

**CONTENTS AND ABSTRACTS****RADIOENGINEERING, RADIOLOCATION  
AND COMMUNICATION SYSTEMS****S.N. Kirillov, A.A. Lisnichuk. MULTI-CRITERIA SYNTHESIS OF SIGNAL-CODE SEQUENCE  
BASED ON DEPENDENT SIGNALS TO ADAPT DATA COMMUNICATION RADIO SYSTEM  
TO NARROW-BAND INTERFERENCE**

Key words: synthesis of signal-code sequences, synthesis of radio signals, adaptive data communication systems, multi-criteria optimization, increase immunity to radio narrow-band interference.

The use of the known signal-code sequences (SCS) in data communication radio system under the action of narrow-band interference leads to significant losses in radio noise immunity.

The aim is to develop the procedure for multi-criteria synthesis of signal-code sequence based on dependent signals to adapt data communication radio system to narrow-band interference.

The proposed procedure of SCS synthesis based on dependent signals makes use of combined quality criterion. This fact allows us to consider the following particular criteria responsible for throughput and attenuation of action from narrow-band interference, out-of-band radiation, noise immunity to «white» Gaussian noise as well as SCS power efficiency.

It is shown that the synthesized signal-code sequences received with the help of multi-criteria synthesis procedure offered increase radio narrow-band interference immunity by more than 23 dB and 20 dB compared to FQPSK signal-code sequence and QPSK signal respectively.

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**D.I. Popov. ESTIMATION ACCURACY OF RADAR TARGET ANGULAR COORDINATE**

Key words: antenna beam, pattern form, discrete scanning, estimation potential accuracy, signal, clutter, radar target, angular coordinate.

The potential to estimate the accuracy of radar target angular coordinate for discrete and linear scanning of antenna beam is considered. The aim of the paper is a comparative analysis of the potential accuracy of angular coordinate estimation for both types of scanning the antenna beam, depending on signal and clutter parameters and angular position of the target. For two positions of a discretely scanned antenna beam, a likelihood function is introduced that takes into account correlation properties of a signal and a clutter. Based on the Cramer-Rao expression, we obtain a formula for the variance of angular coordinate estimate. An approximation is proposed for the form of antenna directivity diagram. The results of calculations of root-mean-square error of angular coordinate measurement are presented. The results of calculations have established the fact that with discrete scanning of antenna beam it is possible to achieve higher accuracy of angular coordinate estimation than with linear scanning.

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**V.K. Klochko, S.M. Gudkov.** CLASSIFICATION OF RADIO THERMAL OBJECTS IMAGES IN SYSTEM OF SEVERAL RADIOMETERS

Key words: passive radiovision, radiometer, millimetric range, classification of images, indices of closeness of images.

In the distributed systems of passive radiovision intended for automatic detection and recognition of observation objects according to several radiometers there is a need for the classification of the images received by radiometers by their compliance to these or those objects.

**The aim of the paper** is to offer the optimum approach to solve the task of images classification responding to criterion of maximum likelihood and allowing to increase definition of images and also to concretize this approach for the offered indices of images closeness which do not require the recovery of images. In operation the algorithm of quasioptimum classification allowing to break a computing barrier in case of search of options is reasonable. The rules of computation of images closeness indices allowing to solve the problem of classification without operations of images recovery and by that to increase high-speed performance of classification algorithm are offered. The possibility of classification on the example of two real radio thermal images is shown.

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**S.S. Mamonov, A.O. Kharlamova.** FORCED SYNCHRONIZATION OF PHASE SYSTEMS AUTOMOTIVE EQUIPMENT WITH LANDING

Key words: phase systems, phase-locked loop, dynamic modes, quasi-synchronous modes, synchronization, limit cycles, rotation of a vector field, multipliers.

