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ELECTRONICS AND ELECTRICAL ENGINEERING

(FOUO 3/82)



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USSR REPORT
ELECTRONICS AND ELECTRICAL ENGINEERING
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AEROSPACE & ELECTRONIC SYSTEMS

UDC 523.503

EVALUATION OF PARAMETERS OF METEOR RISK WITH RESPECT TO RADAR
OBSERVATIONS, PART I: STATEMENT OF PROBLEM

Khar'kov RADIOTEKHNIKA in Russian No 57, 1981
(manuscript received 29 Feb 80) pp 53-56

VOLOSHCHUK, Yu. I., candidate of technical sciences and KASHCHEYEV, L. B.

[Abstract] The development of space travel requires a detailed investigation and production of solutions with respect to a number of applied questions. One of them is the safety of travel in cosmic space. According to a 1977 work from the literature, a risk of damage or destruction of space craft exists in the cosmos, as the result of an impact with meteor bodies. Because of the technical difficulties of collection and analysis of meteor substances directly in cosmic space, planners are forced to use in their calculations averaged evaluations which are based on investigations of damages to aircraft returned to earth and a general prediction of the distribution of meteor substances in space near the earth. In the present work it is proposed to obtain the characteristics of meteor risk, allowing for the time and projectory of flights of cosmic apparatus by an indirect path--on the basis of an analysis of radar observations of the penetration of meteor bodies into the earth's atmosphere. This proposed method has determined limitations, e.g., with selectivity of the equipment used, and it does not give a complete picture of meteor phenomena. However, at the present-day stage it is the most successful method of determining the statistical characteristics of flights of meteor bodies into the space near the earth. A method is also proposed for obtaining a distribution law for the electron density of meteor trails with a uniform law of distribution of image points. Figures 1; references 4: 3 Russian, 1 Western in translation.

[81-6415]

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EVALUATION OF PARAMETERS OF METEOR RISKS WITH RESPECT TO RADAR
OBSERVATIONS, PART II: APPROXIMATION OF IONIZATION CURVE

Khar'kov RADIOTEKHNIKA in Russian No 57, 1981
(manuscript received 29 Feb 80) pp 56-58

KASHCHEYEV, L. B.

[Abstract] Statistical processing of the results of radio-meteor observation is connected with use of the vaporization curve of a meteor substance. This curve makes it possible to put into rigorous conformity the height of image points and the amplitude of a reflected signal for each separately taken trail. The curve of the linear electron density of the meteor trail is approximated by a third degree polynomial. The effect of the initial radius in the area of the maximum of the ionized curve is approximated by a linear equation. The results are presented of calculations, the precision of which is verified by the method of statistical tests. Figures 1; references: 4 Russian.
[81-6415]

UDC 551.1 501.81-509.3148

RECOGNITION OF METEOROLOGICAL OBJECTS BY ENERGY SPECTRUM OF FLUCTUATIONS
OF ECHO SIGNAL INTENSITIES

Khar'kov RADIOTEKHNIKA in Russian No 57, 1981
(manuscript received 27 Feb 80) pp 69-78

BEZRUK, V. M., KORYTTSEV, I. V., OMEL'CHENKO, V. A., candidate of technical sciences, PILIPENKO, Yu. L. and PROSHKIN, Ye. G., candidate of technical sciences

[Abstract] An algorithmic method is proposed for construction of information criteria for meteor objects and automatic identification with respect to them. The energy spectrum of fluctuations of echo signal intensities is used as the initial description. The identification algorithm is based on the spectral-statistical method of identification (Karunen-Loeva). The algorithm makes it possible to construct an automated system for processing echo signals. The efficiency of the identification system was checked by the method of simulation modeling on a computer. Figures 3; tables 1; references: 11 Russian.
[81-6415]

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UDC 621.396

SIMULATING INFLUX OF METEORIC MATTER ALONG RADAR OBSERVERS,
REPORT 4: DETERMINATION OF SOME PARAMETERS OF RECORDED RADIO METEORS

Khar'kov RADIOTEKHNIKA in Russian No 47, 1978 pp 23-25

KHOPOVA, I. P.

[Abstract] The transformation operator for converting the parameters of a meteor particle such as its mass, velocity, trajectory etc. to parameters of the signal recorded by a receiver such as its amplitude-time characteristic, phase, delay time etc. has been established on the basis of the minimum-(rms)error criterion, according to a model which takes into account the processes of meteor trail formation and the reflection of radio waves by a meteor trail. With this operator available, it is now possible to estimate the initial distribution of meteor parameters not directly observable by the radar method. Accordingly, for the MARS high-sensitivity meteor measurements complex at the Khar'kov Institute of Radioelectronics there have been determined the dependence of the least recordable mass M_0 on the velocity V , and the exponent n of the $\beta = \beta_0 V^n$ relation for the ionization coefficient. Numerical experiments were made in order to calculate the diurnal variations of these parameters, to supplement inevitably inadequate measurements. According to these data, the velocity of meteors is maximum in September and minimum in March, their altitude is maximum during the day and minimum during the night. The differences of 20 km/s and 7 km, respectively, are equivalent to changes in the sensitivity of instruments. Figures 2; references: 3 Russia .
[83-2415]

UDC 621.396

STATISTICAL ANALYSIS OF TIME-SERIES ESTIMATES OF PARAMETERS OF WEAK
RADIO METEORS, REPORT 1: FORMULATION OF THE PROBLEM

Khar'kov RADIOTEKHNIKA in Russian No 47, 1978 pp 69-71

VOLOSHCHUK, Yu. I., candidate of technical sciences, and MALYNYAK, M. I.

[Abstract] The statistical analysis of readings of a high-sensitivity radio meteor measurements complex is considered, specifically the problem of reliability of their interpretation. Representation of the readings of any meteor parameter in the form of a time series rather than lengthening of the period of averaging will ensure a higher reliability without smoothing the behavior of this parameter at the individual instants of time and thus masking its characteristics. An inspection of such random series reveals that they are nonstationary and contain seasonal components with various periods. Parametric analysis, particularly with the aid of models of autogression and a sliding mean, is most effective here and, although it

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requires much a priori information, it yields very accurate estimates of these seasonal components. It also facilitates the study of the physical nature of phenomena which a time series describes. Figures 2; references 5: 4 Russian, 1 Western (in translation).
[83-2415]

UDC 621-396

ONE METHOD OF EVALUATING SPEED OF INDIVIDUAL RADIO METEORS

Khar'kov RADIOTEKHNIKA in Russian No 57, 1981
(manuscript received 26 Feb 80) pp 58-63

DAVIDENKO, M. G.

[Abstract] A method is considered for an evaluation of meteor speed, which utilizes all the information included in the amplitude-time characteristics of a reflected signal, and is based on an analysis of spectral and correlation characteristics of the enveloping reflected signal. Formulas are derived which make it possible to model and analyze signals reflected from meteor trails with various values of the parameters R , Δ , V . The method was checked by the real signals of a radar station of the Khar'kov Institute of Radio Electronics. The speed of the meteor body, V , was computed by two methods: diffraction and the method presented in this paper. It is shown that the proposed method gives an evaluation of V close to that obtained by the traditional method. Figures 3; references: 2 Russian.
[81-6415]

UDC 621.396

DEVICE FOR HOOKUP OF STATISTICAL QUANTITY ANALYZER TO COMPUTER

Khar'kov RADIOTEKHNIKA in Russian No 47, 1978 pp 25-27

VOLOSHCHUK, Yu. I., candidate of technical sciences, KOVTUN, I. A. and KHOPOVA, I. P.

[Abstract] For several years the highly-sensitive automatic radar complex MARS at the Khar'kov Institute of Radioelectronics has performed preliminary as well as primary and partial secondary processing of meteor data. This complex can determine the orbits of meteors, their radiants, velocities and altitudes, also their quantitative content. Both hardware and software have been developed for calculating the density of meteoric influx from the quantitative content in real time with the aid of minicomputers rather than through weighting which requires a computer with a large memory. The

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algorithm is based on a statistical simulation of the meteoric flux dynamics. The equipment consists of a statistical quantity analyzer including counters, an interface, a UML-NKh computer for interface control, a "Dnepr" computer for secondary processing of quantitative content data, and an output device. Figures 2; references: 4 Russian.
[83-2415]

UDC 621.369

AUTOMATIC GONIOMETER, REPORT 1: DESIGN PRINCIPLES

Khar'kov RADIOTEKHNIKA in Russian No 47, 1978 pp 3-9

KASHCHEYEV, B. L., doctor of technical sciences, and ZHUKOV, V. V.,
candidate of technical sciences

[Abstract] The design of automatic goniometers for meteor radar stations in a geophysical measurements system including three principal antennas is considered which will ensure sufficiently sensitive and accurate operation in the pulse mode. The angular coordinates and the range of a meteor trail are assumed not to change significantly within a period of 0.05-0.1 s even at a wind with an instantaneous horizontal gradient of $40 \frac{m}{s}/km$. A base distance between antennas larger than half the wavelength of the probing signal ensures an accurate determination of the direction cosines. Increasing the statistical sample of reflections during the existence of a meteor trail ensures a higher signal-to-noise ratio. Ambiguity of phase angle readings is removed by simultaneous additional measurements from other antennas at other base distances than that between the three main antennas, with a reference signal from either a separate auxiliary source or the central main antenna. The range is determined from the time by which the signal reflected by the meteor trail lags behind the probing signal, the error of range measurement being reduced by accumulation of many readings in the computer memory and an ambiguity of range readings being avoided through the use of two scales (base scale of 500 pulses/s and code scale of 100 pulses/s). Errors caused by refraction of radio waves by the troposphere and the ionosphere (D-layer and E-layer), as well as caused by a wind gradient in the meteor region, are treated as random quantities and have been estimated. The reflected signal is known to pass through the entire approximately 1 km high Fresnel zone. References 13: 6 Russian, 7 Western (two in translation).
[83-2415]

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AUTOMATIC GONIOMETER, REPORT 2: PRELIMINARY SIGNAL PROCESSING

Khar'kov RADIOTEKHNIKA in Russian No 47, 1978 pp 9-14

ZHUKOV, V. V., candidate of technical sciences, OLEYNIKOV, A. N. and OLEYNIKOV, V. N.

[Abstract] Preliminary signal processing by an automatic goniometer in a meteor radar station includes detection and then filtration of useful signals as well as formation of triggering pulses for the next signal processing stage. An automatic goniometer must be calibrated first, which is done most effectively on an episodic basis using a source of radio waves at a fixed location in space. The automatic goniometer described here is a 5-channel device containing five staggered antennas with a receiver each, five pulse-type phase meters, one mean-range meter, calibration and control equipment, also one radio transmitter with an antenna, a sync oscillator, an interference suppressor, and a Dnepr-1 digital computer. A phase shift simulator for first calibration and checkout consists of a 200 kHz quartz oscillator and two channels with matching devices, an inductive phase shifter and a frequency halver. There follows a frequency converter transposing the phase shift to 500 kHz, near the intermediate frequency of the automatic goniometer, with 600 kHz serving as the reference frequency. With parasitic amplitude and phase modulation thus eliminated, the output signal is modulated with a sequence of video pulses and can be mixed with noise. Second calibration is done with the aid of a simulator of low-frequency meteor reflections in the form of pulses of 0.2-15 s duration. Interaction between channel equipment of the automatic goniometer and the computer is effected in the alternately "store" and "read" mode. Figures 1; references: 9 Russian. [83-2415]

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AUTOMATIC GONIOMETER, REPORT 3: PRIMARY SIGNAL PROCESSING

Khar'kov RADIOTEKHNIKA in Russian No 50, 1979 pp 72-78

OLEYNIKOV, V. N., OLEYNIKOV, A. N. and ZHUKOV, V. V., candidate of technical sciences

[Abstract] An automatic goniometer for meteor radar systems has been developed which includes pulse-type digital phase meters and stable thermodynamic quartz filters. The primary signal processing involves estimating the phase shifts in spaced antennas and the delay time of signals reflected by a meteor trail. The error of phase meters due to a discontinuous phase characteristic can be eliminated by a preliminary analysis of a phase shift and, if it is close to 0° or 360°, introduction of an additional fixed 180°

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phase shift, or by halving the frequency of the input signal and thus widening the instrument range from 0 to 720°. The first method is noise immune, but the second method is simpler. The equipment for implementing the second method includes an intermediate-frequency stage, an amplifier-limiter, and a pulse shaper. The quantization error here depends on the frequency of quantizing pulses and on the ratio of intermediate frequency to quantization frequency. Errors of phase-difference measurement are caused by instability of both frequencies and by Doppler frequency shifts. The range meter for measuring the mean oblique distance has two scales, one for rough readings unambiguous up to 1500 km and one for fine readings unambiguous up to 300 km. A computer calculates the distance to the reflecting region of a meteor trail and the rms error of measurement from data on the pulse duration and the time interval from leading edge of reflected pulse to next probing pulse. Figures 2; references: 11 Russian.
[82-2415]

UDC 621.396

AUTOMATIC GONIOMETER, REPORT 4: SOFTWARE FOR AUTOMATIC GONIOMETER

Khar'kov RADIOTEKHNIKA in Russian No 50, 1979 pp 79-85

ZHUKOV, V. V., candidate of technical sciences, OLEYNIKOV, A. N. and OLEYNIKOV, V. N.

