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V. Calculation example

Here is an example of the calculation for the microwave sensor that operates at the center frequency of 2.5 GHz. To ensure wide dynamic range, let us choose the resonator length l equal to $2.4\cdot 10^{-2}$ m. Now, taking into account $\Delta d_{max,}$ the capacitor gap d can be selected equal to10^{-3} m. Based on Fig.4, we can determine the capacitance value $C= 0.28$ pF. In that case, the radius of the inner conductor of the coaxial forming a capacitor with the membrane should be $r \approx 3\cdot 10^{-3}$ m (from the parallel plate capacitor formula). For the selected ω and l the cot $(\omega l/c) = 0.32$. Now, taking the mentioned above sizes of the membrane radius R and thickness δ, the ratio R^4/δ^3 will become equal to $8.1\cdot 10^{5.}$ From the expression (6) the shift in the cavity circular resonant frequency $\Delta\omega = (7.3\cdot 10 \text{ rad/s})\cdot\Delta p$.

At $\Delta p =10^{-3}$ Pa, $\Delta\omega = 7.3\cdot 10^4$ rad/s or $\Delta f \sim 10^3$ Hz. Now, let us look at the maximal frequency shift. At $\Delta p = 252$Pa the circular frequency shift is $\Delta\omega \approx 367\cdot 10^{6}$ rad/s or $\Delta f \sim 290\cdot 10^6$ Hz.

VI. Thermal stability

One of the important issues of sensors operability is their thermal stability. The issue can be solved by the combining the reference and measuring resonators in one assembly.

VII. Linearity

As seen from (4) and fig.3, the proposed sensor has good linearity within the measurements range.

Conclusion

In the current paper we have presented a calculation algorithm for a new type of infrasound sensors based on coaxial resonator, which allows to design infrasound sensors of high sensitivity ($\Delta\omega \approx \Delta p\cdot 10^8$ rad/c) and wide dynamic range (≥108 dB). Implementation of such infrasound sensors gives possibility to improve the measurement precision and noise immunity due to frequency domain measurements.

Acknowledgments

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References:

1. Fraden J., "Handbook of Modern Sensors," (Springer-Verlag, Inc, New York, 2004).
2. Polivka J.,"High Frequency Electronics" 6, 4, 32–42 (2007).
3. Pudalov V. M., Khaikin M. S., Dilatometer with sensitivity of 10^{-4}Angstrom, Cryogenics 9, 4, 128–130 (1969).
4. Wheeler G. J.,"Introduction to microwaves," (Prentice-Hall of India, 1963).
5. Schomburg W. K., "Introduction to micro system design," (Springer-Verlag Berlin Heidelberg, 2011).
6. Ponomarev S. D., Andreeva L. E., "Machinery and devices elastic elements calculation," (Moscow, Mashinostroenie, 1980) (In Russia).

Boiko Juliy Mikolayovych,
Khmelnytskyi National University,
PhD, Associate Professor, Department
of Radio Engineering and Communication

Eromenko Alexander Ivanovych,
Khmelnytskyi National University,
Senior lecturer, Department of Physics
and Electrical Engineering

Analysis of solutions to improve efficiency of signal processing devices in telecommunication

Abstract: A description of the model of the synchronization means of telecommunications stochastic equations. The variance of the fluctuation of the synchronization error by solving the Fokker-Planck-Kolmogorov. Calculated error of numerical solution of the equation of a stationary grid method. We obtain the schedule of the distribution of the probability density synchronization errors for different values of the normalized time.