We consider a mathematical model of phase-locked loop (PLL) with delay, in the case of a second-order fractional-rational integrating filter. For the PLL system, conditions for the existence of several quasisynchronous regimes that determine phase-locking regimes have been obtained. The effect of delay on phase multistability of the system is analyzed. A comparative analysis of quasisynchronous regimes obtained is shown on the basis of their multiplicative characteristics. The aim of the paper is to develop a numerical-analytical approach for determining the conditions for the existence of quasisynchronous regimes of phase systems corresponding to the first-order limiting cycles of a system of third-order differential equations with a cylindrical phase space, developing an algorithm for finding unstable limit cycles, determining the low-pass filter and delay coefficients for realization in the system of PLL phase-locked loop.

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**B.I. Filippov, E.A. Malakhova.** PRINCIPLES OF HYDROACOUSTIC COMMUNICATION SYSTEMS CREATION

Key words: hydroacoustic communication link, mobile telecommunication system, cellular network, underwater mobile objects, cellular cells, terrestrial cellular systems, service zone, microcellular communication system.

The article considers the principle of creation of hydroacoustic communication network. **The aim of the paper** is determination of bases to create hydroacoustic communication network. At the same time very valuable experience of terrestrial mobile telecommunication systems creation in case of which tasks of rational use of radio-frequency resource selected for this system, survivability, confidentiality and reliability of message passing were successfully solved is considered. This result was achieved by a reasonable and rational combination of practically all means of improving the transmission quality of messages which the general theory of communication considers nowadays. To support the interaction of mobile underwater objects and repeaters it is recommended to use asynchronously – address transmission in combination with application of noise-type signals. The necessity to

study relative to optimum combinations of interlace, channel coding, races on frequency and encodings of transferred discrete information is specified.

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**A.A. Boev, M.Y. Kernosov, S.N. Kuznetsov, B.I. Ognev, A.A. Parshin. WIRELESS COMMUNICATION CHANNEL WITH 40 GBPS DATA RATE**

Key words: Wireless Optical Communication, 40 Gbps wireless, Free Space Optics, optical communication terminal, MANET, wavelength division multiplexing (WDM), high-speed secure communication channel.

The main driver for the development of wireless optical communications is to increase the bandwidth of wireless channel. In the optical range this can be achieved by relatively simple means, using widely used in fiber-optic technology wavelength division multiplexing (WDM). The efficiency of the specified decision is promoted also by the fact that practically all components for narrow-band transmitters and optical filters are present at the market for fiber optic applications. The challenge is how to integrate these components in a wireless optical channel.

The aim of this work was to verify the possibility of using WDM technology in the atmospheric channel, which is characterized by a high level of turbulence. Atmospheric turbulence leads to significant signal reception instability unlike fiber-optic communication line. In this article the research results of solutions for the transmission of 4 Ethernet 10 Gbps streams via the atmospheric channel at different distances are given. Equipment for research was built on the basis of serially produced Artolink M1-10GE model which provides 10 Gbps data rate on a single wavelength in the initial configuration.

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**COMPUTER ENGINEERING,  
INFORMATION SYSTEMS AND TECHNOLOGIES**

**V.V. Belov, N.N. Vlasov, D.A. Vodichenkov. DESCRIPTION MODEL OF PROSPECTIVELY SIMULATOR OPERATIONAL-TACTICAL MISSILE SYSTEM**

Key words: training simulator facility, complex features, CASE-tools, simulator model 9F694-E.

The article discusses the model, created while designing training simulator facility (product index 9F694-E), intended for training of self-propelled launcher crew (product index 9P78-1-E) of operational-tactical missile complex (OTMS) «Iskander-E» (internal corporate name «Iskander-E tactical ballistic missile system»). Fragments of the created model are discussed in the article. The basic skills received by the trained crew in the training process are formulated. The project decisions realized in 9F694-E productively are used now in the developed project of OTMS exercise machine Iskander-E in general.

*The aim* of the work is to describe the model of prospectively simulator operational-tactical missile system and to present the experience of creating the simulator of the most important subsystem (self-propelled launcher) of the Iskander-E missile defense system.

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**V.P. Koryachko, A.P. Shibanov, V.A. Shibanov, A.Z. Nguen. PROCEDURES FOR SEARCHING OBJECTS BASED ON THE USE OF GERT NETWORKS**

Key words: GERT networks, characteristic functions, object detection, control phase, false object recognition, object skipping, object search time allocation, detection probability, equivalent simplifying transformations method.