[Abstract] The automatic goniometer developed for meteor radar systems operates with a Dnepr-1 third-generation small digital computer. This computer has an immediate-access memory with a capacity of 4092 26-digit numbers and a permanent memory with a capacity of 3072 26-digit numbers. The computer operates according to programs which occupy 3072 numbers in the immediate-access memory and 516 numbers in the permanent memory. The goniometer-computer interaction is effected according to a discontinuous program start-reset-proceed-stop. The computer proceeds to calculate the main parameters of a meteoric reflector, in eight stages, according to a second discontinuous program. Figures 2; references: 7 Russian.
[82-2415]

UDC 621.396.96

SYNTHESIS OF TWO-SCALE ANTENNA SYSTEM OF METEOR RADAR STATION PHASE GONIOMETER

Khar'kov RADIOTEKHNIKA in Russian No 57, 1981
(manuscript received 26 Mar 80) pp 47-52

ZHUKOV, V. V., candidate of technical sciences and OLEYNIKOV, V. N.

[Abstract] In geophysical and astronomical investigations, a meteor radar station (MRS) with a goniometer device makes it possible to employ

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more complex models of interpretation of observation material and to clarify the dependence of the structural and dynamic parameters of the atmosphere on height. Present-day phasometric goniometer systems of a MRS must have a high accuracy of determination of the angles of arrival over a wide interval of their measurements. In the general case realization of contradictory requirements leads to a two-scale method of measurement. The present work displays the principal relationships for multiscale and two-scale systems, and describes the method of choice of the optimum dimensions of antenna bases of the simplest two-scale antenna system of a MRS phase goniometer. Figures 1; references 24: 23 Russian, 1 Western in translation. [81-6415]

UDC 621.372

SOME PROBLEMS OF INVESTIGATING EFFECT OF NONLINEAR PROPERTIES OF RADIO RECEIVING CHANNEL ON RADAR STATION QUALITY INDICES

Khar'kov RADIOTEKHNIKA in Russian No 57, 1981
(manuscript received 13 May 79) pp 39-42

IVANOV, M. A.

[Abstract] It is possible to consider real radar stations as linear only in the relatively narrow dynamic range of signals at the input of its radio receiving channel. Outside of this, it is noticeable that the nonlinearity of the characteristics of radio devices has an effect which leads to a reduction of the quality of operation of a radar station. The effect of the nonlinear properties of radio receiving channels on the quality of functioning of a radar station is still insufficiently investigated. The object of the present work is to develop procedures for an analysis of the effect of nonlinear processes in radio receiving channels on the quality indices of radar stations. The procedure developed for investigation is based on the use of a functional method. The concept of an effective signal-to-noise ratio at the input of equivalent linear receivers is proposed. Expressions are derived which make it possible with comparative simplicity to determine the deterioration of the signal-to-noise caused by the nonlinear distortions in the radio receiving channel. Sufficiently suitable formulas are obtained, applicable for evaluating the effect of nonlinearity of the characteristics of radio receiving channels on the precision of measurements, resolution, information properties, probability of detection of targets, and the noise immunity of radar stations. References: 6 Russian. [81-6415]

UDC 621.317

ACCURACY LIMITS OF RECORDING TIME COORDINATE OF SOME PULSE SIGNALS IN CHANNEL WITH FINITE PASSBAND

Khar'kov RADIOTEKHNIKA in Russian No 50, 1979 pp 113-121

DUDNIK, B. S., candidate of technical sciences, KASHCHEYEV, B. L., doctor of technical sciences, KOVAL', Yu. A., candidate of technical sciences, and MOISEYEV, V. P.

[Abstract] The maximum accuracy of recording the time coordinate of most common pulse signals in measuring-and-information or radar systems is estimated, taking into account the presence of additive fluctuational interference and the finiteness of the channel passband. The analysis is based on the theory of optimal detection and measurement, and is applied to signal recording according to the minimum-error criterion. The standard deviation as well as other parameters characterizing the accuracy (minimum standard deviation, optimum $x = 2\Delta f_T$, energy utilization factor) at either constant signal energy or constant signal power are calculated for simple signals (rectangular, triangular, trapezoidal, cosinusoidal, bell-curve, $\frac{\sin x}{x}$ pulses) and for intricate signals (with linear frequency modulation,

with phase manipulation, 2-frequency signal). Figures 3; tables 3; references: 5 Russian.

[82-2415]

UDC 621.374.4

POSSIBLE MEANS OF CONSTRUCTION AND SELECTION OF MULTICHANNEL VOLTAGE-TO-CODE CONVERTERS FOR RADIO ENGINEERING SYSTEMS

Khar'kov RADIOTEKHNIKA in Russian No 57, 1981
(manuscript received 14 Jan 80) pp 17-22

KLEMIN, A. A. and KULESHOV, V. N., candidate of technical sciences

[Abstract] Multichannel systems of detection with digital processing of signals are widely used in present day radar techniques. Inseparable units of such radio engineering systems are voltage-to-code converters (VCC) which bring about quantization of signals in detection channels, and distribution of voltage codes into digital computers. The present work considers the special features of choice and construction of such VCC. Formulas are derived for evaluation of the high-speed characteristics of converters using selected elements of the base. Recommendations are made with respect to use of multichannel converters. It is shown that it is only possible to use a few of the large number of known structures of multichannel VCC in present day multichannel radio engineering systems with digital processing of signals.

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Among MVCC of successive action it is advisable to select series parallel and "conveyer" coding of channel voltages, based on digit-by-digit procedures. With a large number of channels and a small time for coding, the most favorable is a counting-parallel MVCC. The final choice of a MVCC for radio engineering systems is made as a result of a detailed analysis of the requirements imposed and the permissible equipment cost. Figures 2; references 6: 5 Russian, 1 Western.
[81-6415]

UDC 621.391

AUTOCORRELATIONAL PROPERTIES OF QUASI-PERIODIC PULSE SEQUENCES

Khar'kov RADIOTEKHNIKA in Russian No 47, 1978 pp 44-47

TYRSA, V. Ye., doctor of technical sciences, KOSTYUKOV, O. A. and KARPUKHIN, A. V.

[Abstract] The correlation is established between two pulse sequences which have been generated according to the same law but along different quasi-uniform scales, as in the case of radar signal synthesis by means of angle-time-code converters. The pulses are assumed to be of infinitesimally short duration and regarded as mathematical points. The system of equations describing the coincidences of one point on one scale with all k points on the other scale in N sliding steps is transformed into a system of numerical difference equations. With these equations can be constructed a (kxN) table for an analysis of coincidences and thus of the autocorrelational properties of such pulse sequences. This is demonstrated here on two scales, one twice as long as the other. Figures 2; tables 1; references 3: 2 Russian, 1 Western (in translation).
[83-2415]

UDC 621.396

ACCURACY OF MEASUREMENT OF TIME DELAY OF USEFUL SIGNAL APPEARING WITH INTERFERENCE SIGNAL

Khar'kov RADIOTEKHNIKA in Russian No 50, 1979 pp 125-128

KARLOV, V. D.

[Abstract] In radar practice it is necessary to measure the time delay of the useful signal and to determine the payoff of interference suppression. Here a useful signal and an interference signal appearing together at the radar receiver are considered, their amplitudes and phases as well as their time coordinates not being known. Assuming that all these parameters

do not change during the measurement period, the maximum attainable accuracy of a measurement of the time delay is evaluated for a narrow-band useful signal. The complex envelope of the probing pulse is, furthermore, assumed to have a rectangular frequency spectrum. The results of calculations indicate that the accuracy of measurement depends not only on the degree of overlap of both signals and on their phase difference but also on the amplitude of the interference signal. Figures 2; references: 3 Russian. [82-2415]

UDC 621.396.963

SELF-CONTAINED NAVIGATION BY MEANS OF MAPS

Moscow ZARUBEZHNYAYA RADIOELEKTRONIKA in Russian No 10, Oct 81 pp 3-28

RZHEVKIN, V. A., candidate of technical sciences

[Abstract] Self-contained radioelectronic navigation systems utilize information separated from signals which are reflected or scattered by natural reference points such as heavenly bodies or the surface of the earth. These systems include Doppler systems and systems for navigation by means of maps, also called chart comparison systems. A survey of the state of the art of these systems is presented here. Topics discussed include Doppler self-contained navigation systems, classification of chart comparison systems and their structure, relief measuring systems, radiometric systems, scatterometric systems, preparation of standard maps, methods of analyzing maps, comparison of maps by means of boundary correlation methods and methods of estimating the accuracy of the agreement of maps. Doppler navigation systems are being improved along the lines of using a modern element base and methods of error compensation. Two types of Doppler navigation systems are being created: high-precision for high-speed aircraft and lower-precision for low-speed systems. The specifications of Doppler navigation systems of different generations are compared. A structural diagram of a chart comparison system is presented; this method of navigation is based on comparing maps prepared during the aircraft's flight with standard charts of the same locale. The trend of introducing chart comparison methods and systems of navigation has become very popular in recent years for the purpose of improving the accuracy of the navigation of manned and unmanned aircraft. Relief measuring systems are designed for low-altitude aircraft. These systems are based on comparing relief maps of the terrain. The TERCOM system's capabilities are the most widely discussed at the present time. Relief measuring systems are poorly effective when an aircraft travels with an insufficiently distinctly pronounced relief. For this reason it is suggested that these measuring systems be combined with radiometric navigation systems, which are good for this purpose. Flat terrain, because of its state of high development by man, provides good radar and radiometric data for preparing maps. The main advantage of radiometric chart comparison methods and systems is the simplicity of preparing standard charts of the

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terrain. The accuracy of plotting an in-flight map depends on the sensitivity of the radiometer, which is limited by the intrinsic noise of the receiver and antenna. The sensitivity of modern radiometers can vary over the range of 0.02 to 0.5 °K. The promise of the combined use of radar and radiometric maps for improving the quality of maps plotted is discussed. Scatterometric systems can be used for navigating an aircraft at relatively high altitudes and when relief measuring systems become ineffective over relatively flat terrain. For flying at lower altitudes it has been suggested that a scatterometer be combined with a radio altimeter. The scatterometer measures only the reflection or scattering coefficient while scanning the surface of the earth. In one case a special "image diagnosis" laboratory has been created for studying the development of standard maps of the terrain for surface correlators, including radio electronic, infrared and optical systems. The development of methods of preparing such maps is a central concern. Maps produced in flight are compared with standard maps by means of the usual methods of computing normalized cross correlation functions or modifications of these methods. Boundary correlation is one such method. A boundary is the interface of two abutting sections of terrain which differ in reflection or radiation properties and have a unique configuration as compared with other sections of the same terrain. The standard map is prepared in the form of a template. Chart comparison methods of navigation represent a relatively new trend in the improvement of aircraft navigation systems. It is a trend which is still largely in the research stage. Figures 5; tables 4; references 31: 10 Russian, 21 Western. [97-8831]

UDC 629.7

EXTREMUM CORRELATION NAVIGATION SYSTEMS

Moscow ZARUBEZHNYAYA RADIOELEKTRONIKA in Russian No 9, Sep 81 pp 28-53

BOCHKAREV, A. M.