Keywords: synchronization, stochastic equation, error variance

The coherent and quasicoherent methods for signal receiving require phase auto-tuning frequency as obligate component which forms the reference signal from the received oscillation. To receive discrete information a system needs clock, word and frame synchronization. The important task of synchronization, which is to form reference oscillation at the receiving side of wireless connection, in most of the cases, becomes complicated due to influence of noise, which distorts the received signal, and in some cases due to random character of the signal itself[1]. Such events entail fluctuational phase deviation, which is formed by reference oscillation synchronization system. The effectiveness of data transmission lowers consequently because of losses in transmission of data required for not only synchronization but also for the signal search time and transition onto monitoring mode for all synchronization systems of the receiver[2]. This raises the question of improving synchronization system especially in case of using in communication systems frequency, phase and quadrature methods of manipulation[3]. Thus, improving effectiveness of signal processing in satellite telecommunication is obviously necessary especially for its part which relates to providing its noise resistance in conditions of noise and hindrance. This objective has been achieved through development of methods and means for optimization of filtering devices and semigraphical interpretation of clock synchronization systems on the base of stochastic models what determines relevance of the subject. Research and generalization of the conceptual fundamentals in modern theory of phase

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[1] Juliy Mikolayovych Boiko, Alexander Ivanovych Eromenko. Improvements Encoding Energy Benefit in Protected Telecommunication Data Transmission Channels. Scientific Journal «Communications». Science Publishing Group, USA. Vol. 2, No. 1, 2014, P. 7–14. doi: 10.11648/j.com.20140201.12.

[2] Juliy Boiko, Victor Stetsiuk, Victor Michan. Improving noise immunity of QPSK demodulation of signals in digital satellite communication systems/ TCSET'2012 IEEE. 21 – 24 February. P. 257, Lviv – Slavske.

[3] Boiko J. M. Synthesis problems of clock synchronization devices for receivers of satellite telecommunication data transmission systems/J. M. Boiko, A. I. Eromenko//Bulletin of National Technical University of Ukraine «Kyiv Polytechnic Institute» Series — Radiotechnique. Radioapparatus building. – 2014. – Ed. 58. 55–66 p.

and clock synchronization[1], requires: expanding theoretical interpretation of analytical description made for functioning and optimizing parameters of receivers in conditions representing real complex of hindrance and influence on system processing the manipulated signals through studying changes of the distribution density of synchronization error in clock synchronization system; analysis of average time and dispersion dependences for synchronization system; using various stochastic models with expanded technical interpretation of Markov's modeling, cumulant method and method for statistic linearization. Besides, upgrading circuit structure of the manipulated signal receiver in order to optimize it by using solutions aimed at removing reverse effect, synthesis of the receiver structure with synchronization devices and defining character of signal to noise ratio influence on accuracy of synthesized clock synchronization devices are important.

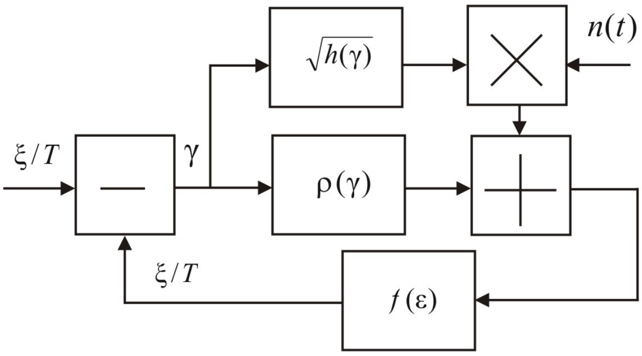

Fig. 1. The research clock synchronization scheme

Model of synchronization system is described by stochastic equations in accordance to the scheme fig. 1. The following symbols are used: $\xi=\xi(t)$ – input influence, $\hat{\xi}=\hat{\xi}(t)$ – influence assessment, $\gamma=\gamma(t)=(\xi(t)-\hat{\xi}(t))/T$ – normalized synchronization error, $\rho(\gamma)$ – discriminatory characteristics, $h(\gamma)$ – fluctuation characteristics, $n(t)$ – Gaussian white noise, $f(\varepsilon)$ – transient pulse function of the linear dynamic element, which describes the effect of processing output signal and adjustment of the clock generator frequency fig.1. Assumption is made that: the influence is slow process, stable due to large amount of symbol intervals; assessment of the target influence is a slow process; normalizing random processes and fluctuation of discriminator's output signal is the condition to be used; spectral density $G(\omega,\gamma)$ is assumed stable in the tract transmission frequency band $G(0,\gamma)$ and fluctuation component is represented as the white noise.

