

<b>CONTENTS AND ABSTRACTS</b>
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## RADIOENGINEERING, RADIOLOCATION AND COMMUNICATION SYSTEMS

### V.A. Prasolov, D.A. Tokarev. AUTOMATIC REPEAT REQUEST WITH TURBO-CODES DECODING

Key words: majority checks, convolutional code, repeats, probabilistic-temporal characteristics.

The approach to increase probabilistic-temporal characteristics of information exchange in data transmission systems applying the combination of forward error correction scheme with repeated data transmission is considered. The aim of the work is to increase the reliability and efficiency of data reception by rational use of repeated requests accumulated on the receiving side. Different options to transmit check symbols of convolutional code are used as the scheme of encoding. The varieties of convolutional coding and majority checks combinations as well as the ways to distribute check symbols of a code according to blocks sent to a receiver successively using perforation technique are considered. The relevance of the research is caused by the necessity to increase reliability and efficiency in the process of transmitting data to the receiver in the conditions of the limitations on the possibility to change frequency-energy resource of data transmission system.

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### D. V. Avramenko. SPECTRAL ESTIMATION OF MULTI-FREQUENCY REFLECTIONS FROM A ROTATING SPACE OBJECT BY LEAST-SQUARES PRONY'S METHOD

Key words: linear vector auto regression, Prony's method, spectrum, spectral, parametric estimation, vector time series modeling, redefined equations system of Yule-Walker, quasiinverse matrix, minimization of mean square error.

The article is devoted to the problem of spectral analysis of reflections from a rotating space object in the process of simultaneous observations in different ranges of lengths of electromagnetic waves. The aim of this work is to improve the quality of spectral estimation of process, variability of multi-frequency reflections from space objects. The method of modeling is based on describing experimental data by the sum of exponential functions. Least squares Prony's method is proposed to be used. The exponential model was used to determine energy spectral density of a signal. It is shown that the application of this method in the presence of decreasing (increasing) of signal power and small (1...5) number of observed periods of object rotation enables to reduce relative deviation  $\Delta F$  (from 2 to 60 times), in comparison with usual vector autoregressive approach.

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### O. V. Pavlov, I. S. Kholopov. COMPARATIVE ANALYSIS OF TWO LED CLUSTER SELECTION ALGORITHMS IN NAVIGATION TASK WITH OPTICAL REFERENCE MARKS

Key words: PnP algorithms, cluster, reference LED emitter, light emission diagram, peak signal-to-noise ratio.

The aim of the work is the comparison of two algorithms for reference LED cluster selection in optical navigation systems with reference marks: the criterion of maximum LED cluster image area and maximum intensity of reference marks. It is shown that if LED light emission diagram is approximated by the family of parametric curves  $\cos^{g-1}\theta_n$  with exponent  $g \geq 2$  and peak signal-to-noise ratio  $q < 15$  then the cluster selection criteria by maximum intensity is more preferable.

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**D. I. Lukyanov, A. S. Mikhailova. AUTOMATIC IDENTIFICATION OF A PERSON ACCORDING TO VOICE USING THE ALGORITHM BASED ON GAUSSIAN MIXES MODEL**

Key words: recognitions of voice information, recognition systems, identification of a person according to voice, method of mean squared deviation, method of minimum distance, method swept-cepstral conversions of RS range, cepstrum, model of Gaussian compounds, optimum number of clusters.

Methods of automatic identification of a person according to voice are researched. The aim of the work is determination of the most effective algorithm of identification of a person on the basis of speech signal providing high probability of correct identification. Pilot studies of the algorithm on the basis of method of mean square deviation, minimum distance, Gaussian mixes are conducted. Identification of a person using the algorithm on the basis of method of mean square deviation isn't completely invariant to initial RS as is effective for short speech messages containing one word. Identification of a person using the algorithm on the basis of method of minimum distance allows to carry out identification at the level of man/woman. One of the most effective methods is the method based on Gaussian mixes model. The optimum number of clusters for recognition is equal to 5. Implementation of the algorithm on the basis of model of Gaussian mixes allows to make correct identification with probability to 75 %.