[Abstract] In extremum correlation navigation systems reference information on the characteristics of a specific section of the terrain is compared with instantaneous information arriving from an airborne sensor. The true position of the object is determined by the comparison and a correction signal is sent to the "coarse" navigation system, usually an inertial navigation system. The name "extremum correlation system" results from the fact that various methods of correlation processing are usually implemented in the comparison unit. These systems are receiving rapid development at the present time. A "morphological" classification of extremum correlation navigation systems (KESN's) is given, based on the isolation of key features and a description of every possible variant of implementing these features. The discussion concentrates on correlation processing of two-dimensional image signals, which are functions of two space coordinates and time. Most systems operate according to this principle. A major problem in

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developing KESN's and in selecting the extremum correlation algorithm is the identification of elements of images which can be predicted with a high degree of reliability. It is impossible to predict an image down to the finest details because such unknown factors as temperature, weather and solar activity influence an image obtained by means of a high-resolution scanning infrared sensor, for example. Therefore the parameters of physical fields of the earth are not ideally stable. A table of various levels of predictability of images and of the possible correlation algorithms which can be used for them is presented. Correlation algorithms are classified in terms of method of extremum correlation processing, approach to image processing, advantages and disadvantages. A brief history of the development of KESN's is given. Extremum correlation processing algorithms are discussed in detail, including the classical correlation algorithm, difference correlation algorithms, processing by means of paired functions, processing by using invariant factors, the amplitude ranking correlation algorithm, correlation processing employing sums of gradient vectors, two-level correlation algorithms, structural methods of extremum correlation processing, the line feature matching algorithm and the phase correlation algorithm. The latter is recommended for correlation processing of images obtained under various conditions of illumination. From the technical viewpoint KESN's come under the heading of the most ideal airborne radio electronic systems. Figures 11; references 30: 4 Russian, 26 Western. [70-8831]

UDC 531.74

ACCURACY OF ESTIMATING POLAR COORDINATES OF OBJECTS BY OPTICAL DETECTION AND RANGING

Khar'kov RADIOTEKHNIKA in Russian No 50, 1979 pp 60-63

GAVRISH, T. V. and TYRSA, V. Ye., doctor of technical sciences

[Abstract] A coherent-light device for measuring the polar coordinates of stationary objects has been invented where a time interval serves as the information carrying parameter. This time interval begins when the scanning beams turn to the reference direction and ends when the reflected signal arrives at the receiver. The beginning of this time interval can be easily established, but its end must be determined by statistical methods taking into account the random nature of the signal and the presence of additive noise. This noise is a shot noise consisting of photon noise in the signal, ambient noise, and internal noise in the photoelectron multiplier. Here the accuracy of measuring the signal delay time with a threshold device on the basis of the Neyman-Pearson criterion of false-alarm probability is estimated, assuming a high signal-to-noise ratio in the case of a near object only 1-2 km away, whereupon expressions are derived for the dispersion and the bias of range and azimuth estimates. References 3: 2 Russian, 1 Western (in translation). [82-2415]

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ANTENNAS & PROPAGATION

UDC 621.396

APPROXIMATION METHOD OF CALCULATING PARAMETERS OF ANTENNA ARRAY WITH
PASSIVE RADIATORS

Khar'kov RADIOTEKHNIKA in Russian No 57, 1981
(manuscript received 19 Mar 79) pp 103-108

NAGIBIN, I. B., candidate of technical sciences and YEGOROV, B. A.

[Abstract] The calculated relations presented in this work make it possible to compute the added resistances of antenna array dipoles on the basis of the mutual resistances, taking into consideration the dimensions of the elements and the distances between them, as well as to find the current distribution in the real dipoles of an array, with the aid of the method of induced electromotive forces. It is proposed to determine the directional properties of the antenna by equivalent currents, obtained with the aid of expressions for the effective length of the dipoles. References: 4 Russian. [81-6415]

UDC 621.396.677.8

SLOT ANTENNAS FOR AIRCRAFT

Moscow ZARUBEZHNYAYA RADIOELEKTRONIKA in Russian No 9, Sep 81 pp 71-83

LOMAN, V. I., candidate of technical sciences, GOTSULYAK, A. F. and
IL'INOV, M. D.

[Abstract] The design of slightly protruding slot antennas fed by waveguides and resonators is discussed. These antennas are suitable for use as hidden antennas on aircraft and have the advantages of simplicity of design, ease of fabrication, of matching well with waveguides and resonators, of the ability to use standard waveguides as feeding systems, of small size, of the ability to receive and transmit at the same time and of the ability to be combined to form arrays with a controlled beam. They also do not have an adverse influence on the aerodynamic characteristics of aircraft.

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Designs of individual slot antennas are described and discussed, beginning with the very first design incorporating lengthwise slots in the wide walls of rectangular waveguides. A slot antenna in the form of a coaxial line is described, whose inner conductor is a tube of metal and whose outer conductor is an insulator tube metalized on both sides, with partial removal of the metalization from both sides of the outer conductor to form a ring slot. Also discussed are a 4-band resonator-slot antenna, a miniature resonator-slot antenna, a miniature slot antenna, a resonator-slot antenna with a T-shaped slot in the resonator lid, a 2-band resonator-slot antenna, a microwave antenna executed with a cross-shaped slot in a shallow square resonator excited by means of four pins arranged symmetrically around the center of the lower wall of the resonator, an antenna with flat spirals in the aperture for relative constancy of gain over a wide frequency band, a wideband antenna with two flat spirals printed onto an insulating substrate with the other ends of the spirals connected to curved dipole elements also lying on the substrate to form a special type of resonator, and a slot-dipole resonator antenna. Antenna beams are discussed, with emphasis on the influence of antenna housings on antenna characteristics when slot antennas are installed on various moving objects. The curvature of adjacent sections of the conducting surface of the housing exerts the greatest influence in this regard. Examples of the use of slot antennas are given, with emphasis on use on aircraft, and the designs of antenna arrays and control of antenna array beams are discussed. Briefly discussed are an antenna array for aircraft radar and a two-dimensional phased array with controlled polarization of the radiated field. Figures 16; references 59: 22 Russian, 36 Western.
[70-8831]

UDC 621.396.677.8

MICROSTRIP ANTENNAS

Moscow ZARUBEZHNYAYA RADIOELEKTRONIKA in Russian No 10, Oct 81 pp 99-115

LOMAN, V. I., candidate of technical sciences, IL'INOV, M. D. and GOTSULYAK, A. F.

[Abstract] A summary is given of designs and methods of analyzing microstrip antennas with a radiating element of simple form, which have become widely used because of ease of fabrication and acceptable electrical characteristics. Microstrip antennas have been developed to satisfy the need for lightweight, low-profile, conformal, inexpensive antennas for use on missiles and aircraft, for example, without disturbing their aerodynamic properties. A microstrip antenna radiating element contains an ideally conducting plate consisting of a dielectric substrate sandwiched between a radiating element and shield. Different shapes of microstrip antenna radiating elements are presented and discussed, along with calculation of the characteristics of microstrip antennas with a rectangular radiating

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element. A theoretical study is presented of microstrip antennas with a round radiating element, in which the calculation of fields in the remote zone, including taking the dielectric into account, is discussed, in addition to the total radiated power, directive gain, losses, efficiency and input impedance of a microstrip antenna. Microstrip antenna arrays are discussed, including an antenna array with uniform amplitude and broadside distribution, a 4-element linear array, a 2-dimensional array, a 2-frequency array and an 8-element antenna array module. Diagrams are shown of a microstrip-dipole antenna and of one such antenna with circular polarization. The dependence of the input impedance of a 2-frequency microstrip antenna on frequency is discussed with two excitation variants. Microstrip antennas are considered an established modern trend which is promising and will receive further development. They can operate in the 0.3 to 17 GHz band. Further development should proceed along the line of improving the efficiency of microstrip antennas and the materials and fabrication technology for their elements, along with the development of systems and units for feeding individual radiating elements and arrays. Figures 31; references 26: 12 Russian, 14 Western.
[97-8831]

UDC 531.74

QUASI-OPTIMAL FILTRATION IN COHERENT-LIGHT DEVICE FOR MEASURING POLAR COORDINATES OF OBJECTS

Khar'kov RADIOTEKHNIKA in Russian No 50, 1979 pp 63-67

GAVRISH, T. V. and TYRSA, V. Ye., doctor of technical sciences

[Abstract] One task in measurement of the polar coordinates of a stationary object with a coherent-light device is estimating the time coordinate of the reflected signal, a signal which appears submerged in additive noise. Here quasi-optimal filtration is considered, inasmuch as optimum filtration of a deterministic signal $s(t, \tau)$ from a nonstationary normal noise $n(t)$ with a spectral density N_0 and a correlation function $k(t, t + \Delta t) = 1/2N_0(t)\delta(\Delta t)$ is difficult. The problem is solved for far objects and a correspondingly low signal-to-noise ratio. The time interval which carries information about brightness-modulated signals is estimated according to the maximum-likelihood principle, whereupon a filter is synthesized for symmetric trapezoidal video signals leaving the photodetector. This filter minimizes the dispersion of estimates of the time coordinate on the probing range of distances. Figures 1; references: 3 Russian.
[82-2415]

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UDC 531.508

ACCURACY OF MEASUREMENT OF SOUND VELOCITY IN AIR WITH DOPPLER RADAR

Khar'kov RADIOTEKHNIKA in Russian No 50, 1979 pp 67-72

BABKIN, S. I.

[Abstract] Smog control involves determination of temperature profiles and vertical wind velocities, for which a radioacoustic instrument measuring the velocity of sound has been developed on the basis of a Doppler radar. It consists of a microwave transmitter, a reference oscillator, a receiver, a tracking filter, an audio oscillator, a frequency meter and a recorder. The principal sources of error are instability of the transmitter frequency, inaccuracy of Doppler frequency measurement and recording through narrow-band filters, instability of the receiver parameters, atmospheric turbulence causing fluctuations of parameters of the reflected signal, spacing of the antennas and misalignment of the acoustic transducer. The total estimated rms error of one sound velocity measurement is 0.72 m/s so that repetitive sounding is required, $n = 16$ measurements reducing the error of temperature determination to 0.3°C and $n = 50$ measurements reducing the error of wind velocity (vertical) to ± 0.1 m/s. Figures 1; tables 1; references 6: 4 Russian, 2 Western.
[82-2415]

UDC 621.391

ESTIMATION OF ENERGY SPECTRUM OF DOPPLER-FREQUENCY FLUCTUATIONS DURING RADAR-ACOUSTIC PROBING OF ATMOSPHERE

Khar'kov RADIOTEKHNIKA in Russian No 50, 1979 pp 89-93

KORYTSEV, I. V.

[Abstract] The performance of a radar-acoustic system during probing of the atmosphere, with filtration of high-frequency interference, is evaluated in terms of estimates of the energy spectrum of Doppler-frequency fluctuations. The analysis involves the discrete analog of the Fourier transform of finite-time realizations (or of the correlation function). On this basis the duration is determined of a realization in N readings necessary for accuracy, the accuracy in turn depending inversely on the number of degrees of freedom in the chi-square distribution of the sum of the squares of independent random quantities (reading errors). Figures 1; references 6: 1 Russian, 5 Western (two in translation).
[82-2415]

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UDC 621.371

USE OF ULTRA-SHORT-WAVE RADIO EMISSION FOR PERTURBATION OF IONOSPHERE

Khar'kov RADIOTEKHNIKA in Russian No 50, 1979 pp 121-125

TKACHEV, G. N., candidate of technical sciences, VERGASOV, A. A. and KARLOV, V. D.

[Abstract] Perturbation of the ionosphere up to the peak of the F-layer by shortwave radio emission is inefficient because of the appreciable absorption. Consequently, perturbation by ultra-short-wave radio emission is preferable. In this case, however, a perturbation can occur only when the intensity of the exciting field exceeds some threshold. Here nonlinear effects occurring in the field of two ultra-short-wave radio pulses are analyzed on the basis of theoretical relations and experimental data. The role of "magnetic" nonlinear effects has been found to become appreciable, and the threshold field intensity to become much lower, when the difference between the carrier frequencies of the two pulses is equal to the Langmuir frequency of electron vibrations (each carrier frequency being much higher than this Langmuir frequency). The perturbation of the particle distribution is calculated using the Vlasov equation and assuming a Maxwell distribution of charged particles in the quiescent state. The characteristic time and the threshold electric field intensity are estimated for typical ionospheric conditions. A comparison of the results with experimental data indicates some differences, attributable to diffuse reflection by the F₂-layer of signals coming from two ground transmitters and to standing rather than traveling density waves of charged particles induced during insufficiently long excitation periods. Figures 1; references 2: 1 Russian, 1 Western. [82-2415]

UDC 621.371

ALIGNED SCATTERING OF RADIO WAVES BY ARTIFICIAL INHOMOGENEITIES PRODUCED BY RADIATION FROM SHORT-WAVE TRANSMITTER WITH OBLIQUE BEAM

Khar'kov RADIOTEKHNIKA in Russian No 50, 1979 pp 129-132

NOVOZHILOV, V. I., candidate of technical sciences, and VERGASOV, A. A.

