11 JANUARY 1979 (FOUO 3/79) 1 OF 1

JPRS L/8215

11 January 1979

USSR

TRANSLATIONS ON USSR SCIENCE AND TECHNOLOGY
PHYSICAL SCIENCES AND TECHNOLOGY
(FOUO 3/79)

U. S. JOINT PUBLICATIONS RESEARCH SERVICE

NOTE

JPRS publications contain information primarily from foreign newspapers, periodicals and books, but also from news agency transmissions and broadcasts. Materials from foreign-language sources are translated; those from English-language sources are transcribed or reprinted, with the original phrasing and other characteristics retained.

Headlines, editorial reports, and material enclosed in brackets [] are supplied by JPRS. Processing indicators such as [Text] or [Excerpt] in the first line of each item, or following the last line of a brief, indicate how the original information was processed. Where no processing indicator is given, the information was summarized or extracted.

Unfamiliar names rendered phonetically or transliterated are enclosed in parentheses. Words or names preceded by a question mark and enclosed in parentheses were not clear in the original but have been supplied as appropriate in context. Other unattributed parenthetical notes within the body of an item originate with the source. Times within items are as given by source.

The contents of this publication in no way represent the policies, views or attitudes of the U.S. Government.

BIBLIOGRAPHIC DATA SHEET	1. Report No. JPRS L/ 8215	2.	3. Recipient's Accession No.
4. Title and Subtitle TRANSLATIONS ON USSR SCIENCE AND TECHNOLOGY - PHYSICAL SCIENCES AND TECHNOLOGY, (FOUO 3/79)			5. Report Date 11 January 1979
			6.
7. Author(s)			8. Performing Organization Rept. No.
9. Performing Organization Name and Address Joint Publications Research Service 1000 North Glebe Road Arlington, Virginia 22201			10. Project/Task/Work Unit No.
			11. Contract/Grant No.
12. Sponsoring Organization Name and Address As above			13. Type of Report & Period Covered
			14.
15. Supplementary Notes			

16. Abstracts

The report contains information on aeronautics; astronomy and astrophysics; atmospheric sciences; chemistry; earth sciences and oceanography; electronics and electrical engineering; energy conversion; materials; mathematical sciences; cybernetics, computers; mechanical, industrial, civil, and marine engineering; methods and equipment; missile technology; navigation, communications, detection, and countermeasures, nuclear science and technology; ordnance; physics; propulsion and fuels; space technology; and scientists and scientific organization in the physical sciences.

17. Key Words and Document Analysis. 17a. Descriptors

USSR
Aeronautics
Astronomy
Astrophysics
Atmospheric Sciences
Chemistry
Computers
Cybernetics
Earth Sciences
Oceanography
Electronics
Electrical Engineering
Energy Conversion
Materials
Mathematics
Mechanical Engineering
Civil Engineering
Industrial Engineering
Marine Engineering
Methods
Equipment
Missile Technology
Navigation and Communications
Detection and Countermeasures
Nuclear Science and Technology
Ordnance
Physics
Propulsion and Fuels
Space Technology

17b. Identifiers/Open-Ended Terms

17c. COSATI Field/Group 01,03,04,07,08,09,10,11,12,13,14,16,17,18,19,20,21,22

18. Availability Statement	19. Security Class (This Report) UNCLASSIFIED	21. No. of Pages 92
For Official Use Only. Limited Number of Copies Available From JPRS	20. Security Class (This Page) UNCLASSIFIED	22. Price

FORM NTIS-35 (REV. 3-72) THIS FORM MAY BE REPRODUCED USCOMM-DC 14952-P72

JPRS L/8215

11 January 1979

TRANSLATIONS ON USSR SCIENCE AND TECHNOLOGY
PHYSICAL SCIENCES AND TECHNOLOGY

(FOUO 3/79)

CONTENTS PAGE

CONTENTS (Continued)

CYBERNETICS, COMPUTERS AND AUTOMATION TECHNOLOGY

UDC 347.7.8:061.3

SEMINARS ON THEORY AND PRACTICE OF SCIENTIFIC-TECHNICAL INFORMATION

Moscow NAUCHNO-TEKHNICHESKAYA INFORMATSIYA, SERIYA 1--ORGANIZATSIYA I METODIKA INFORMATSIONNOY RABOTY in Russian No 9, 1978 pp 20, 27-28

[Article by G. G.]

[Text] A report by V. N. Tverdovskiy (All-Union Agency for Author's Rights) on procedures in acquiring publication and translation rights for articles and books by foreign authors and by soviet authors for overseas use was delivered at the March seminar "Theory and Practice of Scientific-Technical Information," at the Moscow House of Scientific-Technical Propaganda imeni F. E. Dzerzhinskiy.

Since 1967, a system coordinating translations in electrotechnology has been functioning in the electrotechnical industry, it was stated in a report on the effectiveness of coordinating translation activity, presented by T. T. Sychev (Informelektro [Division of Scientific-Technical Information in Electrotechnology, of the All-Union Scientific Research Institute of Electromechanics]). The coordinating system is directed by the Center for Coordinating Translations under the Central Reference Information Collection of Informelektro. Also developed and in service are guidance technical materials: System for Coordinating Translations in Electrotechnology [Sistema koordinatsii perevodov po elektrotekhnike] and Instructions on Compiling and Coding Teletype Requests [Instruktsiya po sostavleniyu i kodirovaniyu teletaypnykh zayavok].

The participation by scientific research institutes, design offices and sector enterprises in the coordinating activity is mandatory. Efficiency in coordinating translations is ensured by a reference file annually supplemented with 7000 secondary documents.

From experience in coordinating translator activity in the sector, it can be stated that elimination of direct duplication, up-to-date information on scheduled and completed translations and prompt filling of requests for translations in the collection, with the aid of modern coding equipment, each year prevents the carrying out of 7000 already-existing translations; the funds saved in this case are roughly 1.5 million rubles annually.

Informelektro copies translations at its own copying center. Since 1971 Informelektro, on receiving the first two copies of translations from organizations and enterprises, transfers the first copy onto microfilm and the other copy is sent to all-union centers coordinating translations of documents of different kinds (patents, standards, articles, books, and so on).

G. A. Tsyganov (GOSINTI [State Scientific Research Institute of Scientific-Technical Information]) spoke at the April seminar, delivering a paper: "Automatic Information Retrieval System" (AIPS) of intersector scientific-technical information from experience at the GOSINTI. He said that a Republican Automatic System of Information Retrieval and Dissemination (RASPRI-1) was developed and is functioning successfully in the GOSINTI.

The RASPRI-1 is built on the three-loop principle. The first loop is embodied in an Minsk-32 computer and the YeS computer; it is an information retrieval unit, whose basis is a multisector file of retrieval images of documents, organized in accordance with the list of headings of the RASPRI-1 information retrieval system. Within each heading of the RASPRI-1 two modifications of the retrieval file organization are possible: direct and inverted. Direct organization of the file of retrieval images of documents is used in the mode of selective dissemination of information for current inquiries and inverted organization--for retrospective retrieval. At the present time the RASPRI-1 information retrieval system is used in the inverted retrieval of information mode. The file of queries is organized by headings.

In the RASPRI-1 information retrieval system document texts are fed directly without preliminary intellectual processing. The main attributes of the document format in the RASPRI-1 IRS [information retrieval system] are as follows: document number, classification index, input and output data and the document text in the natural (Russian) language. The document text can be represented in a formalized form--as different kinds of descriptors expressed by the lexical units of the Russian language or key words. Therefore, the RASPRI-1 IRS exhibits broad possibilities of compatibility with other information retrieval systems at the level of document texts represented on machine carriers.

The linguistic means of the RASPRI-1 IRS can automatically transform a document text into its retrieval image by self-coding.

Special tabulated forms are fed into the first IRS loop: each tabulated form has a set of document numbers corresponding to the inquiry from the viewpoint of the linguistic means of the RASPRI-1 IRS, matching each inquiry number. The tabulated form are used for an address retrieval in the second IRS loop.

The second loop of the RASPRI-1 IRS is a set of subject-oriented numbered card files of the secondary documents on conventional and machine carriers. The address retrieval in the card files based on conventional carriers is done by hand. Documents submitted are verified for their relevance at the address retrieval stage. This procedure, as indicated by the speaker, allows users to be serviced with high precision, virtually close to 100 percent.

The third loop of the RASPRI-1 IRS is a collection of primary information sources--specifically, the TsNTB [central scientific and technical library]. The loop is activated when a user requests a copy of the primary document.

In 1977, 180,000 documents were fed into the RASPRI-1 IRS; about 31,000 documents were fed in the inverted retrieval mode: the documents had been sent to users at 1600 enterprises and organizations in Moscow and Moscow Oblast.

"Operational Characteristics of the Sector-Based Automatic Information Retrieval System in the Indexing of Patent Documents and in Their Retrieval" was delivered by V. P. Mikhaylova (Automatic Information Retrieval System in Electrotechnology, "Source" subsystem). She said that as the sector-based automatic information retrieval system grows, a question arises as to the organizing of specialized patent retrieval when expert examinations are underway of an object under patent protection for innovation or purity or when products are being delivered for export. The conventional approach to patent retrieval requires, first, finding its regulation in the MKI [International Patent Classification], that is, formulating the inquiry in the alphanumeric codes of this system. The paper examined the possibility of transforming the traditional inquiry in the MKI indexes into a query for the descriptor retrieval system. It was shown that retrieval organized by the system principle (based on MKI indexes) is not effective owing to the considerable subject-matter diffuseness of the information in the patent collections. The cause of the diffuseness, V. P. Mikhaylova pointed out, lies in several factors; of these the principal factor is the ambiguity of indexing because the documents can be indexed according to two bases: according to the application of the object under protection and according to its functional designation. Descriptor concepts must be used to augment patent retrieval effectiveness. Indexing documents introduced into the file only with the descriptor lexicon based on the RZh VINITI [Referativnyye zhurnaly VINITI; Abstract Journals of the All-Union Institute of Scientific-Technical Information], without allowing for the specific features of the patent glossary equally fails to yield the desired results. Experiments were conducted showing the weak consistency of the patent glossary lexicon and the sector-based glossary lexicon based on the RZh VINITI. So the two indexing systems must coexist and must be taken into account concomitantly in the same automatic information retrieval system: the hierarchical classificatory field of the subject-matter fragment of the MKI and the instrument of coordinate indexing --the sector-based descriptor lexicon. The correspondence between these two systems is achieved by constructing a classification that is secondary with respect to the MKI, a local classification, that is, one that is meaningful only for a given retrieval file. An algorithm of the formal procedure was developed for constructing the classificatory field and the semantic names of the classes. The class name is the standard inquiry addressed to some one of the conceptual fields of the file. The glossary of the documents supplied by the system in response to the inquiry is the basis for forming lexical entries of the class. The secondary classification compared to the sector-based lexicon of the descriptors constitutes the linguistic support of the patent retrieval with regard to the specific inquiry, which can substantially increase the retrieval effectiveness.

At the May seminar, the paper "System for Satisfying Inquiries of Enterprises and Organizations of the National Economy for Primary Documents" was delivered by T. F. Snastina (GOSINTI [State Scientific Research Institute of Scientific and Technical Information]). She spoke about different primary documents appearing during and as a result of investigations, developments and production activity: reports, articles, reviews and so on. The speaker directed the attention of the seminar audience to the fact that not all information personnel can manage the method of preparing and filling out primary and secondary documents and they allow their duplication.

Specifically, T. F. Snastina dwelt on a form of primary documents of importance, such as sets of designer-drawing documents (DDD) for nonstandard equipment and industrial processes, without which introducing innovations into production is difficult and often even impossible. Yearly, the GOSINTI fills up 250,000 orders for sets of DDD.

Specific examples illustrate how significant is current awareness information in the publicity and dissemination of primary documents; the system of this information in the electrotechnical industry was examined at length. The index "Bibliograficheskaya informatsiya" [Bibliographical Information] is published in 15 series with a scheduling of 1-3 months between issues; "Bibliograficheskiy ukazatel' obmennykh fondov nauchno-tekhnicheskikh bibliotek elektrotekhnicheskoy promyshlennosti [Bibliographical Index of Exchange Collections of Scientific and Technical Libraries in the Electrotechnical Industry] is published quarterly; annually indexes are published to the information bulletins, reviews and so on published in the sector. In the speaker's view, copies of the headings of journals in capitalist countries that are made on order by information users are an important kind of current awareness information.

The paper shed light on the forms and methods of satisfying the inquiries of organizations and enterprises of the national economy for primary documents; mention was made of a trend of the growing number of inquiries: for example, in 1974 about 100 daily inquiries came to the Informelektro Central Reference Collection, and 150--in 1977; each year some 70,000 inquiries are answered.

Concluding, the speaker stressed that the system of filling inquiries for primary documents stands in need of further improvements.

The paper "Technology--the Most Important Factor in the Functioning of an Automatic Information Retrieval System" was read by A. Z. Shneyerson (Informelektro). He expounded at length on the most important problems emerging in the operation of an information retrieval system. The speaker indicated that now a new scientific discipline has emerged in information science--the theory of documentary automatic information services, studying the scientific and scientific-technical problems of converting from an "abstract information retrieval system" to service in a fixed process environment. A. Z. Shneyerson familiarized the seminar participants with the results of studies done in Informelektro based on the Electrotekhnika Automatic Information Retrieval System.

G. I. Gol'dgamer (Informelektro) gave a report, at the June seminar, on several problems in the organizing, use and upgrading of the reference information collection.

Remaining as the most important problem is the automation and mechanization of the set-completion of the reference information collection and document-handling. In speaking about unified sector-based reference information collections, the speaker pointed out that in many instances they have not yet come on the scene; one reason for this situation is departmental, in several cases, not the sector nature of the activity of the Central Sector Agencies of Scientific and Technical Information (TsOONTI). Subsystems of information services were examined, under implementation with the central reference information collection; the suggestion was made to give extra attention to systems of the selective distribution of primary documents (IRPD [izbiratel'noye rasprostraneniye pervichnykh dokumentov]).

In the speaker's view, by 1990-2000 the collections of the GSNTI [State System of Scientific and Technical Information] will double. This will compel efforts even now to be made to engage in solving several of the leading problems. The speaker elaborated the structure of the functioning central reference information collections of the TsOONTI and underscored the necessity of their improvement; he maintained that it is time to free the central information reference collections from exercising the function of the information service of the TsOONTI and to set up information services that in fact must take on providing information support to specialists and scientists in the TsOONTI. This service is being organized at present in Informelektro. The speaker gave much attention to the problem of uncovering the information needs of a variety of information users and methods of discovering information requirements; it was noted that the set-completion of the reference information collection must be done on the basis of information requirement uncovered.

G. I. Gol'dgamer spoke about the system of set-completion of the reference information collection of foreign literature from capitalist countries, functioning in the electrotechnical industry.

The incoming document flow is ranked prominently in the set-completion of the reference information collection. The speaker spoke about the system of setting up and controlling the incoming document flow functioning in the electrotechnical industry.

V. S. Nemirovskaya delivered a paper on the sector-based system of standardization of information activity. Standardization of information activity is linked closely with the growing role of standards in the control of the technical level and quality of products. In June 1977 an expanded plan of measures for the further strengthening of the role of standardization was examined and confirmed at a joint session of Gosstandart SSSR [All-Union State Standards] and the Board of the USSR Ministry of the Electrotechnical Industry; the plan is aimed at the further strengthening of the role of standardization under which scheduling of activities in standardization will be improved, anticipatory standards will be applied and so on.

The sector-based system of standardizing information activity is developing in close association with the standardizing of production, technological and economic activity of the sector.

In electrotechnology a long road has been covered from setting up individual technical-standards and methodological documents to the elaboration of an integrated system for standardizing information activity in the sector.

The first technical-standards documents were confirmed in 1967-1971; since 1975 the concept of a unified system of technical-standards and methodological-organizational documents is being implemented systematically and consistently.

Currently the complex of technical-standards documents and methodological documents in electrotechnology numbers 50 state standards, guiding technical materials, principles, directives and so on. Included in the complex are effective, under-development (including 17, for the first time) and projected documents.

The system of standardization consists of three blocks: system-wide elements; functional subsystems of input, storage, retrieval and publication of scientific and technical information; and organizational aspects of the functioning of subsystems and elements of the sector-based system of scientific and technical information in electrotechnology and the control subsystem.

In the system-wide documents a special place is given to the model draft regulating the procedures of organizing an enterprise information system in which all problems of organizing information support of an enterprise into a unified system are being cumulated.

10123
CSO: 1870

ELECTRONICS AND ELECTRICAL ENGINEERING

EXHIBITS AT THE 1978 LEIPZIG SPRING FAIR IN THE FIELDS OF METROLOGY, DATA ACQUISITION, AND DATA-PROCESSING SYSTEMS

Metrology and Data-Acquisition

East Berlin RADIO FERNSEHEN ELEKTRONIK in German Vol 27, No 6, Jun 78 pp 355-360

[Article by G. Raab]

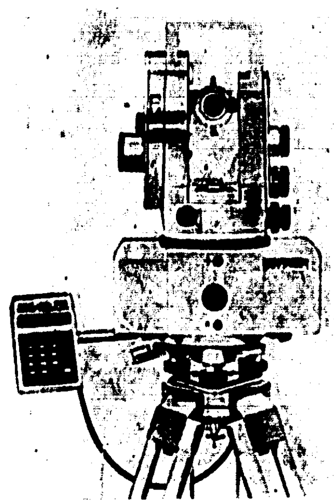
[Text] German Democratic Republic

The exhibits of Carl Zeiss JENA State Enterprise reflect the increasing and fundamental importance of microelectronics. Intensification of science and production based on the use of microelectronics manifests itself in two ways. The availability of photolithographic and microscopic equipment lines, primarily as an aid in production and testing for the microelectronics industry, contributes significantly to the strengthening of the material and engineering base of this industry sector. In addition, microelectronic components find increasing use in precision optical devices, resulting in more effective and easier-to-use instruments.