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**COMPUTER ENGINEERING, INFORMATION SYSTEMS AND TECHNOLOGIES****S.N. Danilin, S.A. Shchanikov, A.E. Sakulin. DETERMINATION OF ARTIFICIAL NEURAL NETWORKS TOLERANCES BASED ON NANOMEMRISTORS**

Key words: Artificial neural networks, neurocomputers, nanomemistors, operation accuracy, tolerances, signal recognition, squitter.

A general approach to modeling and research of artificial neuron networks based on nano memristors (ANNM) as a system based on the methodology of system analysis and simulation modeling is proposed. When developing ANNM, its functional-structural decomposition was performed with the introduction of several levels of hierarchy: the system; Subsystems; Functional links; Circuit elements. A general approach is proposed to the development of methods for determining and providing quality indicators for ANNM functioning as physics-information objects. An algorithm for determining the tolerances for information parameters of the functional links of ANNM in the process of solving the synthesis problem is developed, which allows to assign tolerances to physical parameters of the means for their implementation. ANNM for detecting infocommunication signal against noise background with parameters in a given range is synthesized and investigated. The tolerances for information parameters of neurons of ANNM are determined to provide a given error in output signal for various noise parameters in input signal.

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**S.V. Skvortsov, T.S. Skvortsova, V.I. Khryukin. SELECTION OF STANDARD FITS WITH RANDOM NATURE OF SIZES OF HOLES AND SHAFTS FOR CAD/CAM SYSTEMS**

Key words: CAD/CAM systems, stochastic simulation, holes and shafts, clearances and interferences, tolerances and fits, tolerance intervals, standard fits, recommended and preferable fits.

The task of calculation of tolerance and deviation limits for holes and shafts according to the given limiting sizes of clearance or interference fit is considered. The aim of this work is the development of technique for selecting standard fits that meet specified accuracy requirements with random nature of sizes of holes and shafts. This technique is based on stochastic simulation and takes into account technological features of production. The distribution laws of hole or shaft tolerance intervals can be any and size limits of these tolerances are absent. A method to choose standard fits based on stochastic simulation of mating details sizes have been developed. The conditions of complex application of the method developed in the combination with known methods taking into consideration technological conditions of an enterprise are defined.

**DOI:** 10.21667/1995-4565-2017-61-3-32-40 ..... 32

**S.F. Tyurin, A.Yu. Skornyakova. SELF-TIMED LOOK UP TABLE**

Key words: CMOS transistor, self-timed circuits, look up table, operational stage, spacer stage, paraphase channel, inverter, logical element.

The problem of self-timed look up table use is studied. The version of look up table is proposed. The look up table is adjusted by constants at the constructing stage of uncommitted logic arrays without using RAM and switch fabrics in order to unify logic and reduce the design complexity. The purpose of this article is to design and research the look up table for development of self-timed circuits. Design of look up table for self-timed circuits (LUT-ST) is completed in NI Multisim 10 electronic schematic capture and simulation program by National Instruments Electronics Workbench Group. The program provides confirmation of technical solution efficiency. The article describes the principle of obtaining self-timed look up table from 1-LUTc element with inverters at input variables. A simulation of these elements is performed at the operational and spacer stages.

**DOI:** 10.21667/1995-4565-2017-61-3-41-45 ..... 41

**A.S. Naidenov. MACHINE LEARNING APPROACH IN THE PHISHING ATTACK DETECTION PROBLEM**

Key words: computer systems and networks, computer attacks detection, phishing attacks, machine learning, classification algorithms, n-gram method, ROC analysis.

The article describes phishing attack detection problem in Internet. The aim is to study the relationship between the external resource properties and the presence of phishing addresses. The study builds the classification model to predict the «original / phishing» resource based on the external resource information using machine learning techniques. Original addresses and spoofed Internet resources from public sources («Open Directory Project» and «PhishTank») were collected. The work carries out lexical analysis of resource address: template selection, key word checks, resource address structure allocation, analysis of the connection to the resource: transmission protocol, connection port. Data are enriched with the information about domain using Whois service. The feature selection is based on model. The article report quality evaluation of classification model, error analysis, the possibility of its practical application is made.