Methods for calculating the reliability and probabilistic-temporal characteristics of the process of detecting objects in a given search area are considered. Unlike the prototype, which

contains the mathematical expectation and variance of the execution time of the object detection process using Laplace transforms and z-transforms, numerical and analytical methods for obtaining search time distributions using GERT-networks are considered. The aim of the work is to obtain the distribution densities of object detection for any set of operations performed, the execution time of which is reflected by random variables. Calculations of the stochastic characteristics of the object detection time in the considered region are carried out by the method of equivalent simplifying transformations of the structure of GERT network of the object search process with polynomial computational complexity. Perspectives of further research are considered.

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**V.V. Kureichik, M.A. Zhilenkov. HYBRID ALGORITHM TO SOLVE DESIGN ENGINEERING OPTIMIZATION TASKS WITH ACCOUNT OF ELECTROMAGNETIC COMPATIBILITY**

Key words: Design engineering; optimization; electromagnetic compatibility; Algorithm of the bee colony (Algorithm Bee Colony); Differential evolution (DE); Numerical methods.

The article considers the solution of optimization problems of development design. The statement of the problem is multi-criteria optimization of given development design. The main selected criterion is electromagnetic compatibility (EMC). A mathematical model of the problem is constructed. To solve this problem, the article proposes a modified algorithm of colony bees (Algorithm Bee Colony) and differential evolution (DE) with hybridization by numerical methods for representing the initial solution. As a modification of the proposed approach, global and local improvements are introduced. In the developed hybrid algorithm, the search of solutions is also performed in the vicinity of various solutions, which avoids falling into local optima. A computational experiment was carried out on test benchmarks. The results of the researches show that the developed hybrid approach allows to quickly receive more effective decisions. The obtained results are on the average by 7 % better than the standard ABC algorithm, which indicates the effectiveness of the developed approach. The BCA lies within the range  $O(n \log n) - O(n^2)$ .

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**V.M. Glushan, I.A. Dubrovsky, O.I. Krasnyuk, M.V. Rybalchenko. ANALYSIS OF VLSI DESIGN COMPLEXITY BY MEANS OF HYBRID HIERARCHICAL CLIENT-SERVER SUBSYSTEM**

Key words: hierarchical client-server architecture, VLSI, emulation, hypergraph, circuit decomposition, placing, routing.

This work contains the analysis of the complexity of VLSI design by means of hybrid hierarchical client-server architecture. The aim of this work is to reveal speed capabilities of VLSI design subsystems built upon homogeneous and hybrid hierarchical client-server architectures. The underlying expression of the imitation research process is given here. The following four main design components are counted in the expression: distribution (decomposition) of a circuit over client computers being on different levels of hierarchical architecture; placing elements in each sub circuit performed by last-level computers; connection routing in each sub circuit; external connection routing between circuits transferred from the last level to the zero level. It is presumed that all the algorithms have polynomial complexity. Hypergraphs are used as the model of circuits. In program emulator, random circuit parameter setting is provided: number of elements, number of element's contacts, branching effort. The emulator outputs the main numerical characteristics on the basis of which, it plots graphical dependencies of steps number and external connections number for each hierarchical architecture which make the main contribution to the complexity of design process.

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**V.V. Suskin, V.I. Potapov. MODELS AND ALGORITHMS TO DESIGN FLAT STRUCTURES OF ELECTRONIC MEANS BASED ON FLEXIBLE ELEMENT BASE**

Key words: flat structure of electronic means, graph-theoretical approach, prohibited figures, trace in a single layer, graph, graph edge, planarity, algorithm, analysis, synthesis, electro-radio element.

For the design of flat structures of electronic means on flexible elemental base it is offered to use graph-theoretical approach based on the theory of characterization management instead of topological approach. Complexity of synthesis algorithms of similar structures is caused by the necessity to take into account wide range of various requirements connected with the specifics of their manufacture and features of constructive-technological decision being developed. The aim of the work is the possibility to use mathematical model of electro-radio elements in the form of flexible elemental base where the order of elements outputs is not defined in advance. The procedure of planar graphs construction, based on the theory of characterization management is developed, allowing to reduce the time for search of the optimal decision due to the finding of forbidden figures and their transfer from a forbidden class to the class of allowed.