The COORDIMETER G, an electronic recording device, is used for solving tasks related to the acquisition of photogrammetric test data, and may be readily connected to all photogrammetric measuring instruments made by Carl Zeiss JENA State Enterprise. The electronic system of this recorder contains, among others, a microprocessor, which operates in conjunction with a 1K RAM and a 8K PROM memory. Display is on a screen and by light-emitting diodes.

Another instrument in the field of precision metrology using a microcomputer is the DKM 1-300 DP three-coordinate measuring device, which may be used in metrological and testing procedures in all areas of the metal- and plastic-processing industries. With the instrument it is possible to measure tools, devices, and gauges. It is suitable for the following measuring tasks:

- Lengh measurement in unidimensional, two-dimensional, and three-dimensional Cartesian coordinates;
- Measurement in polar and cylindrical coordinates around vertical and horizontal axes of rotation;
- Direct and indirect angle measurements;
- Point-by point measurements of levelness, parallelness, and roundness.



Electro-optical tachymeter from Carl Zeiss JENA State Enterprise (factory photograph)

The electronic system of the three-coordinate measuring instrument contains, among others, a Robotron K 1510 microcomputer, which performs the immediate evaluation via the measuring and evaluating programs entered through the keyboard. The evaluating programs may be permanently built into solid-state memories.

The microprocessor installed in the EOT 2000 electro-optical tachymeter computes oblique distances, horizontal distances, altitude differences, or heights after entry of a two-digit atmospheric correction, the vertical wind, and the altitude above the control console, displaying the results.

The instrument may be used for all surveying tasks up to 2,000 m range, and because it contains a microprocessor performs efficiently and is easy to use. These advantages are particularly appreciated when the instrument is used in the field.

Soviet Union

The C 9-1 television special oscillograph is used for pulse measurements and visual observation of periodic signals. It is particularly suitable for a thorough study of television signals with visualized grid (lines) on a video monitor, such as measuring the difference phase, differential gain, and characteristic lines of the color-carrier frequency in the SECAM III B color-television system.

Some technical data:

Picture screen: 80 mm by 100 mm
Pass range of the vertical deflection channel: 0 - 20 MHz
Input impedance and parallel capacitance:
Input I: 1 mohm//35 pF
Input II: 75 ohms
Time scales with possibility of five-fold expansion: 0.1 microseconds per cm to 50 milliseconds per cm
Stable synchronization in the frequency range of: 20 Hz - 20 MHz
Error in measurement of signal levels and time intervals: max ±5%
Dimensions in mm: 480 by 160 by 475
Weight: 25 kg

The C1-79 dual-beam oscillograph is equipped with a dual-tilt unit, one with delay. As a result, examinations of any desired part of a signal of complex structure becomes possible. The instrument is used primarily in various areas of science and technology for functional checks and maintenance operations of complex electronic equipment.

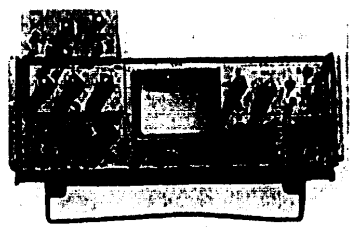
Some technical data:

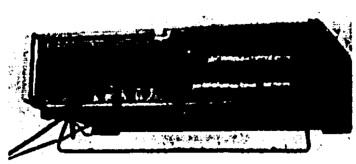
Useful picture screen area: 48 mm by 80 mm
Frequency range: 0 - 100 MHz
Deflection factor: 2 mV/cm to 12 V/cm
Rise time: 3.5 nanoseconds
Overshoot: 5%
Adjustable delay: 1 microsec - 10 seconds
Frequency bandwidth A + B: 0.5 mV/cm
Basic error: ±5%
Horizontal-frequency bandwidth: 0 - 5 MHz

Horizontal deflection factor X-Y: 7.5 mV/cm to 12 V/cm
Dimensions in mm: 348 by 220 by 490
Weight: 19 kg

The Ф 4800 digital multimeter is used to measure resistance values, capacity values, inductivity values, d.c. voltages, direct currents, frequencies, time intervals, and pulse counts. The instrument is also suitable for use as an independent measuring system as well as a measuring unit in automated control and guidance systems.

Some technical data:
Measuring ranges: U: 10^{-3} - 10^{3} V; I: 10^{-3} - 10^{3} mA; C: 10^{-3} - 10^{2} μF; L: 10^{-2} - 10^{1} H; R: 10^{-4} - 10^{3} kΩ; f: 1 Hz - 10^{3} kHz; t: 10^{-3} - 10^{3} sec





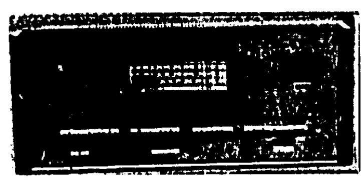
C 9-1 Special television oscillograph from the Soviet Union

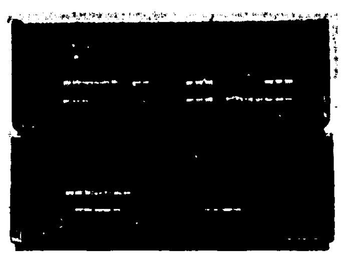
Ф 4800 digital multimeter from the Soviet Union

Selection of the polarity in measuring U, I, and f% is accomposhed automatically, as is the selection of the range in measuring f, t, and N. The U, I, C, L, and R ranges are selected manually.

Input impedance in measuring
U: ≥ 1 MΩ
t, f, n: ≥ 10 kΩ
I: 1
Measuring error: up to 0.25%
Ambient temperature: 5 - 40°C
Relative humidity: 80%
Dimensions in mm: 135 by 380 by 495
Weight: 12 kg

The P 5085 and P 5016 automatic digital alternating current measuring bridges are fully automated instruments for the determination of complex resistances. They are designed for laboratory use.





Φ 5125 phase-shift calibrating instrument from the Soviet Union

K 484/2 recording and measuring system from the Soviet Union

Some technical data:

Measuring ranges	P 5058	P 5016
Capacity in F	$2\cdot10^{-14}$-10^{-3}	10^{-14}-10^{-4}
Inductivity in H	$3\cdot10^{-8}$-10^{-2}	10^{-7}-10^{-2}
Resistance in ohm	0.01-10^{7}	0.1-10^{6}
Conductance in S	10^{-6}-1	-
Loss factor	$5\cdot10^{-4}$-1	$1\cdot10^{-4}$-1
Time constant in sec	$5\cdot10^{-8}$-10^{-4}	
Percent deviation	±0.05-±30	-

Phase shift		10^{-3}-1
Test frequencies in kHz	0.05; 1; 10	1; 5; 10; 50
Base measuring error in %	0.2 - 2	0.02 - 0.05 - 1
Measuring time in sec	0.1 - 5	0.03 - 1
Dimensions in mm	490x495x210	490x495x210
Weight in kg	30	40

The Φ 5125 phase-shift calibrating instrument consists of two quartz-controlled generators, of which the phase position is changed by a precision phase bridge. The instrument is used for calibrating and checking of phase-measuring systems.

Some technical data:

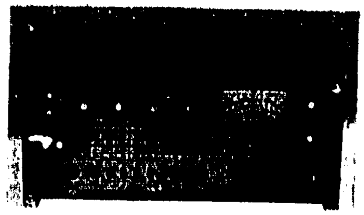
Adjusting range of phase shift: 0 - 359°
Basic error: 0.05 - 2°
Output frequency range: $1\text{-}2\cdot10^4$ Hz
Shape of output signals: sine/square
Quartz-generator frequencies: 2.5 kHz - 200 MHz
Dimensions in mm: 490 by 210 by 375
Weight: 18 kg

The K 484/2 digital recording and measuring system is used to measure d.c. voltage in 30 channels with digital display of the channel number, the result of the measurement, and the measuring time. At the same time, a perforated tape is generated. The system may be used for automation of electrical measurements to check the parameters of technological and production processes in scientific studies carried out under laboratory and factory conditions. It may also be used as a digital voltmeter with printed output.

The system consists of a Φ 4830 digital voltmeter, a measuring-site selector switch, a clock, a recorder, and a perforator. These components are modules in functional and design terms, and may also be used outside the system.

Some technical data:

Test-voltage range in V: 0.0005 - 1.000
Polarity selection: automatic
Test-range selection: manual, automatic, remotely controlled
Accuracy class for ranges: 1 V, 0.1/0.06; 10, 100, 1000 V, 0.15/0.1
Maximum measuring rate: 10 measurements/sec
Accuracy of time-signal output: 0.02%
Dimensions in mm: 490 by 340 by 360
Weight: 32 kg



The BM 539 RLCG measuring bridge from Czechoslovakia

The exhibits of the KOVO foreign-trade enterprise in the field of electronic measuring instruments were developed and manufactured by Tesla in Brno. They demonstrate clearly the effort toward making operation easy and simple. For example, there were many programmable, automatic, and semiautomatic instruments among the exhibits.

The test transmitter BM 536 was developed for precise measurements in the laboratory and the test field. This instrument is particularly suitable for the determination of bandpass and filter curves.

Some technical data:

- Frequency range: 10 Hz - 12 MHz in five subranges
- Frequency setting: decadic
- Setting uncertainty: $1 \cdot 10^{-7}$ with shut-down intermediate-value oscillator ± 1 bit with intermediate-value oscillator on
- Attenuation of harmonic signals: 10 Hz - 100 kHz: 60 dB; 100 kHz - 12 MHz: 40 dB
- Attenuation of non-harmonic signals: > 60 dB
- Internal frequency standard: 10 MHz
- Short-time error of the frequency standard: $1 \cdot 10^{-7}$ after a runup time of 30 min
- Frequency-response error: ± 0.5 dB
- Runup time: 30 min
- Remote control: parallel BCD code
- Interface: IMS-1, according to RS 3826-73
- Dimensions in mm: 430 by 190 by 470
- Weight: 20 kg

In cases where the setting inaccuracy for the output level is too high on the BM 536 generator, the programmable BM 547 attenuator (damping line) may be used. In addition, it is advisable to use the BM 547 for damping and gain measurements on quadrupoles.

The BM 552 vector voltmeter is a selective HF microvoltmeter equipped with two channel systems, as well as a phase-measuring instrument with simultaneous display of the voltage and phase values. With the special coaxial accessory BP 5321, it is possible to measure the reflection factor of impedances and admittances, the s parameter of quadrupoles, and the parameters of semiconductors.

The instrument is particularly suitable in information measuring systems because of its technical properties and equipment. There is automatic setting of the voltage ranges, phase ranges, and frequencies. Both manual and remotely-controlled operation is possible. Programming is accomplished in parallel BCD code.

Some technical data:

- Voltage measurements: 100 microvolts - 1 V in nine ranges
- Frequency range: 1 - 1000 MHz
- Measuring uncertainty: ±2% of full deflection at 0-1 V
- Input impedance: 100 kohms//2.3 pF at 1 MHz
- Input noise: approx. 18 microvolt
- Bandwidth: 1 kHz
- Measurement of the voltage ratio with dual reading,
  - Range: -80 = +80 dB
  - Basic error: ±0.3 dB
- Phase measurement
  - Range: 0 - ±180°
  - Resolution: 0.1°
  - Phase-null shift: 0 - ±180° fpr every 10°
- Measuring uncertainty: ±1.5° for coinciding voltages in both channels
- Outputs:
  - Voltage: 0 - ±1 V
  - Phase: 0 - ±1 V
- Interface: Remote control is possible with the aid of replaceable interface units for IMS-1 or IMS-2
- Dimensions in mm: 330 by 450 by 390
- Weight: 20 kg

The semiautomatic RLCG measuring bridge BM 539 is used for precise determination of the network parameters R, L, C, and G, as well as tolerances in parts. Among others, it contains circuits for the automatic compensation of the loss components on the test object. The compensation of the basic value is accomplished manually to four decimals, where the pointer instrument indicates the mistuning direction of the measuring bridge.

In addition to the standard measurements, the instrument may also be used for the repeated measurement (screening) of parts. Setting of the tolerance field is accomplished simply at the upper and lower limits of the basic component, and the upper limit value of the second part. If the limit values are exceeded, this fact is indicated optically.

Some technical data:

Basic measurements

Measuring ranges

R: 0.5 mohm - 10 Mohm

G: 5 pS - 100 mS

C: 0.0005 pF - 10 microF

L_s: 50 nH - 1000 H

1/L (C): 25 microF - 0.1 F

L_p: 100 microH - 1000 H

D: 0.005 - 1

Permissible measuring uncertainty

R: 1 ohm - 10 Mohms $\pm$(0.1% $\pm$ 1 mohm $\pm$ 0.2 D%)

G: 10 nS - 100 mS $\pm$(0.05% $\pm$0.01 nS $\pm G_x$/100 S $\pm$0.2 D%)

C: 1 pF - 10 microF $\pm$(0.05% $\pm$0.001 pF $\pm$0.2D%)

L_s: 100 microH - 1000 H $\pm$(0.2% $\pm$ 0.2 microH $\pm$0.2D%)

L_p :100 microH - 1000 H $\pm$(0.2% $\pm$ 0.2 microH $\pm$0.2D%)

D: $5\cdot10^{-4}$ - 1 $\pm$(5% $\pm 5\cdot10^{-4}$)

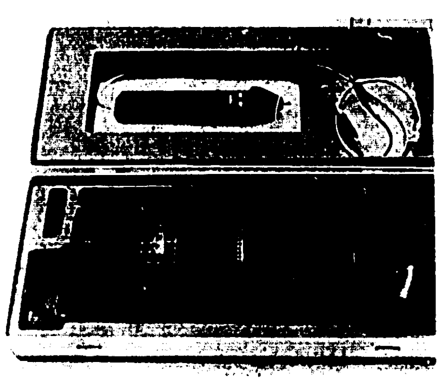
Total range: 0.02% - 20%

Test frequency for tolerance: 1 kHz $\pm$1%

Resolution: 0.01% - 0.001% of the display

Dimensions in mm: 480 by 180 by 370

Weight: 15 kg



BM 541 logic comparator from Czechoslovakia

An automatic sorting system enables, in conjunction with the BM 539 measuring bridge, the sorting of parts with axial leads in the given size into three groups. In measuring the main portion, a decision for three groups is made: smaller, larger, and within tolerance. The mechanism of the instrument places the parts against the contacts. These contacts are connected as Kelvin clamps, and may be converted into a two-terminal circuitry. The sorted parts are collected in three containers below the unit. Three counters indicate the number of parts in the individual containers.

The BM 560 instrument is used for measuring the effective value of the quality factor Q. By means of direct measurement we determine the resonance frequency of the measured object; by means of indirect measurement we determine the coil inductivity, the capacity, and the loss factor of capacitors, the resistivity of bipoles, and other parameters. Among the advantages of the instrument is the low test voltage on the test object.

Major technical parameters:

- Frequency range: 50 kHz - 35 MHz
- Basic frequency error: ±1%
- Test range of the quality factor Q: 5 - 1000
- Capacitance range of the test capacitor: 25 - 450 pF
- Basic error of the test capacitor scale: ±1 pF for C ≤ 100 pF; ±1% for C > 100 pF
- Measuring range for indictivity values: $5\cdot10^{-8}$ H - 0.4 H
- Dimensions in mm: 180 by 490 by 355
- Weight: 13 kg

Basic measuring error of the quality factor Q with the BM 560 from Czechoslovakia

Range	Frequency 50 kHz - 25 MHz	Frequency 25 - 35 MHz
5... 30		
30...100	$\pm\left(3 + \frac{Q_{max}}{Q}\right)\%$	$\pm\left(6 + \frac{Q_{max}}{Q}\right)\%$
100...300		
300...1000	$\pm\left(6 + \frac{Q_{max}}{Q}\right)\%$	

The BM 538 HF impedance and transmission measuring instrument has direct display and is suitable for the determination of the impedance vector $Z = |Z|\cdot e^{j\varphi}$ and the vector of the voltage-transmission coefficient of quadrupoles $A = |A|\cdot e^{j\varphi}$ in the 0.5 - 110 MHz frequency range, for which a separate signal generator is provided. An advantage of the instrument is that it is easy to operate; this allows fast measurements over a wide frequency range. The operation involves merely the setting of the signal frequency of the Z or A region, and if necessary of the phase angle φ. In special measurement jobs, the built-in generator may be replaced with an external HF generator having a slight wobble frequency.

Independent measuring probes are provided for impedance and transmission measurement. The instrument measures impedances in all four quadrants of the impedance plane, and is suitable for measuring the impedance of passive and active components, the input and output impedance of amplifiers, the impedance values of transformers and filters, and for matching operations to measure resonance circuits, and so forth. The values of L and C may be read directly on the instrument's scales for the corresponding frequencies.

The instrument permits fast measurement of voltage transmissions of active and passive quadrupoles over the entire phase plane.

The BM 541 logic comparator permits the in-service fast localization of a faulty logic integrated circuit directly on the circuit board, and also permits a simple analysis of the fault with the aid of a probe. Localization of the faulty output on the tested logical integrated circuit is accomplished with the aid of comparators (16 independent channels) which compare the test sample with a reference component of the same design. The comparator enables the testing of TTL and DTL components with a working voltage of +5 V.