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**O.N. Romashkova, F.O. Fedin, T.N. Ermakova. NEURAL NETWORK COMPUTER MODEL FOR SUPPORTING DECISION-MAKING IN EDUCATIONAL COMPLEXES**

Key words: educational complex, neural network computer model, decision support system, factor analysis, correlation degree, correlation analysis, threshold of significance, neural network, neuron.

The problem of improving the management of the educational complex by creating a neural network model to support the adoption of managerial decisions by the leaders of reorganized educational organizations is considered. The purpose of the work is to develop a neural network computer model that allows to predict the number of students in the educational complex, taking into account the factors that largely influence the choice of the parents of an educational organization. The results of factorial and correlation analysis of the indicators that affect the opinion of parents when choosing an institution for their children are presented. The stages of construction of a neural network are considered. An example of its use is shown.

The constructed neural network computer model can be used in management activity of heads of educational complexes both autonomously and as a module of decision support system.

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**B.V. Kostrov, V.N. Ruchkin, A.N. Kolesenkov. INTELLIGENT CLUSTER PARALLELISM COMPUTER OF NEUROPROCESSOR SYSTEMS**

Key words: intelligent compiler, set-theoretical clustering, explicit and implicit cluster parallelism, compiler algorithm, frame model, expert system, multi-criteria fuzzy choice.

The possibilities are explored and an algorithm for creating an intelligent intellectual compiler based on explicit and implicit cluster parallelism is proposed. The structure of intellectual compilation is considered, analysis of algorithms of explicit concurrency functioning is performed. The aim of the work is the development of mathematical apparatus and algorithms of intelligent compiler of cluster parallelism of neuroprocessor systems. A frame model of expert system for monitoring operations and forming a route has been developed. The interface of explicit and implicit parallelism expert system is described on the basis of multicriterion fuzzy choice of the most rational route

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**SYSTEM ANALYSIS, CONTROL AND INFORMATION PROCESSING****L.A. Demidova, I.A. Klyueva. SEARCH ALGORITHM OF THE PARAMETERS VALUES OF THE BSMOTE-ALGORITHM IN THE PROBLEM OF THE SVM-CLASSIFICATION BASED ON THE IMBALANCED DATASETS**

Key words: imbalanced data, sampling, bSMOTE-algorithm, classification, SVM classifier, radial basis kernel function, PSO algorithm.

The problem of SVM (Support Vector Machine) classification based on the unbalanced data sets applied to generate train sets, using the synthetic algorithm sampling – bSMOTE algorithm (borderline Synthetic Minority Oversampling Technique algorithm) has been considered. The aim of this work is the development of the search algorithm of bSMOTE-algorithm parameters values in the problem of SVM classification of unbalanced datasets, providing the reducing of time expenditures for the development of SVM classifier, characterized by high quality of data classification. The search of SVM classifier parameters values has been implemented with the use of PSO algorithm (Particle Swarm Optimization algorithm). The results of experimental studies confirming the feasibility of the search algorithm of bSMOTE-algorithm parameters values in the problem of SVM classification of unbalanced datasets have been given.

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**A.A. Godeaev, A.V. Gigolaev, N.I. Tsukanova. KOCHONEN CARDS FOR MIXED DATA**

Key words: clustering, Kohonen map, metric, neural network, fuzzy sets, learning without a teacher.

Problems of creation self-organizing Kohonen maps for mixed data and ways of their resolution are examined. It is proposed to select a metric from an allowed set of metrics for each data set and to use fuzzy sets to represent the weights of neurons. The aim of the paper is to create a program which will create self-organizing Kohonen maps and be capable of processing mixed data types using different metrics and to research relations between chosen metric and input data set features with this program. Following problems are discussed: choices of a metric for every data type, data structures for categorical attributes of neuron's weight vector, the algorithm of adjusting these weights to the input effect and methods of dead neurons elimination. Developed program is described and research results obtained with its help are presented.

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**A.A. Voevoda, Yu.P. Filyushov. MULTI-CHANNEL OBJECT CONTROL ALGORITHM SYNTHESIS**

Key words: multi-channel control object, nonlinear coupling of controlled variables and output values, method of Euler Lagrange in Pontryagin form, control synthesis in the function of adjustable variables.