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**K.O. Petrosyants, E.I. Batarueva, N.I. Ryabov. CALCULATION OF DELAY AND VOLTAGE DROP IN DIGITAL LSI INTERCONNECTIONS USING COMPACT ELECTRO-THERMAL SPICE-MODEL**

Key words: LSI interconnections, reduction, electro-thermal model, signal delay in interconnections.

Irregular heating of the interconnection lines leads to the distortion of transmitted signals and to the increase of time delay in particular. The aim of the work is to develop the program for calculating the interconnection model parameters (resistances and capacitances) depending on the temperature at the points along interconnection lines. To achieve this goal the following objective is set: development of program tools for delay modeling in LSI interconnections with account for thermal effects. Authors use the interconnection model in the form of distributed RC-circuit, parameters of which depend on the chip surface temperature distribution. The chip surface temperature is calculated by program tool «Overheat-MC», developed by the authors. Interconnection model parameters – resistances and capacitances of RC circuit sections, are calculated on the basis of temperature distribution along the interconnection. This approach allows to take into account the influence of chip non-uniform overheat on interconnection electrical characteristics. For the simplification of interconnection model and CPU time decrease the multi-sectional RC – model is reduced to compact Pi-shaped equivalent circuit with temperature-depended parameters. It is shown that in comparison to Pi-shaped circuit, the signal magnitude error is at most 7 %, the signal phase error is 2 %. In this case, CPU time decreases on the order of 25-30 %.

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**F.G. Maitakov, A.A. Merkulov, E.V. Petrenko, A.Y. Yafasov. TECHNOLOGY OF VIRTUAL WORKING ENVIRONMENT SYNTHESIS FOR HETEROGENEOUS TERRITORIALYDISTRIBUTED TEAMS**

Key words: technology of working environment synthesis, unification of elements and methods of working environment synthesis, amber industry, heterogeneous team, role model, configuration, widget, plugin.

Modern decision support systems (DSS) significantly reduce decision-making time and improve their quality. However, the huge amount of resources spent on the development of such systems, in conditions of transition to digital economy, necessitates the unification of the elements and methods of working environment synthesis. The aim of the work is to develop the technology for the synthesis of unified virtual working environment for heteroge-

neous territorially distributed teams (HTDT). The authors offer a model of unified virtual working environment and a method for its synthesis, which allow to significantly reduce the costs of developing and implementing DSS in specific subject areas and management level. The technology for the synthesis of virtual working environment for HTDT was tested in the course of developing such software projects as «Tourism Industry», network interactive NBICS.Net laboratory, open interactive 3D laboratory, etc., and showed a significant acceleration in the creation of specific working environments and resource savings. Prospects for the implementation of the model on the example of amber industry in Russia are considered.

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## SYSTEM ANALYSIS, CONTROL AND INFORMATION PROCESSING

### S. N. Kirillov, P. S. Pisaka. QUASIOPTIMAL ALGORITHM OF THE UNIFICATION OF TELEMETRIC INFORMATION FROM TERRITORIAL-DISTRIBUTED RECEIVING STATIONS

Key words: telemetry information, receiving stations, interfering factors, frame allocation, distortion of words, integration of telemetric information, processing quality improvement.

The issues of processing telemetric information (TMI) of space rocket equipment transmitted over the communication channel in the presence of interfering factors are considered.

The aim is to create an algorithm for combining TMIs from geographically distributed receiving stations with a given probability of false alarm in order to improve the quality of processing. Experimental studies were performed on full-scale TMI. The dependences to detect the probability of TMI bit on signal-to-noise ratio for different number of receiving stations are constructed. It is shown that the use of information from 2 of 5 receiving stations allows to increase the average probability of detecting TMI bit  $\bar{P}_o$  by 3–5 % (from 0,959 up to 0,995) in comparison with the combining rule «1 of 5» with different signal-to-noise ratio and the probability of false alarm  $P_{\text{fm}} = 10^{-3}$ .