Some technical data:

Comparator: $U_L < 0.8$ V
$U_H > 2.0$ V

Resolution: 250 nsec. All level differences of ≥ 250 nsec are compared and recorded on the display panel

Maximum repeat frequency: 2.5 MHz

Dimensions in mm: 240 by 110 by 37

Weight: 1.2 kg

People's Republic of Hungary

The TR-1855/Q 100 SECAM analyzer is used to test and check video signals coded according to the SECAM standard, and checks, measures, and sets the modulation parameters of the SECAM coder.

The following may be selected with the analyzer:

- Composite color-picture signal coded according to the SECAM standard;
- Brightness signal;
- Modulated color signal;
- Modulated color signal with bell correction;
- Demodulated color signal after subsequent alignment.

The calibration oscillators permit checking the characterizing frequency values of the SECAM signal. With the aid of the continuously tunable oscillator, the frequencies corresponding to all color signals of the signal to be measured may be simulated and thus measured. Measurement in this case is also accomplished by covering the color signal by the detected signals of the oscillator. The frequency values may be read on a four-digit LED display unit in kHz. The accuracy of the readout may be increased by one position through the use of a vernier unit.

Technical data:

Input signal: SECAM-coded composite television signal
Signal magnitude: 1 V (peak-to-peak) ±3 dB (positive white) at 75 Ω
Input impedance: 75 Ω
Output signals, synchr. signal mixture
Signal value: 4 V ±5% at 75 Ω
Polarity: negative
Output impedance: 75 Ω
Half-line frequency signal
Signal value: 4 V ±5% at 75 Ω
Polarity: negative
Output impedance: 75 Ω
Test signals
SECAM-coded composite television signal
Gain: 0 dB ±0.2 dB
Fluctuation of the amplitude-frequency characteristic, related to 100 kHz: ±0.5 dB, to 8 MHz
Luminance signal
Gain: 0 dB ±0.2 dB
Fluctuation of the amplitude-frequency characteristic: corresponds to a Gauss filter, 3 dB at 1.3 MHz, min. 50 dB at 3.9 dB
Auxiliary color carrier frequency color signal
Gain: 0 dB ±0.2 dB at 4 MHz
Fluctuation of the amplitude-frequency characteristic related to 4 MHz: +0.1 - 0.4 dB between 3 MHz and 5.2 MHz; -3 dB between 2.75 MHz and 5.6 MHz; -20 dB between 2 MHz and 6.5 MHz

Reference oscillators

Quartz frequencies	D_R	D_B
Identification signal	4756.25 kHz	3900.0 kHz
Auxiliary color carrier	4406.25 kHz	4250.0 kHz
Yellow color signal	4361.25 kHz	4020.0 kHz
Blue color signal	4686.25 kHz	4328.0 kHz

Accuracy: $1 \cdot 10^{-5}$

Continuously tunable oscillator

Frequency range: 3.5 - 5 MHz

Short-term instability: ±100 Hz

Frequency measurement:

Frequency: 10 MHz

Setting accuracy: $\pm 2 \cdot 10^{-7}$

Display: Four-digit LED display; five digits with vernier

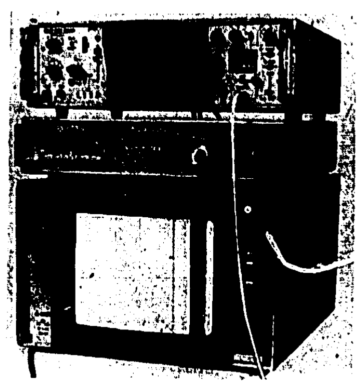
Resolution: 1 kHz or 100 Hz ±1 digital

Power connection: 110, 127, 220, 240 V ±10%/50-60 Hz

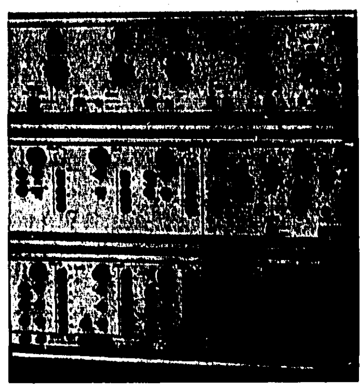
Power consumption: 40 VA

Dimensions in mm: 440 by 90 by 415

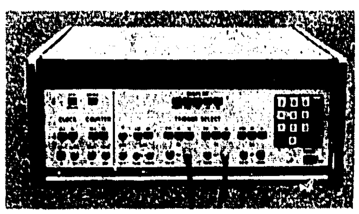
Weight: approx. 10 kg



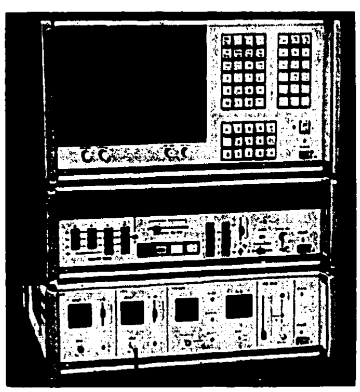
TR-1855/[[Q 100 SECAM analyzer, from the People's Republic of Hungary



TR-0307 pulse generator from the People's Republic of Hungary



TR 0313 pulse generator from the People's Republic of Hungary



TR-4910 signal-form analyzer from the People's Republic of Hungary

The response frequency of the TR-0307 pulse generator (EMG [Electronic Measuring Instruments Factory] 11,590) may be set in a wide range (15 Hz to 100 MHz). The triggering possibilities (internal, external, single, gated) expand the range of applications. The inputs adapt to the TTL logic levels. A new mode of operation is the external width control, which permits the control of the output stage with complex word forms, digitally calibrated times, and so forth.

Some technical data:

- Delay time, adjustable delay-time range: 5 nsec - 30 msec
- Internal triggering, period-time range of the internal control generator: 10 nsec - 66 msec
- Adjustable pulse-duration range: 5 nsec - 30 msec
- External triggering, response frequency: DC - 100 MHz (with pulse triggering)
- Output modes: pulse, square wave, external pulse duration
- Output trigger signal
  - Amplitude: 1.5 V/50 ohms
  - Rise time: 3 nsec
  - Amplitude: 70 mV - 10 V
  - Overshoot: ≤ 5%
- Rise and decay times: 2.5 nsec - 0.5 msec
- Dimensions in mm: 132.5 by 443 by 354
- Weight: 9 kg

Within the framework of specialization in the field of pulse generators, the novelties originate primarily from the People's Republic of Hungary (EMG). A trailbazing novelty is the new programmable, quartz-controlled pulse generator TR-0313 (EMG 12,533). It generates pulse durations of high accuracy (error: $+1 \cdot 10^{-5}$) controlled from either the front panel or by remote control. The pulse generator consists of a period-duration unit, a pulse counter, three time-interval channels each, and an output stage. It is used in development laboratories and manufacturing establishments in the semiconductor industry, and also in the testing of amplifiers and electronic devices.

All data and operating modes are set on the front panel with keys if the unit is operated with internal control. In the case of remote control, the unit may be programmed on the rear panel with program plug wires.

The program-controlled pulse generator may also be operated in automated measuring systems. The program inputs are TTL-compatible. If so desired, the unit may be adapted to the bus system of the Type 666 instrument and the IEC bus. There is a seven-digit display unit.

Some technical data:

Timing-pulse generator
Operating modes: external, internal
Internal timing-pulse generator
Frequency: 10 MHz
Accuracy: $\pm 1 \cdot 10^{-5}$
External timing-pulse generator
Frequency: 10 MHz
Triggering signal: TTL-compatible
Input loading: 2
Timing-pulse signal output
Output amplitude: 2.5 V
Polarity: positive
Internal triggering
Period-duration range: 0.2 - 999,999.9 microsec (100 nsec resolution) or 0.2 - 999,999.9 msec (100 microsec resolution)
Accuracy of period duration: ±0.001% of the set value ±5 nsec
External triggering (EXT.IN)
Response frequency: DC...5 MHz
Trigger signal: TTL-compatible
Input loading: 2
Pulse category

A predetermined number of pulses may be output independently of the period duration. Each time-interval channel has two outputs. A pulse appears on the pulse output after the end of the set time duration. In this case, the set time duration means the pulse appearing between the 50% points of the channel-trigger signal and the rise flank on the output. The duration of the pulse appearing at the TIMING output is the same as the set time duration.

Synchronous signal output

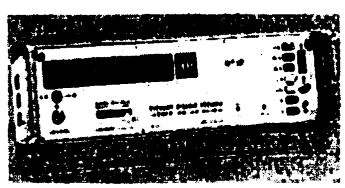
A pulse appears at the beginning of the TIMING interval only with external triggering (EXT). The time uncertainty is, related to the external trigger signal, approximately 100 nsec or 100 microsec (with a 100 microsec timing-pulse signal).

The TR-4910 signal-form analyzer system (EMG S,500) is used to convert any analog and digital signal, and signal form, into a digitally stored information, as well as to visualize and evaluate this information by means of mathematical methods.

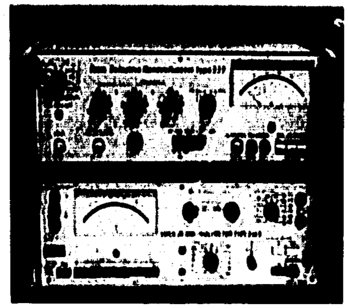
The digital conversion of the analog electrical signals to be tested is accomplished with the aid of an analog-to-digital converter. The analog signals to be tested of various frequencies may be applied directly to the analog-to-digital converter under appropriate offset setting, or they reach the converter from units connected to the converter, having appropriate gain or scan rate. The digitally converted information is stored by the system in a semiconductor-based memory. All further operations are performed on the signals stored in digital form by means of mathematical methods. The content of the memory may be displayed on the monitor of the system. The characteristic parameters of the memory contents may be displayed in numerical form. Relatively simple mathematical operations such as addition, subtraction, calculation of pulse parameters, and so forth, may be performed with the contents of the memory, with the aid of an arithmetic unit.

The Type TR-4910 offers flexibility of the input units and versatility of the mathematical operations, so that the system may be put to a great variety of uses.

Important use areas:
- Digital conversion, storage, and evaluation of signal forms in studies concerning any industrial, medical, biological, physical, chemical, and electrical phenomenon;
- Oscillography with digital storage, oscillograph-like uses with digital evaluation;
- Measurement of pulse parameters at high speed;
- Measurements on dynamic measuring systems, especially to test integrated circuits.



CMP 4 digital level meter from the People's Republic of Poland



Selective nanovoltmeter, No 237, People's Republic of Poland

The following may be built up by combination of functional units:

- Signal-form analyzer
- Response signal-form analyzer
- Sampling oscillograph with digital storage of analog signals
- Oscillograph with digital storage
- Universal signal-form analyzer system.

The following functional units are available:

Signal-form memory, Type 55100
Memory capacity: 4,096 x 8 bits
Memory organization: 4 x 1 Kbyte; 2 x 2 Kbyte; 1 x 4 Kbyte
Number of inputs: 3 (2 parallel 8-bit inputs; 1 series input /for magnetic tape unit/)

Outputs for controlling the electron-beam tube, for X-Y recorder, for digital recorder, for magnetic tape recorder, and for external arithmetic unit.

Digital converter unit, Type 55141
Vertical unit
Number of inputs: 2, independent of each other
Coupling: DC, AC, GND
Impedance: 1 mohm//50 pF
Sensitivity: 50 mV/step
Offset range: ±9.9 V (in 0.1 V steps)
A/D resolution: 8 bits
Measuring range: ±640 mV - ±25.6 V
Trigger modes: pretrigger, posttrigger
Digital delay: up to 999 times the selected time base
Triggering possibilities: CH1, CH2, EXT
Coupling: DC, AC
Trigger-level range: ±4.9 V (in 0.1 V steps). The controls are remotely operable; their position may be interrogated.
Miniprocessor unit: Type 55110
Design: binary, 8-bit
Functions: transfer of data blocks, basic calculations carried out with data blocks, operations within a block, operations with constants, and special block operations (pulse-parameter evaluation)
Operating mode: from built-in keyboard, via external computer Type 666
Display: built-in electron-beam tube
Memory capacity: combination of ROM and/or RAM with up to 8 kbyte or ROM and/or RAM with 16 kbyte
Sampling-digital converter unit: Type 55140
Input data
Vertical unit: Two channels (independent), 50 ohms, DC
Rise time: 350 psec
Sensitivity: 5 mV/div
horizontal unit
Deflection speed: up to 100 psec/div
Trigger: EXT, INT

People's Republic of Poland

Most exhibited products indicate the trend that the development and production of selective and broadband voltmeter and level meters is favored.

The CMP 4 digital level meter is an electronic measuring instrument for the precise determination of a.c. signal levels in the 30 Hz to 120 kHz frequency range. The level is indicated digitally at an uncertainty of ±0.1 dB and the output is BCD-coded for possible recording (TTL level). In the 30 Hz to 30 kHz frequency range, there is a symmetric input and in the

30 Hz to 120 kHz range there is an asymmetric input with switchable input resistor (600 ohms, 950 ohms, high-ohmic). The level measuring range is -60 dB to +20 dB. Dimensions in mm: 128 by 438 by 250; weight: 9 kg.

The No 237 selective nanovoltmeter is designed for a.c. voltage measurements in the 1 Hz to 100 kHz frequency range. Within the above frequency range, phase and amplitude measurements of amplifiers and filters, spectral analyses of low-frequency signals, alignments of measuring bridges, harmonic distortion factor measurements, and many others may be performed.

Some technical data:

- Frequency range: 1 Hz to 99.9 kHz
- Sensitivity (full range): 1 microvolt to 100 mV with preamplifier up to 3 nV
- Measuring uncertainty: ±0.4 dB
- Linearity error: ≤ 0.1%
- Octave damping: 0 - 40 dB
- Input impedance: 100 MΩ//20 pF
- Outputs
- a.c. voltage: 1 V (eff) at full deflection and 600 ohms
- d.c. voltage: 100 mV at full deflection and 100 ohms
- Drift (24 hrs): ≤ 0.2 dB
- Dimensions in mm: 440 by 164 by 330
- Weight: 10 kg

The PFL-22 digital frequency and time-interval measuring instrument permits highly accurate measurements to be carried out in the laboratory on sine or pulse frequencies, sine or pulse periods, frequency ratios of two frequencies, and pulse widths.

There is the possibility of obtaining highly precise frequencies and using the unit as a decadic standard generator in the 1 Hz to 10 MHz frequency range.

Technical data:

- Frequency-measuring range: 0 to 100 MHz
- Instability of the mother generator: $\pm 5\cdot 10^{-9}$/24 hrs
- External control possible: 5 MHz, 10 MHz
- Temperature drift: $2\cdot 10^{-9}$/K
- Dimensions in mm: 446 by 240 by 96
- Weight: 5 kg

The PGP-7 dual-pulse generator is designed for tests in digital and computer technology, television technology, nuclear technology, and control technology under laboratory and production conditions. It may directly control relays or counters since it has a high output power.

Some technical data:

- Frequency range, internal
- Single pulses: 0.5 Hz to 50 MHz
- Pulse pairs: 0.5 Hz to 25 MHz
- Pulse amplitude (50 ohms load): 150 mV - 5 V
- Output impedance: 50 ±10%
- Pulse polarity: positive (normal or inverted pulse); negative (normal or inverted pulse)
- Output voltage (50 ohms): -3 V - 3 V
- Dimensions in mm: 446 by 340 by 98
- Weight: 7 kg

PTC-1 TTL tester from the People's Republic of Poland

The PTC-1 TTL tester is used to test digital TTL components, digital assemblies, and test setups. The auxiliary units required for the testing, such as the square-wave generator, single-pulse generator, pulse detector, pulse former, load resistors, and so forth, are all built-in. The testing may be carried out stepwise, under manual control, or under automatic control. A prototype as reference is required for the testing.

Some technical data:

- Number of outputs tested: up to and including 16
- Number of digital combinations: up to and including 2^{15}
- Digital test setups: 5 x DIL 16; 10 x DIL 14
- Frequency range of the square-wave generator: 1 Hz to 3 MHz

Output voltages: U_0 = 0 to 0.4 V
U_1 = +2.4 to +5.5 V
Supply voltage: +5 V ±0.25 V
Load: ≤ 3 A
Ripple: ≤ 0.25 V
Ambient temperature: +5 to +40°C
Dimensions in mm: 390 by 450 by 146
Weight: 9.6 kg

The ND-960 A fluctuation-measuring instrument is used for tests of the mechanism of tape recorders and phonographs. The instrument permits all tests specified for such devices to be performed in accordance with the provisions of the IEC as of 1969.

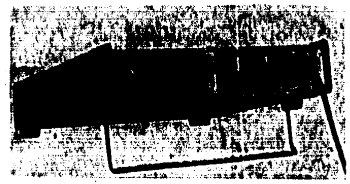
Technical data:

Input parameters
Frequency: 3,150 Hz ±10%
Voltage: 30 mV to 15 V
Input impedance: ≥ 300 kΩ
Audio fluctuation measurements
Measuring ranges: ±0.1; ±0.3; ±1; ±3; ±10%
Frequency response: in normal position linear (according to IEC);
0.2 to 300 Hz
with the internal bandpass filter regulated; optionally, an external filter may be installed
Sound-level fluctuations: ±0.5 to ±20%
Dimensions in mm: 132 by 434 by 300
Weight: 7 kg

Other Development Trends

The new generation of laboratory instruments controlled with microprocessor was represented at the Leipzig Fair by the No 7065 digital voltmeter made by Solartron.The improvement of the properties of the instrument by the systematic introduction of microcomputer technology is indicated in this instance less by the technical parameters (see the measuring ranges); it is demonstrated instead by the improvement in usefulness by multiple utilization of the microcomputer unit:

Ranges:
DC: 10 mV to 1000 V
AC (10 Hz to 50 kHz): 100 mV to 1000 mV
R: 10 ohms to 10 mohms
Tolerance:
DC: $1\cdot10^{-5}$ + 4 digits
AC: $6\cdot10^{-3}$ + 20 digits



Microprocessor-controlled digital voltmeter No 7065
from Great Britain (Photo by K. Schwarzer (14))

The size of the instrument is comparable to that of conventional digital voltmeters; it permits the following operations to be performed for completion and simplification of the measurements in nine programs:

- Multiplication with a constant
- Calculation of percentages
- Addition and subtraction with a constant
- Ratio formation; linear $E = x/a$; logarithmic $E = 20 \log x/a$; square (for power calculations) $E = x^2/a$
- Determination of maximum and minimum values, as well as their difference, which may be stored as desired
- Programming of limit values, the fact that they are exceeded either way may be stored in the memory
- Statistical calculations; every test value is stored, arithmetic mean, variance formation, standard deviation, square mean value
- Temperature measurement with thermocouples, conversion of the effective thermocouple voltage into displayed values is automatic
- Measurements in time interval; ongoing time, measurement with start/stop feature during a day; duration up to 96 hours.

