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CONTENTS

Solid State Circuits

New Documented Standards for Listening Conditions

[Article by M. Yu. Lane, All-Union Scientific Research Institute of Television and Radio Broadcasting]

[Abstract] The new standards for professional listening conditions documented in December 1986 for radio broadcasters in Scandinavian countries are: N12A concerning control room geometry and equipment location for minimum reverberation and interference effects, N12B pertaining to studio monitor equipment, and N12C pertaining to audition room for panel of experts. In these standards are specified to tolerance fields for octave and 1/3-octave noise bands within the audio-frequency range, for the frequency characteristic of the reverberation time, for the frequency characteristic of the free-field sound pressure, and for nonlinear distortions of harmonic and noise signals. Figures 4; references 3: 1 Western, 2 OIRT (International Radio and Television Organization).

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Quasi-Optimum Algorithm of Microprocessor-Aided Processing of Data-Carrying Signals

[Article by A. L. Marimont and Yu. V. Tkachenko]

[Abstract] Linear synchronous digital data transmission systems with tone-frequency channels are considered and the Viterbi algorithm is quasi-optimized for microprocessor-aided processing of digital signals with intersymbol interference in such a system. The transmission system is described by an equivalent model which yields its zeta-transform transfer function and the latter, for the purpose of its calculation, is approximated as a rational fraction with both numerator and denominator functions of z. Assuming a discrete Markov source of order n_0 plus 1 and a linear corrector with resolving feedback, n_0 denoting the length of that corrector, the coefficients of both are calculated in accordance with the principle of error minimization. Optimum values of the modem parameters have been determined from the results of computer simulation. This algorithm executed on a 12-16 bit computer contains much fewer additions and multiplications than an algorithm based on the method of least squares. Figures 2; tables 1; references: 5 Western (1 in Russian translation).

02415/09599

UDC 621.397.132.129

Problems in Producing High-Definition Television Broadcast System
18600056a Moscow TEKHNIKA KINO I
TELEVIDENIYA in Russian No 2, Feb 88 pp 3-6

[Article by S. V. Novakovskiy, Moscow Institute of Electrical Communications Engineering]

[Abstract] The latest developments in broadcast television systems since the nineteen seventies are High-Quality Television, more properly called Superhigh-Definition Television with more than 1000 lines/frame, and Teletext not only covering all territories of the USSR but also extending abroad. The basic problems here are cost and time involved in either installing a new network or compressing the High-Quality Television signal spectrum into the conventional up to 6 MHz band without image distortion, compatibility with the existing 625 lines/frame High-Definition Television system being required in each case. Conversion of standards and formats, extensive or exclusive use of fiber optics, and suitability for low-noise digital transmission need to be considered in system development and design, while safety and affordability need to be considered in equipment (home television sets) production. For preliminary evaluation and subsequent optimum selection, 13 variants of a High-Quality Color television system have been developed: four minimal ones with 1125-1875 horizontal or vertical lines and total $(0.36-1.9).10^6$ elements, four maximal ones with 1875-3125 horizontal or vertical lines and total $(2.7-11.0).10^6$ elements, four with 625-1125 horizontal or 1875-3125 vertical lines containing each a minimum number of longitudinal elements and a maximum number of transverse elements, a fifth such system with 1037 longitudinal and 1.36 times more (1406) transverse elements found to be the most promising tradeoff. Transmission of a 30 MHz wide video signal over fiber optics and radio relay or satellite links operating at the 12 GHz frequency (2.5 cm wavelength) is already feasible.

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UDC 681.84.083.8:621.3.037.372

Effect of Frequency Characteristic Correction on Noise Level in Digital Magnetic Recording Channels
18600056b Moscow TEKHNIKA KINO I
TELEVIDENIYA in Russian No 2, Feb 88 pp 27-30

[Article by S. I. Alyabyev and L. V. Muravnik, Moscow Institute of Electrical Communications Engineering]

[Abstract] For a design and performance analysis of digital magnetic recording systems, four known methods of correcting their channel frequency characteristics are compared with respect to resulting increase of the level. They are: 1. direct correction resulting in a waveform of the corrector output signal almost identical to that of the playback signal, 2. integration resulting in a waveform of the playback signal almost identical to that of the recording signal, 3. differentiation resulting in a waveform of the resolver input signal almost identical to that of the derivative of the playback signal, 4. partial transmission. Following a description of intersymbol interference in accordance with the Nyquist criterion, the dependence of the noise level increment on the correction factor t_0/t_0 (T_0-pulse repetition rate, t_0-rise time of corrector response) is evaluated for each method. The results indicate that partial transmission is most effective, in terms of least noise level increment, formation of class IV pulses being preferable to formation of class I pulses. Figures 4; references 2: 1 Russian, 1 Western.

12223

UDC 621.397.132.129:006

Toward Single Worldwide Standard for High-Definition Television
18600056c Moscow TEKHNIKA KINO I
TELEVIDENIYA in Russian No 2, Feb 88 pp 37-38

[Article by V. A. Khleborodov, All-Union Scientific Research Institute of Television and Radio Broadcasting]

[Abstract] A single worldwide HDTV studio standard is being proposed in West Europe which would be adaptable to those already firmly established in the United States, Canada, and Japan. It would be a two-system standard, common for the digital part of both systems and with two variants for the respective different analog parts. The variant for 1125 scanning lines (1035 active lines) per frame and 60 fields per second would have a 33.75 kHz line frequency. The variant for 1375 scanning lines (1280 active lines) per frame and 50 fields per second would have a 34.375 kHz line frequency. The standard would specify a 2:1 interlace and a 16:9 aspect ratio, one quantization frequency of 74.25 MHz for the luminance signal (or R,G,B signals) and 37.125 MHz for the chrominance signal, one bandwidth of 30 MHz for the luminance signal (or R,G,B signals) and 15 MHz for the chrominance signal, and linear pulse-code modulation with at least 8 bits per reading. Conversion of existing standards to this one with the aid of a 4-readings space(vertical)-time integrator is examined on the basis of both its grid and spectral diagrams. Figures 2

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Design and Performance Parameters of Optical Cables, Based on Data From International Exhibition 'SVYAZ-86'
18600057b Moscow ELEKTROTEKHNIKA in Russian
No 1, Jan 88 (manuscript received 7 May 87) pp 58-64

[Article by D. L. Sharle, candidate of technical sciences]

[Abstract] Design and performance parameters of optical fibers and cables are surveyed on the basis of data

from the International Exhibition "Svyaz-86", at which foreign manufacturers displayed their products. The manufacturers included ABC XTAL (Brazil), Condugel (Brazil), Helkama (Finland), Acome (France), SAT (France), KWO (GDR), and Iskra (Yugoslavia). The data cover geometrical dimensions (core, coatings, sheath), including aperture, attenuation coefficient and bandwidth, also dispersion of graded-index and stepped-index multimode fibers, stranding configurations and overall construction, materials, and weight of cables, also their operating temperature ranges and tensile strength under ice load. Figures 7; tables 8.

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UDC 621.396.62

Digital Receivers for Wideband Signals
*18600074a Moscow RADIOTEKHNIKA in Russian
No 3, Mar 88 (manuscript received after revision
3 Mar 87) pp 7-12*

[Article by M. I. Zhodzishskiy and S. Yu. Sila-Novitskiy]

[Abstract] A comparative design and performance evaluation of digital receiver variants for wideband signals and specifically signals modulated by pseudorandom sequences so as to appear as pseudonoisy ones is made, the purpose being to facilitate selection of the optimum variants for specific applications. Basic functions and structure of such receivers are analyzed, taking into account the structure of incoming signals formed by convolution of a high-frequency carrier and a wideband pseudorandom sequence whose phase changes by 180 deg in correspondence with symbols of transmitted narrow-band digital data. Three basic functional schemes differing in the mode of convolution are considered: 1. analog pseudorandom sequence and analog carrier, 2. analog pseudorandom sequence and digital carrier, 3. digital pseudorandom sequence and digital carrier. Algorithms of microcomputer-programmed signal processing by such receivers, which includes estimating the Doppler shift of the carrier and the envelope delay of the pseudorandom sequence, are algorithms of signal detection generally based on calculation of the signal power and algorithms of signal discrimination by the tracking system. For signal discrimination can be used the Costas algorithm when the tracking system operates without symbol synchronization and the feedback algorithm when the tracking system operates with symbol synchronization. Measurement of the signal frequency is based on averaging the control code and measurement of the signal delay is based on summation of the control code. Figures 10; references 13: 5 Russian, 8 Western.

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UDC 621.375

Stability of Low-Frequency Class-D Amplifier With Negative Feedback
*18600074b Moscow RADIOTEKHNIKA in Russian
No 3, Mar 88 (manuscript received after revision
5 May 87) pp 26-27*

[Article by A. A. Aleksanyan, V. A. Galakhov, and L. L. Mozheyko]

[Abstract] A class-D amplifier is considered which includes a pulse-width modulator, a power switch-amplifier, a low-pass LC-filter, and a frequency-independent negative-feedback loop. A stability analysis based on the frequency criterion and including the transfer function of the modulator is shown to yield an estimate of the maximum allowable feedback factor for such an amplifier excited at frequencies equal to multiples of half the clock frequency and operating with either unilateral or bilateral modulation. This theoretical estimate has been confirmed closely measurements on an experimental model. Figures 2; references: 4 Russian.

12223

UDC 621.375.026

Economical Amplifiers for Radio Receivers
*18600074c Moscow RADIOTEKHNIKA in Russian
No, 3 Mar 88 (manuscript received after revision
3 May 87) pp 31-33*

[Article by N. B. Dogadin and V. N. Nogin]

[Abstract] Two solid-state audio amplifiers for portable (battery operated) radio receivers are shown which have been designed for economy in terms of low metal content and high energy efficiency. Their principal design feature is step voltage control for minimization of power losses in the active components during intermediate switching. Their outstanding performance features are wide dynamic range and absence of high-frequency emissions. The first amplifier contains a series K174UN7 integrated-microcircuit chip, two KT815 transistors, three D310 diodes, and an output transformer with three identical windings. The second amplifier contains a 140UD6 operational amplifier, three KT815 transistors, three KT814 transistors, seven KD504A diodes, no wound components. The maximum output voltage of both amplifiers is the same, because the transistors are connected in parallel rather than in series. Both amplifiers have been tested. Figures 2; tables 1; references: 2 Russian.

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UDC 621.391

Dependence of Estimation Accuracy Pertaining to Point-Target Coordinates and Their Derivatives on Random Variance of Antenna System Parameters

18600052a Kiev IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: RADIOELEKTRONIKA in Russian Vol 31 No 1, Jan 88 (manuscript received, after revision, 27 Oct 86) pp 12-18

[Article by G. S. Nakhmanson] txt

[Abstract] Estimation of target coordinates and their derivatives by a multi-positional antenna system is analyzed for accuracy, assuming that a point target moves within the Fresnel zone and that coherent space-time processing of wideband signals in the antenna system is effected in the presence of internal equipment noise as well as multiplicative interference resulting from instability of amplitude and phase characteristics of the antenna elements. The errors are calculated for conditions of reliable estimation with high signal-to-noise ratio at the output of the processing system. Relations are obtained which indicate the dependence of the estimation accuracy on the variance of antenna system parameters characterizing nonidenticality of antenna elements. For illustration, the results are applied to simultaneous estimation of distance and radial velocity of a target moving within the Fresnel zone of a linear antenna array. Figures 2; references 6: 5 Russian, 1 Western.