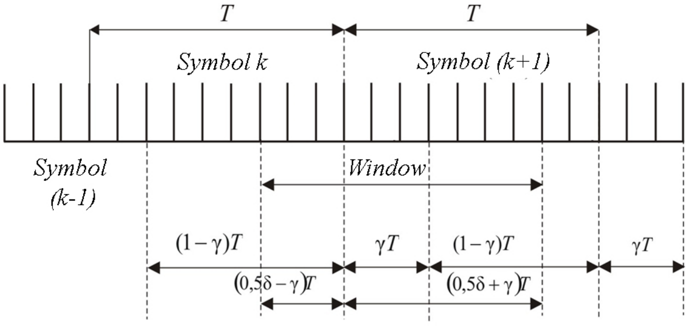

Fig. 2. Pulse sequences in synchronozation system

The synchronization system is described as automatic control system. The input influence is represented as $r(t)=U(t)+n(t)$. The signal is represented analogously as the following: $U(t)=U_0\sum_i S_i h(t-iT-\xi)$, $h(t)=1$, $0\le t\le T$, $h(t)=0$, $t\in(0,T)$. Thus the pulses sequence is given U_0 – having rectangular form $h(t)$, which represents binary character data stream $S_i\in\{+1,-1\}$, $n(t)$ – Gaussian white noise. The research is conducted in order to identify discriminatory and fluctuational characteristics. The synchronization error is specified by $\gamma=(\xi-\hat{\xi})/T$. The pulse sequences to identify synchronization error are represented in fig. 2.

The error signal is expressed as following:

$$\Delta_k=\frac{(U_{2k}+n_{2k})\operatorname{sgn}(U_{1k}+n_{1k})-\operatorname{sgn}(U_{1k+1}+n_{1k+1})}{2}. \tag{1}$$

where $k=0,\pm1,\pm2,\dots$; $U_{1k}=k_1U_0\sum_i S_i\int_{(k-1)T}^{kT}h(t-iT-\gamma T)dt=k_1U_0T\{(1-\gamma)S_k+\gamma S_{k+1}\}$; $U_{2k}=k_1U_0\sum_i S_i\int_{(k-\delta_0/2)T}^{(k+\delta_0/2)T}h(t-iT-\gamma T)dt=$ $=k_2U_0T\{(\gamma+\delta_0/2)S_{k+1}-(\gamma-\delta_0/2)S_k\}$; U_0 – pulse amplitude; k_1, k_2 – transmission coefficients of integrators; $n_{a_k}=N(0,\sigma_\beta^2)$, $\beta=1,2$, $\sigma_\beta^2=k_\beta^2\delta_\beta N_0T/2$, $\delta_1=1$, $\delta_2=\delta_0$.

The random process in the output of discriminator is defined from formula (1). Its statistical characteristics are of use to define discriminatory and fluctuational characteristics $\alpha(\gamma)=M(\Delta_k/\gamma)$, where $M(\Delta_k/\gamma)$ – conditional mathematical expectation at noise samples and symbols.

The normalized discriminatory characteristics obtained by using method of mathematical modeling at different values of signal to noise ratio are represented in fig. 3. The discriminatory characteristic in form of dependence of discriminator's output voltage on the synchronization error is linear when error value is insignificant.

The normalized discriminatory characteristics obtained by using method of mathematical modeling at different values of signal to noise ratio are represented in fig. 3. The discriminatory characteristic in form of dependence of discriminator's output voltage on the synchronization error is linear when error value is insignificant.

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[1] Shakhgildyan V. V. Systems phase locked loop with digital elements/V. V. Shakhgildyan. – Moscow: Communications, 1979. – 224 p.

