table 2

Choice of number of functional element from the quantity of cells of register

Quantity of cells of register	8	9	10	11	12	13
Number of functional element	2,3, 4,8	4,9	3, 10	2,9	1,4, 6, 12	1,3, 4, 13

During realization generator of noise signal a pseudo accidental sequence was chosen by length in 512 elements. In accordance with tab 1 and 2 will get, that thus there must be 9 cells of register, and numbers of functional elements are equal 4 and 9.

Flow diagram generator of pseudo accidental sequence by length 512 elements is resulted on the Fig.2.

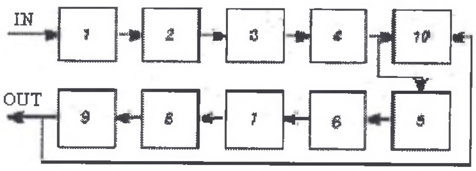

Fig.2. Flow diagram of generator of pseudo accidental sequence long 512 elements:
1 – 9 cells of shift register, 10 – summarization

The formed pseudo accidental sequence possesses the following descriptions:

- probability of appearance logical zero (units) – 50 %;
- conditional probability of appearance logical zero after zero – 50 %;
- conditional probability of appearance unit after unit – 50 %.

4. RESULTS OF MEASURING

The researches were conducted of exactness measuring of frequency descriptions of the offered method measuring. For this purpose artificial is created to the line, possessing parameters: the resistance is electric to the direct current – 55 Ohm/km; the resistance is electric to the isolation lived – 10000 MOhm·km; a capacity is electric working pair lived – 23,8 nF/km. Giving on the entrance tension by the face value 1 In on different frequencies got peak description, presented on the Fig.3. Further through the mathematical model of measuring complex got peak description, shown on the Fig.4. Comparing descriptions, got an error of measuring 10 %.

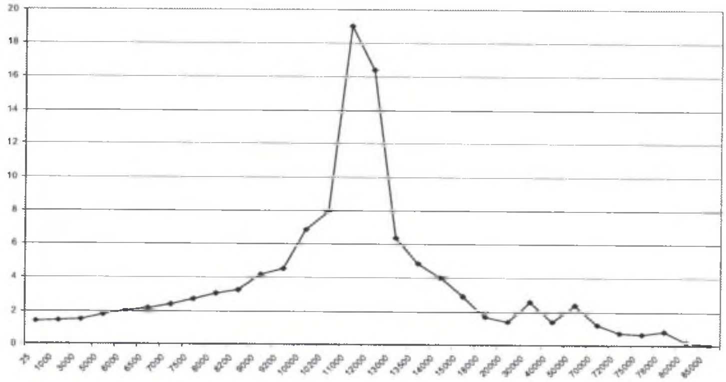

Fig.3. Peak description, got on the artificial line

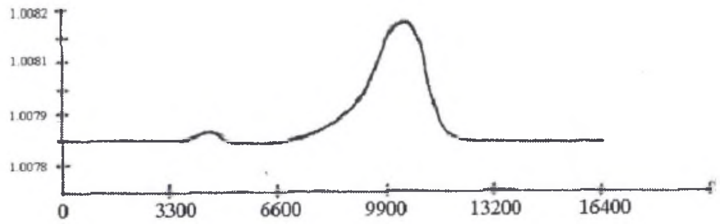

Fig.4. Peak description, got on the model of line by the offered method
Structure of device control

A flow diagram of the checking system is resulted on the Fig.5.

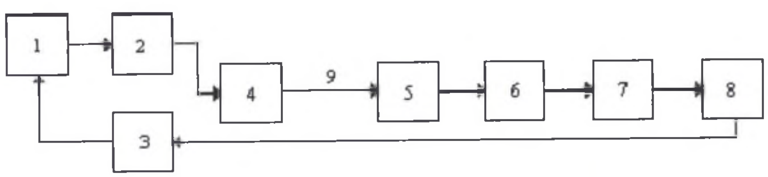

Fig.5. Flow diagram of measuring device: 1 – COMPUTER; 2 – transmitter on the central fast; 3 – receiver on the central fast; 4 – switchboard; 5 – receiver on the eventual station; 6 – transformer of measuring signal; 7 – transmitter on the eventual station; 8 – electronic key; 9 – object of measuring (communication channel)

For measuring of parameters communication channel it is suggested to carry out the transmission of measuring signal from the side of central fast, where a measuring complex is located. COMPUTER (1) forms the request for measuring and measuring signal. If a channel is free, through transmitter (2) and switchboard (4) a measuring signal is given in the object of measuring (9). On the eventual station through receiver (5) a measuring signal gets on transformer of measuring signal (6). From the return of this block get a spectrum of measuring signal after passing through the object of measuring. These data through transmitter (7) and electronic key (8) are sent on the central fast, where through receiver (3) act on COMPUTER (1), where the final data processing is and output of results measuring.

5. CONCLUSION

With the target of development automatic device for the control and diagnosing of communication channels and automation with the use of noise signal, a checking feature is considered and measuring of parameters communication channels on the basis of method authentication, the mathematical ground is resulted method of spectral analysis, a method is chosen of forming noise signal and method of organization device of control.

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