02415/09599

UDC 519.24

Separation of Space-Time Vector Signals by Means of Multichannel Antenna and Receiver Equipment

18600052b Kiev IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: RADIOELEKTRONIKA in Russian Vol 31 No 1, Jan 88 (manuscript received, after revision, 13 Oct 86) pp 18-23

[Article by A. I. Knyaz]

[Abstract] Linear separation of space-time vector radio signals in a group is considered, for detection according to the criterion of minimum interference-to-signal ratio, and generalized antenna-receiver configurations for this purpose are comparatively analyzed. Such configurations being essentially multichannel ones containing antenna elements with phase centers, they fall into three basic classes: local, diverse, and hybrid local-diverse. The algorithms of separation including an algorithm of double weighting are applied to two cases of practical interest, namely separation of vector-time radio signals by a local antenna system and of space-time radio signals by a diverse antenna system. Figures 3; references 8 Russian.

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UDC 621.396.677.32

Optimum Attainable Characteristics of Yagi Antennas

18600065f Moscow RADIOTEKHNIKA in Russian No 3, Feb 88 (manuscript received after revision 30 Jul 87) pp 80-81

[Article by A. A. Yefanov, M. Yu. Mikhaylov, and A. F. Chaplin]

[Abstract] Design of Yagi antennas is analyzed, for estimation of their optimum attainable performance characteristics. The dependence of directive gain, standing-wave ratio, and side-lobe level as well as of both resistive and reactive components of the input impedance on the length and spacing of array elements relative to the radiation wavelength, also on the frequency deviation, has been evaluated numerically by the method of nonlinear mathematical programming. The results reveal that the classical method of antenna design is not adequate for this type of antenna. They also indicate the feasibility of attaining of high input impedance, wideband and two-band Yagi antennas additionally requiring a close spacing of parasitic elements. Figures 2; tables 2; references: 6 Russian.

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UDC 621.396.677

Aerospace Solid-State Active Phased Antenna Arrays: Review

18600066a Kiev IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: RADIOELEKTRONIKA in Russian Vol 31 No 2, Feb 88 (manuscript received 29 Jun 87) pp 4-14

[Article by D. I. Voskresenskiy, V. L. Gostyukhin, and K. G. Klimachev]

[Abstract] The state of art in use of multifunctional solid-state active phased transmitter and transmitter-receiver antenna arrays in aerospace communication systems is reviewed, including a comparative design and performance analysis of various satellite antenna layout schemes for gigahertz frequency bands. Hybrid reflector antennas and multibeam arrays are regarded as the most promising ones. The description of various aerospace and ground radar stations using active phased antenna arrays covers known excitation methods and operating modes. Figures 7; tables 1; references 26: 11 Russian, 15 Western.

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Radiation Field of Printed Spiral Conductor Consisting of Semicircular Segments

[Article by V. V. Chebyshev]

[Abstract] A sequence of flat semicircular metal strips with successively larger radii in a multilayer dielectric medium is considered as a practical model of a printer-circuit Archimedes spiral. Evaluation of its performance as current conductor and as radiator is based on numerical solution of the corresponding system of first-kind Fredholm integral equations, with application of both discretization and self-regularization principles. An algorithm is shown which yields a well-conditioned system of linear algebraic equations for the currents and the electric field of such a spiral. This algorithm has been programmed in FORTRAN-Dubna language on a BESM-6 high-speed computer. Figures 1; references 3: 2 Russian, 1 Western (in Russian translation).

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Inaccuracy of Determining Antenna Radiation Patterns With Aid of Discrete Fourier Transform

[Article by D. G. Asatryan]

[Abstract] Determination of antenna radiation patterns with the aid of discrete Fourier transforms is analyzed for accuracy, the relative quantization error largely depending on the field amplitude-phase distribution pattern in the antenna aperture. For estimation of this error and establishing its upper bound, considering a cophasal linear antenna array and assuming a symmetric amplitude distribution in the aperture, the radiation pattern is represented by the Fourier transform of that field distribution. In the case of uniform quantization, the discrete transform is a power series in the generalized Fourier argument u, and an inverse-power series in the number of readings N. Only the first term of the latter series is retained, which yields a relative quantization error inversely proportional to N^2. Four field amplitude distributions are considered: cosinusoidal, uniform, exponential, parabolic. Expressions are derived for the minimum error as the number of readings N in each case increases toward infinity. References 6: 5 Russian, 1 Western (in Russian translation).

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Highly Efficient Computer Optics for Processing Signals From Multielement Antenna Arrays

[Article by M. I. Nekrasova and V. S. Temchenko]

[Abstract] Several differently synthesized transparencies for computer-aided optical processing of antenna signals are described, a high efficiency of these transparencies being realized particularly in hybrid optoelectronic processors for multielement antenna arrays such as a ring array. These transparencies are based on coding two phases or two amplitudes, coding both imaginary and real parts of the transmittance function in two adjacent resolution elements, or on use of a phase medium for both phase and amplitude transfer. A comparative design analysis reveals their energy and accuracy characteristics. Figures 3; references: 4 Russian.

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Effect of Discreteness of Exit Plane of Optical Processor Processing Signals From Antenna Array With Coherent Light on Apparent Directional and Energy Characteristics of Antenna

[Article by A. A. Rymov]

[Abstract] Discrete optical processing of signals from antenna arrays with coherent light is analyzed for the effect of the discreteness of the processor exit plane on the image of a radiation pattern in that plane, specifically on the directive gain and the side lobes. The dependence of the directive gain and the side-lobe level on the displacement of the light spot center and on the number of elements in the charge-coupled-device processor array is evaluated, analytically and numerically, taking into account permissible distortions and in the first approximation disregarding finiteness of the dynamic range. Figures 1; references: 4 Russian.

12223

UDC 621.396.67.01

Phase Synthesis of Antenna Arrays With Interacting Elements

[Article by A. S. Kondratyev]

[Abstract] Synthesizing phased antenna arrays by fixing the current amplitudes and matching the current phases in the radiators is considered, a procedure being proposed which takes into account interaction of array elements and allows minimizing the norm of difference between synthesized and desired radiation patterns. Such a phase synthesis of an arbitrarily intricate radiation pattern in the mean-square approximation is reduced to minimization of the corresponding deviation functional. In the case of an unknown amplitude multiplier, a positive constant which determines the amplitude distribution pattern, it either is calculated as the one which minimizes that functional for arbitrary given initial phases or is included in the set of variables. This multiplier for a scanning antenna array must have the same magnitude at every angle. For an equidistant antenna array the problem of synthesis can, in the approximation of given currents, be solved analytically. An equidistant scanning antenna array has therefore been selected for numerical calculation of synthesized radiation patterns. Figures 6; references 18: 10 Russian, 8 Western (2 in Russian translation).

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UDC 550.388.2

Compression of Pulse Signals During Their Reflection and Scattering by Ionospheric E$_S$-Layer

[Article by V. D. Gusev, I. Yu. Zhidovlenko, and L. I. Prikhodko]

[Abstract] Compression of linearly frequency modulated radio pulse signals by an ionospheric E$_S$-layer sufficiently thin so as not to absorb the signal and having an intrinsic local gradient is evaluated, for the purpose of determining the combined effect of a regular ionospheric gradient and scattering by small-scale inhomogeneities in the triangular-layer-with-percolation mode. Signals with modulation appropriate for the backscattering path and with a carrier frequency higher than the maximum usable are considered. Numerical analysis by statistical testing with direct simulation of the dielectric permittivity as a random quantity, with white noise generated by the method of linear congruence, and with transformation of the correlation function by the method of digital filtration, assuming that the anisotropic two-dimensional correlation function for random inhomogeneities is a Gaussian one, has yielded the envelopes of a reflected pulse and a scattered pulse respectively. They indicate that both regular refraction at the layer surface and scattering by inhomogeneities in the layer degrade the compression of the reflected pulse, which must be considered in the design of linear frequency modulation for high interference immunity and resolving power necessary for probing the ionosphere. Figures 2; references: 6 Russian.

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UDC 621.396.67.01

Scattering of Electromagnetic Waves by Antennas (Review)

[Article by L. S. Benenson and Ya. N. Feld]

[Abstract] Scattering of electromagnetic waves by antennas is reviewed, considering that the characteristics of a scattered field are both integral and differential effective cross-sections of a body as well as the second-rank scattering matrix. The engineering method of calculation for strongly conducting and absorbing but weakly reflecting black bodies in the Kirchhoff approximation is first outlined generally and then applied to apertural antennas. The integral scattering characteristics of any antenna are subsequently evaluated by application of the optical theorem, which follows directly from Poynting's theorem, to absorbing scatterers and antennas. The scattering pattern of an antenna is most expediently calculated by the superposition method, the two superposed fields being the field which a loaded antenna scatters upon incidence of the primary wave and the field radiated by this antenna operating in the transmitter mode under conditions of excitation in absence of a primary field. Analysis of two-positional scattering patterns requires inclusion of shadow scattering and of back scattering, also of reflection by the receiver, of polarization mismatch between primary field and antenna, and of scattering by sharp edges as well as by protuberances especially significant in the case of lateral incidence of waves. Particularly interesting in this respect are reflector and horn antennas, but scattering by radiators of simplest geometrical form such as a thin recti-linear one and a thin helical one is important fundamentally. With analysis of scattering by antennas covered, synthesis of antennas with prescribed scattering characteristics becomes the major problem. One method of synthesis, compensation with properly inserted additional active sources, is applicable only when the primary field remains invariable and the scatterer position relative to it remains fixed. Another method, based on determining

the reactance distribution over the scatterer front surface as indicator of the scatterer shape, is applicable only when the incidence angle of the primary wave remains constant. Difficulties in realization of a variable reactance have been overcome by determining the shape of the rear surface, slender cylindrical, with low impedance and small impedance gradient. Figures 2; references 40: 27 Russian 13 Western (5 in Russian translation).