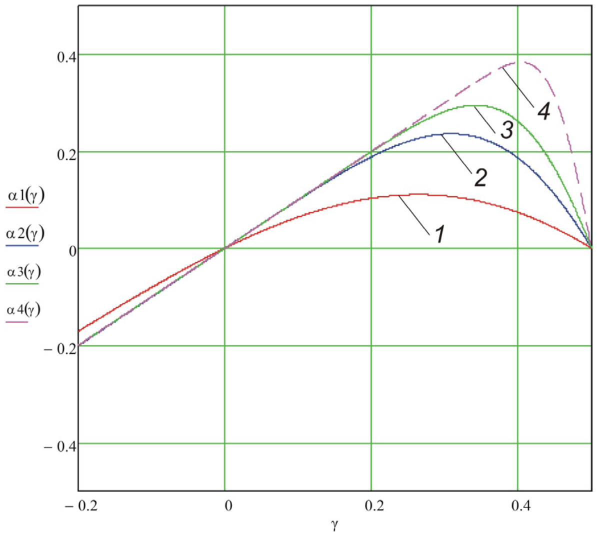

Fig. 3. Graphs of normalized discriminatory characteristics at varoius values of signal to noise ratio:
1 – $h_0^2 = 1$, 2 – $h_0^2 = 4$, 3 – $h_0^2 = 10$, 4 – $\delta_0 \to opt$

In synchronization scheme the input process $U(t)$ is treated by in-phase and secondary phase integrators, in the form of coherent filters, during symbol interval T fig. 4. In the in-phase tract the comparator identifies symbol polarity, and detector defines transitions in accordance to the algorithm: if $a_k = a_{k-1}$, then $I_k = 0$; if $a_k = -1$, $a_{k-1} = +1$, then $I_k = +1$; if $a_k = +1$, $a_{k-1} = -1$, then $I_k = -1$, and defines the sign of synchronization error. In the secondary phase circuit the synchronization error value is assessed, here $\delta_0 T$ – processing interval. The coherence of circuits is provided by delay link $(1-\delta_0/2)\cdot T$ so that these signals coincide. The complex of circuit components together with multiplier form measuring component — synchronization system discriminator. The output signal Δ_k is processed with the use of filtering and furthermore used for frequency control in pulse generator and integrators in order to remove a synchronization error.

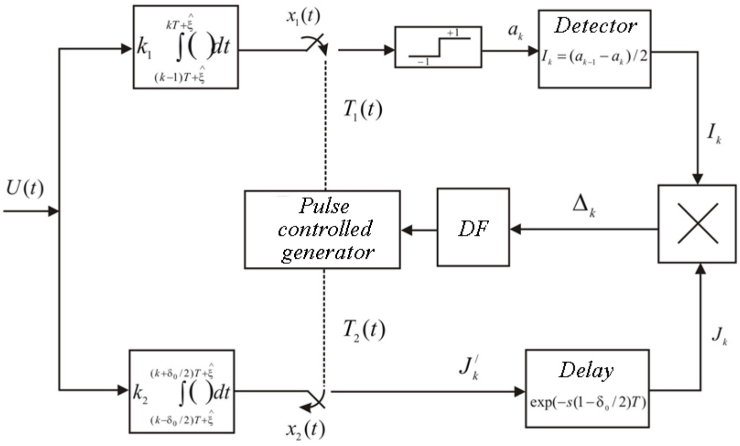

Fig. 4. The structural scheme of synchcronization system in case of fixing scan and reset moments

The dispersion of fluctuational error in synchronization system is to be defined using the equation of Markov's random process, which density of probability distribution $P = P(\gamma, t)$ is expressed by Fokker-Planck-Kolmogorov equation[1]:

$$\frac{d\gamma}{dt} + k\alpha(\gamma) = k\sqrt{h(\gamma)}n(t), \quad 0 \le t,$$

$$\gamma(0) \sim P_0(\gamma) \tag{2}$$

where $P_0(\gamma)$ initial density distribution of synchronization error.

$$\frac{\partial P}{\partial t} = -\frac{\partial}{\partial \gamma}\left(A(\gamma)P\right) + \frac{1}{2}\frac{\partial^2}{\partial \gamma^2}\left(Z(\gamma)P\right), \quad P(\gamma,0) = P_0(\gamma), \tag{3}$$

where $U_0(\gamma) = -k\alpha(\gamma)$, $Z(\gamma) = k^2 S(0,\gamma)$.