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### V.V. Ignatyev, O.B. Spiridonov, V.M. Kureychik, A.V. Kovalev, A.S. Ignatyeva. METHOD OF HYBRID CONTROL IN INTELLIGENT SYSTEMS BASED ON PID AND PID-FUZZY-CONTROLLERS

Key words: automation, control, hybrid systems, adaptive system, model, PID controller, FUZZY-controller, base of fuzzy rules, neuro-fuzzy inference, training.

The aim of the work is development of a method of hybrid control based on PID and PID-FUZZY-controllers, that allows to connect formalizable and non-formalizable knowledge while designing modern automated and automatic control systems of technological process. To achieve the aim of the work, the approach to technical object control is developed using an adaptive system of neuro-fuzzy inference. The main control elements of the developed adaptive system of neuro-fuzzy inference are PID- and PID-FUZZY-controllers as well as classical and fuzzy control models developed on their basis. The interaction of two models is provided by the developed hybrid control system. As a result of the interaction of two models, the base of fuzzy controller rules is automatically formed based on the knowledge of the object obtained by its control with the help of classical controller, that allows to completely exclude the participation of expert in the design and adjustment of fuzzy controller parameters. In the developed adaptive system of neuro-fuzzy inference, the signal of deviation, signal of deviation differential and signal of control in the classical model are used as data for creation a hybrid network. Signals of deviation and control in a fuzzy model with already automatically generated rules of fuzzy inference are used as data to verify a created hybrid network in order to detect the fact of its retraining. Thus, the application of hybrid control method based on the adaptive system of neuro-fuzzy inference with the use of PID

and PID-FUZZY-controllers allows to provide effective control of a technical object in the conditions of uncertainty.

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**L.A. Demidova, Yu. S. Sokolova. TWO-STAGE DATA CLASSIFICATION METHOD BASED ON SVM ALGORITHM AND THE K NEAREST NEIGHBORS ALGORITHM**

Key words: SVM classifier, support vectors, kernel function type, kernel function parameters, regularization parameter, kNN classifier, classification method.

The classification problem of elaborate multidimensional data which is inherent in various socio-economic, technical and other systems has been considered. The aim is the classification accuracy increase of elaborate multidimensional data by means of development of two-stage classification method based on the combined use of SVM and kNN classifiers. At the first stage of the classification method SVM classifier on the base of initial learning dataset  $U$  is developed and the width of  $\Omega$ -area containing all objects classified erroneously by SVM classifier. Objects classified erroneously together with correctly classified objects which are also located in the  $\Omega$ -area and the corresponding classes tags of objects from  $\Omega$ -area form the new  $G$  dataset. At the second stage of the classification method kNN classifier developed on the base of information about the objects of  $U \setminus G$  set is applied to all objects of  $G$  data set from  $\Omega$ -area. In case of improvement of the classification quality of objects belonging to  $\Omega$ -area, the offered two-stage method can be recommended for classification of new objects. The parameters values of kNN classifier are defined experimentally to provide the greatest possible classification accuracy of objects. As the correctly classified objects can also get to  $\Omega$ -area created in the above-stated way, the condition of applicability of the offered method is general improvement of classification quality. The given results of experimental studies confirm the efficiency of the offered method application in the classification problem of elaborate multidimensional data.

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**INSTRUMENT ENGINEERING  
AND INFORMATION-MEASURING SYSTEMS**

**D.A. Morozov, B.A. Polonsky, A.YU. Kuzmich, E.Yu. Grachev, A.A. Trubitsyn. HIGH-VOLTAGE POWER SUPPLY FOR MICROFOCUS X-RAY TUBE OF MEDIUM POWER**

Key words: X-ray tube, high-voltage power supply, resonant converter, voltage multiplier, half-bridge driver, power MOS-keys, PWM controller, stabilizer of emission current

The work is devoted to the development of a high-voltage power supply unit for a micro-focus X-ray tube that includes a negative high voltage source of 80 kV and a cathode emission stabilizer for a tube up to 3 mA (240 watts). To increase the efficiency of sources and reduce mass-dimension indicators, the sources are built on the basis of resonant power converters providing switching of power switches at zero current or zero voltage. The aim of the work is to develop and simulate the circuit of a high-voltage resonant converter using the original method of controlling output voltage by changing the supply voltage of power stage of resonant converter. Using the scheme of modern silicone compound Silagerm-2106 for high-voltage insulation elements allowed to further reduce the dimensions of circuit and to place it in a typical telecommunications unit.