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Frequency-Dependence Compensating Antenna Arrays

[Article by A. F. Chaplin and B. V. Koval]

[Abstract] The performance of linear antenna arrays with nonequidistant spacing of radiators for compensation of the frequency dependence of the radiation pattern is analyzed, assuming a fixed number M of isotropic radiators with equal current amplitudes and linearly unequal current phases spaced in accordance with the law of minimally ordered sequences. The radiation pattern of such an array is calculated by the method of Fourier series and superposition on an equidistant array of the same length a mirror-symmetric current amplitude distribution and a monotonic linear current phase distribution, whereupon expressions are derived for the directive gain and bandwidth frequency ration. For synthesis of such an array is proposed a 2-step procedure: first determining the period d of the equidistant array which will match the highest operating frequency and the maximum phasing angle, then determining the number of nonequidistant radiators M which will ensure the necessary performance (width of major lobe, level of lateral radiation, directive gain, efficiency). This procedure is demonstrated numerically for an array of 18 radiators spaced according to the minimally ordered sequence 0, 2, 10, 22, 53, 56, 82, 83, 89, 98, 130, 148, 153, 167, 188, 192, 205, 216 to operate at the 1.01d wavelength with a zero phasing angle. Synthesis of such an array on the basis of Fourier coefficients is hardly feasible. Figures 5; references 5: 3 Russian, 2 Western (1 in Russian translation)

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Experimental Study of Surface Magnetostatic Waves Excited on Meandrous Retarding Structure

[Article by M. V. Smelov]

[Abstract] An experimental study of surface magnetostatic waves excited on and propagating along a meandrous retarding structure was made, the structure having been produced by thin-film technology on a 0.5 mm thick Policor substrate. The transmitter-exciter formed a 10 mm long arm containing an 8 mm long meander formed by a 0.050 mm wide microstrip with 0.400 mm period and 0.200 mm steps. The receiver-exciter formed an 8 mm long single-rod antenna containing a 0.050 mm wide microstrip parallel to the inside meander edge 5 mm away from it. Both exciters were covered by 0.020 mm thick YIG film, 10 mm wide and 20 mm long, with a 1750 G saturation value of magnetic induction. The meander was designed for a 3 GHz critical frequency corresponding to transition from symmetric to asymmetric oscillations under no load. The recorded amplitude-frequency characteristic reveals a more efficient excitation of higher harmonics and a minimum attenuation not less than 15 dB. This and the dispersion characteristic indicate presence of natural oscillations within the three-dimensional structure. Figures 2; references: 1 Russian

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Electric Positioning Drive for Antenna Rotating Mechanisms

[Article by V. M. Drobushevskiy, S. F. Drugov, V. I. Panteleyev, and A. M. Strizhkov, Krasnoyarsk Polytechnic Institute]

[Abstract] An electric positioning drive for antenna rotating mechanisms with precise tracking and automatic control is synthesized on the basis of a stepper torque motor with a thyratron-transistor exciter feeding the commutator. Design and performance analysis of such a drive involves simultaneous solution, by numerical simulation, of three coupled differential equations describing the electromechanical system. Automatic control with a system of closed loops requires a corrector, a digital-to-analog converter, a position-to-code converter, two summators, and a frequency regulator consisting of a code-to-frequency converter with an integrator and an error-sign sensor. Neither speed reducer nor speed sensor are required and static error of the displacement angle is eliminated in such a drive. The measured characteristics of an experimental prototype agree very closely with the theoretical characteristics calculated on a digital computer. Article was presented by Department of Automation and Telemechanics. Figures 3; references: 2 Russian.

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Space Correlation of Radio Signals Reflected by Sea Surface

[Article by B. I. Orekhov, A. A. Garnakeryan, V. D. Bukharin, and A. S. Afanasyev]

[Abstract] A correlation between parameters of radio signals reflected by a shallow continuous but randomly uneven sea surface with large-scale ripple and parameters of that surface is established on the basis of field calculations by the Kirchhoff method. The probing signal, normally or almost normally (0-30 deg) incident, is assumed to be a monochromatic electromagnetic wave and the radar antenna is assumed to have a narrow radiation pattern. The two relevant space correlation functions are derived in analytical form, taking into account correlation between ripple slopes in mutually orthogonal directions x,y and assuming a normal ripple waveform in both directions. Probing with microwaves and with short waves is considered, experimental probing of Black Sea coast waters having been done with 10 m waves from an airplane during the 1971-74 period and during the 1982-86 period. Figures 1; references: 5 Russian.

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UDC 681.89

Monolithic Acoustoelectronic Devices on Basis of LiNbO₃(Substrate)-InSb(Film) Structure

[Article by S. F. Belyy, A. M. Bashkirov, V. I. Gavrilin, A. M. Gulyayev, and A. A. Lavrenov]

[Abstract] The monolithic version of acoustoelectronic devices consisting of an InSb film on a LiNbO₃ substrate is described, namely interdigital surface-acoustic-wave amplifier and convolvers. Their design and performance characteristics are reviewed and analyzed on the basis of theoretical and experimental data covering the 1964-1985 period of research and development. Particularly interesting is the effect of light on performance parameters including their temperature and time dependence. This version is also suitable for acoustoelectronic detectors, of the SAW kind and the Hall-effect kind, for an acoustoinjection SAW transistor, and various other devices. Figures 6; references 13: 7 Russian, 6 Western

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UDC 621.372.542.29

Two-Dimensional Filters Built on Charge-Coupled-Device Arrays

[Article by S. I. Miroshnichenko]

[Abstract] Design and performance of a two-dimensional filter built on a charge-coupled-device array and operating in the nondirectional-charge-transfer mode, with a 3-phase memory and a 3-phase register, are analyzed on the basis of a system of difference equations which relate voltages across potential-well capacitances to contour charges. Solution of this system of equations yields the input impedance as a function of the time frequency and then the two transfer ratios, each as a function of the corresponding space frequency. An experimental prototype of a semicausal Lf_x-LF_y low-frequency filter was built and evaluated, HF_x-Hf_y high-frequency filters and hybrid filters as well as noncausal filters being also feasible with appropriate multiplication of signal samples. Figures 2; references 6: 4 Russian, 2 Western (in Russian translation).

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Linearization of Transfer Function of Analog-to-Digital Converter With Phase Modulation

[Article by A. F. Mikheyev and V. Ya. Androsenko]

[Abstract] An analog-to-digital converter with phase modulation is considered for simplification of radar data processing, a frequency-dependent phase modulator and a synthesized one with pulse-amplitude transforming elements being available for this purpose but the nonlinearity of their modulation characteristic as well as of the input transducer contributing appreciably to nonlinearity of the overall transfer function. Four methods of linearizing that transfer function are described: 1) modulator reversal twice during a conversion cycle, when the modulator is a frequency-dependent one; 2) sine-cosine approximation and resolution of the input signal; 3) tangent correction on the analog side, when the transducer of the analog input quantity is a potentiometer, lengthens the linear range by an order of magnitude; 4) digital correction, when the nonlinearity of the output characteristic is small, is simplest in terms of circuitry. Figures 4; references: 4 Russian.

Comparative Performance Evaluation of Receivers of Radar Signals Submerged in Background Noise With Varying Intensity

[Article by S. S. Gremyachenskiy and Yu. V. Yakovlev]

[Abstract] Receivers of noncoherent narrow-band pulse signals appearing with additive variable-intensity and thus nonstationary Gaussian noise are comparatively evaluated with regard to efficiency. Receivers of this class include a special device for measuring the spectral noise density and correspondingly regulating the detector transfer ratio, a matched filter, an amplitude detector, a summator, and a resolver. The noise is assumed not to vary within the duration of a pulse signal so that the matched filter does not significantly alter its nonstationarity parameters, the input pulses are assumed to be weak, and the summator output signal is assumed to be a Gaussian one. The receiver efficiency, in the asymptotic sense under these conditions, is accordingly calculated in terms of detection probability monotonically related to the output signal-to-noise ratio. It is calculated for receivers with square-law detector, with linear detector, with logarithmic detector, and with detectors ensuring constant dispersion of the output noise. The optimum ones, receivers with square-law detector, are most efficient but structurally most complex. The advantages of receivers with logarithmic detector and receivers with constant output noise dispersion can be combined by adding a differentiating circuit behind the logarithmic detector or in a receiver with limiting, in which cases nonparametric detection with nonadjustable threshold as well as complete normalization of not only the power but also the output noise are possible. Figures 2; references: 5 Russian.

Compensation of Systematic Error in Radio Direction Finder

[Article by Yu. G. Bulychev and A. A. Korotun]

[Abstract] The systematic error of elevation measurements made, with data smoothing, by a radio direction finder is calculated for a target moving in a straight line. The calculations are based on analysis of the trigonometric relations in a local system of coordinates with the origin at the center of the radar site and with the target location given by its azimuth as well as elevation. An algorithm using quantities invariant in time and immune to anomalous readings is constructed for optimum estimation and subsequent compensation of that error by a single direction finder. Figures 1; references: 4 Russian.

Correlational Algorithm for Synthesis of Simulator of Scattering Pattern Attributable to Real Bodies

[Article by V. V. Leontyev and S. O. Shelest]

[Abstract] A method of simulating the scattering pattern or, more precisely, the effective-scattering-area diagram of intricately shaped real bodies is shown, the algorithm of synthesizing a simulator of the real body involving subdivision of the latter's diagram into m sectors and its simulation within each sector with two space-diverse reflectors. The sectors are thus made mutually independent and to each can be assigned its own system of polar coordinates, which simplifies the proper placement of its

reflector pair. The algorithm is workable when the real effective-scattering-area diagram has been measured p times in one plane with given imprecision and with the aspect angle varied from zero to 360 degrees. The real diagram is regarded as an ergodic random process non-stationary relative to the aspect angle and as a process with finite, discrete in time, instantaneous space-frequency spectra. The diagram of each simulating reflector is assumed to consist of only one cos^2-lobe of a certain width. The accuracy of the simulating diagram relative to the real one is maximized by minimizing the average difference of readings. The algorithm is programmable on a computer. Figures 6; references: 4 Russian.

12223

UDC 621.396.6.001:681.3

Algorithms for Synthesis of Electronic Tracking Systems
*18600065d Moscow RADIOTEKHNIKA in Russian
No 2, Feb 88 (manuscript received 9 May 87) pp 58-60*

[Article by V. I. Merkulov and V. A. Yefimov]

[Abstract] An algorithm for synthesis of electronic tracking systems is constructed according to the Letov-Kalman optimality criterion and involving solution of the Riccati equation for evaluation of a 2nx2n compound symmetric penalty matrix. The algorithm, a modification of the conventional one for linear systems, is more computer-economical. Mathematically both are identical, being based on the same model, which is demonstrated on the assumption that both tracking and control processes are free of any perturbations. References 4: 3 Russian, 1 Western (in Russian translation).