[Abstract] Earlier experiments made by other authors with action of vertical short-wave radio emission on the ionosphere have revealed that such waves disturb the uniform distribution of the electron concentration and thus produce artificial inhomogeneities. An experiment was made by the authors of the present work with the use of a powerful shortwave transmitter with an oblique beam in the east-west direction, its purpose being to determine the scales of such inhomogeneities and to detect aligned scattering of radio waves by them in this case. The transmitter-receiver set was spaced so as to

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satisfy the geometrical conditions of sensitivity to aligned scattering. Satisfactory data were obtained for a correlational analysis. Figures 1; references 5: 3 Russian, 2 Western.
[82-2415]

UDC 621.396.67+621.396.96(047.1)

METHODS OF THEORETICAL AND EXPERIMENTAL INVESTIGATION OF NONSTATIONARY SCATTERING AND RADIATION OF ELECTROMAGNETIC WAVES

Moscow ZARUBEZHNYA RADIOELEKTRONIKA in Russian No 9, Sep 81 pp 3-27

ASTANIN, L. Yu., candidate of technical sciences, and KOSTYLEV, A. A., candidate of technical sciences

[Abstract] The basic methods of studying nonstationary problems in the scattering and radiation, or reception, of electromagnetic waves are discussed. The properties of electrodynamic entities, because of the space-time nature of the problem, must be described by means of families of dynamic characteristics determined for various angles. For a selected angle the problem is solved by means of methods of the theory of chains with lumped parameters. Polarization effects are also taken into account in determining dynamic characteristics. The problems discussed can be solved both in the time and frequency regions and the existence of a mutually unique relationship between solutions obtained in this manner makes it possible to select the approach most appropriate for a specific problem and to compare solutions arrived at by various methods. The properties of radiators and scatterers are described by means of standard test effects, i.e., the signals exciting the antenna in the case of radiating antennas and plane fields striking the object in the case of scatterers or receiving antennas. Analytical, numerical and hybrid methods of investigation are employed for a theoretical solution to nonstationary electrodynamic problems. The effectiveness of these methods varies for various groups of problems. The main advantage of analytical methods is the ability to find a graphic relationship between the results of a solution and controlled parameters of a problem. Analytical methods are especially important in the high-frequency region, for the use of numerical methods involves a body of computations which even modern computers are not up to handling. Topics discussed include nonstationary radiation of elementary radiators, nonstationary radiation of a cylindrical dipole of finite length, nonstationary radiation of aperture antennas, and the interrelationship of antenna characteristics in the nonstationary radiation and reception modes. Existing analytical methods are characterized by a limited range of application, particularly with respect to the frequency band. Separate methods are used for the low-frequency, high-frequency and resonance regions. Numerical methods, possible because of the use of computers, supplement analytical methods in solving nonstationary problems involving the use of ultrawideband signals. Numerical methods can be used for the Rayleigh and resonance ranges, where great difficulties

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are encountered when using asymptotic high-frequency methods. The use of the method of integral equations for solving nonstationary problems is discussed and a comparison is made of computing programs for solving nonstationary problems. Hybrid methods, representing the combined use of analytical and numerical methods, are discussed. Experimental methods for studying the ultrawideband characteristics of elements of the radio channel discussed include methods of measuring the ultrawideband characteristics of antennas and microwave equipment and methods of measuring the ultrawideband scattering characteristics of a radar object. Methods of designing ultrawideband measuring apparatus are discussed, along with methods of processing measurement data. The combined use of theoretical and experimental methods is necessary in studying nonstationary scattering and radiation of electromagnetic waves. Analytical methods in particular make it possible to evaluate the influence of the design parameters of a piece of apparatus on its electrodynamic properties. However, experimentation becomes the main tool for research as problems become more complicated. Comparison of the results of theoretical and experimental research plays an extremely important role. Figures 7; references 142: 23 Russian, 119 Western.
[70-8831]

UDC 621.317

PROBLEM OF POTENTIAL PRECISION OF TIME POSITION FIXATION OF SIGNAL WITH SCALE COMPARISON OF TIME KEEPERS

Khar'kov RADIOTEKHNIKA in Russian No 57, 1981
(manuscript received 28 Mar 80) pp 63-69

BAVYKINA, V. V. and KOVAL', Yu. A., candidate of technical sciences

[Abstract] Stability of the reproduction of the dimensions of time units and the prospects for further improvement of the characteristics of standards advance an increase of the precision of mutual comparisons of the dispersed keepers of the time scale into a number of primary problems. A successful solution of these problems makes it possible substantially to improve all the system of metrological assurance of time measurements. An error of comparison so standards results from many factors, especially by a change of the delays in transmission channels of signals because of the instability of the propagation time and the inaccuracy of fixation of the time position of the signal in a reception--registration system. The potential error of fixation of the time position of a signal is determined with the aid of the theory of evaluation of strong signals. The potential error of measurement of the delay time of the signal with an unknown initial phase of the carrier is given. In the present paper an analysis is made of the dependence of the potential precision of fixation of the time position of a signal on the signal-interference ratio, with errors in determination of time position of the signal taken into account. The

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dependence is considered of the dispersion of the error of fixation of the time position of the signal on the relationship of the observation interval and the correlation interval. The threshold signal-interference ratio necessary for normal functioning of a system of evaluation of the time position of a signal with ideal autocorrelation functions is determined. Figures 3; tables 1; references: 7 Russian.
[81-6415]

UDC 621.317.757

FORMING AND QUANTIZATION OF COMPLEX OF ENVELOPES OF BAND-PASS SIGNALS

Khar'kov RADIOTEKHNIKA in Russian No 57, 1981
(manuscript received 28 Jan 80) pp 12-17

MIROSHNIKOV, A. N. and CHAYKOVSKIY, V. I.

[Abstract] This paper is partially based on previous work in 1966, 1977 and 1979 by V. I. Chaykovskiy (see above). Possible variations of forming a complex of envelopes of band-pass signals and its discrete equivalent are considered. The structure of a device for realizing a procedure for forming a complex of envelopes is shown in figure 1, and the structure of a device for forming a complex of envelopes with the use of clipped reference signals in figure 2. The two methods are based on a preliminary formation of a complex of envelopes in analog form and its quantization with the aid of an analog-digital converter. Relations are derived which make it possible, as shown in figure 3, to organize forming of a discrete sequence of readouts of a complex of envelopes of a band-pass signal without preliminary analog processing. Forming of the readouts of a complex of envelopes of a filter $\phi\omega$ employed in the device is by a band-pass filter, which limits the effective range of the device by the band $\Delta\omega$ and decreases the level of quantification noise. Figures 2; references: 5 Russian.
[81-6415]

UDC 621.373

FEASIBILITY OF FORMING COMPOUND SIGNALS WITH EQUIPMENT FOR DIGITAL FREQUENCY SYNTHESIS

Khar'kov RADIOTEKHNIKA in Russian No 47, 1978 pp 27-31

BOTSMAN, P. D.

[Abstract] It is demonstrated that a universal device for forming arrays of multidigital signals with a programmable structure and with coherent modulation laws can be constructed with equipment for digital frequency

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synthesis. A single-ring digital frequency synthesizer for this purpose consists of a reference oscillator, a synchronizable oscillator, a low-pass filter and a phase detector. According to the fundamental differential equation and the transfer function describing this device, an increment of the variable frequency division factor produces an increment of the frequency of the synchronizable oscillator. Further calculations including application of the limit theorem reveal that, in fact, various frequency or phase manipulated signals with coherent envelopes and without amplitude variations during transients can be formed. Their parameters can, furthermore, be stabilized by means of phase-type automatic frequency control. References: 6 Russian.
[83-2415]

UDC 621.391

ADAPTIVE COMPENSATION OF INTERFERENCE SIGNALS CORRELATED ON LONG TIME INTERVAL

Khar'kov RADIOTEKHNIKA in Russian No 47, 1978 pp 64-68

GARBUZOV, Yu. V., MOTORA, A. A. [deceased], DUDNIK, B. S. and SEMENOV, S. F.

[Abstract] Adaptive compensation of radio interference by means of an auxiliary reference channel is considered, this being more effective than direct filtration. A compensator is shown which does not have a separate reference input but shunts the main channel and contains a time-delay element in front of the compensator. The time delay must be such that at the compensator input there will appear wideband signal components uncorrelated and interference components correlated, owing to their periodicity, with the signals at the main input. A performance analysis of this system, which includes a controllable phase shifter and a phase detector, reveals the existence of a phase feedback with inertia. When the transient period here is much longer than the signal correlation time and much shorter than the interference correlation time, then the compensator will extract the signal almost without distortion, with high-frequency interference suppressed, independently of the phasing. However, a delayed and partially distorted "companion signal" will also appear. Figures 4; references 5: 4 Russian, 1 Western.
[83-2415]

UDC 621.391

EFFECT OF FINITENESS OF TRANSMISSION BAND ON MAXIMUM ERROR IN TIMING OF PULSE SIGNALS

Khar'kov RADIOTEKHNIKA in Russian No 47, 1978 pp 60-64

KOVAL', Yu. A., candidate of technical sciences, and MOISEYEV, I. V.

[Abstract] Minimization of the inaccuracy in fixing the instant at which pulse signals appear at the output of a device is considered, specifically the effect of the finiteness of the transmission band on the maximum error in the case of channels with an approximately rectangular amplitude-frequency characteristic. The analysis is based on the criterion of minimum dispersion of pulse timing, in a tradeoff relation with the signal-to-noise ratio and interference immunity. The results extend to phase-manipulated signals with a rectangular envelope. Figures 1; references: 5 Russian.

[83-2415]

UDC 621.391

SIGNAL IDENTIFICATION BY SPECTRUM IN BASIS OF DISCRETE EXPONENTIAL FUNCTIONS

Khar'kov RADIOTEKHNIKA in Russian No 50, 1979 pp 4-10

OMEL'CHENKO, V. A., candidate of technical sciences, and MATEVITSKIY, Ye. O., doctor of technical sciences

[Abstract] Signal identification through measurement of the signal spectrum in a basis of discrete exponential functions simplifies the process, inasmuch as an analog spectrum analyzer can be replaced with a digital one. This process is described and an identifier system is constructed which uses basis functions of the natural basis of the signal ensemble as informative indicators. Such a basis is obtained from the general Karunen-Loew expansion, whose fast convergence allows a signal to be represented as a vector of minimum dimensionality. It is often more expedient to determine the signal spectrum in two steps, first in an intermediate basis which yields primary indicators and then in a second basis for adaptive identification with conversion from the nonoptimum DEF (discrete exponential functions) basis to an asymptotically optimum basis according to a rule which minimizes the mean error probability. The equipment for such an adaptive-identification mode of operation consists of an analog-to-digital converter and a special-purpose computer, the structural variant of informative indicators depending on the particular problem at hand. References: 7 Russian.

[82-2415]

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SIGNAL IDENTIFICATION BY GENERAL KARUNEN-LOEW INDICATORS DETERMINED FROM ENERGY SPECTRUM

Khar'kov RADIOTEKHNIKA in Russian No 50, 1979 pp 10-17

OMEL'CHENKO, V. A., candidate of technical sciences, MATEVITSKIY, Ye. O., doctor of technical sciences, BEZRUK, V. M. and BALABANOV, V. V.

[Abstract] Signal identification is considered where the indicators have been constructed on the basis of the generalized Karunen-Loew expansion according to estimates of the energy spectrum. All the information necessary for identification of signals is assumed to be lumped in the first two moments of their distributions, and the adaptive sample is assumed to be known. The energy spectrum can be described in the time domain and in the frequency domain, through a Fourier transformation, with an appropriate estimate of the correlation function. Indicators are constructed in two steps, first primary indicators facilitating a discretization of the original description and then informative secondary indicators. An asymptotically optimum decision rule which minimizes the mean error probability is established after the chi-square distribution of spectrum estimates has been approximated with a normal distribution. The equipment for such an adaptive identification includes a high-speed spectrum analyzer and a digital computer. An experiment was performed using a parallel-type analyzer and a Yes-1020 Unified System computer, with complex exponential function in the time domain as primary indicators and a decision rule which yielded the first five basis functions corresponding to the largest five eigenvalues as informative indicators. The results demonstrate the feasibility of signal identification by only a few informative indicators, with appropriate smoothing coefficients, but also that the accuracy of identification will improve as the number of such indicators is increased. Figures 2; tables 2; references: 8 Russian.
[82-2415]

UDC 621.391

SIGNAL IDENTIFICATION FROM SPECTRA OBTAINED BY ANALYZERS OF PARALLEL OR QUASI-PARALLEL TYPE, REPORT 6: SIMULATION OF BASIC IDENTIFICATION RULES INVOLVING SPECTRAL INDICATORS

Khar'kov RADIOTEKHNIKA in Russian No 47, 1978 pp 36-44

OMEL'CHENKO, V. A., candidate of technical sciences, MATEVITSKIY, Ye. O., doctor of technical sciences, BALABANOV, V. V. and BEZRUK, V. M.