The solution of equation (3) at synchronization system stationary mode $\frac{\partial P}{\partial t} = 0$ is found as:

$$P(\gamma) = c^{-1}\exp\left(-\int_0^{\gamma} \frac{2h_0^2\chi_0\alpha_n(U) + dh(U)/dU}{h(U)}dU\right), \quad |\gamma| \le 1/2 \tag{4}$$

where $\chi_0 = \frac{4}{U_0 kT}$ — parameter opposite to normalized noise band of the synchronization system linear model; $c = 2\int_0^{1/2} \exp\left(-\int_0^{\gamma} \frac{2h_0^2\chi_0\alpha_n(U) + dh(U)/dU}{h(U)}dU\right)d\gamma$ — normalizing constant.

Synchronization system accuracy is assessed by dispersion of normalized synchronization error:

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[1] William C. Lindsey. Synchronization systems in communication and control. – Prentice Hall, Inc. Englewood Cliffs, New Jersey, 1972. – 600 p.

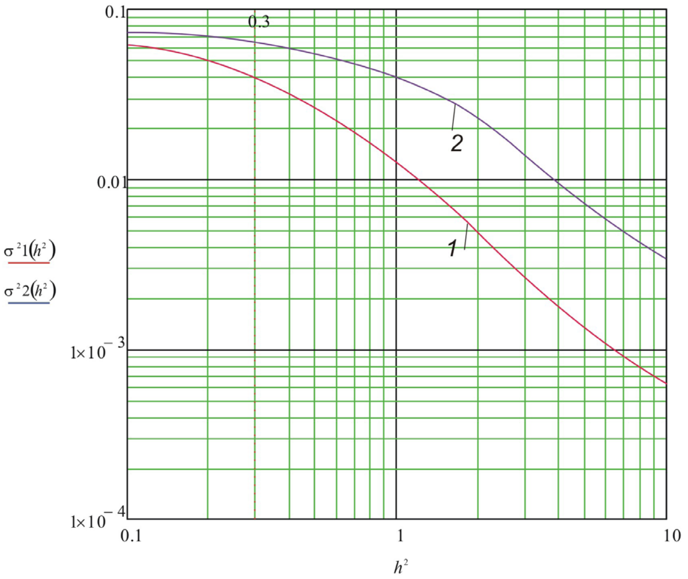

Fig. 5. Graphs of dispersion error σ_γ^2 dependence on signal to noise ratio h_0^2: 1 $\chi_0 = 50$; $2 - \chi_0 = 10$;

$$\sigma_\gamma^2 = 2\int_0^{1/2} \gamma^2 P(\gamma) d\gamma . \tag{5}$$

The mathematical modeling will be performed and error dispersion influence will be assessed in dependence on signal to noise ratio for some values of χ_0 parameter. In particular fig. 5 demonstrates assessment carried out for $\delta_0 = 1$ and fig. 6 — for $\delta_0 = \delta_{0опт}(h_0^2)$.

The conducted research has indicated that in case of narrowing synchronization system band the dispersion of fluctuational error reduces. In fig. 6 solid lines 1 and 2 demonstrate effect that the window width minimizes synchronization error dispersion for each value of signal to noise ratio, however lines 3 and 4 demonstrate constant width of the window.

Analysis of transition mode of synchronization system can be done with the use of numerical solving Fokker-Planck equation by grid method when distribution density of synchronization error changes. The equation (6) will be used with inserting normalized time $t_н = 4\varpi t$, where $\varpi = k_1 k_2 U_0 T / 4$ – noise band of linear model of synchronization system. In this case the canonic form of stochastic Fokker-Planck equation for distribution density $P = P(\gamma, t_н)$ can be written.

$$\frac{\partial P}{\partial t_н} = \frac{\partial}{\partial \gamma}\left(\alpha(\gamma)P\right) + \frac{1}{D_0}\frac{\partial^2}{\partial \gamma^2}\left(h(\gamma)P\right), \quad t_н \geq 0, \quad P(\gamma, t_н) = P(\gamma \pm 1, t_н), \quad P(\gamma, 0) = 1 . \tag{6}$$

In the research the distribution density of the initial condition will be assumed uniform, $D_0 = 2h_0^2 / \varpi T$ — equation parameter, $\Delta F_{нор} = \varpi T$ — normalized noise band.