12223

UDC 621.391.01

Pulsed Frequency and Time Modulation of Noise as Signal Carrier
*18600068c Moscow RADIOTEKHNIKA I
ELEKTRONIKA in Russian Vol 33 No 1, Jan 88
(manuscript received 16 Apr 86) pp 87-95*

[Article by A. P. Trifonov and V. I. Parfenov]

[Abstract] Pulsed frequency and time modulation of signal-carrying noise is considered, use of noise as information carrier being advantageous where a high degree of secrecy is required. The useful signal is modulated by a pulse of given duration whose unknown position in time lies within an apriori given period and it is split into two components, each containing a multiplicative centered Gaussian narrow-band stationary random process with given spectral power density and the two processes being mutually independent but correlated in time. For detection of such a signal in the presence of Gaussian white background noise, a maximum-likelihood receiver
is synthesized. Its maximum-likelihood estimates have a bias and a dispersion which can be calculated with an accuracy which improves asymptotically as the duration of the modulating pulse and its position range in time become longer. Figures 2; references 10: 8 Russian, 2 Western

12223

UDC 621.396.969.11

Design Optimization of Multiscale System for Distance Measurement
*18600072a Kiev IZVESTIYA VYSSHIKH
UCHEBNYKH ZAVEDENIY: RADIOELEKTRONIKA
in Russian Vol 31 No 3, Mar 88 (manuscript received
after revision 19 Jan 87) pp 3-9*

[Article by V. V. Klimakov]

[Abstract] Design optimization of a multiscale system for distance measurements without ambiguity of readings is considered, a direct algorithm without constraints on the bases of scales being used for removal of ambiguity and approximate estimation of an anomalous error. The optimization problem is essentially one of finding the number of scales and determining the time periods of unambiguous readings on the combination of scales which, at a given total energy drawn by the measuring instrument and equally divided among all scales, give unambiguous readings over a given range of distances with the minimum anomalous error. The problem reduces to finding a set of not worse scale base combinations. This cannot be done analytically with three or more scales. The two optimality criteria are probability of an anomalous error and a coefficient characterizing expansion of the range of unambiguous distance (time delay) readings. The optimization procedure and the algorithm of ambiguity removal are demonstrated on a 3-scale system, with relevant numerical data and performance characteristics. Figures 3; tables 4; references 8: 7 Russian, 1 Western.

12223

UDC 681.5.015.44

Characteristics of Estimation Process for Determining Coordinates and Velocity Vector of Moving Object
*18600074d Moscow RADIOTEKHNIKA in Russian
No 3, Mar 88 (manuscript received 8 Jun 87) pp 47-49*

[Article by B. I. Shcherbakov]

[Abstract] The algorithm of estimating the trajectory of a moving object, namely the position vector (coordinates) and the velocity vector, on the basis of equally precise but generally not equally discrete independent measurements is analyzed, assuming uniform rectilinear motion of the object and normal distribution of estimation

errors. The estimate of each vector is expressed as a polynomial containing the estimate of the other vector and its accuracy is shown to depend accordingly on two coefficients, one being the time interval between successive measurements and both being functions of the number of measurements already made. The correlation matrix of estimates is expressed as a vector product of two matrices: the matrix of readings and a square matrix consisting of four scalar elements. Estimates based on equally discrete measurements are treated as a special case. Estimates either optimum according to the criterion of minimum r.m.s. error or within prescribed accuracy are obtainable. References 2: 1 Russian, 1 Western.

12223

UDC 621.372.824

Temperature Dependence of Attenuation Along Superconducting Coaxial Communication Lines
18600074e Moscow RADIOTEKHNIKA in Russian No 3, Mar 88 (manuscript received after revision 10 Jun 87) pp 62-66

[Article by D. Ya. Galperovich, V. I. Grechkov, and T. V. Korzhakova]

[Abstract] Experimental data on the temperature dependence of attenuation along three differently constructed superconducting coaxial cables are evaluated and correlated with theoretical calculation of the attenuation as due to the sum of temperature-dependent power losses in the superconductors and in the dielectric insulation respectively. Two of the cables are produced in the USSR, both with Nb wire 0.47 mm in diameter as inner conductor and a sleeve of monolithic 4D teflon 1.53-1.55 mm in diameter as insulation. In the first cable the outer conductor is 0.013 mm thick and 6 mm wide Nb tape would with overlapping and the stabilizing sheath is a braid of stainless steel wires 0.1 mm in diameter. In the second cable the outer conductor is 0.030 mm thick and 5.2 mm wide Nb tape wound with abutting and the stabilizing sheath is 0.030 mm thick and 5.2 mm wide Cu tape wound with abutting. Both cables are protected by a single layer of 0.070 mm thick and 8 mm wide superconducting coaxial line tape wound with 50 percent overlap. The third cable, produced in Japan, consists of a Pb-coated Cu wire 0.48 mm in diameter as inner conductor and 0.1 mm thick Pb-coated Cu tape wound into a tube as outer conductor with a sleeve of fluoroethylene 1.58 mm in diameter between them as insulation. The protective sheath of this cable is made of polyester tape wound into a tube 2mm in diameter. In both cables with Nb conductors losses in the latter are assumed to be temperature dependent according to London's law. In the cable with Pb-coated Cu conductors losses in the latter are assumed to be temperature dependent according to Pippard's law. The critical temperatures for Nb tape annealed at 1000 deg C for 1 h after chemical etching and Nb wire annealed at 1100 deg C for 1 h after deoxidation are 9.1 K and 9.2 K respectively,

such conductors being used in the second cable. For the Nb conductors with much higher O_2-content used in the first cable the critical temperatures are 7.0-7.7 K and 8.7 K respectively. Attenuation measurements were made over the 4.2-7 K temperature range, with the operating frequency varied from 1 GHz to 18 GHz in 1 GHz steps. The closest agreement with theoretical calculations was obtained for the higher-quality second cable, the temperature dependence of attenuation along this cable being quite weak at frequencies below 4 GHz. Figures 5; tables 2; references 6: 4 Russian, 2 Western

12223

UDC 621.391.2

Multichannel Rank Detector of Optical Signals
18600074g Moscow RADIOTEKHNIKA in Russian No 3, Mar 88 (manuscript received 16 May 87) pp 86-89

[Article by A. P. Stepin]

[Abstract] Multichannel rank detectors of optical signals are considered, the optimum such detector known to be more stable than the optimum parametric one in the case of variable distributions of input quantities and only slightly less efficient but to have a much more intricate structure. An algorithm of detection is therefore proposed which results in a much simpler structure and also does not require constraints on the signal power for attainment of nearly optimum performance characteristics. It is based on the likelihood ratio and on existence of a functional relation between interference distribution and signal plus interference mixture distribution. Detection by testing the Lehman alternatives is valid when dependence of the likelihood ratio on the ratio of mean interference value to mean signal value as well as on the degrees of signal and interference coherence is taken into account. The detector structure is synthesized accordingly, the algorithm having been tested for signals up to 30 times more coherent than the interference. Figures 2; references 7: 3 Russian, 4 Western (in Russian translation)

12223

UDC 621.396.96.01

Natural Bases and Polarization Portraits of Fluctuating Radar Targets and of Stable Ones
18600075c Moscow RADIOTEKHNIKA I ELEKTRONIKA in Russian Vol 33 No 2, Feb 88 (manuscript received 5 Jun 86) pp 326-330

[Article by L. A. Zhivotovskiy]

[Abstract] For convenient analysis of echo signals from a fluctuating radar target and simplified calculation of their polarization characteristics from their coherence matrix, a "natural basis" is introduced in which the

polarization portrait of such a radar target as well as of a stable one on the Poincare sphere appears in canonical form. Three classes of radar targets are defined parametrically, stable ones representing a special case of class I with maximum intensity of signals leaving the target and maximum power of signals entering the matched receiver corresponding to the same transmitter polarization. Figures 2; references: 3 Russian.

12223

UDC 658.012.56:681.3.06

Performance Evaluation of Software for Computer-Aided Air Traffic Control on Basis of Fuzzy Logic

[Article by Yuriy Nikolayevich Minayev, doctor of technical sciences, and Yuriy Viktorovich Reshetnyak, engineer, Kiev Institute of Civil Aviation] Engineers

[Abstract] The performance of software for computer-aided air traffic control is evaluated on the basis of fuzzy logic and appropriate criteria, latent errors most often emerging only during tracking with nonstandard input data sets either not included in the test procedure or not provided for in the semantics being the principal factor which detrimentally influences the software performance. The apparatus of fuzzy logic has been found to be very adequate for such situations and is used here, strong statistics not being available so that probabilistic methods are inapplicable and expert estimates being characterized by subjective indeterminacy. Fuzzy inferability takes into account the possibility of correct software performance even in the presence of errors, inasmuch as it provides means for error compensation as well as means for expert software examination and certification. The appearance of nonstandard input data sets and the occurrence of functional failures are classified into imprecise "seldom", "often", "close to ..." frequency ranges, whereupon an integral performance indicator is defined for each range. There follows determination of the convergence ratio in sets X and Y, this ratio being obtained by pairwise comparisons, and then determination of the preference ratio for x in X to y in Y. The procedure is demonstrated on an example with an even finer expert classification of nonstandard input data sets and functional failures into "always", "often", "not always", "not often", "seldom", "almost never", "never" frequency ranges. References 8: 4 Russian, 4 Western (3 in Russian translation).

12223

UDC 681.3.06:551.46

Graphic Program Package for Visualization of Hydrophysical Fields in Oceanography

[Article by Aleksandr Ivanovich Perederiy, candidate of technical sciences, and Yuriy Anatolyevich Trakhtman, senior scientific associate, Scientific Research Institute of Geology, Dnepropetrovsk State University]

[Abstract] A graphic program package for an oceanographic data bank has been developed which consists of two mutually independent parts, the MAP01 graphic part for mapping isolines on grids and an APS auxiliary program set for interfacing the MAP01 with the oceanographic data bank. The package can be used in three modes. Formation of input data for the MAP01 on the basis of data sampled from the oceanographic data bank occurs according to an 8-step algorithm and involves working the APS alone. Plotting graphic information on the basis of data prepared by the APS involves working the MAP01 alone not only for mapping isolines in cartographic projections (cylindrical with equally spaced parallels, cylindrical isogonic, conical isogonic) but also shielding isolines (coastline contours), for which an 8-step algorithm is proposed, and plotting supplementary graphic information. In the third mode both parts of the package actively involved. The package consists of 60 programs, including 28 programs of the GRAFOR set, with a total capacity of approximately 2000 operators. It is written in FORTRAN 4 for a YeS-1022 or older computer with a memory of at least 512 kbyte capacity. It requires two magnetic disc storages and 1-3 magnetic tape storages. The package is capable of producing grid models with various degrees of detail elaboration on large arrays of randomly distributed space data. It is adjustable for any ocean region and is now used on a trial basis at the Institute of Marine Hydrophysics, UkSSR Academy of Sciences. References: 11 Russian.

12223

531.383

Dependence of Flight Safety on Accuracy and Reliability of Navigation Systems

[Article by A. A. Ressin, A. D. Troyanovskiy, and B. Ya. Tsilker, Riga Institute of Civil Aviation Engineers]

[Abstract] The degree of flight safety depending on the accuracy and the reliability of both inertial and radio

navigation systems used for flight control is estimated on the basis of a probabilistic model. The probability density of lateral deviation from the course is calculated for two modes of navigation, either with the radio system normally active and the inertial system as standby so that each system operates alone or with both systems simultaneously active. The failure rate of a radio navigation system is assumed to remain constant and the r.m.s. error of an inertial system is assumed to increase linearly with time at a rate of approximately 1.85 km/h during transoceanic flight, the probability density of lateral deviation during flight with an inertial navigation system alone having a bilateral exponential distribution. It is necessary that the inertial navigation system remain adequate for a sufficiently long period of time after failure of the radio navigation system. The length of that period is determined on the basis of those probability density estimates and the known probability of collision of two planes flying on parallel courses. Article was presented by Department of Flight Safety. References 8: 6 Russian, 2 Western.