[Abstract] Signal identification by statistical testing is considered, this method involving measurement of primary physical indicators by either

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a parallel or quasi-parallel spectrum analyzer, with initial compression by the generalized Karunen-Loew expansion and subsequent fast Fourier transformation. The signal distribution in the space of secondary indicators can be arbitrary with interdependent parameters, but for simplicity is approximated here with a normal one. The identification process has been simulated on a YeS-1020 Unified System computer, the adaptive algorithm including estimation of the joint correlation matrix, calculation of the orthogonal transformation matrix, and estimation of the statistical characteristics, all programmed in the FORTRAN language. Typical results of identification by this procedure are shown for signals coming from a pseudorandom-sequence generator. Figures 3; tables 4; references 3: 2 Russian, 1 Western (in translation).
[83-2415]

UDC 621.391.15:519.2

CLASSIFICATION OF SIGNALS ACCORDING TO ENERGY SPECTRUM UNDER CONDITIONS OF A PRIORI INDETERMINANCY

Khar'kov RADIOTEKHNIKA in Russian No 57, 1981
(manuscript received 29 Jan 80) pp 3-12

OMEL'CHENKO, V. A., candidate of technical sciences, MATEVITSKIY, Ye. O.,
doctor of technical sciences, BEZRUK, V. M. and BALABANOV, V. V.

[Abstract] The paper is devoted to the use of the spectral-statistical method for classification of signals according to the energy spectrum method. After a statement of the problem, the information characteristics of signals are considered, which are constructed according to the energy spectrum on a base of the Karunen-Loeva expansions and a multiple discriminant analysis. A decision principle is derived with respect to the criteria of maximum empirical risk. The special features of systems of recognition are considered, and the results of experimental investigations are presented. Systems of recognition are realized on the base of a Minsk-32 computer and a 60-channel analyzer of spectra of the parallel type. The programs were composed in the Fortran language. Figures 4; tables 6; references: 15 Russian.
[81-6415]

UDC 621.391

DISTRIBUTION OF PULSE AMPLITUDES IN SOME INDUSTRIAL INTERFERENCE

Khar'kov RADIOTEKHNIKA in Russian No 50, 1979 pp 21-25

GORDILOV, A. A.

[Abstract] The immunity of radio receivers to industrial interference depends not only on the mean level but also on the fine structure of such

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an interference. The amplitude distribution of industrial interference pulses is not always a log normal one, as usually characterized. An experimental study was made to determine this distribution with a.c. commutator motors used as the source of interference. The measuring equipment included antennas, interchangeable high-frequency amplifiers with noninductive detectors, and an S8-2 memory oscillograph. As amplifiers served either of three receivers SMV-3 ($f_0 = 300$ MHz, $\Delta f \approx 120$ kHz), PA-12a ($f_0 = 2$ MHz, $\Delta f \approx 9$ kHz), 66-RTM-A2-ChM ($f_0 = 150$ MHz, $\Delta f = 28$ kHz). The data, processed in the form of statistical series, fit an exponential distribution of the $F(\Delta) = 1 - e^{-\alpha\Delta}$ kind with $\alpha \approx 0.3-0.8$, in agreement with the theory of sliding contacts. Two interference components are distinguishable: one approaching a Gaussian fluctuation noise with small amplitudes and a high pulse repetition rate, one with larger amplitudes and a lower pulse repetition rate. The first component is caused by current mainly flowing through "metallic contact spots" produced by breakage or electrical breakdown of the contact film, the second component is caused by interruptions of contact between brushes and commutator bars with attendant arcing. Figures 2; tables 1; references 6: 4 Russian, 2 Western (in translation).
[82-2415]

UDC 621.398

SIMILAR METHODS OF RECEPTION OF MULTIFREQUENCY SIGNALS

Khar'kov RADIOTEKHNIKA in Russian No 57, 1981
(manuscript received 28 Apr 80) pp 42-47

ZHURAKOVSKIY, Yu. P. and MOKHNATSKI, V., candidates of technical sciences

[Abstract] The problem of detecting errors with the aid of multifrequency signals is considered. It is shown that use of an interference detector is effective during detection of distorted signals which give a large number of errors, if it is derived at a simple receiver. In order to increase the noise immunity of multifrequency signals a generalized differential circuit (GDC) for inclusion of filters can be used in the receiver. This method was proposed in 1971 by Yu. P. Zhurakovskiy (see above). GDC makes it possible to avoid false operation of the threshold elements connected to the output of the receiver. In addition to a discussion of the general characteristics of the receivers, a detailed analysis is presented of the noise immunity of receivers in the case of reception of multifrequency signals. Figures 3; references: 2 Russian.
[81-6415]

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CIRCUITS & SYSTEMS

UDC 621.372

DETERMINATION OF VOLTERRA KERNELS OF MULTIDIMENSIONAL NONLINEAR
RADIOELECTRONIC CIRCUITS BY MEANS OF 'NONLINEAR INPUT SIGNALS'

Khar'kov RADIOTEKHNIKA in Russian No 50, 1979 pp 25-34

MAKARENKO, B. I., doctor of technical sciences, SULTANOV, A. S.,
candidate of technical sciences, and IVANOV, M. A.

[Abstract] Analysis and synthesis of nonlinear radioelectronic circuits by the method of Volterra kernels is very convenient and effective, linear systems being regarded here as a subclass of nonlinear ones. With the use of "nonlinear currents", the process of determining the Volterra kernels from a given system of nonlinear equations describing a circuit can be reduced to a precisely defined sequence of operations easily performed with the aid of a digital computer. Here this principle is extended to the larger class of multidimensional circuits describable by a nonlinear equation of the

$$\sum_{i=1}^k x_i = \sum_{j=0}^{\infty} \alpha_j \frac{d^j y}{dt^j} + \sum_{l=2}^{\infty} b_l y^l$$

kind, where x_i is the i -th input signal and y is the output signal. Because the dimensionality of "nonlinear currents" is not necessarily the same as that of the electric current, they are replaced by more general "nonlinear input signals" with a dimensionality depending on the specific conditions of the problem. The latter concept is further extended to nonlinear elements excitable by signals of a more general form. Solution of the equations yields recurrence relations for the "nonlinear input signals" and determining the Volterra kernels with the aid of these relations involves linearization of both the square matrix of coefficients in the system of nonhomogeneous equations of state and the matrix of external (input) actions. The procedure is demonstrated on a circuit consisting of a nonlinear capacitance across two a.c. voltage sources in parallel, one in series with a nonlinear resistance and one in series with a linear element characterized by a transfer function $H(s)$. Figures 1; references 3: 1 Russian, 2 Western.
[82-2415]

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UDC 621.383

SIGNAL FOR CIRCUIT WITH POINT-CONTACT PHOTORESISTOR IN MAXIMUM-SENSITIVITY MODE

Khar'kov RADIOTEKHNIKA in Russian No 50, 1979 pp 93-98

CHUZHNIKOV, I. T., KOLESNIKOV, S. P. and RUDNEVA, L. V.

[Abstract] A photoelectric image converter is considered which consists of a glass disk with many implanted thin conducting bars. There are also two conducting grids implanted in the disk, one at each face, surrounding each bar but insulated from all and also from one another. On the receiver face is deposited a photosensitive film making electrical contact with the bars and with the respective grid, on the other face is deposited a load film. Polycrystalline PbTe, having a high electrical resistivity and being highly sensitive in the infrared range, is the most suitable material for photoresistor films. Here the performance of such a circuit is analyzed for a determination of the necessary signal voltage and the optimum design parameters. Figures 3; tables 1; references 5: 4 Russian, 1 Western. [82-2415]

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COMMUNICATIONS

UDC 621.372

WAVES IN NONHOMOGENEOUS MULTICONDUCTOR TRANSMISSION LINES WITH SKIN EFFECT

Khar'kov RADIOTEKHNIKA in Russian No 47, 1978 pp 52-56

DIKAREV, V. A., candidate of physico-mathematical sciences, and
NUZHNYI, Yu. S.

[Abstract] High-frequency processes in a nonhomogeneous multiconductor transmission line with skin effect are analyzed on the basis of asymptotic solutions to the modified system of telegraph equations

$\epsilon^2 \frac{dX}{dx} = A(x, \epsilon)X$ ($a \leq x \leq b$), where $\epsilon = (i\omega)^{-1/2}$ (ω - frequency) and

$X = (V_1, \dots, V_m, I_1, \dots, I_m)$ is the sought vector-function with V_k, I_k denoting the transforms of voltages and currents in the k -th of m conductors. The $(2m \times 2m)$ matrix-function $A(x, \epsilon)$ has an asymptotic expansion at $\epsilon \rightarrow 0$ which is uniform on the interval $[a, b]$. The solution reveals what waves exist and their mode of propagation. Here only the skin effect is calculated and, for illustration, the method is applied to a symmetric single-conductor line as well as to a symmetric 2-conductor one. References 5: 4 Russian, 1 Western.
[83-2415]

UDC 621.372

CALCULATING ELECTROMAGNETIC WAVES IN MULTICONDUCTOR TRANSMISSION LINES USING MATRIX WITH MULTIPLE SPECTRUM AND PARAMETERS SLOWLY VARYING ALONG THE LINE

Khar'kov RADIOTEKHNIKA in Russian No 47, 1978 pp 56-60

NAUMEYKO, I. V.

[Abstract] Approximate solutions to the generalized system of telegraph equations in the matrix form $Y' = A(x, \omega)Y$, with x the coordinate of length, ω the frequency and Y denoting a $2m$ -dimensional vector-function of voltages

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and currents, are sought by an asymptotic method. The matrix $A(x, \omega)$ can have eigenvalues retaining a constant multiplicity throughout the range of variable x , but is everywhere within this range reducible to diagonal form through a nondegenerate linear transformation. The problem reduces to a system of linear differential equations with variable coefficients and with boundary conditions at both ends of the line. An exact solution is impossible, a solution by conventional numerical methods becomes unwieldy and inefficient for a large number of multiple eigenvalues, but a fast converging series can be obtained when the parameters vary slowly along the line. References: 3 Russian.
[83-2415]

UDC 621.372

REFLECTION COEFFICIENT OF ELLIPSOIDAL INHOMOGENEITY IN COAXIAL CHANNEL

Khar'kov RADIOTEKHNIKA in Russian No 47, 1978 pp 78-81

BOYKO, A. P. and BOGOMOLOV, A. S.

[Abstract] Measurements of microwave power by the ponderomotive method must take into account interaction of electromagnetic waves and inhomogeneities in coaxial channels, specifically reflections. Here the reflection coefficient (ratio of amplitude of reflected waves to that of incident waves), characterizing the secondary fields, is calculated for an ellipsoidal inhomogeneity and a propagating TEM-mode. In this case the reflection coefficient is found to be proportional to the volume of such an inhomogeneity, to increase parabolically with rising frequency, and to increase exponentially with increasing dielectric permittivity of the ellipsoid material. Figures 3; references: 3 Russian.
[83-2415]

UDC 621.372

ALGORITHM FOR ANALYSIS OF SIGNALS IN NONHOMOGENEOUS COMMUNICATION CHANNELS

Khar'kov RADIOTEKHNIKA in Russian No 47, 1978 pp 47-51

DIKAREV, V. A., candidate of physico-mathematical sciences, and MEL'NIKOV, A. F.