Describes A method of multi-channel object control synthesis in the structure of which nonlinearities like multiplication and division connecting the adjustable variables and output values are

included has been considered. Some simplification of the object is the model of generalized electric machine. Usually applying certain control multichannel object is artificially reduced to single-channel structure. In such systems, by means of force control fast compensation of disturbances while forming the desired motion trajectory is provided. But the possibilities of force control are limited by the voltage of power supply. When all department resources are exhausted, to reduce the time of output value formation in a single-channel system is not possible. Control opportunities are limited and do not allow to adjust multiple output values. The aim of the work is to enter structural parametric compensation of nonlinearity, which provides linear dependence of output values from the task. Using variation method the task to change the state of multi-channel object in minimum time during the formation of multiple output values in terms of set limitations has been solved.

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#### **A.I. Bobikov, T.S. Bubnova.** SMITH PREDICTOR PROPERTIES ADJUSTMENT USING SIMULINK RESPONSE OPTIMIZATION SOFTWARE

Key words: Object with delay, Smith's predictor, PI controller, Simulink response optimization, transfer function (TF).

In industrial control systems, there is often a delay, often associated with the transportation of materials or energy. The appearance of Smith predictor in 1957 provided the developers with the opportunity to reduce negative effect of delay on the response quality of the controlled system. In this paper we consider a modified Smith predictor with a filter, used to reduce the influence of disturbances and increase the robustness of control system. Using the Simulink response optimization package, it is proposed to optimize filter settings, as well as PI controller, since manual tuning is laborious enough and does not always allow finding optimal system parameters. In addition to optimizing the parameters, the package makes it possible to take into account the uncertainty of dynamic parameters of control object, in order to ensure the robustness of the system.

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#### **G.V. Syroezhkin, A.B. Savinetsky, A.M. Maurer.** AVERAGE IMAGE CREATION METHODS USING REFERENCE LANDMARKS

Key words: average portrait, mean image, image transformation, triangulation, reference landmarks, Galton, Perrett, face.

The problem of average image creation using reference landmarks is studied. The aim of the research work is to develop average image creation methods based on averaging transformed group of images using different number of reference landmarks. Averaging methods based on two, three and arbitrary number of reference landmarks using carcass are reviewed. The results of the application of methods on the selection of images of human faces confirm the possibility of creating specialized software for the creation of generalized images.

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### **INSTRUMENT ENGINEERING AND INFORMATION-MEASURING SYSTEMS**

#### **A.A. Voevoda, K.M. Bobobekov.** INVERTED PENDULUM EVALUATION PARAMETRES IN STABILIZATION SYSTEM OF ANGULAR POSITION

Key words: evaluation of object parameters, active identification, inverted pendulum, stabilization system, polynomial synthesis method, control object, PID – regulators, variation of object parameters, special nomograms.

The problem of estimating the parameters of the inverted pendulum on a cart in the system of angular position stabilization and control of this cart given position is investigated. The linear approximation model includes four integrators and three unknown parameters. Regulators are calculated by polynomial and represent PID – regulators. To solve the problem of estimating the parameters of the object active identification method is used which consists of setting the initial angular position of the pendulum and measuring angular position values of the pendulum and the position of the cart at predetermined times that gives three numbers (amplitudes). Identifica-

tion problem thus can be reduced to establishing links between three object parameters and three values of the transients at fixed times for which it is necessary to measure the values of three amplitudes for the object with different parameter values. It is assumed that object parameters can take the values of specified intervals that can be interpreted as a cube with a uniform grid, for each point of which it is necessary to carry out the experiment to measure three amplitudes. Results of these measurements can be represented in the form of tables or nomogram according to which it is not difficult to solve the problem of identification of object parameters. Aim of the work: Determination of pendulum parameters on the car in stabilization system using special nomograms using the method of active identification.

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**V.V. Suskin, V.T. Fam. MATHEMATICAL MODEL OF THE DESIGN OF PHOTO-ELECTRIC PANEL WITH COOLING**

Key words: photo-electric panel, design and technological parameters, efficiency, absorption coefficient, sunlight, heat conductivity, heat convection, laminar process, turbulent process.