12223

Hydroacoustic Differential Range Finding System for Locating Objects

[Article by Yu. M. Osadchiy and V. A. Omelchenko, Sevastopol Institute of Instrument Design]

[Abstract] An algorithm is constructed, on the basis of relevant geometrical relations, for determining the two Cartesian coordinates of an object in a horizontal plane with the aid of a differential range finding system which consists of three hydroacoustic beacons on shallow water, such a system not requiring a signal transmitter on the object. The calculations, including an accuracy analysis with the errors expressed in the form of complete differentials and considering that nonuniformity of the acoustic velocity in water is the major source of errors, have been programmed for execution on a computer. Article was presented by Department of Higher Mathematics. Figures 3; references: 4 Russian

12223

UDC 621.317.33

Design of Linear Displacement Transducers With Low-Capacitance Sensors

[Article by M. M. Sirazetdinov, Ufa]

[Abstract] A design of low-capacitance linear displacement-to-voltage converting transducers is proposed, its gist being maintenance of equal areas under the voltage-time curves characterizing the discharge process after the sensor capacitor has been charged by voltage pulses of given amplitude. The discharge curve being an exponential one, introduction of appropriate negative feedback ensures an equal area with a smaller sensor capacitance. This is achieved by means of a pulse generator with frequency stabilization, an electronic switch, a 2-diode-2-resistor bridge, a reference capacitor, two low-pass filters, a summator, and a comparator, an adjustable resistor being added for compensation of stray capacitance. Such a transducer was built and tested for comparison with two other variants, one with a twin-T bridge and one with compensation of nonlinearity by equalizing feedback. Its measured performance curve (conversion characteristic) was found to deviate from the calculated one by not more than 10 percent, with a temperature drift of a comparator (operational amplifier) output voltage not exceeding 0.5 percent over the 20-60 degrees C range. Figures 3; references: 3 Russian.

02415/09599

UDC 621.376

Digital Frequency Synthesizer With Uniform Grid

[Article by V. S. Grigoryev and V. Yu. Kapustin, Taganrog Institute of Radio Engineering imeni V. D. Kalmykov]

[Abstract] A digital frequency synthesizer with uniform grid on the basis of two variable-divisor frequency dividers is proposed which features automatic frequency switching and computation of the minimum reference frequency with which the necessary accuracy of the output frequency will still be maintained. The divisor, an integer, necessary for generating an output frequency with required accuracy is computed in the first divider once for each specific output frequency. The reference frequency is then continuously divided by that divisor in the second divider. The number of discrete frequencies thus synthesizable cannot exceed 1 plus half the frequency range divided by the allowable absolute frequency error, the reference frequency necessary for operation with integral divisors depending on that error as well as on the upper limit of the synthesizer frequency range. In addition to the reference-frequency generator, two frequency dividers, and the readout device, the synthesizer contains two counters, multiplication logic, and a direct-access memory. Such a synthesizer can be used as basis of a tunable digital-analog generator of periodic signals whose output frequency and allowable frequency error decrease with an increasing number of period quantization steps. Article was presented by Department of Automation and Telemechanics. Figures 2; references: 5 Russian.

02415/09599

UDC 535:534

Graph Method of Constructing Mathematical Models of Optoacoustic Gas Analyzers

[Article by V. V. Vodnev and I. V. Korablev, Moscow Institute of Chemical Apparatus Design]

[Abstract] An earlier conceived graph method of constructing mathematical models of optoacoustic gas analyzers is elaborated for such a gas analyzer with a two-beam differential optical system and with mirrors as shutter blades improving both the sensitivity and the stability of the instrument. The optical system is simulated by a signal line graph with appropriate subgraphs, including three loops and four straight segments, where nodes represent radiation fluxes impinging on a given optical component and arcs represent transmission, reflection, or absorption of light by it. Design and performance analysis of an optoacoustic gas analyzer, including comparative evaluation of possible variants, can proceed on the basis of such a model in accordance with the theory of graphs and its applicable rules. Article was presented by Department of Automatic Control Systems. Figures 3; tables 1; references: 4 Russian.
02415/09599

UDC 621.391.81.61

Scattering and Emission of Millimetric Waves by Natural Objects

[Article by G. A. Andreyev and L. F. Chernaya]

[Abstract] The method of probing remote natural objects such as uneven earth surfaces with millimetric waves they scatter and emit is evaluated on the basis of theoretical estimates, some of these estimates being verifiable by comparison with available experimental data. These estimates are based on use of the electrodynamic model for description of scattering of electromagnetic waves by randomly uneven surfaces and of the two-component model for description of the surface roughness of terrains, the latter model being combined with the method of tangent planes. These estimates include the effect of random unevenness on both scattering and emission of millimetric waves, also the polarization characteristics of millimetric waves emitted by earth surfaces. Figures 3; references 35: 28 Russian, 7 Western (1 in Russian translation).

12223

UDC 621.385.632.01

Nonresonant Fields in O-Type Electron-Wave Systems

[Article by N. L. Romashin and V. A. Solntsev]

[Abstract] The theory of nonrelativistic electron-wave systems in narrow channels such as an irised waveguide is refined by addition of dynamic corrections to the quasistatic part of the nonresonant space-charge field, the field of dynamic corrections being described by a fast converging difference series which is obtained by separation of poles. A finite expression is obtained on this basis for the dynamic part of the depression coefficient, first a homogeneous retarding structure and then a periodic one being considered. The analysis is completed by consideration of a negative depression coefficient, in the case of systems such as a waveguide with an impedance wall where the field does not split into resonant and nonresonant parts, this situation being interpreted physically by associating an electric charge and a magnetic current with each section of the electron beam. Figures 3; references 12: 11 Russian, 1 Western (in Russian translation)

12223

UDC (621.315.21:538.945).025.001.5

Mechanical and Electrical Characteristics of Superconductor for Alternating-Current Cable

[Article by P. I. Dolgosheyev, candidate of technical sciences, V. V. Smilgevich, engineer, and N. V. Polyakova, engineer]

[Abstract] The article concerns the use of a superconductor material such s the intermetallic compound NB_3Sn for an alternating-current cable consisting of a pair of flexible current-carrying ribbons wound coaxially on a cylindrical core and stabilized by normally conducting Cu or Al strips. Its mechanical characteristics are analyzed from the standpoint of retention of its high electrical performance indicators and considering that the latter deteriorate precipitously as the mechanical strain exceeds the critical 0.2 percent level. The fundamental system of relations for components of the strain tensor is transformed by rotation of the Cartesian system of coordinates through some twist angle. Solution of the resulting equations of stress and strain yields the dependence of the superconductor strain on the core radius, flexural or torsional strain being dominant and shearing strain assumed to be absent. The dependence of the power loss per unit area of current-carrying superconductor (mW/cm_2) on the intensity of the intrinsic magnetic field (A/cm) in liquid helium (4.2 K) is then established, the power loss being consistently higher after than before winding. Numerical results for superconductor cables carrying a current of commercial 50 Hz frequency are close within 20 percent to experimental data pertaining to such cables with ribbons laid at a 45 deg angle on cores of 12-36 mm radii, the 5.5 mm wide inner ribbon consisting of 36 strands and the 10.5 mm wide outer ribbon consisting of 20 strands. A typical 16 percent increase of power loss in a magnetic field of 0.1 T strength indicates a need for control of the cable manufacturing process and especially keeping the amount of solder to a minimum. Figures 3; references 4: 1 Russian, 3 Western (1 in Russian translation).

12223

UDC (621.315.616.7:537.31).001.4

Shields Made of Electrically Conducting Polymers for Flexible Cables

[Article by A. L. Zubilevich, engineer]

[Abstract] Design and performance of electrically conducting polymer shields for flexible cables in a magnetic field are analyzed, these new synthetic shield materials containing acetylene black or carbon powder as filler in a polymer matrix and intended to replace braided metal shields where interference immunity is not critical. The shielding attenuation is calculated on the basis of Maxwell field equations in a cylindrical system of coordinates for a wave propagating in a longitudinal electric field through a material with given dielectric permittivity and magnetic permeability, with appropriate boundary conditions stipulated at both outside shield surface (shield-air) and inside shield surface (shield-dielectric). The frequency dependence of the shielding attenuation in a magnetic field and its dependence on the electrical conductivity of the shield material indicate a need for maximizing the latter, 1 S/m being the minimum required for effective shielding and 20 S/m having already been attained but 200-1000 S/m being desirable. Such shields would be even more effective than braided metal ones over the 1-200 kHz frequency range. Experiments with RPShE7 radio cables (rubber insulation plus rubber sheath) confirm these conclusions, the measured shielding attenuation being slightly larger than theoretical at low frequencies and smaller than theoretical at high frequencies. Figures 4; references 2: 1 Russian, 1 Western (in Russian translation).

12223

UDC 654.14:65.011.56

Principles of Designing Automatic Control System for Telegraph Communication Networks

[Article by I. A. Parikozhka, P. V. Bershteyn, N. I. Kaplinskiy, and Ye. I. Roytman]

[Abstract] A procedure for designing an automatic control system by standard methods is outlined which will ensure maximum channel capacity of a telegraph communication network in any operating mode with optimum utilization of available hardware. Such a system must process data for its three essential functions. One function is organization and engineering management, which involves estimating the state of the network and appropriate planning of its expansion. The second function is operation control, which involves appropriate utilization of resources and facilities including standby equipment. The third function is dynamic control, which involves high-speed adaptation to changing conditions such as random load surges or dips and equipment failures. The procedure itself begins with structural and functional layout, a two-level system being considered with data analysis and processing on the first level followed by state-of-network analysis and performance optimization on the second level. The design procedure is programmed for automatic control with aid of DVK-3M2 or DVK-4 microcomputer multiprocessor arrays, with possibility of adding a third level for modifications of structure and message flux distribution. Provisions

are also included for interaction of the automatic control system for a telegraph communication network and that for the primary network. Figures 1; references 3: 2 Russian, 1 Western.

02415/09599

Effect of Electromagnetic Fields on Optical Communication Cables

18600059a Moscow VESTNIK SVYAZI in Russian No 1, Jan 88 pp 32-36

[Article by V. N. Korshunov and E. L. Portnov, staff members, Moscow Institute of Electrical Communications Engineering]

[Abstract] The effect of external electromagnetic fields on optical communication cables, especially during short circuits along neighboring high-voltage power transmission lines, is evaluated in accordance with basic applicable circuit theory. Four known types of optical communication cables are compared: 1) fiber-optic ones without metallic components, perfectly immune to electromagnetic interference but mechanically unprotected; 2) fiber-optic ones with one or several outer metal sheaths; 3) fiber-optic ones with inner metal core; 4) metal-conductor cables without fiber optics, mechanically strong but unshielded against electromagnetic interference. The interference characteristic, namely dependence of the induced longitudinal e.m.f. on the short-circuit current in a nearby power transmission line operating at 50 Hz frequency and on the density of grounding points along an optical communication cable, calculated for a typically 40 km long one with both metal sheaths and metal core indicates that grounding of metallic components helps reducing effects of electromagnetic interference but not adequately. Only fiber-optic communication cables must be used, therefore, except in special cases absolutely requiring mechanical protection. Figures 9.