Stationary solution of equation (6) is used for numerical solution (3) by grid method.

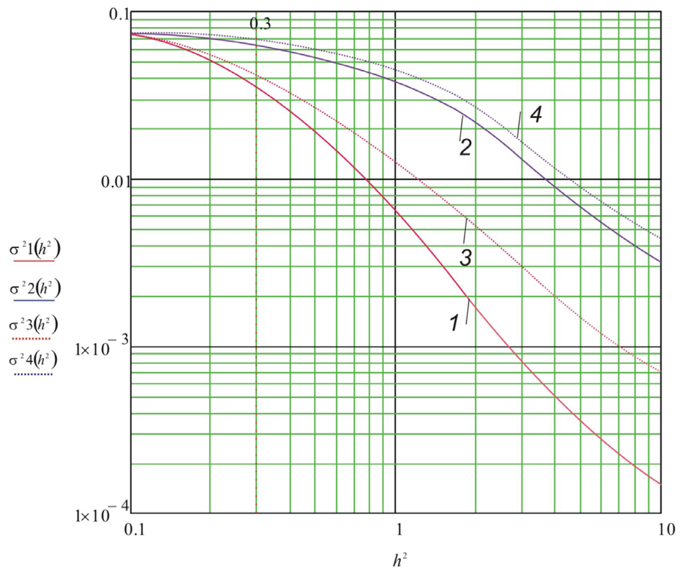

Fig. 6. Graphs of dispersion error σ_γ^2 dependence on signal to noise ratio h_0^2: 1 – $\chi_0 = 100$, $\delta_0 \to opt$, 2 – $\chi_0 = 25$, $\delta_0 \to opt$;
3 – $\chi_0 = 100$, $\delta_0 = 1$; 4 – $\chi_0 = 25$, $\delta_0 = 1$

The essence of this method is in inserting the grid having nodes $x_k = x_0 + k\xi$, $k = 0, \pm 1, \pm 2, \ldots, \pm N$, $x_0 = 0$, $\xi = 1/2N$, $t_l = t_0 + \delta l$, $l = 0, 1, 2, \ldots$, $\tau_0 = 0$, ξ, δ – grid. The grid function is represented as $\hbar_{k,l} = \hbar(\gamma, t_н)$ when $\gamma = x_k, t_н = t_l$ and differential operators are replaced with difference ones. Initial conditions are: $P_{k,0} = 1$, $k \in (0, \pm N)$, $P_{-N,l} = P_{N,l}$, $P_{N+1,l} = P_{-N+1,l}$, $P_{-N-1,l} = P_{N-1,l}$. References testify that solution is possible to find at the new layer on conditions mentioned above. The stability condition of the difference scheme is worthy to mention: $\frac{\delta}{\xi^2} < \frac{D_0}{2}$.

The equation (6) rewritten with recurrent formulas becomes:

$$P_{k,l+1} = P_{k,l} + \frac{\delta}{2\xi}\left(\alpha_{k+1}P_{k+1,l} - \alpha_{k-1}P_{k-1,l}\right) + \frac{\delta}{D_0\xi^2}\left(h_{k+1}P_{k+1,l} - 2h_k P_{k,l} + h_{k-1}P_{k-1,l}\right), \quad (7)$$

$$l = 0,1,2,...,$$

There is a numerical solution of this equation which appears as:

$\omega(\phi,\tau) = 1/2\pi \cdot (\mathrm{ch}\,\tau\text{-}\mathrm{ch}\,\tau \cdot \cos\phi)$.

The error should be assessed by comparing grid functions of two types — the accurate and the numerical solutions; and by finding $\Delta = \frac{\omega_T(\phi,\tau) - \omega_ч(\phi,\tau)}{\omega_T(\phi,\tau)} \cdot 100\%$ along the layers in nodes of selected grid.

This approach will be used to assess error of clock synchronization. Fig. 7 shows transient process, fig. 8 — dependences of numerical solution (7), and fig. 9 represents graphs, which describe process of setting on stationary mode at error probability $p_0 = 10^{-3}$, in case of Gaussian minimum shift keying (GMSK) digital manipulation. Modeling parameters are: $\Delta F_{нор} = 5 \cdot 10^{-2}$, $\xi = 0{,}01$, $\delta = 0{,}001$.