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**V.V. Suskin, V.T. Fam.** MODEL OF CALCULATION OF THE TEMPERATURE MODE OF THE PHOTOELECTRIC PANEL WITH COOLING THE HEAT RADIATOR IN THE FORM OF CHANNELS

Key words: Photovoltaic panel, structural and technological parameters, efficiency coefficient, temperature gradient, solar radiation, thermal conductivity, differential equation.

Considering and studying on building a model for calculating the status of solar panels with cooling the heat radiator in the form of channels, working at high temperatures. The aim of the article is to develop a model and to study the dependence of solar panels with cooling the heat radiator in the form of channels on technology-fabrication and operation parameters. The research of a given mathematical model in different values of initial parameters has been performed. This kind of mathematical study including initial parameter values has shown that the temperature on solar panel surface is reduced by the application of panels with cooling the heat radiator in the form of channels. The model has been developed to enable optimization of technology-fabrication parameters of solar panels with cooling by heat radiator in the form of channels used to create effective structures with small performance changes when working in high operating temperatures.

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**V.D. Rogachev, A.V. Nabatchikov, S.V. Rodin.** DEVICE FOR STORAGE BATTERY SELF-DISCHARGE COMPENSATION WITH CURRENT SOURCE BASED ON PHOTOELEMENTS

Key words: battery, compensation self-discharge, cells, electrolyte, capacitance.

A device to compensate self-discharge rechargeable battery used as a current source of solar cells is considered. The proposed device provides individual adjustment to compensate self-discharge of each battery, has short circuit protection and does not require power for industrial network or other sources of electricity. The aim of this work is to develop recommendations and proposals to compensate self-discharge of storage batteries kept in storage and under field conditions using modern polycrystalline solar cell.

The urgency of this work is explained by the fact that batteries of military vehicles are used to power the starting system and ensure its readiness for use as intended. During long storage the batteries are subject to self-discharge and lose their electric capacity which leads, to ensure their serviceability, to the compensation of its loss.

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**B.I. Filippov, T.B. Trush.** METHOD TO MEASURE SIGNAL DISTRIBUTION DURATION IN HYDROACOUSTIC CHANNEL BASED ON MESSAGES TO SINGLE TIME SCALE

Key words: hydroacoustic channel, measurement object, multifunction sonar, operational hydroacoustic complex, single time scale.

The work is dedicated to the measurement of distance by determining the signal propagation time between the measured object (MO) and the multifunctional sonar (MS) based on the binding of hours established in MO and MS to scale a single time. It is shown that major factors determining the value of the error in determining the distance between MO and MS along with disturbance acting on the signal in the communication channel include regular component of relative instability of oscillators used for tasks in MO since the time of transmission of the acoustic signal in the direction of MS, as well as for fixing the detection of this signal in MS. The estimate of allowable error information generators has been received, which must not exceed the value of  $4,8 \cdot 10^{-9}$  in the conditions of usage as crystal oscillator GK75 – the vehicle. Requirements to choose the generator model, which should implement the reduction of oscillators' frequencies, are formulated. It is shown that the relative instability of generator frequency model should not exceed  $5 \cdot 10^{-10}$ . As a generator model the domestic equipment of frequency – timing MRK - 23 is proposed to be used.

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## ELECTRONICS AND NANOELECTRONICS

**V.K. Bazylev, A.M. Zhidkov, V.A. Korotchenko, V.E. Skvortsov, T.N. Andreasyan.** PHYSICAL MECHANISM OPERATION OF ORBITRON ELECTRONIC TRAP IN IONIZATION GAUGE

Key words: orbitron vacuum sensor, computer modeling, motion of electrons.