The task to analyze known solutions for the design of photovoltaic solar panels to maintain their performance when working in high temperature environments is considered. Research of algorithm modeling demonstrates the proper rendering of solar thermal photovoltaic devices, which enables the automated design process and optimum solution design technology. The aim of this article is to formalize the methodology that provides efficient storage of solar photovoltaic panels that operate in high temperature environments. The results of this mathematical model can be derived with different initial parameter values.

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**A.N. Shesterkin. DETERMINING LIGHTING RELIABILITY OF PLASMA DISPLAY PANEL**

Key words: plasma display panel, display element, delay in discharge occurrence, superposition of exponential distributions, probability of lighting, average delay, statistical modeling.

The aim of the work is to determine reliability of display element, lighting of which is possible both by «itself» and by «illumination». In order to describe delay in the discharge occurrence it is proposed to use superposition of two exponential distributions. The first term of the distribution takes into account the display after selflighting, the second one – delay after illumination of the element. The properties of the element with such characteristics were analyzed. Conducted statistical modeling of the researched processes has confirmed the validity of the results.

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## ELECTRONICS AND NANOELECTRONICS

**A.S. Aref'ev, G.P. Gololobov, D.V. Suvorov, M.A. Serpova, E.V. Slivkin. EVALUATION OF SPRAY COEFFICIENT IN DEVELOPMENT TECHNOLOGY OF THE DEVICES FOR PLASMA ELECTRONICS**

Key words: cathode sputtering, solid surface, ion beam, erosion processes, sputtering coefficient, thermal peaks regime, high-temperature field, atomized atoms, gas-discharge devices, collisional theory, calculation technique, electron microscopic examination of a surface.

The article presents various cathode sputtering regimes based on the cascade collision theory of Zygmund. The relevance of studying the cathode sputtering process in relation to various fields of science and technology, in particular, the technology of creating devices for vacuum and plasma electronics, is shown. The aim of the work is to develop a methodology for estimating the coefficient of atomization of a material in the process of cathode sputtering when creating devices for plasma electronics. Estimation of the spray coefficient based on the thermal peak regime as the most probable is given. A feature of the presented method for calculating the local sputtering coefficient is that the estimate is based on the erosion model of the collision theory in cathode sputtering, taking into account the melting and evaporation processes of the cathode material. A function describing the distribution of sputtered cathode particles with respect to the component pulse normal to the atomized surface is determined.

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**D.S. Kusakin, V.G. Litvinov, N.B. Rybin, V.S. Litvinova, V.N. Shchelushkin, A.I. Khudysh.** LOCAL INVESTIGATION OF C-V CHARACTERISTICS OF A SOLAR CELL BASED ON P-SI WITH MODIFIED SURFACE

Key words: measuring complex, C-V-characteristic, charge carrier concentration profile, atomic force microscopy, solar cell, conductive probe AFM.

An automated measuring complex was developed for the local study of volt -faradic characteristics of semiconductor structures based on the probe system of an atomic force microscope. A technique for measuring electrical capacitance is described when contacting a sample surface with AFM probe. The aim of this work is to conduct studies of electrical properties of a semiconductor structure with developed surface relief used in the production of solar cells based on Si. Experimental C-V characteristics of a test sample with developed surface relief in the depth of the relief and on its elevation have been obtained. The charge carrier density profile for the test structure at the elevation and in the basin is constructed. A difference in the concentration of charge carriers in different regions of the test sample was observed.

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**N.V. Rybina, S.P. Vikhrov, N.B. Rybin.** CLASSIFICATION OF THIN-FILM STRUCTURE RELIEF SELF-ORGANIZATION DEGREE BY 2D DFA AND AMI METHOD

Key words: thin-film structures, order, surface, self-organization, average mutual information, maximal mutual information, two-dimensional detrended fluctuation analysis, correlation properties, scaling index.

The aim of this work - classification of thin-film structures according to the degree of self-organization by scaling index, average mutual information and maximum mutual information determined by two-dimensional detrended fluctuation analysis and average-mutual-information method.