Data-Processing Systems

East Berlin RADIO FERNSEHEN ELEKTRONIK in German Vol 27, No 6, Jun 78
pp 361-362

[Article by D. Henkel]

[Text] The exhibits in the field of computer technology and data processing all show highly increased versatility. It is a characteristic feature that in addition to the already customary ESER [Unified Computer System] line, the emphasis is on miniaturized data engineering and data processing, in which areas major qualitative and quantitative growth is evident. There is a clear-cut trend toward the use of microelements so as to provide the devices with performance characteristics which meet the modern needs.

Based on the favorable experiences gained with socialist economic integration within the ESER project, a start was made a few years ago under the leadership of the Soviet Union on a similar international project concerning the development and manufacture of a line of small computers. The first results of this project were presented by the Soviet Union by the CM-1 to CM-4 control computers.

Within ESER itself, a phase of complex development is just about completed. Series 1 of the ESER, of which the device technology was exhibited in recent years, will shortly be replaced by Series 2. This latter designation is used for new data-processing devices made available to users, featuring new and improved system characteristics, increased reliability, and, of course, compatibility with devices from Series 1.

German Democratic Republic

Robotron Combine State Enterprise exhibited the EC 1055 data-processing system, which is in Series 2 (see title picture). The central component of this system is the EC 2655 central processor unit recently developed by the Robotron combine. It may be regarded as a further development of the EC 2640, which has been produced for several years. It has a capability of performing approximately 400,000 operations per second. Even the exterior appearance suggests development from the EC 2640. The central processor unit has only 50 percent of the volume of the EC 2640 (three instead of six cabinets). The control console installed on the front of the EC 2640 is no longer found. Instead, there is a separate control module, designated EC 7069, which is used both by the system user and maintenance technician. The concept of this control module, including the use of a display unit with keyboard and a series printer, permits the use of not only an increased communication speed but also offers significantly superior operating convenience.

In a modern form, the EC 7069 control module may also be used in the EC 1040 instead of the interrogation unit provided therein.

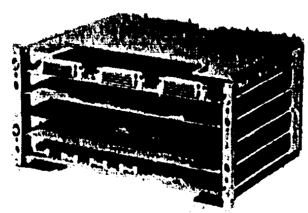
The reduction of the volume in the EC 2655 was achieved primarily by the following engineering measures:

- Realization of the operative memory as a solid-state memory on the basis of MOS components. A capacity of 1Mbyte, including the required power supply unit, is accommodated in a single cabinet. Maximum memory capacity is 2Mbyte.

- Use of a more effective method of power supply.

The EC 2655 realizes 183 commands from the command set of Series 2 of the ESER. The input and output system is characterized by the use of block multiplex channels instead of the selector channels, and by the possibility of data transfer via a 2-byte wide interface.

Worthy of special mention is the realization of the principle of the so-called virtual memory, which allows the establishment of a programmer using a virtual operative memory capacity of 16Mbyte. This possibility is provided with the also newly developed OC6-EC operating system made in series in the Soviet Union for the large models of Series 2.



K 1520 microcomputer system from the Robotron Combine State Enterprise (factory photograph)

Finally, the EC 2655 features an extensive diagnostic facility.

Robotron presents a new microcomputer system with the K 1520. This model may be used for installation in devices and also for the assembly of an independent microcomputer system.The primary unit of this computer is a microprocessor in n-channel MOS technology, which has the advantages of increased switching speed compared to the p-channel technology presently used. The system is offered in four versions, all equipped with a 4Kbyte memory. Connection of peripheral devices through connector/control units is possible: K7622 control module, DARO 1210 perforated-tape reader, DARO 1215 tape perforator, DARO 1250 cassette tape recorder, and BD 4000 alphanumeric display with printer.

The programmable minicomputer Robotron K 1001, exhibited already last year, was further developed and is now shown in the K 1002 and K 1103 versions. The new versions feature broader application field. The K 1002 is equipped with a magnetic-card unit for insertion of programs and data, as well as for output of the contents of the operating memory. The K 1033 is additionally equipped with an internal printer for the optional printout of intermediate and final results.

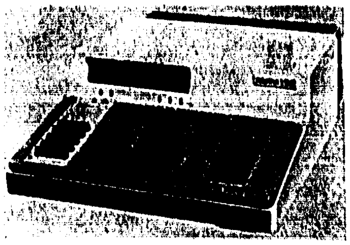
The factories forming part of the Robotron Combine State Enterprise since early 1978, the erstwhile Zentronik combine, also exhibited new and developed products.

The DARO 1750 magnetic-card computer was equipped with the MFM 2/4 floppy-disk unit manufactured in the People's Republic of Hungary. This expands the memory capacity available in direct access 60- to 120-fold.

The series of small bookkeeping machines 1330 to 1350 was expanded by the DARO 1355 electronic bookkeeping machine. It combines the features of the conventional models—minimum space requirement, simple operation, and fast program change—and offers the advantages of electronic components compared to electro-mechanical components.

The DARO 1255 magnetic-tape converter serves for the preparation of data stored with data-acquisitoon devices on 3.81 mm magnetic-tape cassettes to enable further processing in computers by conversion to 12.7 mm magnetic tape, with appropriate data format. The outstanding properties of this instrument were achieved in the framework of an international cooperation project among the socialist countries. Czechoslovakia developed the keyboard; the People's Republic of Poland developed the PK-1 magnetic-tape cassette unit; and the People's Republic of Bulgaria developed the ISOT-5003 magnetic tape unit.

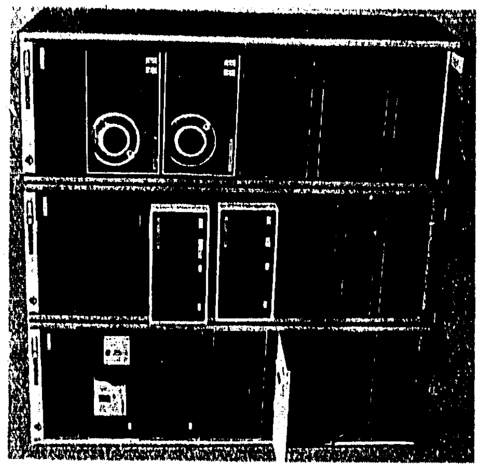
The ROSY 4000 speech dialog system was developed with the cooperation of Dresden Technical University; this device was exhibited in Leipzig as a demonstration model for timetable information used by the German Railways. This is a character-controlled speech synthesizer, converting a discrete sound-character information into comprehensible speech. With the aid of the synthetic speech it is possible to use the telephone as a computer terminal opening access through the telephone system. Characteristic for the use of a synthetic language is the transmission of small amounts of information for a large number of users. Thus, information systems of all kinds are regarded as the main applications of the speech-dialog system.



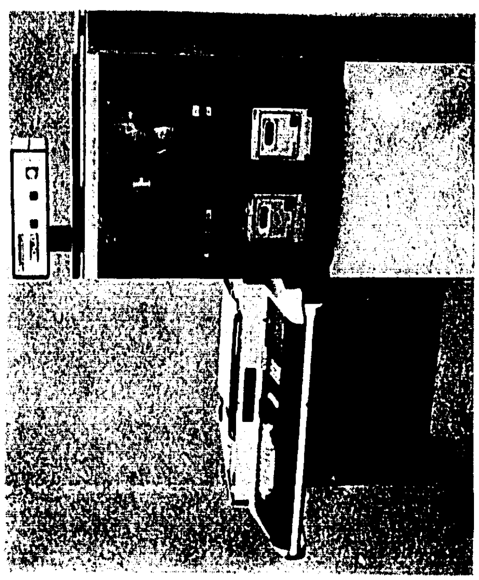
K 1002 programmable minicomputer from Robotron Combine State Enterprise (factory photograph)

K 1003 programmable minicomputer from Robotron Combine State Enterprise

CM-3 control computer from the Soviet Union

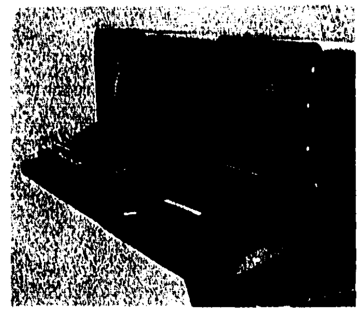


ISOT-0310 small computer



DARO 1255 magnetic-tape converter from Robotron Combine State Enterprise

Felix C-256 data-processing system (photograph taken by K. Schwarzer (5))



The "bars" terminal processor from the Soviet Union, with a Hungarian-made screen terminal

Soviet Union

As mentioned earlier, the Soviet Union exhibited the small computer system (SKR) for the first time. This is the CM-3 control-computer complex, part of the CM-1 to CM-4 computer series designed in the form of a module. Computers of this series are designed on the basis of the modular-design principle. The CM-3 realizes 65 commands and has an operational speed of up to 200,000 operations per second. It permits both byte- and word-oriented operation (one word has 16 bits). The working memory has a capacity of up to 32K words. The input/output interface is realized on the basis of the unibus principle.

The SM-3 control computer may be used as an autonomous system for the automation of design functions, as well as of technological processes, and also in hierarchy systems in conjunction with ESER computers as satellite processors for data concentration and preprocessing.

The "bars" terminal processor was also exhibited in the Soviet pavillion. It is a connecting unit between various terminal systems and electronic computers. Since it operates as a multiple-path switch, it may also be used as a multic-channel adapter in computer centers. Its particular advantage is the microprogram-controlled interface, so that the connection of another terminal than originally intended becomes relatively problem-free.

The People's Republic of Bulgaria and the Socialist Republic of Romania

The ISOT-0310 small computer demonstrates that the trend was followed in the People's Republic of Bulgaria also: small computer systems for scientific and technological control units in modular design. Accommodation of functional groups (including peripheral devices and their connection controls) in modules created a modular system which permits simple adaptation to a variety of user needs.

In addition to the processor and operative memory, eight peripheral-device controls are offered. They range from perforated-tape readers, magnetic-tape units and magnetic-disk memories to cassette terminals.

The technical parameters of the ISOT-0310 are of the same order of magnitude as those of the above-described CM-3 small computer made in the Soviet Union.

Exhibiting the Felix C-256 computer, the Socialist Republic of Romania demonstrated the technological level achieved already in Series 1 of ESER. The central processor unit is built in TTL technology, and realizes 102 commands. A ferrite-core operative memory is used; its capacity is 256 Kbyte, which may be doubled. The input/output system has multiplex and selector channels. The alternating-disk unit with a 29 Mbyte capacity (expandable to 58 Mbyte) was worthy of special note among the assortment of conventional peripheral devices for computer systems.

2542
CSO: 1870

ELECTRONICS AND ELECTRICAL ENGINEERING

UDC 621.391.26

THE DETECTION OF A QUASIHARMONIC SIGNAL HAVING AN UNKNOWN FREQUENCY IN NOISE OF AN UNKNOWN POWER AND SPECTRAL FORM

Kiev IZVESTIYA VUZ RADIOELEKTRONIKA in Russian Vol 21 No 7, 1978 pp 108-111

[Article by V.N. Prokof'yev, manuscript received 10 March 77, and following reworking, 25 May 77]

[Text] Multiple alternative detection of a sinusoidal signal against a background of noise is analyzed, where the frequency of the signal belongs to a rather broad range of possible values and is unknown. The practically justified digitization of this range into resolution intervals (sections) is assumed, for example, where the doppler shift of the frequency is measured by a set of filters; the white or nonwhite noise power is unknown; the signal has a random initial phase or amplitude and phase (reception in incoherent or Rayleigh channels).

The problem is solved as the detection of a signal with the readout of the frequency interval. The solution rules are found based on the statistical principal of invariance [1, 2], and are invariant to the initial phase of the signal and the scale of the observations. They keep the probability of false alarms constant, do not depend on interfering parameters of data distributions and are suitable for realization in automated devices.

"White" noise. There are M resolution segments (with $2\pi/T$; T is the duration of the signal) at frequencies of ω_i, $i = \overline{1, M}$. The signal in an incoherent channel is $S_i(t) = \sqrt{2E/T}\cos(\omega_i t + \theta_i)$, E is the energy of the signal in the interval T, θ_i is the uniformly distributed initial phase, ω_i is one of the equiprobable frequencies, $i \in (\overline{1, M})$. It needs to be determined whether the observed realization is gaussian noise or a mixture of noise and one(with an indication of which) of M equiprobable signals $S_i(t)$, $i = \overline{1, M}$, i.e., the following hypothesis needs to be checked:

$$H_0: x(t) = n(t), \quad 0 < t < T,$$
$$H_i: x(t) = S_i(t) + n(t), \quad i = \overline{1, M}, \tag{1}$$

where n(t) is the realization of the noise with the unknown power spectrum $N_0/2$.

We shall use as the initial sample of the oscillation x(t), $0 \leq t \leq T$, its quadrature components in the frequency intervals:

$$(x, y) = \left\{x_r, y_r : x_r(y_r) = \sqrt{\frac{2}{T}} \int_0^T x(t) \cos \omega_r t (\sin \omega_r t)\, dt,\ r = \overline{1, n};\ n \geq M\right\}$$

(the case where n > M corresponds to taking additional "noise" segments, for example, with the same value of the noise level N_0).

Taking the prerequisites into account, the distribution of the data (x, y) averaged over the phase Θ_i for the case of a signal in the i-th segment is:

$$p_i(x, y) = (\pi N_0)^{-n} \exp\left(-\frac{z^2 + E}{N_0}\right) I_0\left(\frac{2\sqrt{E}}{N_0} z_i\right),\ z^2 = \sum_{r=1}^{n} (x_r^2 + y_r^2),$$

$$z_i^2 = x_i^2 + y_i^2, \quad i = \overline{1, M};$$

$I_0(\cdot)$ is a modified Bessel function; the density $p_0(x, y)$ for the noise is derived at E = 0. Problem (1) reduces to checking the hypotheses:

$$H_0 : p_0(x, y);\ H_i : p_i(x, y),\ i = \overline{1, M}; \qquad N_0,\ E \text{ are unknown} \qquad (2)$$

where N_0 and E are unknown, the solution is to be sought among those rules which are invariant with respect to the scale of the observations. For the description of such rules, it is convenient to compute the density $\omega_i(x, y)$ of the data for events which are invariant to the scale in the space of values (x, y). Using the procedure of [2], one can find that here:

$$\omega_i(x, y) = \exp(-q)\, \Psi(n, 1;\, qs_i),\ s_i = z_i^2/z^2,\ q = E/N_0,$$

$\Psi(.,.;.)$ is a degenerate hypergeometric function.

The invariant solution of problem (2) should be based on the functions $\omega_i(x, y)$ or on the ratios of s_i for which they are monotonic. According to the solution theory of [3], in the symmetrical problem being treated here, the optimal rule which for a fixed probability α of a false alarm minimizes the error probability (missing and "confusing" signals), has the form:

$$\text{Assume } H_i, \text{ if } s_i = \max_{(j)} s_j > C$$
$$\text{Assume } H_0, \text{ if all } s_j \leq C,\ j = \overline{1, M} \qquad (3)$$

where C is the threshold number. Rule (3) is the desired invariant solution of the problem. It differs from the well-known rules for the case of a specified noise level in that it is based on the ratios of s_j, $j = \overline{1, M}$, and for this reason, does not depend on the interfering parameter N_0; the threshold C likewise does not depend on N_0 (the densities of the statistics s_j for the case of H_0 do not depend on N_0).

We shall employ an asymptotic ($n \to \infty$) approximation of the distributions of s_j to estimate the effectiveness of algorithm (3). At the limit of $n \to \infty$, the quantities $S_j = 2ns_j$ are independent and each have a χ_2^2 distribution (with two degrees of freedom), which is central for the case of H_0 and noncentral for the case of a signal with a noncentrality parameter of $\delta^2 = 2q$. In this case, we obtain the threshold C of the rule, the probability β of missing the signal, and the probability ε of "confusing" the signal (false indication of a "signal" section):

$$C \sim 2\ln[1-(1-\alpha)^{1/M}]^{-1};\ \beta \sim (1-\alpha)^{1-1/M}[1-Q(\delta, \sqrt{C})];$$

$$\varepsilon \sim 1-\beta-\sum_{l=0}^{M-1}\frac{(-1)^l\binom{M-1}{l}}{l+1}\exp\left(-\frac{ql}{l+1}\right)Q\left(\sqrt{2ql/(l+1)}, \sqrt{C(l+1)}\right),$$

where

$$Q(a,b)=\int_b^\infty x\exp\left(-\frac{x^2+a^2}{2}\right)I_0(ax)\,dx;$$

$\binom{a}{b}$ is the number of combinations of a using b.