[Abstract] An algorithm of signal analysis is shown which takes into account distortion of signals in nonhomogeneous multiconductor communication channels. It is based on the telegraph equation in matrix form

$$\epsilon^2 \frac{dX}{dx} = A(x, \epsilon)X, \text{ where } \epsilon = (i\omega)^{-1/2} \text{ } (\omega = \text{frequency}), \text{ which describes the}$$

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propagation of oscillations through such a channel. The matrix $A(x, \epsilon)$ has an asymptotic expansion which is uniform on an interval $[a, b]$ on which there exist p linearly independent smooth vector-functions. The matrix $A_1(x)$ is assumed to be positive-definite, in accordance with the law of energy conservation. The algorithm yields a solution to the corresponding eigenvalue problem. References 7: 6 Russian, 1 Western. [83-2415]

UDC 621.391

DISTRIBUTION OF DOPPLER FREQUENCY SHIFT IN METEOR COMMUNICATION LINE

Khar'kov RADIOTEKHNIKA in Russian No 47, 1978 pp 14-16

YELISEYEV, V. I. and CHERNYI, V. I.

[Abstract] The parameters characterizing the distribution of the Doppler frequency shift in a meteor communication line are evaluated according to the fundamental relation for the change in the phase path during the measurement period and on the basis of a statistical analysis of readings taken over such a period. Measurements have been made with meteor channel equipment along a 700 km long meridional route, using a signal of 60 micro-second duration with a carrier frequency of 57 MHz and linearly frequency modulated over a 6 MHz band. Readings were taken over 8 h periods from midnight to 8 AM. Here the results are presented in the form of a histogram, useful for the design of meteor communication receivers. Figures 1; references 6: 5 Russian, 1 Western (in translation). [83-2415]

UDC 621.391

ERROR IN CALCULATION OF FREQUENCY CHARACTERISTICS OF METEOR COMMUNICATION CHANNEL

Khar'kov RADIOTEKHNIKA in Russian No 47, 1978 pp 17-20

YELISEYEV, V. I.

[Abstract] The frequency characteristics of communication channels are calculated most accurately, from known time characteristics, by the method of Fourier integrals. Here the total error of such a calculation for meteor communication channels is estimated, taking into account the inaccuracy of the Kotel'nikov series used for time discretization of signals as well as the inaccuracy of their amplitude quantization. Other independent errors include those caused by amplitude fluctuations, noise, non-linearity of the oscillograph sweep and random deviations of readings from true values. References: 6 Russian. [83-2415]

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UDC 621.396

METHOD OF ESTIMATING CORRELATIONAL PROPERTIES OF BASIC CHARACTERISTICS OF METEOR COMMUNICATION LINES

Khar'kov RADIOTEKHNIKA in Russian No 50, 1979 pp 85-89

AKSENOV, Yu. V.

[Abstract] The characteristics of a data transmitting meteor channel vary continuously as the result of various causes and, therefore, optimization of its performance requires immediate estimations of its parameters. This can be done by measurements and statistical analysis, taking into account the real time of detection of essentially random deviations, or by prediction of the channel behavior on the basis of models. The first method requires minimization of the time of system response to external perturbations during operation and is most effectively implemented by means of adaptive control. The second method requires a tradeoff between accuracy and simplicity in terms of the number of parameters included in a model. Such a tradeoff can be established only through an analysis of correlations between individual model elements. Here the number of reflections by a meteor trail per hour is selected as the fundamental element and, on the basis of calculations of the empirical correlation factors, a close but variable correlation (0.85-0.95) is established between this parameter and the total duration of recorded flares (total on-time of threshold device in the receiver) per hour, a weaker but stable correlation (0.7-0.89) between the total duration of flares and the maximum duration of a flare, and a weak correlation (0.10-0.15) between the total duration of flares and the mean duration of radio reflections by a meteor trail. Hardly any correlation is found between other parameters such as minimum amplitude and minimum duration or minimum duration and maximum duration. Most importantly for prediction purposes, the correlation between the number of reflections per hour and the maximum duration of a flare is close and steady ($r = 0.8$) at a zero probability of noncorrelation. References: 6 Russian.
[82-2415]

UDC 621.396

USE OF CODES IN SYSTEM OF REMAINDER CLASSES FOR DATA TRANSMISSION OVER METEOR CHANNEL, REPORT 1: FORMULATION OF PROBLEM

Khar'kov RADIOTEKHNIKA in Russian No 50, 1979 pp 51-56

VOLOSHCHUK, Yu. I., candidate of technical sciences, and GRANKIN, P. F.

[Abstract] The problem of selection and design of codes for transmission of messages over a meteor channel is analyzed, codes which consist of an information carrying part and a monitoring part. Binary codes are considered with a system of numeration in the remainder classes, where a number

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is represented by the remainder of its division by a selected base. Because interdigital coupling is completely absent here, unlike in the conventional system of positional numeration, all rational operations can be performed in parallel on each digit individually and thus much faster with simpler equipment. Other advantages of such codes include equal treatment of both parts and the possibility of adaptation to different interference backgrounds without significant modifications of encoder and decoder equipment. Conversion to the positional numeration system is shown. References 8: 6 Russian, 2 Western (one in translation).
[82-2415]

UDC 621.396

USE OF CODES IN SYSTEM OF REMAINDER CLASSES FOR DATA TRANSMISSION OVER METEOR CHANNEL, REPORT 2: ERROR DETECTION AND CORRECTION CAPABILITY OF SUCH CODES

Khar'kov RADIOTEKHNIKA in Russian No 50, 1979 pp 56-60

GRANKIN, P. F. and POSOSHENKO, V. A.

[Abstract] An interference immune code in the system of remainder classes, a code with an information carrying part and a monitoring part, is constructed for general and specifically meteor transmission channels. The information bases are selected so as to cover the entire operating range with the minimum number of digits, and the monitor bases are selected identically so as to fully ensure detection of errors. Moreover, an information carrying symbol will not change upon conversion to the positional numeration system with fewer bases. These principles are demonstrated on a code with bases $P_1 = 3$, $P_2 = 5$, $P_3 = 7$, $P_4 = 11$, $P_5 = 13$ for transmission of numbers from 0 to 32. The redundancy here is superfluous from the standpoint of checking the information for errors, but is necessary for reliable transmission in the presence of interference. Figures 1; references: 2 Russian.
[82-2415]

UDC 621.396:621.398.9

SYSTEMS FOR REMOTE CONTROL OF HIGH-FREQUENCY AND MEDIUM-FREQUENCY RADIO COMMUNICATIONS EQUIPMENT

Moscow ZARUBEZHNYAYA RADIOELEKTRONIKA in Russian No 10, Oct 81 pp 47-65

VENSKAUSKAS, K. K., candidate of technical sciences

[Abstract] In recent years the carrying capacity and efficiency of HF and MF radio communications systems have been improved by the creation of

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remote-controlled equipment which adapts to the influence of noise and changes in radio wave propagation conditions and thus makes it possible to create totally unattended systems. A survey is presented of the design principles and key specifications of non-USSR remote control systems for radio communications equipment in the HF and MF bands. Several remote control systems are described in order to show their typical design features and differences in specifications. Remote control is accomplished centrally by means of a computer. The noise immunity of communications systems is improved by placing radio centers in places with a low level of industrial noise, so that maintenance costs are reduced and the efficiency and reliability of systems are improved. Remote control systems are divided into three types: systems for the remote control of large radio center equipment, of radio receiving equipment and of radio communications equipment. The first category includes the Philips (Netherlands) PARCS system for HF receiving and transmitting equipment of radio centers; the "Matelo" system developed by the English Marconi firm, which was first designed for the remote control of naval aviation communications radio centers and then was given broader application; the IFS59 and IFS6 systems developed in the FRG, designed for controlling a radio station in Elmshorn and Usingen, respectively; and the Marconi Communications Systems digital H6800 remote control system for radio receivers and transmitters. The second category includes the Plessey (England) PRC 2250 system designed for remote control of the PR 2250 radio receiver; the Philips RL 157 system for the remote control of RO 156 radio receivers; and the Mackay Marine (USA) 3020 RC system for the remote control of series 3020 receivers. The third category includes the Rockwell International (USA) RCT-32 system for remote control of strategic communications equipment; the Rohde and Schwarz (FRG) IEEE-488 system for type EK 070 receivers, SK 1004 transmitters and XK 104 and XK 403 radio stations; the F 76000 system developed in Denmark and used for controlling radio communications equipment such as type S 76000 transmitters and M 76000 receivers; the Philips RC 790 system for controlling transmitters with an RC 790 driver and the RM 795 radio station; and the UUIP (Sweden' firm's AU-3-1013 remote control system for overall control of radio communications equipment and terminal and auxiliary equipment. There has been a worldwide trend in recent years toward creating adaptive communications systems utilizing unified remote control systems similar in design principles and specifications. These systems employ the address-multichannel principle of transmitting remote control information with heavy emphasis on address transmission. Sporadic and cyclic operating modes are used with a common-group or individual type of remote control information transmission. Transmission speeds vary widely from 50 to 2400 bits per second in keeping with CCITT standards. Figures 10; references: 23 Western.

[97-8831]

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COMPONENTS, HYBRIDS & MANUFACTURING TECHNOLOGY

UDC 681.325.3

MODERN MICROELECTRONIC VOLTAGE-TO-FREQUENCY CONVERTERS

Moscow ZARUBEZHNAJA RADIOELEKTRONIKA in Russian No 9, Sep 81 pp 100-106

CHISTYAKOV, N. P.

[Abstract] The parameters of microelectronic voltage-to-frequency converters being produced by firms in the USA are presented in a table. These data provide a basis for a survey of the state of the art of these devices. All of these devices convert both unipolar and bipolar signals with a maximum input signal amplitude of 10 V and a maximum speed of response of 1 MHz in the Analog Devices 460 J model. In the Burr-Brown VFC-52 conversion nonlinearity is not greater than 0.005 percent. Temperature instability of the transmission factor for all of these devices varies from $20 \cdot 10^{-6}$ per degree Celsius to $100 \cdot 10^{-6}$ per degree Celsius. Voltage-to-frequency converters produced presently for the most part are matched in terms of output signal level with TTL logic, making a buffer unit necessary for matching with other logic elements. The low cost of these devices is an important advantage. Conversion nonlinearity and transconductance are the basic parameters for evaluating the fitness of a voltage-to-frequency converter. The three main methods of designing these devices differ with respect to the type of feedback employed: They either have an open feedback loop or have pulsed feedback or δ - σ modulation. The principles underlying these methods are discussed. Illustrating the principle of δ - σ modulation is a bipolar integrated circuit device developed by Raytheon; it has conversion nonlinearity of not greater than 0.025 percent at frequencies to 100 kHz and not greater than 0.015 percent at frequencies to 1 kHz. The microcircuit includes a reference voltage source, a precision voltage-to-current converter, a current switch, an operational amplifier and a highly stable one-shot multivibrator consisting of an R-S flip-flop, a sawtooth voltage generator and a comparator. Modern voltage-to-frequency converters can be improved by improving conversion transconductance, enabling the matched operation of these devices with microprocessors, and by developing a device of this type based on MOS technology and having an integrating capacitor located outside of the case. The advantages of these devices make it convenient to use them for designing various devices for analog information processing, such as high-resolution analog-digital converters. Figures 10; references 18: 9 Russian, 9 Western. [70-8831]

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UDC 621.372

PARAMETERS OF STRONGLY COUPLED CAVITY RESONATORS

Khar'kov RADIOTEKHNIKA in Russian No 47, 1978 pp 91-97

PASHCHENKO, Zh. F., candidate of technical sciences, and
TERESHCHENKO, A. I., doctor of technical sciences

[Abstract] Cavity resonators are used as microwave circuits, either as independent devices or as components of larger complexes. Here the performance characteristics of strongly coupled cavity resonators in a multi-cavity device are calculated by the matrix method, which reduces the system of integral equations for partial regions of a geometrically intricate surface to algebraic equations for the equivalent matrix elements. Accordingly, expressions are obtained for self- and mutual admittances in an N-cavity resonator. All elements of the admittance matrix are functions of the frequency, and a solution of the corresponding eigenvalue problem yields the spectrum of natural frequencies. The Q-factor of each component cavity can also be easily calculated. The method is demonstrated on a simple array of two cylindrical resonators in parallel, such a device being used for improving the stability of a NH_3 -maser. Figures 2; references: 6 Russian.
[83-2415]

UDC 621.372

EFFECT OF CUTOFF REGION ON CHARACTERISTICS OF IRREGULAR RECTANGULAR RESONATOR

Khar'kov RADIOTEKHNIKA in Russian No 47, 1978 pp 97-100

FILATOVA, N. A. and BURTOVOY, D. P., candidate of technical sciences

[Abstract] A rectangular resonator with cutoff is considered, such an irregular waveguide resonator being often used with semiconductor microwave devices. Its Q-factor and resonance wavelength are calculated as functions of the location of the movable metal end wall, perpendicular to the resonator axis, in the cutoff region. The needed expression for the crest factor takes into account the appropriate boundary conditions for the electric field. Numerical results have been obtained with the aid of an M-222 digital computer for a trapezoidal resonator with a skin-effect layer and a propagating H_{101} -mode. An increase of the length of the cutoff region is found to decrease the resonance wavelength, but with a smaller frequency drift than in a regular rectangular resonator, and correspondingly to increase the Q-factor. Experimental data confirm this theoretical conclusion. Figures 3; references: 1 Russian.
[83-2415]