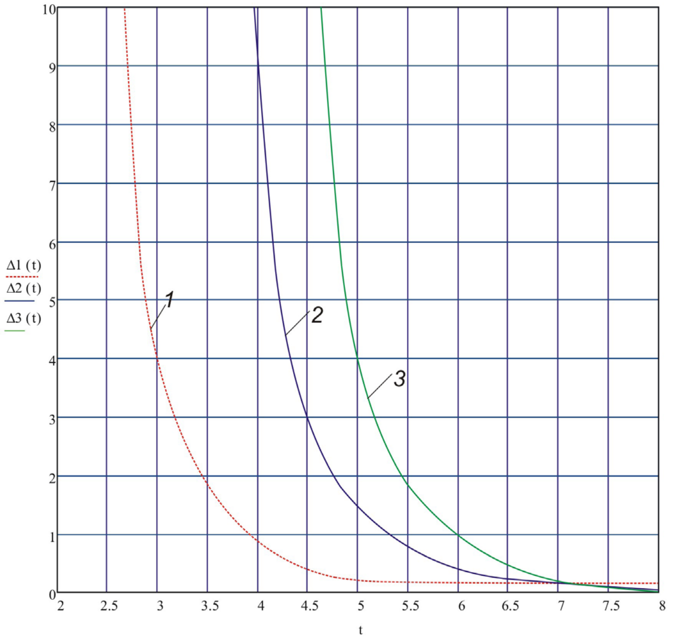

Fig. 7. Graphs of transient processes $t_н$ ($p_0 = 10^{-3}$): 1 – $\varpi t = 5 \cdot 10^{-2}$; 2 – $\varpi t = 1 \cdot 10^{-2}$; 3 – $\varpi t = 5 \cdot 10^{-3}$

The research has identified less than one percent error in numerical search of solution using grid method fig. 8.

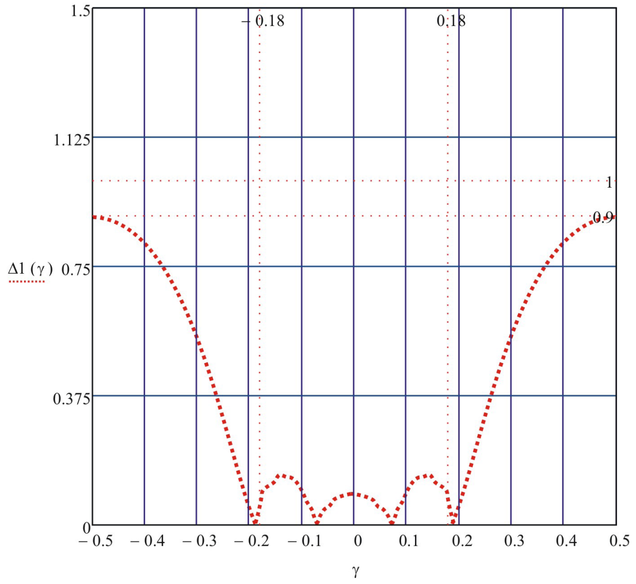

Fig. 8. Numeical stationary solutions by grid method: Δ – given in percents

The research results in form of graphs which describe transient process for the value of signal to noise ratio that corresponds to error probability $p_0 = 10^{-3}$ (fig. 9) and assessed dependences of transient process duration in a system in case of deviation of current dispersion $\sigma^2_{current}$ of synchronization error on its value in stationary mode $\sigma^2_{stationary}$, testify that in case of narrowing band in synchronization system, what means reducing monitoring error, the transient process time gets increased (fig. 7). Besides, in case when the band of synchronization system changes then getting on stationary mode goes with larger amount of symbols.