In the special case n = M = 2, precise formulas are found:

$$C=\frac{2-\alpha}{\alpha};\ \beta=\left[1-\frac{\alpha}{2}(1+\exp(-q(1-\alpha)))\right]\exp\left(-\frac{\alpha q}{2}\right);$$

$$\varepsilon=\frac{\alpha}{2}\exp\left[-q\left(1-\frac{\alpha}{2}\right)\right].$$

For a Rayleigh channel, the optimal invariant rule likewise has the form of (3) with the same threshold C; the probabilities β and ε are asymptotically equal to:

$$\beta \sim (1-\alpha)^{1-1/M}\{1-[1-(1-\alpha)^{1/M}]^{1/(1+\bar{q})}\};$$

$$\varepsilon \sim \sum_{l=1}^{M-1}(-1)^{l+1}\binom{M-1}{l}\frac{[1-(1-\alpha)^{1/M}]^{l+1/(1+\bar{q})}}{1+l(1+\bar{q})}-\beta,$$

where $\bar{q} = \bar{E}/N_0$, $\bar{E}$ is the average energy of the signal. For the special case n = M = 2, the precise formulas for β and ε here are equal to:

$$\beta=\frac{(1-\alpha)(1+\bar{q})}{(1+\alpha\bar{q}/2)[1+(1-\alpha/2)\bar{q}]};\ \varepsilon=\frac{\alpha(1+\alpha\bar{q}/2)}{(2+\alpha\bar{q})[1+(1-\alpha/2)\bar{q}]}.$$

"Nonwhite" noise. To obtain an invariant solution, it is assumed here that the change in the noise power in the range being analyzed is rather smooth: in it, one can segregate m pairs of adjacent sections so that the noise power in each pair is the same, and equal to $N_{0j}/2$, $j = \overline{1,m}$ (acceptable in practice for a step approximation of the form of the noise spectrum). The indeterminacy of the form of the noise spectrum is thereby expressed in the appearance of m unknown parameters of N_{0j}, $j = \overline{1,m}$. The signal can appear with equal probability in one of the pairs (occupying any one of its sections).

As before, we will employ the set $(x,y) = \{(x_{1j},y_{1j}), (x_{2j},y_{2j}), j = \overline{1,m}\}$ (the subscripts 1 and 2 indicate the first and second intervals of the j-th pair) of the quadrature components of the process being observed, which we shall assume here to be a generalized linear process; the class of such processes is broad (and contains not just gaussian processes) [4]. Although the quantities x_{1j}, y_{1j}, x_{2j} and y_{2j}, $j = \overline{1,m}$, are not independent, they still asymptotically ($T \to \infty$) independent and normal to the dispersions $N_{0j}/2$, $j = \overline{1,m}$. This follows from Vol. 13, Chapter IV in [4], and the Remarks following it.

We shall determine the invariant solution rule for the asymptotic model cited above for the observations. In this case, rule optimality is of an asymptotic nature, while the properties of its invariance which are important in practice occur without asymptotic hypotheses. Considering the hypotheses adopted, and the invariance of the problem, one can find that the solution should be based on statistics of the form $v = \{v_j, j = \overline{1,m}\}$, where $v_j = \max(s_j, 1/s_j)$, $s_j = z^2_{1j}/z^2_{2j}$, $z^2_{1(2)j} = x^2_{1(2)j} + y^2_{1(2)j}$, where the quantities v_j, $j = \overline{1,m}$, are independent (asymptotically). Having written the combined distribution of the given v for the case of a signal in the i-th pair of sections, one can convince oneself that the optimum (asymptotically) invariant solution has the form (identical for incoherent and Rayleigh channels):

$$\text{Assume } H_i, \text{ if } v_i = \max_{(j)} v_j > C,$$

$$\text{Assume } H_0, \text{ if all } v_j \leq C,\ j = \overline{1,m},$$

Where the threshold is $C \sim [1 + (1-\alpha)^{1/m}]/[1 - (1-\alpha)^{1/m}]$.

The probability of missing the signal is $\beta = \frac{1}{m}\sum_{i=1}^{m} \beta_i$, where the probabilities β_i of a miss with a signal in the i-th pair are as follows for incoherent and Rayleigh channels respectively:

$$\beta_i \sim \begin{cases} (1-\alpha)^{1-1/m} \exp\left(-\frac{q_i}{2}\right)\left\{\operatorname{sh}\left[\frac{1}{2} q_i (1-\alpha)^{1/m}\right] + (1-\alpha)^{1/m} \operatorname{ch}\left[\frac{1}{2} q_i (1-\alpha)^{1/m}\right]\right\}, \\ 4(1-\alpha)\Delta_i/[(1+\Delta_i)^2 - (1-\Delta_i)^2(1-\alpha)^{2/m}],\ \Delta_i = 1 + q_i \ \text{либо (or)}\ (1+q_i)^{-1}. \end{cases}$$

One can likewise estimate the "confusion" error ε.

We will note in conclusion that the invariant solution of the problem treated here can also be derived in the case of multichannel (diversity) reception with different and unknown noise levels in the channels.

BIBLIOGRAPHY

1. Leman E., "Proverka statisticheskikh gipotez" ["Checking Statistical Hypotheses"], Moscow, Nauka publishers, 1964.

2. Gayek Ya., Shidak Z., "Teoriya rangovykh kriteriyev" ["Rank Criteria Theory"], Moscow, Nauka Publishers, 1971.

3. Middleton D., "Vvedeniye v statisticheskuyu teoriyu svyazi" ["Introduction to Statistical Communications Theory"], Moscow, Sovetskoye Radio Publishers, 1962, 2.

4. Hannan E., "Mnogomernyye vremennyye ryady" ["Multidimensional Time Series"], Moscow, Mir Publishers, 1974.

8225
CSO:8144/0483

ELECTRONICS AND ELECTRICAL ENGINEERING

UDC 621.372.2

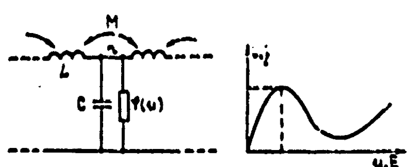
WAVE SPECTRUM CONVERSION USING SPATIAL HARMONICS

Gor'kiy IZVESTIYA VUZ RADIOFIZIKA in Russian Vol 21 No 8, 1978 pp 1156-1160

[Article by Yu.K. Bogatyrev and N.P. Yampurin, Gor'kiy Polytechnical Institute, manuscript received 4 Jul 77]

[Text] The conversion of the spectrum of spatial harmonics of opposing waves is analyzed in an active periodic structure with square-law nonlinearity. The specific features of three-wave interaction are ascertained for various boundary conditions. The possibility of simultaneously amplifying all of the interacting waves is demonstrated.

Besides the coupling due to nonlinearity, coupling can also arise between waves which propagate in periodic structures because of the interaction at spatial harmonics [1, 2, 6-9], where this coupling has a substantial influence on the processes of generating and converting a wave spectrum. Theoretical and experimental studies of interactions of this type were previously conducted primarily as applied to conservative systems in nonlinear optics, as well as to parametric radio frequency structures [2, 7-9]. Moreover, to convert a signal frequency in the microwave band, it is expedient in a number of cases to employ periodic structures with active, nonlinear elements (for example, for the purpose of boosting the power of the converted signals).



(a) (b)

Figure 1. a) The equivalent circuit of a section of the structure; b) The characteristic of the active nonlinear elements.

A wave device in the form of an LC line with mutually coupled sections, periodically loaded with active elements having an N-shaped volt-ampere characteristic (Figure 1), which is typical of tunnel, Gunn diodes, etc., is studied in this paper. The primary specific feature of the operation of such a device consists in the use of nonlinear, synchronous interaction at the spatial harmonics of the opposing waves (due to undesirable reflections from inhomogeneities in conventional waveguide systems) for the purpose of the efficient generation and conversion of a spectrum of signals. The specific features of three wave interaction are ascertained for various boundary conditions.

The dispersion characteristic (Figure 2) of the structure treated here (Figure 1a) corresponds to the equation:

$$D(\omega, k) = \omega - 2\omega_0\left(1 + \frac{2M}{L}\cos k\right)^{-1/2}\sin\frac{k}{2} = 0, \tag{1}$$

where $\omega_0 = (LC)^{-1/2}$, and M is the mutual inductance between the adjacent sections. According to (1), the conditions for spatial synchronization in such a structure for three waves are:

$$\omega_1 = \omega_2 + \omega_3, \quad k_1 + k_2 + k_3 = 2\pi \tag{2}$$

and can be met by means of varying the parameter M/L for values of $k_1 < 1.5$ and $|k_2| \geq 2$.

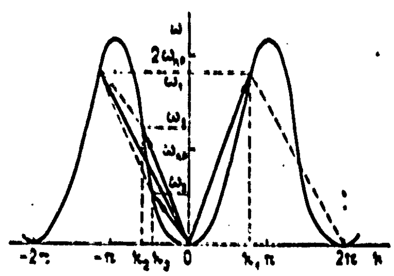


Figure 2. The dispersion characteristic of the structure where M/L = 0.4 ($\omega_{1,2,3}$, $k_{1,2,3}$ are the frequencies and the wave numbers of the interacting waves).

To realize the possibility of obtaining the second harmonic 2ω (where $\omega_2 = \omega_3$) of the signal frequency being converted and to provide for stable operation of the system as a whole, it is expedient here, in contrast to a self-oscillating mode, to select the operating point close to the maximum of the N-characteristic (Figure 1b), where the following approximation is justified for small signals: $\phi(u) \approx -gu - \beta u^2$ ($g \lessgtr 0$, $\beta > 0$, $|g| \ll \beta u_{max}$). In this case, the square-law effects of the active conductivity will dominate the linear and cubic ones, while the equations for the slowly changing amplitudes $A_i(n)$ and phases $\phi_i(n)$ of the steady-state, timewise interacting waves ($\partial/\partial t = 0$) with a voltage of $u_1 \sim A_1 \times \exp[j(\omega_1 t - k_1 n + \phi_1)]$, $u_{2,3} \sim A_{2,3} \times \exp[j(\omega_{2,3}t + k_{2,3}n + \phi_{2,3})]$, which satisfy the conditions (2), have the following form according to [1]:

$$\begin{aligned} \frac{dA_1}{dn} &= \beta_1 A_2 A_3 \cos\Phi, \\ \frac{dA_2}{dn} &= -2\beta_2 A_1 A_3 \cos\Phi, \\ \frac{dA_3}{dn} &= -2\beta_3 A_1 A_2 \cos\Phi, \\ \frac{d\Phi}{dn} &= -\left(\beta_1\frac{A_2A_3}{A_1} - 2\beta_2\frac{A_1A_3}{A_2} - 2\beta_3\frac{A_1A_2}{A_3}\right)\sin\Phi - \Delta, \end{aligned} \tag{3}$$

where $\Phi = \phi_1 - \phi_2 - \phi_3 - \Delta n$, the mistuning $\Delta = |k_2| + |k_3| - |k_1|$, $\beta_i = \rho\beta/2N_i$ is the coupling coefficient,

$$N_i = \left[1 + \frac{4M}{L}\sin^2\frac{k_i}{2}\left(1 + \frac{2M}{L}\cos k_i\right)^{-1}\right]\left(1 + \frac{2M}{L}\cos k_i\right)^{-1/2}\cos\frac{k_i}{2}.$$

In terms of external form, system (3) is similar to equations which describe the parametric generation of waves in reactive media [8, 10], as well as stimulated Mandelstam-Brillouin scattering in the case of opposing propagation directions of the Stokes component and the hypersonic wave [9]. Consequently, the solution of (3) formally matches the solutions first derived in [10]. However, such a solution in the case considered here has a complete ly different physical meaning as compared to [10], as will be shown below. An exact solution of system (3) for the squares of amplitudes of the voltage waves has the form [10]:

$$A_1^2(n) = U_0^2[a + (b - a)\,\mathrm{sn}^2 X(n)],$$

$$A_2^2(n) = 2U_0^2\beta_2[\eta^2 - b + (b - a)\,\mathrm{cn}^2 X(n)]/\beta_1,$$
$$A_3^2(n) = 2U_0^2\beta_3[1 - b + (b - a)\,\mathrm{cn}^2 X(n)]/\beta_1, \tag{4}$$

where a, b, and c ($a < b < c$) are the roots of the equation,

$$Z^3 - \left(\eta^2 + 1 + \frac{\Delta^2}{16\beta_2\beta_3 U_0^2}\right)Z^2 + \left(\eta^2 + \frac{\Delta D_0\beta_1}{4\beta_2\beta_3 U_0^4}\right)Z - \frac{\beta_1^2 D_0^2}{4\beta_2\beta_3 U_0^6} = 0,$$
$$Z = A_1^2(n)/U_0^2,\quad \eta^2 = V_0^2/U_0^2,$$
$$V_0^2 = 2\beta_2 A_1^2(n) + \beta_1 A_2^2(n),\quad U_0^2 = 2\beta_3 A_1^2(n) + \beta_1 A_3^2(n),$$
$$D_0 = A_1(n)A_2(n)A_3(n)\sin\Phi + \Delta A_1(n)/2\beta_1$$

are the integrals of equation (3), $X(n) = 2U_0[\beta_2\beta_3(c - a)]^{1/2}n + F(\theta, k)\cdot\mathrm{sgn}[\cos\Phi(0)]$ is the argument of the elliptical functions, $\Phi(0)$ is the phase shift at the point $n = 0$, $F(\theta, k) = \int_0^\theta[1 - k^2\sin^2\phi]^{-1/2}d\phi$ is an elliptical integral of the first kind with the modulus $k^2 = (b - a)/(c - a)$ and the argument $\theta = \arcsin\left[\left(\frac{A_1^2(0)}{U_0^2} - a\right)\Big/(b - a)\right]^{1/2}$.

In the simplest case of physical interest, where there is no mistuning, $\Delta = 0$, the following situations are possible depending on the type of boundary conditions.

a) Zero boundary conditions for the high frequency waves, $a_1(0) = a_2(n_0) = 0$, and nonzero boundary conditions for the low frequency wave, $a_3(n_0) \neq 0$ (n_0 is the length of the structure), according (4), the steady-state amplitudes of the interacting waves are:

$$A_1(n) = \eta(\beta_1/2\beta_3)^{1/2}A_3(0)\mathrm{sn}[X(n)],$$
$$A_2(n) = \eta(\beta_2/\beta_3)^{1/2}A_3(0)\,\mathrm{cn}[X(n)],$$
$$A_3(n) = A_3(0)\mathrm{dn}[X(n)], \qquad (5)$$

where $X(n) = (2\beta_1\beta_2)^{1/2}A_3(0)n, \quad \eta = A_1(n_0)/A_3(n_0)(\beta_1/2\beta_3)^{1/2}$.
The functions $\mathrm{sn}[X(n)]$ and $\mathrm{cn}[X(n)]$ have a period of 4K, and $\mathrm{dn}[X(n)]$ has a period of 2K; $K = F(\pi/2, \eta)$ is a complete elliptical integral of the first kind.

If the relationship of [8] is satisfied

$$X(n_0) = (2m + 1)F(\pi/2, \eta) \quad (m = 0, 1, 2, \ldots), \qquad (6)$$

which determines the threshold of the amplitude of the low frequency wave at the boundary of the structure, $n = n_0$, then generation of high frequency waves takes place at frequencies of ω_1 and ω_2. When $m = 0$, a quarter of the variation period of the functions $\mathrm{sn}[X(n)]$ and $\mathrm{cn}[X(n)]$ is packed in the length of the structure (Figure 3a). The amplitudes of the low frequency and high frequency waves increase, reaching a maximum at the boundaries of the structure, while the rate of their rise slows down, tending to zero. If $m \geq 1$, there occurrs a periodic variation in the amplitudes of the waves. According to (6), the threshold value of the amplitude $A_3(n_0)$ increases with an increase in the parameter m:

$$A_{3\ \mathrm{thresh}} = A_{3\,\mathrm{nop}} = (2m + 1)\mathrm{dn}[X(n_0)]/2n_0(2\beta_1\beta_2)^{1/2}.$$

b) Zero boundary conditions for the forward high frequency wave, $A_1(0) = 0$, and nonzero conditions for the return waves, $A_{2,3}(0) \neq 0$. Relationship (6) is not observed in this case. For values of the amplitude of the low frequency wave lower than the threshold ($m = 0$), conversion of the waves at frequencies of ω_2 and ω_3 to a wave with a total frequency of ω_1 is accomplished with the amplification of all waves.

c) Nonzero boundary conditions for all waves: $A_1(0)$, $A_{2,3}(n_0) \neq 0$.

For the condition $A_1(n_0) = A_2(0) = 0$, expression (6) is observed. The solution in this case has the form of (5), where:

$$\eta = \frac{A_2(n_0)}{A_3(n_0)}, \quad X(n) = 2A_3(0)(\beta_2\beta_3)^{1/2}n + F\left(\frac{\pi}{2}, \eta\right)\mathrm{sgn}[\cos\Phi(0)].$$

Depending on the sign of $\cos[\Phi(0)]$, the picture of the wave amplitude distribution is shifted either to the left ($\cos[\Phi(0)] > 0$), or to the right ($\cos[\Phi(0)] < 0$) by a quarter of the period of the function $F(\pi/2,\eta)$. The distribution of the amplitudes of the oscillations for any of the modes (m = 0) has the form shown in Figure 3b. In contrast to Figure 3a, the amplitudes of all waves fall off along n.