02415/09599

Digital Fiber-Optic Transmission Systems

18600059b Moscow VESTNIK SVYAZI in Russian No 1, Jan 88 pp 63-64

[Article by M. K. Razmakhin]

[Abstract] A fiber-optic system for digital data transmission available in the GDR is described on the basis of reports from the Nachrichtenelektrotechnik combine published in the journal EXPORT. It is the DUeS-LL-8 system with a capacity of 120 telephone channels and a speed of 8 Mbit/s for local and station-to-station networks, plant intercommunication, railroad traffic control, and interfacing of computers. It is compatible with pulse-code-modulation equipment which operates with 30 primary-multiplexing 2.048 Mbit/s channels and 120 secondary-multiplexing 8.440 Mbit/s channels. It was developed in the late nineteen seventies and operates in service since the early nineteen eighties, with jitter

suppression and repeater-amplifier control. The updated DUeS-LL-34 variant for 480 telephone channels includes an HDB-3 codec for conversion of the input signal coming from a ternary-multiplexing interface at a rate of 34.368 Mbit/s into a unipolar one and then into a linear code at a rate of 41.2416 Mbit/s.

02415/09599

Accelerate Construction of Fiber-Optic Communication Lines

18600080a Moscow VESTNIK SVYAZI in Russian No 3, Mar 88 pp 21-24

[Article by I. S. Ravin, communications engineer, and V. I. Maksimov, deputy chief, Main Management of Communication Equipment Construction, USSR Ministry of Communications]

[Abstract] Optical communication lines have already been installed and activated in four metropolitan telephone networks: Moscow, Leningrad, Gorkiy, Kishinev. These systems include OK-50-2 fiber-optic cables designed for operation in the 850 nm wave band with an attenuation not exceeding 5 dB/km over 7.5 km long runs or 3 dB over 11 km long runs and Sonata-2 equipment designed for operation at a rate of 8448 kbit/s with an energy potential of 50 dB plus 6 dB margin. Experience indicates that the main problems impeding overall conversion to such communication systems related to the production of fiber-optic cables. It is primarily necessary to better meet delivery schedules. While only the Moscow Elektroprovod plant has fully met its contractual obligations, all other enterprises run by the Main Management of Materials and Equipment Supply at the USSR Ministry of Communications have delivered only 30-60 percent on time. Another shortcoming is inadequate coordination between the Scientific-Industrial Department at the All-Union Scientific Research Institute of Cable Industry and the appropriate agencies at the USSR Ministry of Communications. There is a need to improve production of equipment for digital secondary and tertiary zonal channels, to improve the layout of power supply to unattended repeater stations, and to improve the design of tools for laying fiber-optic cables. Preference is given to single-mode fiber optics and Sopka optical communication equipment is being produced along with Sonata equipment.

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Spectral Multiplexing of Fiber-Optic Communication Lines

18600080b Moscow VESTNIK SVYAZI in RussianNo 2, Mar 88 pp 50-51

[Article by G. I. Grodnev]

[Abstract] Wavelength division of optical communication channels by spectral multiplexing of fiber-optic cables is possible owing to the weak frequency dependence of the attenuation coefficient in such cables over the usable wave band. A compounder is inserted between n optical transmitters operating at a different wavelength

each and the cable on its entrance side. A separator is inserted between the cable on its exit side and n optical receivers operating at a different transmitter wavelength each. The most common devices for compounding and separating are an isosceles dispersing prism or a plane diffraction grating between two biconvex lenses. The first lens in a compounder and the second lens in a separator are focusing lenses. The second lens in a compounder and the first lens in a separator are collimating lenses. The main advantages of a diffraction grating are its smaller size, lower insertion loss, and lower cost. Another device is a plane light-filter-splitter passing light of one wavelength from a collimating lens to a focusing lens (or vice versa), both lenses located on a common optical axis and the filter inclined at a 45 deg angle to that axis so as to reflect light of another wavelength from that collimating lens to another focusing lends (or vice versa) whose optical axis is perpendicular to that of the other lenses. There are usually two fibers in an optical cable, for two-way communication, so that both compounder and separator must be designed for such an arrangement. Figures 5.

12223

Use of Double-Quad Cable With 1KM-120 Pulse-Code-Modulation Equipment
18600080c Moscow VESTNIK SVYAZI in Russian No 3, Mar 88 pp 52-54

[Article by B. Z. Berlin, deputy chief engineer, Leningrad Metropolitan Telephone Network, Y. V. Dobin, chief engineer, L. I. Kayzer, chief engineer, Yu. A. Parfenov, chief of laboratory, D. V. Nefedova, senior engineer, and L. S. Chervyakov, junior scientific associate, Leningrad Department, Scientific Research Institute of Communications]

[Abstract] An experiment has been performed by specialists from the Leningrad Metropolitan Telephone Network and the Scientific Research Institute of Communications in Leningrad, for the purpose of establishing the feasibility of a huge cost reduction by use of the KSPZPB 2x4x1.2 double-quad cable instead of the MKGS 4x4x1.2 quadruple-quad cable in up to 960-channel telephone networks and instead of either ZKP 1x4x1.2 or ZKA 1x4x1.2 single-quad cable in up to 240-channel telephone networks for operation with IKM-120 pulse-code-modulation equipment in digital secondary transmission circuits. Having a water-repellent filler, the KSPZPB cable requires neither hermetic sealing nor maintenance of atmospheric or higher internal pressure and also does not require a lead sheath. The electrical performance characteristics of this cable were found to be adequate at operating frequencies of 352, 512, 1024, 4224 kHz. Its installation did not require any equipment modification and pilot operation with two such cables for two-way communication over a telephone line with 7 intermediate stations 2.6-3.7 km apart was found to be adequate over a period of 2.5 years with a saving of 87,000 rubles. Tables 3.

12223

Potential Transformers for SF6-Filled 330-500 kV Cubicle Switchgear

[Article by V. K. Kilevoy, engineer, Yu. A. Zaytsev, engineer, and S. V. Chagovets, engineer]

[Abstract] A series of two single-phase potential transformers ENOG-330-83UZ and ENOG-500-UZ with a shell-core construction has been designed in 1983 for SF6-filled 330 kV and 500kV cubicle switchgear respectively, both having conventional features which should facilitate advancing their production schedule as well as novel features which should reduce material and labor costs while ensuring high performance indicators and reliability. Each consists essentially of a magnetic structure, a cylindrical multilayer primary winding around the primary one, a jacket, SF_6 - SF_6 spacers, and special shields around sharp edges, inside a cylindrical housing with elliptical bottom and a bell cover. Differences between these two transformers and the existing ENOG-110-79UZ and ENOG-220-79UZ include the form of voltage equalizers for protection against lightening surges, all wires of the same diameter (smallest 0.2 mm) rather than of stepwise increasing diameter (0.25-0.71 mm), and use of water-repellent synthetic film rather than cable paper as interlayer insulation. Prototypes of both transformers were fully tested under the minimum permissible pressure of SF_6 gas, namely 0.39 MPa gage. They were found to feature a high accuracy, with a very weak temperature and frequency dependence of errors, a high transformation ratio with a solidly grounded neutral and during transients, and immunity to ferroresonance and relaxation oscillations. Their performance is otherwise comparable with that of Soviet NKF potential transformers and of German Messwandler-Bau instrument transformers in the same voltage classes. Figures 2; tables 1; references: 3 Russian.

12223

Universal Wideband Squid Meter for Measurement of Magnetic Properties

[Article by L. Z. Avdeyev, O. V. Snigirev, and V. V.
Khanin]

[Abstract] A universal SQUID meter operational over
the 4.2-300 K temperature range with a magnetizing
field of up to 50 mT intensity has been developed for
measurement of magnetic properties such as magnetic
susceptibility of materials, its magnetic moment resolu-
tion being $(6-8).10^{-12}$ $A.m^2.Hz^{1/2}$ at frequencies up to 2
kHz and higher. Its cryogenic instrument part consists of
a magnetic system with a superconducting solenoid and
a superconducting flux transformer as well as a stabiliz-
ing Nb shield between their respective windings, a vac-
uum-thermal system with seals and a thermostat, and a
supporting mechanical system. Its data recording and
processing part is based on an Elektronika D3-28 micro-
computer with peripheral equipment and VPF (measure-
ment of infralow-frequency noise in real time), TREK
(measurement of magnetic properties with specimen
moving), TZV (determination of temperature depen-
dence with specimen stationary), GRAF (graph plotting
from flexible magnetic disk storages) software. Interfac-
ing with four voltmeters and two clock-pulse generators,
also with an Endim 620.02 XY-plotter, proceeds through
series K140, K155, K252 integrated microcircuits. The
instrument was tested $Mn_xHg_{1-x}Se$ semiconductors,
their magnetic susceptibility being measured at temper-
atures from 4.5 K to 7.5 K (superconducting transition
of $Mn_{0.25}Hg_{0.75}Se$ at 3.6 K) in a residual magnetizing
field of $0.8.10^{-4}$ T intensity. Its resolution was found to
worsen with rising temperature, owing to relaxation
processes and temperature drift. The authors thank V. V.
Migulin and K. K. Likharev for fruitful discussions.
Figures 3; references 6: 3 Russian, 3 Western.

12223

UDC 666.11.01

Controlling Fabrication of Optical Fibers With Aid of Laser-Heater

[Article by Ye. M. Dianov, V. V. Kashin, V. I. Masychev, V. N. Perminova, S. M. Perminov, S. Ya. Rusanov, and V. K. Sysoyev, Institute of General Physics, USSR Academy of Sciences, Moscow]

[Abstract] The feasibility of using a low-power auxiliary laser-heater for process control in fabrication of optical fibers is examined, using four 100 W CO_2-lasers around the fiber instead of a single 400 W one having already been tried but not quite successfully for ensuring a uniform heat distribution over the extrusion zone. The control loop is to include a thermometer which measures the temperature in the extrusion zone where the quartz fiber begins to narrow down under action of the main laser-heater and which feeds signals to a power regulator for the control laser-heater at the end of the extrusion zone. Considering that a laser-heater is a source of thermal noise, compensation of the latter is also included. Following an analytical description of the process dynamics, with a cubic temperature dependence of the thermal conductivity of quartz glass according to the Rosseland approximation and with the fiber radius along the extrusion zone approximated as a $\tan^{-1}$-function of the axial coordinate, the complete corresponding equation of transient heat conduction with both melting and extrusion rates satisfying conservation of mass is solved for appropriate boundary conditions. Stabilization in time by a numerical method has yielded a steady-state solution for given process parameters including extrusion rate and width of the extrusion zone upon space discretization of the temperature field and the heat transfer coefficient. The control system is synthesized accordingly to match the process dynamics, with a regulator having the appropriate frequency characteristic. For fiber fabrication with a 400 W laser-heater, control with a 50 mW laser-heater according to this scheme appears to be feasible. In an experiment this has been achieved with a 400 W CO_2-laser as main heater and a 3 W CO-laser as control heater, the latter in a nonselective cavity featuring a high power stability. Figures 4; references 11: 4 Russian, 7 Western (2 in Russian translation).