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UDC 621.372

GRAPHICAL REPRESENTATION OF DEPENDENCE OF RESONANCE WAVELENGTHS ON
GEOMETRICAL DIMENSIONS OF RESONATORS, REPORT 3: SOME GENERALIZATIONS
BASED ON CONFORMAL MAPPING

Khar'kov RADIOTEKHNIKA in Russian No 47, 1978 pp 88-91

PASHCHENKO, Zh. F., candidate of technical sciences, and
TERESHCHENKO, A. I., doctor of technical sciences

[Abstract] A universal expression for a resonance wavelength in resonators of various shapes, as a function of the geometrical characteristics of resonators including a form factor, is presented in the form of families of $c/\lambda_{res} - \alpha/\lambda_{res}$, $c/\lambda_{res} - b/\lambda_{res}$, $b/\lambda_{res} - \alpha/\lambda_{res}$, $c/\lambda_{res} - r/\lambda_{res}$ and $c/\lambda_{res} - r_1/\lambda_{res}$ curves for H-modes and E-modes. Here c is the length of a resonator, α and b are the sides of a rectangular resonator, r is the radius of a cylindrical resonator, r_1 is the inside radius of a coaxial or butterfly resonator, and λ_{res} is a resonance wavelength. By plotting the coordinates of a point on such a curve corresponding to resonance in a certain mode, one can determine the necessary dimensions of a resonator of a given shape. A more extensive graphical procedure will yield the design of resonators of other shapes as well. Figures 1; references: 3 Russian.
[83-2415]

UDC 621.396

SCATTERING MATRIX OF ARRAY OF TWO SLITS IN RECTANGULAR WAVEGUIDE

Khar'kov RADIOTEKHNIKA in Russian No 47, 1978 pp 72-78

KATRICH, V. A.

[Abstract] The scattering matrix of two oblique slits in a rectangular waveguide is calculated, the slit generally having an arbitrary mutual orientation but in special cases intersecting or located with an overlap along the waveguide axis. The partial self- and mutual admittances of such a pair of slits are calculated by a simple method of solving the problem of excitation. The waveguide is first assumed to be infinitely long with an infinitesimally small wall thickness. The energy parameters, namely reflection and transmission coefficients, are then calculated for an X-slit. The effect of higher harmonics is evaluated and found to be small, decreasing further with increasing thickness of the waveguide wall as well as upon insertion of a dielectric filler. A sine half-wave thus adequately approximates the electric field distribution along such slits for engineering design purposes. Figures 1; references: 8 Russian.
[83-2415]

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UDC 621.396.6

INVESTIGATION OF VARACTOR FREQUENCY MULTIPLIER WITH ASSISTANCE OF FUNCTIONAL METHOD

Khar'kov RADIOTEKHNIKA in Russian No 57, 1981
(manuscript received 19 May 80) pp 82-86

IVANOV, M. A., MAKARENKO, B. I., doctor of technical sciences and
SULTANOV, A. S., candidate of technical sciences

[Abstract] A new approach is proposed for an investigation of frequency multipliers with assistance of the functional method. The results of numerical calculations, fulfilled with the assistance of the "Minsk-32" computer, for the concrete circuit of a varactor frequency doubler with a parallel connection of a varactor, corresponds well with experimental data. The proposed approach to an analysis of frequency multipliers has a general nature, because introduction of a considerable number of simplifying assumptions and hypothesis is not envisaged. The approach in question should be used for a wide class of frequency multipliers. Figures 5; references: 3 Russian.
[81-6415]

UDC 621.396.966

HIGH-FREQUENCY AMPLIFIERS BASED ON SURFACE ACOUSTIC WAVES

Moscow ZARUBEZHNYA RADIOELEKTRONIKA in Russian No 10, Oct 81 pp 66-83

GAVRILIN, V. I., GULYAYEV, A. M., candidate of technical sciences, and
KARPEYEV, D. V.

[Abstract] A summary is given of the physical processes and basic theories of surface acoustic wave (SAW) amplification and questions are discussed relating to the design, fabrication technology and application of acoustoelectronic amplification structures. Recently the simplicity, compactness and promise of SAW amplifiers employing a layered piezoelectric-semiconductor structure have created great interest. This structure makes it possible to compensate the losses of a few dozen decibels characteristic of previous SAW devices and also to achieve amplification of a high-frequency input signal. The operating principle of an SAW amplifier is discussed, together with the propagation and excitation of surface waves, the interaction of a surface acoustic wave with charge carriers and Adler's model (1970, 1971) of the amplification effect. Designs of SAW amplifiers are discussed, along with fundamentals of the theory of SAW amplification, including the Kino-Reeder theory (1971) and the theory of the amplification of a surface acoustic wave for a monolithic structure. Experimental data are presented on amplifiers utilizing a CdS piezoelectric semiconductor chip and amplifiers

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with a layered structure. The latter have surpassed the former because of the bad piezoelectric and especially semiconductor properties of CdS chips. Experimental data are presented on an LiNbO_3 -InSb film structure, on the influence of an external magnetic field, the noise properties of amplifiers and carrier trapping effects. The fabrication technology for SAW amplifiers is discussed in detail, along with application of the SAW amplification effect. One application discussed is acoustic convolvers possessing intrinsic two-way amplification. A device is described which achieves a gain of 20 dB with a supply voltage of 50 V and at the same time functionally processes a high-frequency signal. Figures 19; references 123: 9 Russian, 114 Western.
[97-8831]

UDC 621.398

SOME FEATURES IN DESIGN OF HIGH-SPEED ANALOG COMMUTATORS

Khar'kov RADIOTEKHNIKA in Russian No 50, 1979 pp 104-109

KULESHOV, V. N., candidate of technical sciences

[Abstract] The performance of analog-to-digital converters in multichannel radio engineering equipment depends largely on the characteristics of the analog components and, particularly, of analog commutators. Their basic performance parameters are switch-on time, switch-off time, and the referred error of switching of channel voltages. Here the design of analog commutators for maximum speed and accuracy is analyzed in terms of operational logic. It is also analyzed from the standpoint of tradeoffs between the necessity to isolate control circuit from switch circuits on the one hand and the speed of operation as well as manufacturability on the other. Circuit integration is, accordingly, a problem. Most promising is the use of field-effect transistors, especially enhanced MOS transistors with a p-channel, as switching elements. A circuit is shown which consists of a switch with two such transistors in series and a compound control stage with two bipolar transistors. The performance of a 2-step analog commutator built with these components and operating according to an appropriately adjusted logic appears to be satisfactory, pending an error and transient analysis. The design can, furthermore, be easily adapted for microelectronic (silicon) circuit integration. Figures 2; references: 2 Russian.
[82-2415]

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COMPUTERS

UDC 681.142

ERROR OF FINITE-LENGTH DISCRETE SIMULATION OF RANDOM PROCESSES WITH GIVEN DISTRIBUTION AND CORRELATION FUNCTION ON DIGITAL COMPUTER

Kharkov RADIOTEKHNIKA in Russian No 50, 1979 pp 98-104

SIMOVSKAYA, S. F., candidate of technical sciences, and LEBEDEVA, O. M.

[Abstract] Random processes can be simulated on a digital computer according to programs which generate from a sequence of dependent quantities with a given mean value and standard deviation from independent uniformly or normally distributed random numbers. Universal algorithms used for this are uneconomical in terms of machine time and, consequently, maximally economical special-purpose algorithms are preferred. Here problems of practical implementation of such discrete-simulation algorithms are examined, particularly the error of finite-length sequences simulating a stationary random process. Considered are a stationary normal random process with given correlations and a stationary Rayleigh random process with an exponential correlation function. Calculations made on YeS-1020 Unified System and Minsk-32 computers, respectively, are compared with theoretical calculations. The results indicate that in each case the accuracy of simulation and the error of the correlation function depend on the length of the realization sequence, the error still being large with $N = 100$, but becoming insignificant with $N = 1000$ discrete ordinates. Figures 2; tables 2; references: 2 Russian.
[82-2415]

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ELECTRON DEVICES

UDC 621.375

EXTENSION OF OPERATING RANGE OF GUNN-DIODE OSCILLATORS

Khar'kov RADIOTEKHNIKA in Russian No 47, 1978 pp 100-102

MOLYAVKO, V. I., candidate of physico-mathematical sciences

[Abstract] An experimental study was made for a Gunn-diode oscillator with a II-waveguide resonator. The device included plungers for mechanical tuning and a varactor for electronic tuning, also a low-pass filter and a load connected through a stripline Y-inductor. Its amplitude-frequency characteristic was measured over the 3.7-12.8 GHz range and found to be notched. The frequency deviation due to an increase of the varactor voltage was found to alternate from positive in the bands 3.7-5.7, 6.8-9.7, 10.2-11.3 GHz to negative in the bands 5.7-6.8, 9.7-10.2, 11.3-12.8 GHz. With an AA703A Gunn-effect diode and a minimum resonator Q-factor of 3000, the maximum continuous power output was 2 mW, at a bias voltage of 8.5 V and a diode current of 760 mA. (Text illegible.) With a 2A602D varactor diode, the maximum tuning range could be extended to 180 MHz. The results indicate that a II(or H)-waveguide resonator appreciably widens the operating range of such an oscillator. Figures 2; references: 1 nonRussian. [83-2415]

UDC 621.385

HARMONIC GENERATION IN M-TYPE TRAVELING-WAVE TUBES

Khar'kov RADIOTEKHNIKA in Russian No 47, 1978 pp 102-106

BELOUS, B. A., GERASIMOV, V. P. and SHEIN, A. G., candidate of physico-mathematical sciences

[Abstract] A unisegmental M-type TWT frequency multiplier is considered and the conditions of efficient harmonic generation are established on the basis of a rigorous analysis. The self-consistent system of integro-differential equations describing the interaction of the fundamental-frequency

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signal and of its second and third time harmonics with the electron beam in a multifrequency M-type traveling-wave tube have been solved numerically. Here the calculated distributions of the power of each harmonic component along the interaction space are shown, as well as the output power at each frequency in some cross section near the center of the interaction space as a function of the ratio of coupling resistances R_1/R_2 and R_1/R_3 , respectively. Figures 3; references 8: 6 Russian, 2 Western.
[83-2415]

UDC 621.385

MULTIFREQUENCY OPERATION OF M-TYPE AMPLIFIER WITH CATHODE IN INTERACTION SPACE

Khar'kov RADIOTEKHNIKA in Russian No 47, 1978 pp 107-110

CHURYUMOV, G. I. and SHEIN, A. G., candidate of physico-mathematical sciences

[Abstract] An M-type amplifier with the cathode in the interaction space can serve as a device where the electron beam interacts with complex high-frequency fields containing several signals at different frequencies. Here such a device with a cylindrical structure is analyzed, including the case of a large frequency separation between signals. Since calculations in a cylindrical system of coordinates are very difficult, this cylindrical structure is replaced with a quasi-plane one on the assumption that the cathode and the anode have approximately equal radii. Calculating the interaction involves calculating the trajectories of electrons and fields. The problem reduces to solving the corresponding equations of motion in normalized Lagrange coordinates and this is done here for the interesting case of the high-frequency field drifting to the input of the device, assuming negligible space-charge fields and no reflections at the ends of the retarding system. On this basis have been determined fundamental and second-harmonic gain and power distributions along the interaction space in a model of such an amplatron without dispersion and with a frequency-independent coupling resistance. Figures 3; references: 5 Russian.
[83-2415]

UDC 621.385

EFFECT OF LONGITUDINAL NONUNIFORMITY OF ELECTROSTATIC FIELD ON CHARACTERISTICS OF M-TYPE TRAVELING-WAVE TUBE

Khar'kov RADIOTEKHNIKA in Russian No 47, 1978 pp 110-116

SOVA. A. V.