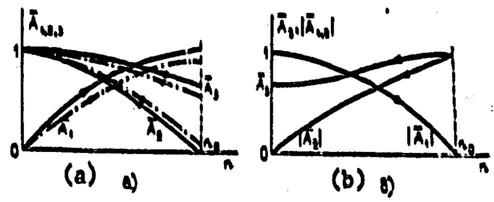


Figure 3. The spatial distributions of the normalized wave amplitudes
$$\bar{A}_1(n) = A_1(n)/\eta A_3(0)(\beta_1/2\beta_2)^{1/2},\quad \bar{A}_2(n) = A_2(n)/\eta A_3(0)(\beta_2/\beta_1)^{1/2},$$
$$\bar{A}_3(n) = A_3(n)/A_3(0)$$
for the boundary conditions:

a) solid lines: $\bar{A}_1(0)=\bar{A}_2(n_0)=0,\quad X(n_0)=F\left(\frac{\pi}{2},\ \eta\right);$

dashed - broken lines: $\bar{A}_1(0)=0,\quad \bar{A}_2(n_0)\neq 0,\quad X(n_0)<F\left(\frac{\pi}{2},\ \eta\right);$

b) $\bar{A}_1(n_0)=\bar{A}_2(0)=0,\quad X(n_0)=F\left(\frac{\pi}{2},\ \eta\right).$

The results obtained can be physically explained in the following manner. In cases (a) and (b), the energy is picked off from the nonlinear elements, and the wave amplitudes rise along the structure. In case (c), the situation is reversed: The energy of the wave is absorbed by the nonlinear elements and their amplitudes fall off during the propagation. If $m \geq 1$, something which corresponds to relatively large amplitudes of $A_3(n_0)$, modes (a) and (c) alternate.

Values of the parameters of $\beta_2 = \beta_3$ and $\eta = 1$ ($V_0^2 = U_0^2$) in the solution of (4) correspond to the degenerate case of wave interaction when $\omega_2 = \omega_3$, $k_2 = k_3$, and opposing waves of the fundamental (ω_2) and doubled ($\omega_1 = 2\omega_2$) frequencies propagate in the structure. The physical interpretation of the behavior of the functions $a_{1,2}(n)$ in this case is similar to that described above.

Thus, the results of the studies which were carried out show that in a periodic structure with an active square law conductivity, the effective interaction of opposing waves is possible using spatial harmonics, which accompanied by frequency conversion or generation. In contrast to periodic systems with reactive parameters [2, 3, 7, 8], such structures make it possible to amplify the waves in addition to converting and generating them. However, in contrast to the case of explosive instability [4], the effects of the simultaneous rise or decay of the waves are determined here primarily not by the ratio of the phases, by rather by the amplitudes of the interacting waves.

BIBLIOGRAPHY

1. M.I. Rabinovich, D.D. Rozenblyum, "Mezhvuzovskiy sb. Dinamika sistem" ["The Collected Works of the Higher Educational Institutes, 'System Dynamics'"], No 4, Gor'kiy, 1974.

2. A.S. Gorshkov, V.F. Marchenko, IZV. VUZOV - RADIOFIZIKA [PROCEEDINGS OF THE HIGHER EDUCATIONAL INSTITUTES - RADIOPHYSICS], 10, No 6, 825 (1967).

3. S.A. Akhmanov, R.V. Khokhlov, "Problemy nelineynoy optiki" ["Problems in Nonlinear Optics"], Nauka Publishers, Moscow, 1967.

4. M.I. Rabinovich, A.L. Fabrikant, IZV. VUZOV - RADIOFIZIKA, 19, No 5 - 6, 753 (1976).

5. Yu.K. Bogatyrev, V.P.Paskhin, M.I. Rabinovich, IZV. VUZOV - RADIOFIZIKA, 18, No 5, 695 (1975).

6. Yu.K. Bogatyrev, K.A. Gorshkov, L.A. Ostrovskiy, RADIOTEKHNIKA I ELEKTRONIKA [RADIO ENGINEERING AND ELECTRONICS], 21, No 3, 458 (1976).

7. A.S. Gorshkov, P.S. Korotkov, I.T. Trofimenko, RADIOTEKHNIKA I ELEKTRONIKA, 21, No 6, 1344 (1976).

8. K.I. Volyak, A.S. Gorshkov, RADIOTEKHNIKA I ELEKTRONIKA, 18, No 10, 2075, (1973).

9. I.L. Fabelinskiy, "Molekulyarnoye rasseyaniye sveta" ["The Molecular Scattering of Light"], Nauka Publishers, Moscow, 1965.

10. J.A. Armstrong, N. Bloembergen, J. Ducuing, and P.S. Pershan, PHYS. REV. 127, 1918 (1962).

8225
CSO:8144/0482

ELECTRONICS AND ELECTRICAL ENGINEERING

UDC 621.371.3

STUDIES OF THE SURFACE OF WATER AREAS USING MICROWAVE RADIOMETRY (REVIEW)

Moscow RADIOTEKNIKA I ELEKTRONIKA in Russian No 10, 1978 pp 2107-2119

[Article by A.M. Shutko]

[Text] Theoretical research and experimental field studies were made of the interrelationship between the characteristics of a microwave field and the state and physical and chemical parameters of a water surface, the temperature and the degree of mineralization. Substantial spectral differences in the degree of influence of various hydrophysical parameters on the characteristics of the radiation were ascertained. Spectral methods for determining the temperature and state of the surface of the Pacific Ocean were proposed taking into account the specific features of the radiation field. The problem of determining the optimum portions of the spectrum for probing the characteristics of a water surface was formulated and solved by approximation.

Estimates of the precision in determining a number of hydrophysical parameters were derived.

Introduction

Microwave radiometry methods are effective tools for the remote probing of the surface of water basins. The data of contrast and spectral measurements of the average values, the intensity of the variations and also the degree of polarization of the radiation, which can be obtained by radiometers mounted on board aircraft, contain information on the spatial-timewise variations in the intensity of wave agitation, the thermodynamic temperature and the salinity of the surface layer, with a thickness of up to several centimeters, as well as concerning the presence of films of petroleum products and floating ice.

By virtue of the fact that the influence of various hydrophysical parameters on the characteristic of a microwave radiation field is manifest unequally in different portions of the spectrum, it is necessary to choose the optimal spectral ranges for the reliable identification of the nature of a perturbing factor (espicially in the presence of several perturbation sources simultaneously).

For the solution of this problem, it is necessary to know the sensitivity of the radiation field in different portions of the microwave spectrum to variations in the hydrophysical parameters cited above.

The intensity of the radiation of a water surface is characterized by the brightness temperature*:

$$T_b = \kappa T_{eff} \qquad (1)$$

where κ is the radiative capacity of the surface; T_{eff} is the thermodynamic temperature within the boundaries of the skin layer, the thickness of which, l_{em}, amounts to from 1/3 to 1/10 of the electromagnetic wavelength, and thereby varies within a range of from a few millimeters to several centimeters in a wavelength range of from 1 to 30 centimeters.

The quantity κ is homogeneous over the depth of the water medium, and is determined by the value of the dielectric permittivity of the water and the specific features of the geometric structure of the surface (wave formations), in particular, by the relationships between the characteristic dimensions of the nonuniformities and the electromagnetic wavelength. The values of κ at at given wavelength depend on the temperature and the degree of mineralization (salinity) of the water.

The emissivity depends substantially on the type of polarization of the radiation and the observation angle.

For the case of vertical and horizontal polarizations respectively:

$$\varkappa_{в\lambda}=1-R_{в\lambda}=\frac{4|\varepsilon_\lambda|\sqrt{|\varepsilon_{\lambda э}|}\cos\theta\cos\left(\delta-\frac{\delta_1}{2}\right)}{|\varepsilon_\lambda|^2\cos^2\theta+|\varepsilon_\lambda|+2|\varepsilon_\lambda|\sqrt{|\varepsilon_{\lambda э}|}\cos\theta\cos\left(\delta-\frac{\delta_0}{2}\right)}, \qquad (2)$$

---

* The brightness temperature of the "ocean--atmosphere--space" system is a function of the meteorological parameters of the atmosphere (at wavelengths shorter than 3 cm) and the cosmic radio radiation (at wavelengths longer than 30 cm) in this case.

(3)
$$\varkappa_{r\lambda}=1-R_{r\lambda}=\frac{4\sqrt{|\varepsilon_{\lambda\theta}|}\cos\theta\cos\frac{\delta_{\theta}}{2}}{\cos^2\theta+|\varepsilon_{\lambda}|+2\sqrt{|\varepsilon_{\lambda\theta}|}\cos\theta\cos\frac{\delta_{\theta}}{2}}.$$

The following symbols are adopted in (2) and (3): $\varepsilon_\lambda = \varepsilon'_\lambda - i\varepsilon''_\lambda$; $\varepsilon''_\lambda/\varepsilon'_\lambda = \tan\delta_\lambda$; δ_λ is the loss angle; $\varepsilon_{\lambda_э} = \varepsilon'_\lambda - \sin^2\Theta$; $\varepsilon_{\lambda_э} = \varepsilon''_\lambda$;

$$\operatorname{tg}\delta_{\lambda\theta}=\frac{\varepsilon_\lambda''}{\varepsilon_\lambda'-\sin^2\theta};\quad |\varepsilon_\lambda|=\varepsilon_\lambda'\sqrt{1+\operatorname{tg}^2\delta_\lambda};$$

$$|\varepsilon_{\lambda\theta}|=\varepsilon_\lambda'\sqrt{1+\operatorname{tg}^2\delta_{\lambda\theta}}.$$

For the case of vertical observation, $\Theta = 0°$:

(4)
$$\varkappa_{s\lambda}=\varkappa_{r\lambda}=\varkappa_{n\lambda}=\frac{4\sqrt{|\varepsilon_\lambda|}\cos\frac{\delta}{2}}{|\varepsilon_\lambda|+2\sqrt{|\varepsilon_\lambda|}\cos\frac{\delta}{2}+1}.$$

The coefficient of radiation polarization, which is defined as the ratio of the difference in the components $T_{ЯВ}$ [$T_{b.\ vert}$] and $T_{ЯГ}$ [$T_{b.\ hor}$] to their sum, decreases monotonically with an increase in the observation angle.

Layers of foam formations on a water surface substantially change the radiative capability of the "layer--water" system. This effect is due to the considerable difference between the effective dielectric properties of foam and the water medium, as well as to the scattering of the electromagnetic radiation in the thickness of the foam layer.

The influence of the factors indicated above is manifest in the form of a variation in the average radio brightness value, as well as in spatial-timewise variation in the intensity of radioradiation in the case where the spatial resolution element and the observation time constant are less than the spatial-timewise correlation intervals, which characterize the properties of the perturbation source, or are commensurate with them.

I. The Characteristics of Radio Radiation Under Conditions of Wave Agitation

The large-scale components of wave formations are described by a steady-state random function ζ (x, y, t), which are characterized by the distribution density of the slopes $p_0(\zeta'_x, \zeta'_y, \nu)$ having different effective values $\sigma_{\zeta'_x}$ and $\sigma_{\zeta'_y} = \nu\sigma_{\zeta'_x}$ in the direction of the wind and in a direction normal to it respectively (ν is a wave agitation three-dimensionality indicator). A normal distribution is used, as well as modified forms which are well known in the literature, including assymetrical distributions. We shall characterize the space-time properties of the model by a two-dimensional normal density of the instantaneous distribution of the slopes with correlation functions in the corresponding directions. The correlation properties are described by a decaying oscillatory function with different values of the indicator for the wave agitation irregularity α_0 (the ratio of a quasiperiod to a correlation interval, defined as a drop in the level of the correlation factor by e times), as well as by a bell function [4].

The radiative properties of the surface, the average values of $\bar{\kappa}$, the intensity of the variations in the radio radiation σ_κ, and the polarization factor $k_p = (\kappa_v - \kappa_h)/(\kappa_v + \kappa_h)$ [$\kappa_v = \kappa_B = \kappa_{vertical}$, $\kappa_h = \kappa_\Gamma = \kappa_{horizontal}$] are determined in a Kirchhoff approximation (from geometric optics):

(5) (5) $$\bar{\varkappa}_{B,\Gamma}(\theta,\psi) = a \int_{\Omega_\theta}\int_{\Omega_\varphi} \varkappa^{*}_{B,\Gamma}(\theta,\psi,\vartheta,\varphi)\,\tilde{p}(\vartheta,\varphi,\nu/\theta,\psi)\,\eta(\vartheta,\varphi/\theta,\psi,p_0)\,d\vartheta\, d\varphi$$

(6) (6) $$\sigma^2_{\varkappa_{B,\Gamma}}(\theta,\psi) = b \int_{\Omega_\theta}\int_{\Omega_\varphi} [\varkappa^{*}_{B,\Gamma}(\theta,\psi,\vartheta,\varphi) - \bar{\varkappa}_{B,\Gamma}(\theta,\psi)]^2 \tilde{p}(\vartheta,\varphi,\nu/\theta,\psi) \times \eta(\vartheta,\varphi/\theta,\psi,p_0)\,d\vartheta\, d\varphi.$$

Here a and b are normalizing factors; $\kappa^{*}_{v,h}$ are the current values of the radiative capacity for vertical and horizontal polarizations: $\kappa^{*}_{v,h} = \kappa_{h,v} \pm (\kappa_v - \kappa_h)\cos^2\alpha$; α is the depolarization angle; $\kappa_{v,h}$ are the local values of the radiation coefficient, defined by relationships (2) and (3), the angular function for which at centimeter and decimeter wavelengths is approximated (with an accuracy of no worse than 90-97%) by polynomials of the form: $\kappa_v(\Theta_1) = \kappa_0 + A_v\Theta_1^2 + B_v\Theta_1^4$, $0 \leq \Theta_1 < 70°$; $\kappa_h(\Theta_1) = \kappa_0 - A_h\Theta^2$, $0 \leq \Theta < 90°$; $\Theta_1 = \arccos q$; $q = \cos\Theta\cos\theta - \sin\Theta\sin\theta\cos(\psi - \phi)$; $\zeta'_x = \partial\zeta/\partial x = \tan\theta\cos\phi$; $\zeta'_y = \partial\zeta/\partial y = \tan\theta\sin\phi$; $J_\pi = \sin\theta/\cos^2\theta$ is the Jacobian of the transform of the density values $p_0(\zeta'_x, \zeta'_y, \nu)$ into $\tilde{p}_0(\theta, \phi, \nu)$; Θ, ψ and θ, ϕ are the angular coordinates of the direction of observation and the normal to the surface; $\tilde{p}$ is the conventional density of the distribution of the slope angles with respect to the observation direction, related to the true density $\tilde{p}_0$ by the relationship:

(7) $$\tilde{p}(\vartheta,\varphi,\nu/\theta,\psi) = c\tilde{p}_0(\vartheta,\varphi,\nu)P(\theta,\psi,\vartheta,\varphi);$$
$$P(\theta,\psi,\vartheta,\varphi) = \frac{\cos\{\theta + \operatorname{arctg}[\operatorname{tg}\vartheta\cos(\psi-\varphi)]\}}{\cos\vartheta}$$

c is a normalizing factor; η is a function which takes into account the shading of the surface elements; accounting for only the effects of self-shading is accomplished by the appropriate selection of the integration limits in the regions Ω_θ and Ω_ϕ.

Approximate analytical expressions for the values of $\Delta\kappa$, σ_x and the correlation function ρ_x of the emissivity as a function of the observation angle Θ and the parameter σ_Θ have the following form (a two-dimensional model where $\psi = 0°$; $0 \leq \Theta < 40°$):

(8) $$\Delta\varkappa_{\text{B},\text{r}} \simeq A_{\text{B},\text{r}}\theta_0^2;\quad \sigma^2_{\varkappa_{\text{B},\text{r}}} = 2A^2_{\text{B},\text{r}}\sigma_0^2(2\theta^2+\sigma_0^2);$$

(9) $$\rho_{\varkappa_{\text{B},\text{r}}}(u) = \frac{1}{2\theta^2+\sigma_0^2}\left[2\theta^2\rho_0(u)+\sigma_0^2\rho_0^2(u)\right].$$

For a fixed value of Θ:

(10) $$\sigma_{\varkappa_{\text{B},\text{r}}}(\lambda_1)/\sigma_{\varkappa_{\text{B},\text{r}}}(\lambda_2) = A_{\text{B},\text{r}}(\lambda_1)/A_{\text{B},\text{r}}(\lambda_2).$$

The intensity of the fluctuations as a function of the linear dimensions of the field of view of the antenna (the attenuation function of the fluctuations χ; $\sigma_{x_\chi} = \chi\sigma_x$) is determined by the expressions:

When $\rho_\Theta(u)$ is specified in the form of an exponential oscillatory function:

(11) $$\chi^2(d_0,\alpha_0) = \frac{d_0\alpha_0+1}{(2\pi d_0)^2} - \frac{e^{-d_0\alpha_0}}{(2\pi d_0)^2}\left(\frac{2\alpha_0}{\pi}\sin 2\pi d_0 + \cos 2\pi d_0\right),$$

where $d_0 = d/\overline{\Lambda}$ is the ratio of the linear size of an amitting section d to the average length of a sea wave $\overline{\Lambda}$;

When $\rho_\Theta(u)$ is specified in the form of a bell function:

(12) $$\chi^2(d_1) = \frac{1}{2\theta^2+\sigma_0^2}\left\{2\theta^2\left[\frac{\sqrt{\pi}}{d_1}\Phi(\sqrt{2}d_1) - \frac{1}{d_1^2}\left(1-e^{-d_1^2}\right)\right] + \right.$$
$$\left. +\sigma_0^2\left[\frac{\sqrt{\pi}}{\sqrt{2}d_1}\Phi(2d_1) - \frac{1}{2d_1^2}\left(1-e^{-2d_1^2}\right)\right]\right\},$$

where $d_1 = d/u_0$; u_0 is the size of the correlation interval based on a drop in the level of the correlation function by e times; Φ is the gaussian probability integral.