02415/09599

UDC 621.365.3

Thermal Conditions in Electrical-Resistance Furnace for Extrusion of Optical Fiber, Part 1: Generalized Mathematical Model of Heater

[Article by V. N. Vasilyev, G. N. Dulnev, and V. D. Naumchik, Leningrad Institute of Precision Mechanics and Optics]

[Abstract] For a design and performance analysis of electrical-resistance furnaces on a more rigorous than merely empirical basis, to ensure optimum thermal conditions for formation of optical fibers by extrusion from quartz ingots, a mathematical model is constructed describing the temperature field in the heater structure and accounting for three modes of heat transfer with attendant heat losses. These are radial heat conduction through the cylindrical wall, forced heat convection within the closed inner cylindrical air gap with heat radiation from heater surface to inner shield and to outer housing shell, and natural heat convection within the closed outer cylindrical air gap with heat radiation to outer two shields. A crucial problem in solution of the corresponding integrodifferential equation of first order in the vertical axial coordinate and in time, of the fourth degree in temperature, is determining the coefficients of convective heat transfer and the temperatures of shields. This done, considering the geometry of heat transmission channels and existence of boundary layers at surfaces of structural components. Figures 3; references 14: 8 Russian, 6 Western (2 in Russian translation).

02415/09599

UDC 681.7.068

Bragg Fiber Optics

[Article by A. N. Lazarchik]

[Abstract] Structural optimization of optical Bragg fibers consisting of a solid core and a multilayer sheath is shown, based on the matrix of tangential field components and on expression of each component in terms of a Bessel function. The procedure for synthesis of the optimum fiber structure involves first determining the core radium which minimizes the transverse energy flux and then further minimizing this flux with respect to the inside radii of successive sheath layers. A fiber is synthesized by this method for the guided mode only, this mode propagating entirely through the core made of a low-index material. Disregarded are the natural modes, which propagate with multiple reflections along the sheath made of high-index materials. The dispersion equation is derived for a Bragg fiber with an even number of layers in the sheath. Numerical analysis of fiber structures with large core radii has revealed that single-mode light propagation is possible only through fibers optimized for the He_{11}-mode. Figures 4; references 5: 3 Russian, 2 Western (1 in Russian translation).

12223

UDC 621.373.826

Increasing Efficiency of Laser Power Stabilization

[Article by V. I. Butkevich]

[Abstract] A compound control system which includes
three interacting regulators is proposed for efficient
stabilization of laser emission power, fluctuations of the
latter in the case of gas-discharge lasers being caused by
fluctuation of the gain when the discharge current or the
gas composition varies and by fluctuation of the loss
factor as well as of the frequency or, in the case of
multimode emission, by interaction of modes. The three
negative-feedback loops are in parallel and contain a
low-noise amplifier each, a fourth loop consisting of a
beam-splitter plate, a photodetector, and a comparator
thrown around them so that the comparator output
signal controls simultaneously the pump, the piezocera-
mic cavity corrector, and an external regulator. The
external regulator facilitates compensation of the faster
power variations, while adjustment of the mirrors and
the pump facilitates compensation of the slower power
variations. The system includes also a monitoring sec-
ond photodetector, behind the beam-splitter plate.
Power stabilization is possible not only when both pho-
todetectors are identical but also, under different condi-
tions for optimum control, when the transmission band
of the control photodetector is wider or narrower than
that of the monitoring one. The performance of this
control system is analyzed by simulation with an elec-
tronic model. Another variant of such a control system,
a parallel-series one with the external regulator in series,
is also found to be feasible and efficient. The author
thanks V. Ye. Privalov and A. V. Mironov for helpful
discussions. Figures 4; references 21: 14 Russian, 7
Western.

12223

UDC 621.396.22.029.7:621.8.391.63

Chromatic Dispersion in Multimode Fiber Optics

[Article by T. V. Babina and M. Karasek]

[Abstract] Chromatic dispersion in graded-index multi-
mode fiber optics was measured by the pulse method,
using two subnanosecond radiation pulses from different
semiconductor lasers with a 40 nm difference of wave-
lengths. Six dimensional variants of a fiber having a
plastic-clad silica core doped with Ge and P, their
lengths ranging from 928 m to 1685 m, had been
produced by the MCVD method in the Joint Silicates
Laboratory at the Czechoslovak Academy of Sciences.
One fiber, 2383 m long, had been supplied by VALTEK
(France). Measurements were made with Gaussian
pulses of 500 ps half-power width, one of 855 nm
radiation from an RCA C86039W3 double-heterojunc-
tion laser and one of 895 nm radiation from a single-
heterojunction laser. Both lasers were pumped by elec-
tric discharge with Gaussian pulses of 3.5 ns duration
and of an amplitude exceeding the threshold by a factor
of 62. In addition to chromatic dispersion were also
measured the pulse widening and the bandwidth. Figures
2; tables 1; references 2: 1 Czechoslovak, 1 Western.

12223

UDC 621.373.826

Depression of Intrinsic Power Fluctuations and Shot Noise in Power-Stabilized Laser

[Article by Ya. A. Fofanov]

[Abstract] The feasibility of depressing both intrinsic
power fluctuations and shot noise in a laser by means of
feedback from a photodetector to the pump only has
been established experimentally on an LS-1 He-Ne laser
with a 30 cm long cavity. The laser operated in the
single-frequency mode, with slight cavity misalignment
for regulation of net gain over losses. The level of
intrinsic power fluctuations was lowered to the level of
shot noise and fluctuations of the photodetector current
in the feedback loop dropped to a level below that of the
shot noise. Figures 2; references: 9 Russian.

12223

UDC 539.413:666.11

Strength Characteristics of Graded-Index Fiber Optics With Protective Polymer Shells Under Flexural Load in Steady Temperature Field

[Article by Yu. N. Loskutov and V. D. Chernenko,
Leningrad]

[Abstract] The strength characteristics of graded-index
fiber optics with multilayer cylindrical protective struc-
ture consisting of polymer layers, under a flexural load in
a steady temperature field, are calculated on the basis of
the corresponding equations of stressed-strained state
including thermal expansion and assuming that an initial

straight rod bends into a circular arc. As a specific example is considered a fiber-optic cable consisting of a glass core and three protective shells; the outer shell having a soft polymer coating, the middle shell having a hard polymer coating, and the inner shell having a varnish coating. The minimum allowable bending radium and its temperature dependence over the temperature range from -60 deg C to 85 deg C, also the temperature dependence of optical losses due to bending over the temperature range from -80 deg C to 80 deg C, have been calculated for such a fiber-optic cable with given Young moduli and Poisson ratios as well as tensile and compressive strengths. Such a calculations are made, for expediency, starting from the outer layer and proceeding inward. Figures 3; references: 6 Russian.

12223

UDC 621.317.7

Magnetooptic Current Transducer Operating With Fiber Optics

[Article by V. B. Arkhangelskiy, A. B. Bakhmend, S. F. Glagolev, T. P. Kazakova, and T. G. Paley, Leningrad Institute of Electrical Communications Engineering imeni Professor A. M. Bonch-Bruyevich]

[Abstract] A magnetooptic direct-current transducer operating with fiber-optic transmission lines from the light source and to the photoreceiver has been developed with azimuth modulation of light intensity by alternation of the polarization plane, much more easily realizable amplitude modulation not yielding a sufficiently high signal-to-noise ration and not allowing separation of useful signals associated with current measurement from parasitic signals associated with instability of transducer components. The polarization of light is alternated between two mutually orthogonal planes, which requires two light beams alternately impinging on a double-beam plane-polarizer such as a Wollaston prism and a Faraday cell, the latter integrating the angle of rotation of the polarization plane over a closed contour and thus ensuring unambiguous current-to-angle conversion independent of the cell dimensions. The transducer includes also a double-beam analyzer which, with its planes of transmission perpendicular to the polarizer planes, converts changes of azimuth angle into changes of light intensity. A photoreceiver converts light coming from the analyzer into electric signals and is followed first by two photocurrent amplifiers, each controlled by a differential amplifier with a low-pass input filter, then by circuitry which includes a voltage summator, two synchronous detectors and two tuned amplifiers for extraction of the light-source-switching-frequency harmonic as well as an attenuator for suppression of alternating voltages from
the summator and the differential amplifiers. Design and performance analysis of this transducer is based on the equations for the output voltages of the two photocurrent amplifiers with first one and then the other light source turned on. An experimental prototype of this transducer with a Faraday cell consisting of a BF-1320 glass rod inside a solenoid was tested with two ILPN-204 semiconductor lasers as light sources and a 6 m long KVSP-60-1/0 fiber-optic cable containing O-TS-1-2 strands, such a cable length ensuring adequate isolation of the low-potential zone from the high-potential zone at operating voltages up to 500 kV. The current range of the transducer errors, systematic and random, did not exceed 0.5 percent and 0.2 percent respectively over the entire range. Article was presented by Department of Communication Lines. Figures 1; references: 4 Russian.

12223

UDC 621.382:621.396

Optical Inspection of Printer-Circuit Boards

[Article by V. A. Vul and Yu. P. Golinkov, Moscow Institute of Printing Arts]

[Abstract] Optical inspection of printer-circuit boards is described, the nearly normal intensity distributions of light reflected by the dielectric substrate and of light reflected by the conductor strips having been found to be mutually independent with an overlap as wide as 1-1.5 standard deviation of either one of them. Distinguishing between dielectric and conductor on the basis of the wobble of a sharply focused light beam scanning the board surface is proposed with subsequent conversion of the wobble into an electric signal by a photoreceiver containing a synchronous detector, threshold distinction being too inaccurate because the intensity of light reflected by a dielectric can be higher as well as lower than that of light reflected by a conductor. The light beam enters through a deflector cell, which ensures resolution of two contiguous positions on the board surface, it is driven along one coordinate by a galvanometric scanning mirror and is focused on the board surface by an objective while the board is moved along the other coordinate by stepper motors with high-precision control. A trajectory of the light spot at right angles to conductor strips ensures maximum modulation depth and facilitates direct measurement of conductor width as well as of conductor separation. Electric signals from the photoreceiver are appropriately coded for further processing. The productivity of such an inspection system is low, about 30 boards per hour, and its main advantage is high precision needed especially in integrated-circuit technology. Article was presented by Department of Applied Mathematical and Computer Engineering. Figures 2; references: 2 Russian.