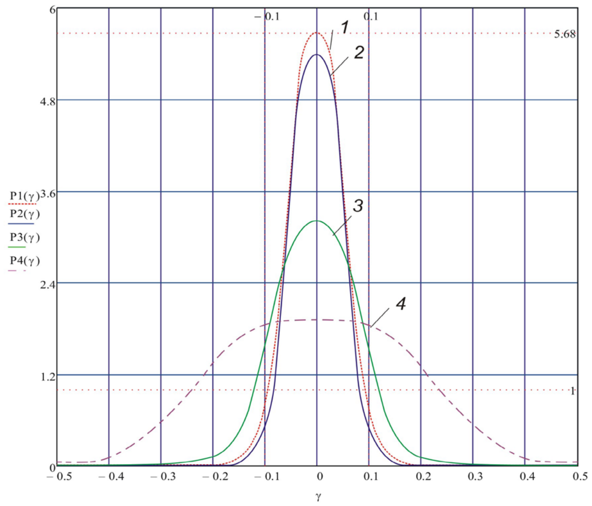

Fig. 9. Graphs of density of probability distribution at different values of normalized time $t_и$ ($p_0 = 10^{-3}, \varpi t = 5 \cdot 10^{-2}$): 1 – stationary state; 2 – $t_и = 2$; 3 – $t_и = 1$; 4 – $t_и = 0.5$

Paper represents obtained analytical and graphical changes of discriminatory characteristics at different values of signal to noise ratio, and research that bonds influence of signal to noise ratio and accuracy of clock synchronization device (CSD) on condition of their equal noise bands defined that at the level of $\sigma_\gamma^2 = 10^{-3}$ the benefit of CSD-1 as compared with CSD-2 makes almost 0.98 dB, for CSD-3–2.7 dB.

References:

1. Juliy Mikolayovych Boiko, Alexander Ivanovych Eromenko. Improvements Encoding Energy Benefit in Protected Telecommunication Data Transmission Channels. Scientific Journal «Communications». Science Publishing Group, USA. Vol. 2, No. 1, 2014, P. 7–14. doi: 10.11648/j.com.20140201.12.
2. Juliy Boiko, Victor Stetsiuk, Victor Michan. Improving noise immunity of QPSK demodulation of signals in digital satellite communication systems/TCSET'2012 IEEE. 21–24 February, pp. 257, Lviv – Slavske.
3. Boiko J. M. Synthesis problems of clock synchronization devices for receivers of satellite telecommunication data transmission systems/J. M. Boiko, A. I. Eromenko//Bulletin of National Technical University of Ukraine «Kyiv Polytechnic Institute» Series – Radiotechnique. Radioapparatus building. – 2014. – Ed. 58. – 55–66 p.
4. Shakhgildyan V. V. Systems phase locked loop with digital elements/V. V. Shakhgildyan. - Moscow: Communications, 1979. – 224 p.
5. William C. Lindsey. Synchronization systems in communication and control. – Prentice - Hall, Inc. Englewood Cliffs, New Jersey, 1972. – 600 p.

Inogamdjanov Davrug D.,
Kasimov Otabek R.,
Dr. prof. Askarali D. Daminov
Tashkent institute of textile and light industry

The influence of construction phase on the moving ability of cross-sections of woven structure

Abstract: The purpose of this study is to work out for bases to predict of properties for single flat woven fabrics depending to construction phases. A structural model of cross-section of single flat fabric is described based on the Pierce's model. Form transformation of the yarn like straight, semi-arch and arch are considered according to the alteration of thread tension under the theory of Novikov. The value contributions to movement index of warp and weft and their total moving ability in cross-sections at all structure phases of fabric are summarized.

Keywords: woven fabric structure, yarn cross-section, yarn form, yarn moving ability.

Introduction. It is well known that woven fabrics are extremely complicated materials and do not conform to any of the ideal parameters which normally assumed in engineering structural analysis and mechanics[1]. From the geometric viewpoint, the woven fabric mostly consists of cross-section of lines of two systems located mutually perpendicularly. The smallest group of yarn interlacing including all design of fabric called unit cells (or repeat) as illustrated in Fig.1.

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[1] Daminov A. D. Bases of forecasting of structure and design of textile cloths. Doctorate dissertation. Tashkent – 2006 (in Russian).