Changes in the radio brightness which are caused by the long period waves of a swell with a slope $\delta\Delta\theta$, where $0 \leq \theta < 40°$, are evaluated by the approximate expression:

(13) $$\Delta\kappa_{v,h} \simeq 2A_{v,h}\theta\Delta\theta.$$

An isotropic model has been adopted for the small scale components, which are described by the effective height σ_h and the normal correlation function of the rises with a characteristic interval l.

The radiative properties are determined by the method of small perturbations by means of comparing the albedo $A = R_\sim + D_J$, determined by the reflective $R_\sim$ and diffusion D_J components, with a reflection factor R_- for a smooth surface. This is equivalent to comparing $\Delta R = R_- - R_\sim$. The size of $R_\sim$

is defined by modified Fresnel coefficients [8]. A procedure for the approximate determination of D_J from the size of the scattering factor in the reflection direction J_0 and the width of a cone in which the main energy of the diffusion field is concentrated was treated in [2]. The approximate representation of $R_\nu(\Theta)$ and $D_J(\Theta)$ permits the derivation of an approximate expression for estimating the degree of change in the radiative capacity*:

$$\Delta \varkappa_\lambda(0) \simeq \left[R_{\sim\lambda}(0)\cos^2 0 - C\left(\frac{l}{\lambda}\right)\cos 0\right]\left(\frac{4\pi\sigma_h}{\lambda}\right)^2. \quad (14)$$

The radiative characteristics of the dual scale model are established by substituting values of $\kappa + \Delta\kappa$ in (5) and (6) instead of κ, where the quantity $\Delta\kappa$ is determined approximately by (14).

The influence of atmospheric parameters on the size of the average values and variations of the intensity of the radio radiation is taken into account by substituting the following values in (5) or (6) instead of κ for the model of large scale formations (or $\kappa + \Delta\kappa$ for the dual scale model):

$$\varkappa_{\text{в,г}}^{(A)}(0, \psi, \vartheta, \varphi, \gamma_A) = \varkappa_{\text{в,г}}(0, \psi, \vartheta, \varphi) + [1 - \varkappa_{\text{в,г}}(0, \psi, \vartheta, \varphi)] \times \varkappa_A(0, \psi, \vartheta, \varphi, \gamma_A), \quad (15)$$

where κ_A is the normalized value of the radio brightness of the atmosphere at the level of the surface; γ_A is the absorption factor for oxygen, water vapor and cloud cover. A planar-layer model of the atmosphere was adopted in the calculations for the case of $0 \leq \Theta_A < 0.4\pi$, and Θ_A is the zenith angle:

$$\varkappa_A = \begin{cases} \beta[1 - \exp(-\Gamma(\gamma_A, \theta, \psi, \vartheta, \varphi))] & \text{при (when) } 0 \leq \theta_A < 0{,}4\pi; \\ \text{const} & \text{при } 0{,}4\pi \leq \theta_A < \frac{\pi}{2}; \\ 0 & \text{при (when) } \theta_A > \frac{\pi}{2}; \end{cases} \quad (16)$$

$$\theta_A = \arccos g; \quad g = \cos 0 \cos 2\vartheta - \sin 0 \sin 2\vartheta \cos(\psi - \varphi);$$

$$\beta = \frac{T_A - \Delta T}{T_0};$$

T_A, T_0 and ΔT are the temperature of the atmosphere at the surface, the temperature of the surface, and the correction for a nonisothermal atmosphere.

---

* The conclusion was proposed by A.Ye. Basharinov.

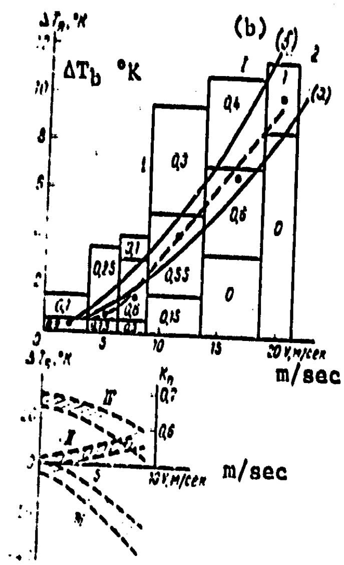


Figure 1.

The radiative characteristics of the surface of the sea as a function of the intensity of wave agitation (wind velocity):

I. $\Theta = 0°$;

1. Experiment with the "Kosmos-243" satellite, wavelength 8.5 cm, and the histograms are for the distribution of the increments in radio brightness (plan view);
2. Calculation for a model with a foam layer having a thickness of: (a) 0.5 cm; (b) 1 cm;

II, III, IV. The data from measurements taken from a shore station for the intensity of horizontally (II) and vertically (III) polarized radiation and the polarization factor (IV) at a wavelength of 3.2 cm, where $\Theta = 80°$.

The radiative properties of foam formations are evaluated from the formulas for the emissivity of layered media for models of foam in the form of a statistical mixture of water and air, a porous dielectric. Theoretical mixture relationships are employed to estimate the effective value of the dielectric permittivity of a foam layer (for example, Odelevskiy formulas for statistical and matrix mixtures). Also derived were estimates of the absorption and scattering coefficients of the model of a foam-spray layer in the form of a cloud of hollow spheroids, which was characterized by a distribution function of the dimensions of the bubbles, the air concentration, the layer thickness, and the relative coverage area. Taking into account averaging in the field of view, the magnitude of the fluctuations of radio radiation is estimated by the relationship:

$$\sigma_{\varkappa_t} = \chi\sigma_{\varkappa_u}; \quad \chi^2(d_0, P_s) = \frac{2}{[d_0\mu(P_s)]^2}\left[d_0\mu(P_s) - 1 + e^{-d_0\mu(P_s)}\right]; \tag{17}$$

$\sigma_{\varkappa_\pi}$ are the nonaveraged fluctuations:

$$\sigma_{\varkappa_\pi} = \Delta\varkappa_s\sqrt{P_s(1-P_s)}; \tag{18}$$

$\Delta\kappa_\pi$ is the increase in the emissivity due to the foam; R_π is the relative foam coverage area; χ is the attenuation function of the fluctuations; $\mu = 1/P_\pi(1 - P_\pi)$; $d_0 = d/\bar{\Lambda}$; d is the linear dimension of the field of view; $\bar{\Lambda}$ is the average length of a sea wave.

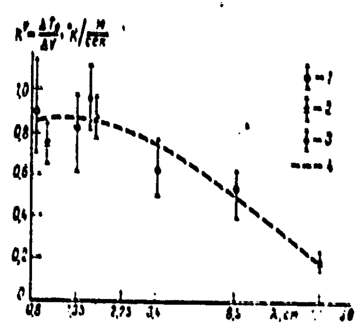


Figure 2.

The spectral dependence of the slope of the radiative-wind relationship.

The measurement data:

1. From the "Kosmos-243" satellite [11];
2. In the "Bering" experiment [9];
3. From the literature [10];
4. Averaged values.

We shall give a few results of the calculations and the data of measurements.

The calculations were carried out in a wavelength range of 0.8 - 30 cm, and some of the results are given in [1 - 6]. The experiments were conducted in the period from 1964 to 1977 on the water basins of the Black, Azov, Caspian, Barents, and Okhotsk Seas and the Pacific Ocean from a shore station, from aircraft laboratories, and from a satellite in wavelength bands of 0.8 - 3, 0.8 - 8.5 and 0.8 - 30 cm; the sensitivity of the radiometers was 0.1 - 1° K. Some of the results are given in [1, 3 - 7]. The measurement data confirm the justification of the basic model representations (see Figures 1 - 3).

At grazing observation angles, for the case of a wave agitation intensity of up to four balls [4 points on a 12 point scale], the radiative properties were primarily determined by the effective slope angle, practically regardless of the form of the distribution function of the slopes. Based on the calculated data, the sensitivity of the radio brightness to a change in the effective angle at $\Theta = 60 - 80°$ is characterized by values of around $-(2-4)°$ K/eff. angular deg., for the case of vertical polarization, and about $+(1-3)°$ K/eff. angular deg. for the case of horizontal polarization.

An increase in the effective slope angle from 0 to 10° with a growth in the intensity of wave agitation is accompanied by depolarization of the radiation by 10 - 30% in a range of angles of $60 < \Theta < 80°$.

If the dependence of the slope distribution intensity on the observation direction (7) is not taken into account, the error in the determination of the values of $\Delta\kappa$ and σ_κ reaches 50% and more. In experiments from a shore station at wavelengths of 1.6 - 3 cm, depolarization of the radiation is noted, as is a decrease in the intensity of vertically polarized radiation by 10 - 20° K when the wind velocity increases from 0 to 7 m/sec; with horizontal polarization, an increase in the radio radiation intensity is noted with a slope of about 1 - 1.5 ° K/(m/sec) (see Figure 1).

Values of the slope of the radiative-wind relationships, which are smaller than follow from the calculation for large waves, are explained by the smothing influence of small scale formations and the dependence of the effective parameters of large scale inhomogeneities (in this case, σ_Θ), which determine the radiative properties, on the wavelength of the radiation.

The calculations indicate the presence of azimuthal functions $\kappa(\psi)$ and $\sigma_\kappa(\psi)$ (with a wave agitation three-dimensionality indicator of $\nu < 1$), which were registered in a number of experiments. For the case of normal sounding, the radiative properties are determined by foam formations, small scale components, and to a minor degree, by large waves. The data of Figure 1 illustrate the calculated and experimental values for the increase in radio brightness at a wavelength of 8.5 cm with a change in the wind velocity. Shown in Figure 2 is the spectral curve for the slope of the radiative-wind relationships based on measurement data from the "Kosmos-243" satellite [11] and in the "Bering" experiment [9].

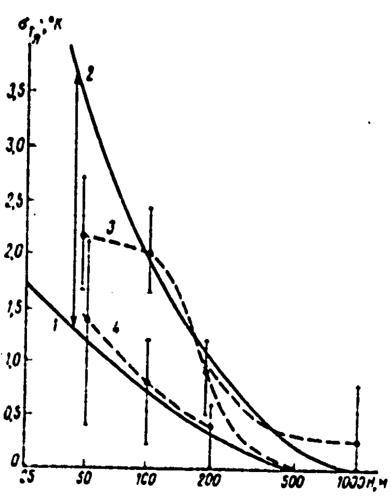


Figure 3. The intensity of the fluctuations in radio radiation. Wavelength 3 cm, observation angle 25°, beam width 3°:

1-2. Calculated values, wave agitation at 3-4 points on a 12 point scale;
3. Wind waves and swells;
4. Wind wave agitation.

Maximum values of the fluctuations are noted at angles of $\Theta = 60$-$70°$. For the case of linear dimensions of the field of view which exceed the length of a sea wave, the fluctuations are attenuated by 5 to 10 times, and the influence of swells is noted (Figure 3). The correlation functions are distinguished by an oscillatory character.

The influence of atmospheric background light is a determinative factor at grazing angles when receiving horizontally polarized radiation in a wavelength range of $\lambda < 3$ cm. With an increase in the radio brightness of the atmosphere, the fluctuations with vertical polarization increase, and decrease for horizontal polarization.

2. The Characteristics of Radio Radiation Under Conditions of Variations in the Temperature and Salinity of the Water Surface

Calculations of the sensitivity of the radiation field to variations in the thermodynamic temperature and salinity were carried out using the Debye formula, taking into account ionic conductivity [6, 12 - 15]*. The spectral curves for the slope of the radiative-temperature and radiative-mineralization relationships, determined from the data of calculations and measurements, are shown in Figure 4 for several values of the temperature and salinity. A quantitative correspondence is observed between the theoretical and experimental values of the radiative characteristics based on the measurement data in the centimeter wavelength band, obtained under laboratory conditions from on board aircraft laboratories and the "Kosmos-243" and "Kosmos-384" satellites [1 - 4].

The data of radiometric measurements at a wavelength of 8.5 cm from the "Kosmos-243" satellite above the relatively calm regions of water basins (wave agitation less than 3 - 4 points on a 12 point scale) are compared in Figure 5 with the data of shipboard measurements of the temperature of the water surface [7]. The observed scatter in the points, besides being due to a possible influence of variations in the degree of water darkness and errors in equipment calibration which were not taken into account, is also due to the considerable fluctuation noise of the radiometer (approximately $\delta T_b \approx 0.7°$ K at $\tau = 1$ sec) and the lack of refinement in the procedure for comparing the data, in which the values of radio brightness averaged in the field of view of the receiver with an area of about 2,000 square kilometers is matched up with a limited sample (1 - 2 values) of the data of point contact measurements. The averaged radiative-temperature function is close to linear with a slope factor which corresponds to the calculated value.

The sensitivity of the radiation field to variations in the salinity is noted at wavelengths longer than 5 - 10 cm. The data of experimental studies

---

* The first approximate model estimates of the relationships between the thermal and radio brightness contrasts of a sea surface were derived in [15].

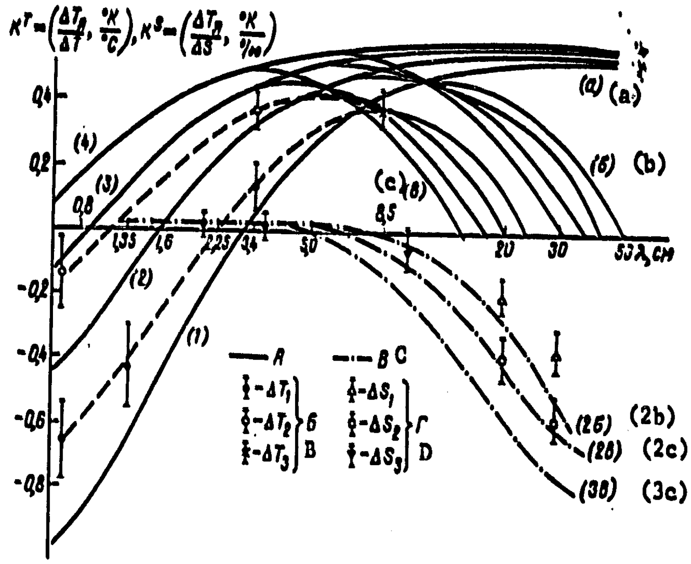


Figure 4.

The spectral curve for the slope of the radiative-temperature (I) and the radiative-salinity (II) functions.

I: A. The calculated values for a salinity of -- (a) 0 ‰; (b) 20 ‰; (c) 40 ‰, and a temperature of: (1) 0° C; (2) 10° C; (3) 20° C; (4) 30° C;

B. Experimental data from the "Kosmos-243" satellite in temperature ranges of -- (ΔT_1) - (0-10)° C; (ΔT_2) - (10-20)° C; (ΔT_3) - (0-30)° C.

II: C. Calculated values -- for a salinity of (2b) - 20 ‰; (2c) - 40 ‰, and a temperature of 10° C, and (3c) - 40 ‰, 20° C;

D. Experimental data from an aircraft in salinity ranges of -- (ΔS_1) - (0-20) ‰; (ΔS_2) - (20-30) ‰; (ΔS_3) - (0-30) ‰.

performed in five portions of the spectrum in a wavelength range of from 2 to 30 cm from on board the aircraft laboratory of the Institute of Radio Engineering and Electronics of the USSR Academy of Sciences above the water basins of the Sea of Okhotsk (S ≈ 30 - 35 ‰), the Amur estuary (S ≈ ≈ 0 - 2 ‰), and the Tatarskiy Straits (5 ≤ S ≤ 30 ‰) at a water temperature of 10 - 15° C provided quantitative confirmation of the representational models which were developed.

The sensitivity of the radiation field to a change in the concentration and composition by parts of the salts right up to values of S = 200 - 300 ‰ is shown by the calculations and confirmed by the data from experiments performed above the water basins of internal water reservoir: Lake Sivash and the Kara-Bogaz-Gol Bay (see Figure 6).

3. The Formulation and Approximate Soluation of the Problem of Estimating Hydrophysical Parameters from the Data of Microwave Radiometric Measurements

As follows from the theoretical concepcepts and the measurement data, the sensitivity of the microwave radiation field to variations in the temperature, salinity, and intensity of wave agitation vary substantially over the spectrum. The specific spectral features of radio radiation are also characteristic of portions of the water surface which are covered with a film of petroleum products, or floating ice, as well as of radiation components (or absorption) of the atmosphere [6].

These differences are the basis for methods of determining the hydrophysical parameters under complex weather conditions from the data of simultaneous measurements of the radio radiation:

$$T^{\text{я}}_{\lambda_i} = F_{\lambda_i}\,(Q_1^{\Gamma\Phi}, \ldots, Q_j^{\Gamma\Phi}, \ldots, Q_v^{\Gamma\Phi}; Q_1^{A}, \ldots, Q_l^{A}, \ldots, Q_z^{A}) \quad (19)$$

in selected portions of the spectrum λ_i; $Q_j^{\Gamma\Phi}$ are hydrophysical parameters, and Q_l^{A} are atmospheric parameters; $i = 1, 2, \ldots, u$; $u \geq v + z$ [16, 17].

To obtain reliable information, the solution of system (19) for the parameters Q_j^{hf}, Q_l^{A}, should be stable over all intervals of there variation for the case of the existing model indeterminacy and the natural nonuniqueness of the radiative-hydrophysical functions and the relationships between the radiative characteristics and meteorological parameters, and the errors in measurements of radio brightness should also be taken into account. Such a problem is solved by means of selecting spectral segments which maximize the determinant of the system of equations (19)(or minimize the error in determining the parameters Q_j^{hf}, Q_l^{A}).

This problem was solved approximately for the case where only the hydrophysical parameters T, V, and S were taken into account (19), with a subsequent check of the stability of the solution and estimates of the additional errors by means of accounting for the specific radio radiation spectral features of the atmospheric parameters in the chosen portions of the spectrum, and the errors in their independent determination.