[Abstract] In an M-type traveling-wave tube the longitudinal nonuniformity of the electrostatic field, resulting from interaction of the electromagnetic

wave with a periodically nonhomogeneous structure, causes the output characteristics of such a device to depend on this nonuniformity. Here this dependence is analyzed for a retarding system with a comb structure. The equations of motion for electrons in the two-dimensional case and the Laplace equation for the electric field potential are solved for a gap region and a slot region. A numerical solution reveals how the amplitude of the fundamental component and that of the second harmonic vary with gap height and slot width. The output characteristics of a magnetron amplifier, namely power and phase shift, are then calculated as functions of the magnetron length for various values of the field nonuniformity parameters as well as for a uniform electrostatic field. The results of calculations for a monochromatic input signal are compared with results of measurements. Figures 1; references: 1 Russian.
[83-2415]

UDC 621.385.6

REALIZATION OF REGIME OF INVERSE TRANSFORMATION IN AUTOMATIC PHASE TRAVELING-WAVE TUBES

Khar'kov RADIOTEKHNIKA in Russian No 57, 1981
(manuscript received 31 Mar 80) pp 114-118

BONDARENKO, B. N. and KRYZHANOVSKIY, V. G.

[Abstract] The present work is concerned with the use of autophase traveling-wave tubes (TWT) as converters of microwave energy into direct current. A determination is made of the requirements imposed on autophase TWT in order to obtain a maximum efficiency. This consideration is conducted within the framework of a one-dimensional theory formulated in 1979 by the above authors on the basis of the electron--wave processes in O-type TWT. Problems connected with construction of the device, with power supply sources and other items are not touched upon. Use of the autophase TWT as a converter of microwave energy into directed current is promising. Numerical calculations and graphs are presented. Figures 2; references 6: 5 Russian, 1 Western in translation.
[81-6415]

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INSTRUMENTATION & MEASUREMENTS

UDC 531.7

CAPACITIVE VIBRATION TRANSDUCER FOR MEASURING AMPLITUDES OF MECHANICAL VIBRATIONS OF MOUNTING PLATES

Khar'kov RADIOTEKHNIKA in Russian No 50, 1979 pp 109-113

SHINKO, V. I. and FROLOV, V. A., candidate of technical sciences

[Abstract] A capacitive vibration transducer is proposed for detecting small-amplitude audio-frequency vibrations of a chassis and subsequent measurement of the vibration amplitude. It consists of a controlled quartz oscillator, a matching device, a high-frequency amplifier, a limiter, a frequency detector, a low-frequency amplifier and a linear rectifier. The frequency detector and the rectifier are built with integrated microcircuits, K2DS242 and LUTCh01A series respectively. A special construction of the capacitive probe, a center rod on a pad inside a brass yoke filled with a dielectric and a coaxial connecting cable, ensures high sensitivity and interference immunity of the transducer. A circuit and performance analysis indicates that this instrument has a very linear "vibration amplitude-signal" characteristic. Figures 2; references: 4 Russian.
[82-2415]

UDC 538.569:536:621.372.823

INVESTIGATION OF TEMPERATURE FIELD OF CIRCULAR WAVEGUIDE

Khar'kov RADIOTEKHNIKA in Russian No 57, 1981
(manuscript received 19 Mar 80) pp 108-114

VARLAMOVA, N. A., KUKUSH, V. D., candidate of technical sciences and
MARTYNENKO, L. G., candidate of technical sciences

[Abstract] The results are presented of an investigation of the temperature of the walls of a circular waveguide, conducted with the object of developing measuring equipment for microwaves of large levels. The physical model is a tube with a uniform interior diameter, the middle part of which is

thin-walled with a length l and a thickness δ (absorptive wall). It is made of a high-resistance alloy (constantan, nichrome, etc.). The terminal parts are sections of a thin-walled copper waveguide, the temperature of which is kept constant. In the case of passage of electromagnetic waves through this waveguide channel, part of the microwave energy is absorbed and the temperature of the thin-walled section is increased. A precise analytical solution of the problem of temperature distribution in the waveguide system investigated encounters significant mathematical difficulties. However, the structural features of the microwave measuring devices and the known physical characteristics of the heat exchange makes it possible to simplify the problem under consideration, in practice not reducing the precision of the results produced. The analytical expressions presented for the temperature field of the wall of the circular waveguide and the graphic dependences make it possible to calculate the parameters of concrete measuring devices. Figures 3; references: 4 Russian.
[81-6415]

UDC 621.372

ANALYSIS OF 2-CHANNEL INTERFEROMETER WITH PRISMATIC LIGHT DIVIDERS AS SYSTEM OF COUPLED MULTIPOLES

Khar'kov RADIOTEKHNIKA in Russian No 47, 1978 pp 81-88

ADONINA, A. I., candidate of physico-mathematical sciences

[Abstract] The characteristics of a 2-channel interferometer with prismatic light dividers are analyzed theoretically by simulation of its components with multipoles. For simplification without significant reduction of accuracy, it is assumed that the input face of each prism has an area much larger than the cross-sectional area of the incident beam and that all faces are infinitely large so as to make diffraction at the prism edges negligible. The two prisms are simulated with octupoles, the latter coupled through two quadrupoles simulating two loads: a dielectric plate between lateral faces of the prisms and a long line of rereflecting mirrors other lateral faces of the two prisms. On the other side each octupole is connected to a quadrupole simulating a load on the idle face of the corresponding prism. The entire system is then replaced with an equivalent octupole which has four arms. Its scattering matrix is calculated. The results indicate that the resonance characteristics of this interferometer are better than those of a prismatic wavemeter but worse than those of a Fabry-Perot interferometer. Figures 3; references: 4 Russian.
[83-2415]

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MICROWAVE THEORY & TECHNIQUES

UDC 621.317.799:621.385.6

DEVICE FOR INVESTIGATION OF AMPLITUDE AND PHASE INSTABILITIES OF HIGHLY SENSITIVE MICROWAVE BAND AMPLIFIERS

Khar'kov RADIOTEKHNIKA in Russian No 57, 1981
(manuscript received 13 Mar 80) pp 119-122

SHAMFAROV, Ya. L., doctor of technical sciences, CHERPAK, N. T., candidate of physicomathematical sciences and TRIDUB, A. V.

[Abstract] The paper describes a device developed by the authors for experimental investigation of phase and amplitude instabilities of masers, in which measurement of the phase shift or a change of the amplitude are accomplished at operational frequency (7 GHz), and a weak total signal is amplified by a superheterodyne receiver and fixed by a recorder. The device can be used for measurement of stability and other types of microwave band amplifiers intended for amplifying both weak and more powerful signals. The device makes it possible with small input signals ($\sim 10^{-9}$ W) to measure phase shifts to 0.005° , and measurement of amplitude to 0.002 dB. Figures 2; references: 1 Western.
[81-6415]

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POWER ENGINEERING

UDC 621.373.52

EXPONENTIAL VOLTAGE GENERATORS WITH CONTROL OF NONLINEARITY

Khar'kov RADIOTEKHNIKA in Russian No 57, 1981
(manuscript received 17 Jan 80) pp 78-82

BORISENKO, A. A., GUBAREV, S. I. and KUZNETSOV, V. N., candidates of technical sciences

[Abstract] An equivalent circuit is proposed, on the basis of which a mathematical model of the functioning of exponential voltage generators with a discrete-controlled slope is worked out. One of the variations of its practical realization is presented. It is seen that a linear form of the output voltage is a particular form of the exponential. Figures 2; references: 4 Russian.
[81-6415]

UDC 621.396

MEASUREMENT OF LEVELS OF CONTINUOUS COMPONENT OF AUDIO-FREQUENCY INTERFERENCE FROM POWER NETWORK

Khar'kov RADIOTEKHNIKA in Russian No 50, 1979 pp 17-20

YATSYSHIN, V. I., candidate of technical sciences, and TSATURYAN, E. N.

[Abstract] Measurement of levels of the continuous component of interference from power networks is difficult because of the unavailability of standard instruments with an adequate resolving power. A technique for measuring the weak audio-frequency interference has been developed with the use of laboratory equipment including Helmholtz rings calibrated with respect to magnetic field intensity and a set of tunable receivers with ferrite antennas. One of these instrument receivers, with a fixed bandwidth of 10 Hz, records the amplitudes of interference harmonics near which the continuous interference component is measured with receivers having adjustable bandwidths. The effective interference level is determined as the sum of

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receiver responses to the continuous component and to the lumped harmonic component respectively, the former being proportional to the square root of the bandwidth and the latter being proportional to the n-th power of the bandwidth (n denoting the number of discriminator stages in the amplification channel). The ratio of the amplitudes of the respective voltages is a direct estimate of the difference between the levels of the two interference components, and also an indicator of the minimum detectable useful signal. With only one discriminator stage using an active filter in the amplification channel, experimental measurements were made of the continuous interference component between the 18th and the 19th current harmonics in an industrial power network. More accurate results can be obtained by extraction of beats between the two interference components. Figures 1.
[82-2415]

UDC 621.396

SPECTRUM OF CONTINUOUS INTERFERENCE COMPONENT FROM POWER NETWORK

Khar'kov RADIOTEKHNIKA in Russian No 50, 1979 pp 20-21

YATSYSHIN, V. I., candidate of technical sciences, and TSATURYAN, E. N.

[Abstract] The continuous component of audiofrequency interference from industrial power networks was measured by suppression of the harmonic component with the aid of narrow-band comb filters. Here the results are shown: the averaged spectral distribution of the continuous interference component, approximately a $1/f^2$ -distribution, referred to a 1 Hz band. For comparison, the spectral distribution of voltage harmonics was measured with tunable receivers (10 Hz bandwidth) inside Helmholtz rings and found to be approximately a $1/f^3$ -distribution. The continuous component does not exceed 1% of the harmonic component near 50 Hz. Therefore, the improvement of the transmission of useful signals over communication channels is worth the cost of suppressing the harmonic interference component. Figures 1; references: 1 Russian.
[82-2415]

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QUANTUM ELECTRONICS, ELECTRO-OPTICS

UDC 778.4;621-397

TRANSMISSION OF HOLOGRAMS IN REAL TIME SCALE

Khar'kov RADIOTEKHNIKA in Russian No 57, 1981
(manuscript received 28 Sep 79) pp 86-90

ALEKHIN, V. I., candidate of technical sciences and BORDUN, V. P.

[Abstract] A process is considered for recording an amplitude (absorption) hologram transmitted via a communication channel, by the method of line scanning in the form of a rectangular raster, and for recovery of images in a real time scale. It is shown that the required frequency of transmission of hologram frames is possible with a specific speed of erasure. Some possible methods are described for weakening parasitic images appearing as the result of pulsation of frames during recovery of holograms. The relative amplitudes obtained by undesirable images are sufficiently high. By enlarging the frequency of change of frames, it is possible to decrease the amplitude of the spectral components of holograms. The previous frames of the hologram will not noticeably distort the recovered images because they differ little from one another. However, it is difficult in practice to realize a system according to such a principle, because it is necessary to enlarge its broadbandness. It is considerably more convenient to remove the undesirable images by a change of the form of the erasure curve. The closer the form of this curve approaches rectangular, the stronger the required effect appears. In fact, if the erasure is performed through the time T_k , then the pulsations are absent and the preceding frame of the hologram is completely erased. In order to obtain the form of an erasure curve close to rectangular it is possible to use a material for recording with a large time constant τ . Photochromy materials, the erasure speed of which is considerably increased during infrared irradiation correspond to a certain degree with these requirements. References 3: 2 Russian, 1 Western.
[81-6415]

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UDC 621.391

EFFECT ON DENSITY OF INFORMATION RECORDING OF LOOSE JOINING OF PHOTO
EFFECT CARRIER TO SCREEN OF CATHODE RAY TUBE WITH FIBER FACE PLATE

Khar'kov RADIOTEKHNIKA in Russian No 57, 1981
(manuscript received 28 Sep 79) pp 91-94

ALEKHIN, V. I., candidate of technical sciences and BORDUN, V. P.

[Abstract] A fundamentally new stage in the field of creation of opto-electronic devices for filtration and processing of radar signals is the development of such devices on the base of a cathode ray tube (CRT) with a fiber face plate. Use of a CRT makes it possible to increase the efficiency of transfer of light energy to the plane of the photo effect carrier, to raise the density of information recording, and to increase the recording speed. All these advantages, however, are retained only in the case where during recording of information the photo effect carrier is found in contact with the fiber-optical shield. The present work evaluates the effect of loose joining of the photo effect carrier on the brightness of the CRT beam in the plane of the photo effect carrier and the resolving power, which determine the density of information recording on a unit of area of the photo-effect carrier. Figures 3; references 3: 2 Russian, 1 Western in translation.

[81-6415]

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