12223

Numerical Analysis of Functionally Very Large-Scale-Integrated Arrays Taking Into Account Thermal Effects, Part 1: Model

[Article by I. I. Abramov and V. V. Kharitonov, Belorussian Institute of Railroad Transportation Engineers, Gomel]

[Abstract] In this first of three articles is constructed a discrete topological model which describes very large-scale arrays of functionally integrated elements forming semiconductor devices, for numerical analysis of physical processes in such devices taking into account thermal effects. The model is derived from a continuous one which accordingly contains the equation of heat conduction in addition to the fundamental equations of semiconductor physics, including Shockley-Reed-Hall generation recombination and Caughey-Thomas mobility at 300 T but disregarding the temperature dependence of mobility. All variables in the continuous model have been normalized so as to save computer time for subsequent numerical simulation. Because analytical solution of those equations for the electrostatic potential, the intrinsic electron and hole concentrations, and the temperature or the inverse of its one-third power is not possible, this continuous model is replaced with the discrete one by conversion of its differential equations such as the Poisson equation for space charge into finite-difference equations for a two-dimensional grid covering the semiconductor device in accordance with the A. N. Tikhonov-A. A. Samarskiy integrointerpolation scheme and the G. I. Marchuk method. Figures 1; tables 1; references 7: 5 Russian, 2 Western.

02415/09599

Numerical Modeling of Si and GaAs Field-Effect Transistor With Source Opposite Gate

[Article by G. P. Pavlov]

[Abstract] A field-effect transistor with symmetric source opposite gate structure is considered, its advantages over the planar device being a narrower gate and a higher transconductance as well as a higher cutoff frequency. A two-dimensional mathematical model of such a field-effect transistor is used for comparative performance evaluation of its Si and GaAs versions. The model is based on the Poisson equation and the continuity equation. The field dependence of the electron velocity in the weak-field approximation is different in the two materials, a critical electric field existing for GaAs but not for Si, while the saturation electron velocity is the same in both and equal to 10^7 cm/s. The equations of charge transfer and charge transfer kinetics in a small device with appropriate boundary conditions, assuming no generation and no recombination as well as disregarding transient heating of electrons, were solved numerically on a BESM-6 high-speed computer by the method of finite differences with a space grid and time discretization. The small-signal performance analysis, including calculation of the current-voltage characteristics, was based on expansion of the transient currents in both source and gate circuits under small voltage steps into Fourier integrals for calculation of the y-parameters. The results indicate that the Si version has a higher cutoff frequency but a lower transconductance than the GaAs version, their current gain and power level being approximately the same. Considering the better technological characteristics of Si, the GaAs field-effect transistor with source opposite gate structure is likely to be replaced by the Si version which is considered suitable for use in microwave devices. Figures 2; references 6: 3 Russian, 3 Western.

12223

Functional Speed of Integrated Circuits

[Article by B. N. Fayzulayev]

[Abstract] The performance of LSI and VLSI computer components is analyzed on the basis of Rent's law, their functional speed being defined as the maximum total number of NAND, NOR switching events per unit time and being equal to the clock frequency times the degree of integration divided by the average number of logic stages between input and output. Into account are taken design as well as logic features of integrated circuits. As the two limiting cases are considered IC arrays for purely parallel and for purely sequential processing. The functional speed is shown to generally decrease as the Rent exponent increases i.e. the higher the degree of parallelism. Figures 2; tables 1; references 7: 5 Russian, 2 Western.

12223

Full Self-Testing of Large-Scale-Integrated Circuits With LSSD Structure

[Article by V. N. Yarmolik and Ye. P. Kalosha, Minsk Institute of Radio Engineering]

[Abstract] The testing of VLSI circuits which have an LSSD structure is analyzed, such a structure being

particularly amenable to self-testing. A generator of pseudorandom M-sequences, most useful for this purpose, is synthesized so as to make full self-testing of combinatorial circuits possible. The algorithm of this synthesis is based on a probability theorem pertaining to successful search of an M-sequence with a 2^m-1 long period which will yield all possible binary combinations for the shift register. According to this 5-step algorithm are constructed primitive polynomials generating M-sequences with the required properties. The probability of ensuring linear independence on the number z of inputs in the tested circuit, a function of both z and m, is shown to increase with increasing m and to decrease with increasing z. Figures 2; tables 1; references 8: 3 Russian, 5 Western.

12223

UDC 539.293.535

Measuring Parameters of Layers Doped by Ion Implantation of Basis of Infrared Reflection Spectrum (Model of Gaussian Impurity Distribution)

[Abstract] The problem of determining the impurity distribution in a Si layer doped by ion implantation is considered and a method is proposed for determining the "effective Gaussian profile" of free charge carriers from characteristics points on the measured infrared reflection spectrum. Nomograms of the three profile parameters (maximum carrier concentration N_{max}, depth z_O of N_{max} below surface, depth d of N_{max}/e below N_{max}) have been plotted on the basis of those points according to the phenomenology of nonhomogeneous semiconductors and the theory of thin-film coatings, with the aid of appropriate empirical data and verifiable approximations. Figures 3; references 15: 9 Russian, 6 Western (1 in Russian translation).

12223

UDC 539.216.22:538

New Method of Flaw Detection in Epitaxial Ferrite-Garnet Films

[Article by V. L. Dorman, A. V. Kovalev, I. V. Nikonets, V. N. Pavlov, and V. L. Sobolev, Donetsk State University]

[Abstract] A new method of flaw detection is proposed for quality control of epitaxial ferrite-garnet films with domain structure, a method based on application of a nonuniform magnetic displacing field for a short duration and subsequent tracking of the domain intergrowth
dynamics. The square magnetic field pulse must be of a duration sufficiently long to allow uniform magnetization of the inspected film segment and must have an amplitude sufficiently high for driving the inspected film segment constitutes a seat of domain nucleation which, after removal of the magnetic field and attendant collapse of a domain wall owing to loss of stability, will result in domain intergrowth. Interaction of two colliding structures, a band structure propagating from the edges of the defectoscope coil and a radial comb structure propagating from the defect, produces a stable structure whose geometry is determined by the location of the defect relative to the defectoscope coil. Moving the coil over the film specimen facilitates continuous nonvisual inspection which requires neither intricate television equipment and electronic circuitry nor high-speed photography. Such an inspection can be readily automated with the aid of a polarization microscope with a diaphragm inside its tube and a stepper motor driving its stage, an incandescent lamp with power regulation as adjustable-intensity light source, a generator of current pulses for the defectoscope coil with a synchronizing trigger, a power amplifier, a photomultiplier, a pulse voltmeter, and a pulse counter. A defectoscope with such an automatic control system operating by this method was successfully tested on specimens of films containing 0.003-0.005 mm wide cylindrical magnetic domains. Figures 4; references 4: 1 Russian, 3 Western.

12223

Reproduction of Quantized Pulses in Josephson-Junction Arrays, Part 1

[Article by K. K. Likharev, O. A. Mukhanov, and V. K. Semenov, Moscow State University imeni M. V. Lomonosov]

[Abstract] Reproduction of quantized pulses in Josephson-junction arrays is analyzed for the weak-line case, which allows treating the processes in any one junction independently of those in all other junctions so that source and load nonlinearity can be disregarded. Switching such a junction from one steady state to another and the attendant transient process are examined, considering first incidence of a single ideally square pulse and then incidence of successive such pulses. Calculations are based on the resistance model, which is valid for shunted Josephson junctions. The time range of correct reproduction is defined and the dependence of this range on the duration of the incident pulse is established. Equal-delay curves within the reproduction range have been plotted on the basis of numerical simulation using the COMPASS computer program package for various durations of the incident pulse, also for real and thus other than square incident voltage pulses. The analysis of pulse reproduction is furthermore refined by including the parasitic effects of the intrinsic capacitance of a

Josephson junction and the inductance of a transmission line connecting such a junction to the pulse generator. Figures 5; references 10: 2 Russian, 8 Western.

12223

UDC 621.382

Electrical Testing of Photomasks

[Article by S. M. Kuzin, V. A. Ovchinnikov, and V. N. Panasyuk]

[Abstract] Inspection of chip topology by electrical measurement of photomask fabrication parameter such as deviation of the photoresist width from nominal is examined, such measurements being more accurate and reliable than optical ones as basis for further miniaturization of circuit elements and raising the degree of integration on larger chip surfaces. The results of such a measurement are evaluated analytically in terms of the relation between geometrical width and electrical resistance, the variation of width along the photomask axis as a function of the axial coordinate fitting a complete second-degree polynomial in that coordinate. Figures 3; references 6: 5 Russian, 1 Western

12223

UDC 535.8

Planar Optics for Optical Lithography

[Article by G. A. Bashkina, S. V. Babin, A. I. Yerko, A. V. Davydov, and V. V. Martynov, Institute of Problems in Technology, of Microelectronics, and Extra-Pure Metals]

[Abstract] An experimental study was made concerning the feasibility of planar optics with submicron resolution, Fresnel zone plates in the form of polymer refracting layers with photoresist coating films having been produced and then tested for diffraction characteristics in the 500-600 nm wave band. They were produced by exposure to an electron beam, with various shapes of the focal spot. A precise surface profile with a triangular profile necessary for ensuring a given glance angle was formed by this method on 800 nm thick layers of polymethyl methacrylate. The authors thank N. V. Gornakova for preparing linear zone plates and Professor V. V. Aristov for helpful discussion of the results. Figures 3; references: 3 Western.

12223

UDC 621.383.4:546.681'19

Effect of Thermomechanical Influencing Factors on Electron Photoemission by GaAs on Glass Substrate

[Article by S. A. Botnev, M. N. Zargaryants, Ye. S. Kovarskaya, N. G. Kopalin, I. A. Krikanov, and A. E. Petrov]

[Abstract] The effect of thermal stresses on the photocathode characteristics of p-GaAs on glass substrates is evaluated on the basis of an experimental study, thermal stresses arising because the coefficient of linear thermal expansion is different for the two materials. For the study $Al_{0.5}Ga_{0.5}As/GaAs/Al_{0.5}Ga_{0.5}As$ heterostructures were grown on n-GaAs(100) or p-GaAs(100) layers by liquid-phase epitaxy from a closed space, with 0.003-0.005 mm thick strongly doped GaAs:Zn layer and 0.001-0.003 mm thick weakly doped $Al_{0.5}Ga_{0.5}As$:Zn layer. Each specimen was divided into two parts, one being hot-pressed to a glass substrate and one being glued with Canada balsam to a plane-parallel glass or sapphire plate. Subsequent chemical etching left $p-Al_{0.5}Ga_{0.5}As/p-GaAs$ heterostructures on transparent substrates. Their relevant physical properties (thermal absorption coefficient, diffusion length for minority carriers, electron-hole recombination rate, optical transmission coefficient, photoluminescence yield, photo-e.m.f.) were measured at a reference temperature of 300 K. Electron photoemission at higher temperatures up to 650 deg C, below decomposition of GaAs, was measured by the method of Augerelectron spectroscopy and thermal strains were measured by the dilatometric method. Specimens were also subjected to temperature-pressure and activation cycling, and degradation of heterostructures hot-pressed to glass substrates was found to occur only when the resulting tensile stresses had exceeded a certain threshold level. The quantum yield of such photocathodes was found to depend appreciably on the degree of their thermomechanical compatibility with chemical composition and physical properties of the substrate. The authors thank L.N. Kurbatov for steady interest in the study and helpful discussion of the results. Figures 4; tables 1; references 19: 9 Russian, 10 Western (3 in Russian translation).

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