Model surfaces with different degrees of ordering (self-organization) were produced. Their relief was studied by 2D detrended fluctuation analysis and average-mutual-information method. Based on the research results of model surfaces, value lists of scaling index, average and maximum mutual information were compiled which allow to classify thin-film structures by the degree of self-organization. An improvement of obtained results was realized using a-Si:H thin-film samples. An attempt to estimate the influence of the technological regimes of the growth (time of deposition, pressure of hydrogen in the chamber) on self-organization processes in a-Si:H films was made.

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**T.S. Valova, Y.V. Garmash.** MATHEMATICAL MODEL OF FUEL INJECTION CONTROL SYSTEM OF INTERNAL COMBUSTION ENGINE

Key word: mathematical model, control system, internal combustion engine, fuel injection system, performance, spray nozzle, converter parameters of electric energy, response time of the injector, exhaust gas toxicity.

In the article the mathematical model of construction and elements of the control system of fuel injection, allowing to adjust the response time of high-speed nozzles depending on the operating mode of the internal combustion engine are considered. The aim of the study is to assess theoretical ways to improve the performance of control system for an internal combustion engine to reduce response time of solenoid injectors. Dosing the amount of fuel depends on the duration of electric pulse supplied to the winding of solenoid injectors by electronic control system and affects the ecology of the environment. The duration of injector control electrical pulse is calculated by the microcontroller of the electronic system of engine control module (ECM) based on signals of sensor values of throttle opening, air temperature, engine temperature, engine speed, load, and other sensors. Stability of indicators of the injector is largely determined by the performance of its valve. For this reason, when designing high-speed electromagnets reducing response time and time of the release is said to be a high priority.

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**T.S. Valova.** ELEMENTS CONTROL THE FUEL INJECTION SYSTEM OF AN INTERNAL COMBUSTION ENGINE

Key word: the control system, the internal combustion engine, the fuel injection system, performance, spray nozzle, converter parameters of electric energy, the response time of the injector rise time current travel time of the armature of the injector, exhaust gas toxicity.

The paper considers the elements of the control system of fuel injection, allowing to adjust the response time of high speed electromagnets, depending on the operating mode of internal combustion engine. The aim of the study is to improve operational characteristics of the control system, allowing to reduce response time of solenoid injectors. The response time, especially at high engine speeds, affects the completeness of combustion and environment ecology. Dosing the amount of fuel depends on the duration of electric pulse supplied to the winding of solenoid injectors electronic control system. The duration of an electrical pulse injector control is calculated by the microcontroller of the electronic system of engine control module (ECM) based on signals of sensor values of throttle opening, air temperature, engine temperature, engine speed, load, and other sensors. Stability of indicators of the injector is largely determined by the performance of its valve. For this reason, when designing high-speed electromagnets reducing response time and time of the release is said to be a high priority.

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**V.G. Gorohova, A.T. Rott, A.I. Kudyukin, E.N. Moos, V.A. Stepanov, L.F. Sjatishева.** EXHAUST-TUBELESS TECHNOLOGICAL PROCESSES FOR CERAMIC-METAL HIGH-VOLTAGE VACUUM ARC EXTINGUISH CHAMBERS PRODUCTION (VDK-110)

Key words: vacuum, technologies, arc extinguish chamber, ceramic-metal, arc, electrodes, outgassing, nodes, pumping, temperature, sealing, a jacket, soldering, solder.

The diagram and the device of ceramic-metal high-voltage vacuum arc-suppressing chamber (KDV) is described. The technological chain of assembly of KDV conductive node is provided. The technology of exhaust-tube group pumping, soldering, annealing is described. Manufacturing technique features of arc-suppressing cameras on 110 kV are shown.

The aim of the work is increase in production capacities of enterprise and implementation new large-size cameras into production. The question to increase the resource of vacuum arc-suppressing cameras to 105 switches by increasing plasma stability in vacuum arc chamber and the complex of other constructive and technology solutions is considered. The main means for increase the output is the transition of production from nowadays accepted option of exhaust-tube pumping of cameras to exhaust-tubeless technology of receiving vacuum. In the course of pumping there is deleting of all gases both free and dissolved in product details from the volume of product. These purposes require long warming up of a jacket and details of products at the temperature up to 5000 C.

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