Electron motion numerical simulation results in well-known highly sensitive vacuum gauge of orbitron type at spiral-shuttle particle path with time lapse about 10 ns, axial oscillations period 50 ns, general number of turns about 4000 and path length before 200 m has been shown. On the first step the particle acquires azimuthal component velocity on the way out of local potential well of cathode that prevents its hit for anode. On the second step the electron gets batches of supplementary axial deceleration on intercepting well and reduces the amplitude of axial oscillations. The third step shows significant reducing of spiral radius oscillation amplitude. The aim of the paper is to define physical mechanism operation of optimal orbitron electron trap in ionization gauge.

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**D.V. Suvorov, G.P. Gololobov, M.A. Serpova, YU.M. Stryuchkova, N.B. Rybin.** ELECTROCHEMICAL SYNTHESIS OF NANOSTRUCTURED COATING BASED ON TITANIUM DIOXIDE

Key words: anodizing, electrochemical synthesis, titanium dioxide, nanotubes, coating structure, films, catalytic coating, anodic oxidation.

The article presents the results of the study of titanium dioxide anodic layer morphology obtained by electrochemical synthesis under various anodic conditions. A method for the electrochemical formation of nanoporous TiO<sub>2</sub> structure under the conditions of superimposing an alternating voltage component to a constant component (in the frequency range 100 Hz – 1 MHz) is proposed. The aim of the work is to study the influence of the electrode potential and the anodizing regime on geometric characteristics of TiO<sub>2</sub> coating. It is shown that under certain conditions of anodic oxidation, coatings based on TiO<sub>2</sub> have tubular structure with a high degree of ordering relative to the substrate. Formation of titanium dioxide films under the conditions of superposition of a variable component of the potential with a constant component leads to an increase in coating formation rate by 5-7 times and to qualitative structural changes: open intertube space appears, «intertubular bridges» are formed, and the shape of nanotube cross section is «rounded».

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**A.V. Ermachikhin, N.V. Mukhin, V.G. Litvinov, N.B. Rybin, M.V. Rudenko, N.V. Gaponenko, P.A. Kholov.** ELECTRICAL RESISTANCE INVESTIGATION OF STRONTIUM TITANATE FILMS FORMED BY SOL-GEL METHOD

Key words: strontium titanate, ferroelectric, electrical resistance, current-voltage characteristic, capacitor structure.

The changes in the electrical resistance of a strontium titanate film prepared by sol-gel method under the influence of pulsed and linearly increasing voltage are considered. The aim of this paper is investigation of changing of capacitor structure electrical resistance based on a strontium titanate film from a high-resistance state to a low-resistance state and vice versa. The reversible change in electrical resistance of a strontium titanate film by four orders of magnitude is studied. The electrical resistance of the capacitor structure has varied from several ohms to several tens of kilohms. On the basis of current-voltage characteristics and under illumination the photovoltaic properties of strontium titanate films are presented.

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**V.A. Karachinov, M.V. Kazakova, D.V. Karachinov, D.A. Evstigneev, D.A. Bondarev. REFRACTOMETRIC SiC-DETECTOR WITH HOLE MICRORELIEF**

Key words: carried out lattices method, image, thermal field, heat flow, SiC-detector, microholes, laser processing.

Implementation of carried out lattice method, using the TV-shadow system for registration of temperature fields of heated gas streams, requires the creation of new detectors able to further fulfill the function of defocused lattice.

The aim of the work is to develop basic method of visualization of temperature processes in heated flows by means of modified SiC-detector with ordered microholes on its surface in the form of lattice for visualization, as well as to determine basic parameters of the way to manufacture a detector. As a result of studies different SiC-detectors with different depth of microholes have been produced. It is determined that the selection of basic characteristics of the sensor depends on temperature zone settings of studies and its functions in the system. The technology of microholes manufacturing is developed and testing of the method is conducted. The obtained results of laser processing energy parameters calculation allowed determining the optimal parameters for obtaining microholes, the minimum size of which reached several micrometers.

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