A piecewise linear approximation of the increments in the radio brightness for each parameter is employed to solve this problem:

(20)

$$\Delta T^{\text{я}}_{\lambda_i}(Q_j) = T^{\text{я}}_{\lambda_i}(Q_j) - T^{\text{я}}_{\lambda_i}(Q_{\text{мин (макс)}}),$$

$$\Delta T^{\text{я}}_{\lambda_i}(Q_j) = k_{i_I}{}^{j}(Q_{j_I} - Q_{j_{\text{мин}}}) + \ldots + k^{j}_{i_m}(Q_j - Q_{j_{m-1}})$$

and the linear model of the interrelationship of the parameters in each individual portion m = I, II, ..., a, b, c (see 21).is also used. Indeterminacy factors which are inherent in the dependence of the radio brightness on temperature, salinity and wave agitation (the change in the slope, parallel displacements of the relationships) are taken into account, as well as random variations in the radio brightness due to the influence of related factors (for example, fluctuations caused by atmospheric parameters) and fluctuating noise.

In the absence of the influence of atmospheric parameters, and where the water capacity of clouds is taken into account with an error of no more than 1 - 3% in wavelength range of $0.8 \leq \lambda \leq 30$ cm, the solution for the parameters T, V and S is the most stable (Figure 7) in portions of the spectrum $\lambda_1 = 5 - 10$ cm, $\lambda_2 = 0.8 - 1.6$ cm, $\lambda_3 = 25 - 30$ cm (where $0 \leq T \leq 30°$ C; $0 \leq S \leq 40$ ‰; $0 \leq V \leq 25$ m/sec).

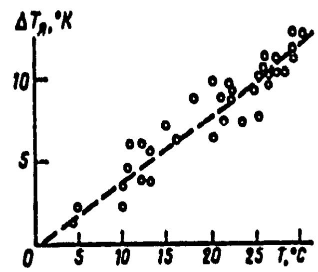


Figure 5. The relationship between the increase in radio brightness at a wavelength of 8.5 cm and thermodynamic temperature (experiment with the "Kosmos-243" satellite).

At these wavelengths, the operator of system (19) for intervals of the values $T \in a$; $V \in b$; $S \in c$ has approximately the following form:

(21)

$$A\Big|_{a,b,c} = \begin{pmatrix} k^T_{1_a} & k^V_{1_b} & k^S_{1_c} \to 0 \\ k^T_{2_a} & k^V_{2_b} & k^S_{2_c} \to 0 \\ k^T_{3_a} & k^V_{3_b} \to 0 & k^S_{3_c} \end{pmatrix}.$$

The approximate expressions (22) - (28) permit the estimation of the error in the determination of the parameter T due to the following:

a) The parallel shift of the radiative functions $T_b(T)$ and $T_b(V)$ by the amounts ΔT_0 and ΔV_0:

(22)

$$\Delta T = (\text{Det}\ \ {}_{,V})^{-1}[k_{1_a}{}^{T}k_{2_b}{}^{V}\Delta T_{0_1} - k_{2_a}{}^{T}k_{1_b}{}^{V}\Delta T_{0_2} + k_{1_b}{}^{V}k\ \ (\Delta V_{0_1} - \Delta V_{0_2})],$$

(23)

$$\text{Det}_{T,V} = k_{1_a}{}^{T}k_{2_b}{}^{V} - k_{2_a}{}^{T}k_{1_b}{}^{V},$$

b) A change in the slope $(\tilde{k}^T = k^T(1+\alpha^T);\ \tilde{k}^V = k^V(1+\alpha^V))$:

(24) $\Delta T|_T = (\mathrm{Det} + \Delta\,\mathrm{Det})^{-1}[\Delta T_{я_1}' k_{2_0}^V \alpha_2^V - \Delta T_{я_2}' k_{1_0}^V \alpha_1^V - T\Delta\,\mathrm{Det}]$,

(25) $\Delta\,\mathrm{Det} \simeq k_{1_0}^T k_{2_0}^V (\alpha_1^T + \alpha_2^V) - k_{2_0}^T k_{1_0}^V (\alpha_2^T + \alpha_1^V)$,

(26) $\Delta T_я' = \Delta T_я - \Delta T_я (T_{\text{наиб}}^{\theta}(a-1)) - \Delta T_я (V_{\text{наиб}}^{\theta}(b-1))$,

c) Random variations in the radio brightness (for example, due to a change in the state of the atmosphere):

(27) $\Delta T \simeq (\mathrm{Det})^{-1}(\tilde{\Delta} T_{я_1} k_{2_0}^V - \tilde{\Delta} T_{я_2} k_{1_0}^V)$,

d) Fluctuating noise:

(28) $\delta T \simeq |\mathrm{Det}|^{-1}\sqrt{\overline{(\delta T_{я_1} k_{2_0}^V)^2} + \overline{(\delta T_{я_2} k_{1_0}^V)^2}}$.

Errors in the estimates of the parameter V are determined by the analogous symmetrical relationships.

The error in the determination of the salinity due to variations in the temperature ΔT for fixed values of T and S is evaluated by the expression:

(29) $\Delta S|_{S,T} \simeq -(k_{3_0}^T / k_{3_0}^S)\Delta T|_{S,T}$.

Changes in the slope of the radiative functions at a wavelength λ_3 are reduced to the errors:

(30) $\Delta S \simeq [k_{3_0}^S(1+\alpha_3^S)]^{-1}[-\Delta T_{я_3}'\alpha_3^S - k_{3_0}^T T(\alpha_3^T - \alpha_3^S)]$.

For random variations in radio brightness:

(31) $\Delta S \simeq (k_{3_0}^S)^{-1}[\tilde{\Delta} T_{я_3} - k_{3_0}^T \Delta T(\tilde{\Delta} T_{я_1}, \tilde{\Delta} T_{я_2})]$.

The error due to fluctuating interference is:

(32) $\delta S \simeq |k_{3_0}^S|^{-1}\sqrt{\overline{(\delta T_{я_3})^2} + \overline{[k_{3_0}^T \delta T(\delta T_{я_1}, \delta T_{я_2})]^2}}$.

Evaluations show that for example, when T = 5° C, V = 10 m/sec, S = 35 ‰ and δT_b = 0.2° K, the errors amount to δT = 0.3° C, δV = 0.22 m/sec and δS = 0.42 ‰.

Variations in the slope of the radiative-temperature and radiative-mineralization functions within limits of 3% ($\alpha_1^T = \alpha_2^T = \alpha_3^T = \alpha_3^S \leq 3\%$) and the radiative-wind relationships within limits of 20% ($\alpha_1^V = \alpha_2^V \leq 20\%$) lead to the following errors in the determination of the temperature, salinity and wind velocity: $\Delta T = -0{,}12°$ C, $\Delta V = -0{,}5$ м/сек, $\Delta S = -0{,}8$‰.

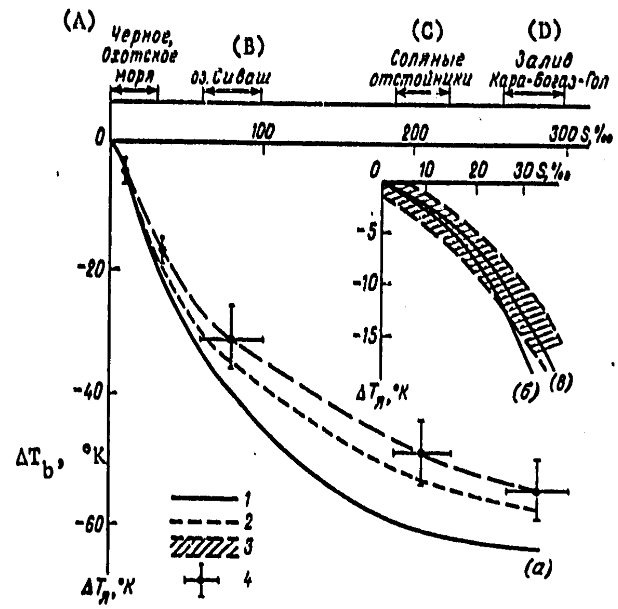


Figure 6. The radio brightness increment at a wavelength of 30 cm as a function of the concentration of salts:
1. Calculated values for NaCl salt at a temperature of: (a) 18° C; (b) 15° C; (c) 10° C;
2. Calculated values for a mixture of salts;
3, 4. An experiment at T = 10 - 15° C (3) and T = 15 - 18° C (4).

Key: A. Black Sea, Sea of Okhotsk;
B. Lake Sivash;
C. Salt basins;
D. Kara-Bogaz-Gol Bay.

The influence of the atmospheric parameters is approximately taken into account by expressions (27) and (31).

The two-dimensional radio brightness fields $g\{\Delta T^b_{\lambda_i}, \Delta T^b_{\lambda_k}\}$ (Figure 8) are the graphical representation of the system of radiative-hydrophysical equations for the different pairs of channels (λ_i, λ_k). The optimization procedure for λ_i and λ_k consists in selecting the spectral intervals which assure a maximum of the length of the partial vectors $\overline{q}^{Qj}_{i,k}$ and $\overline{q}^{Qh}_{i,k}$ and an angle between them which is maximally close to $\pi/2$, something which corresponds to the maximization condition for the determinant (23).

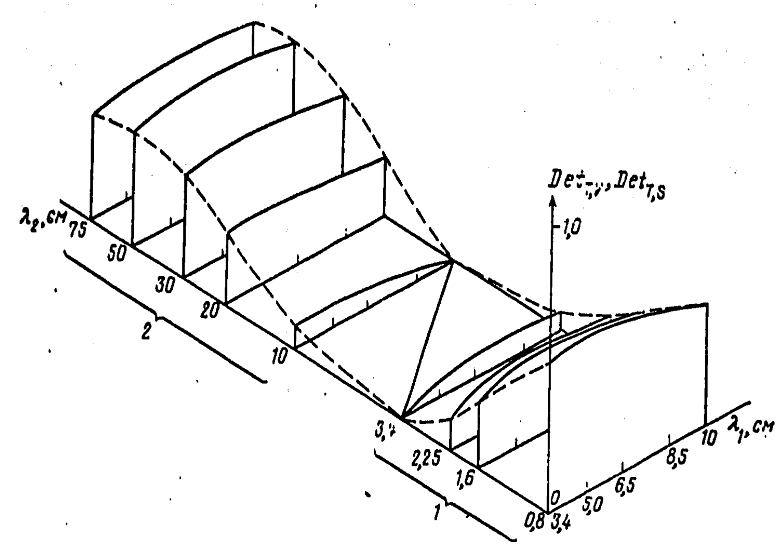


Figure 7. The spectral function for the determinants of the system of radiative-hydrophysical equations for the parameters T, V and S (calculated):
1. $Det_{T,V}$; 2. $Det_{T,S}$;
$T = 20°C$; $S = 40\ ‰$; $7.5 \leq V \leq 25$ m/sec

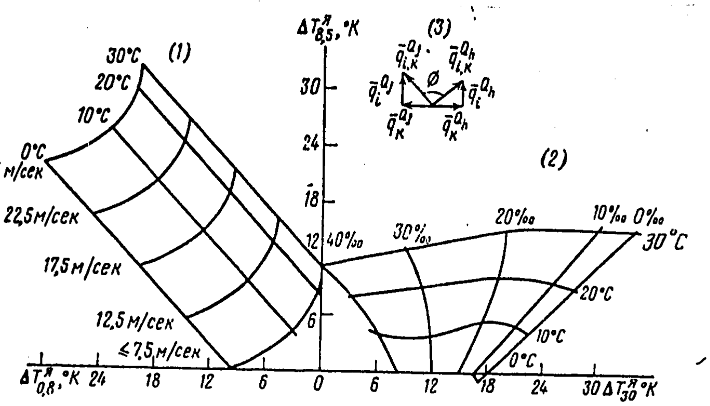


Figure 8. The two-dimensional radio brightness fields for the case of a variation in the parameters T, V and S (calculated)
1. (T,V), $\lambda_i = 8.5$ cm, $\lambda_k = 0.8$ cm;
2. (T,S), $\lambda_i = 8.5$ cm, $\lambda_k = 30$ cm;
3. The partial vectors: $\bar{q}_{i(k)}^{q_{j(h)}} = \frac{\partial T^{я}_{\lambda_{i(k)}}}{\partial Q_{j(h)}}$; $\bar{q}_{i,k}^{q_{j(h)}} = \bar{q}_i^{q_{j(h)}} + \bar{q}_k^{q_{j(h)}}$

It is useful in this procedure to employ measurement data in the infrared band to monitor the state of the atmosphere and the surface temperature in the absence of cloud formations.

The effectiveness of these methods has been confirmed experimentally in [3, 5-7, 11].

BIBLIOGRAPHY

1. A.M. Shutko, TRUDY GGO [PROCEEDINGS OF THE MAIN GEOPHYSICAL OBSERVATORY IMENI A.I. VOYEYKOV], 1968, No 222, 19.

2. A.M. Shutko, TRUDY GMTs [PROCEEDINGS OF THE MAIN METEOROLOGICAL CENTER], 1969, No 50, 103.

3. A.Ye. Basharinov, A.M. Shutko, "Preprint IRE AN SSSR" ["Preprint of the Institute of Radio Engineering and Electronics of the USSR Academy of Sciences], No 63, 1971.

4. N.M. Tseytlin, A.N. Shutko, G.M. Zhislin, "Preprint IRE AN SSSR" , No 6, (155), 1974.

5. A.Ye. Basharinov, et al., in the collection, "Issledovaniya v oblasti radiotekhniki i elektroniki 1954 - 1974 gg" ["Research in the Fields of Radio Engineering and Electronics 1954 - 1974"], IRE AN SSSR [Institute of Radio Engineering and Electronics of the USSR Academy of Sciences], 1974.

6. A.M. Shutko, B.G. Kutuza et al, "Radiofizicheskiye issledovaniya planet. Itogi nauki i tekhniki, Radiotekhnika" ["Radiophysical Studies of the Planets. Results of Science and Engineering. Radio Engineering"], 16, VINITI [All-Union Institute of Scientific and Technical Information], 1978.

7. A.Ye. Basharinov, et al., "Kosmicheskiye issledovaniya" ["Space Research"], 1971, 9, 2, 268.

8. S.Ya. Braude, IZV. VUZOV MVO SSSR (RADIOFIZIKA) [PROCEEDINGS OF THE HIGHER EDUCATIONAL INSTITUTES OF THE USSR MINISTRY OF HIGHER EDUCATION (RADIO-PHYSICS)], 1959, 2, 5, 691.

9. "Sovetsko-amerikanskiy eksperiment 'Bering'" ["The 'Bering' Soviet-American Experiment"], Proceedings of the Final Symposium, edited by K.Ya. Kondrat'yev, Yu.I. Rabinovich, W. Nordberg, Gidrometeoizdat Publishers, 1975.

10. W. Nordberg, J. Conaway, P. Thaddeus, QUART. J. ROY. MET. SOC., 1969, 95, 404, 408.

11. A.Ye. Basharinov, A.S. Gurvich, S.T. Yegorov, "Radioizlucheniye Zemli kak planety" ["The Radio Radiation of the Earth and Planets"], Nauka Publishers, 1974.

12. N.A. Armand, A.Ye. Basharinov, A.M. Shutko, IZV. VUZOV MVSSO SSSR (RADIOFIZIKA) [PROCEEDINGS OF THE HIGHER EDUCATIONAL INSTITUTES OF THE USSR MINISTRY OF HIGHER AND SECONDARY SPECIAL EDUCATION (RADIOPHYSICS)], 1977, 20, 6, 809.

13. V.Yu. Rayzer, Ye.A. Sharkov, V.S. Etkin, IZV. AN SSSR, FIZIKA ATMOSFERY I OKEANA [PROCEEDINGS OF THE USSR ACADEMY OF SCIENCES, ATMOSPHERIC AND OCEANIC PHYSICS], 1975, 11, 6, 652.

14. Yu.I. Rabinovich, V.V. Melent'yev, TRUDY GGO, 1970, No 235, 78.

15. S.V. Pereslegin, IZV. AN SSSR, FIZIKA ATMOSFERY I OKEANA, 1967, 3, 1, 47.

16. A.M. Shutko, "Sposob SVCh radiometricheskogo opredeleniya sostoyaniya poverkhnosti akvatoriy" ["A Method for the Microwave Radiometric Determination of the State of the Surface of Water Areas"], Patent No. 319918 of 25 May 1970.

17. A.M. Shutko, "Sposob opredeleniya temperatury poverkhnosti akvatoriy s letatel'nykh apparatov" ["A Method of Determining the Surface Temperature of Water Areas from Aircraft"], Patent No. 335613 of 24 July 1970.

8225
CSO:8144/0484

PUBLICATIONS

THE LYAPAS-M PROGRAMMING SYSTEM

Minsk SISTEMA PROGRAMMIROVANIYA LYAPAS-M in Russian 1978 signed to press 2 Dec 77, pp 2-6, 239

[Annotation, foreword and table of contents from book by A.D. Zakhrevskiy and N.R. Toropov, Nauka i tekhnika, 220 pages, 3450 copies]

[Annotation]

[Text] The structural design of complex technical systems and primarily of computers and other discrete devices reduces to the solution of varied problems of combinatorial logic formulated within the framework of automata theory, combinational analysis, logic-tree theory, and other fields of present-day discrete mathematics. The automation of design work necessitates the compilation of programs for the solution of these problems on computers, but the existing programming languages, which are chiefly designed to solve problems of a computational nature, prove to be ineffective for this purpose.

The book describes the new algorithmic language LYAPAS-M and a programming system oriented toward combinatorial-logic problems and implemented on Minsk-32, BESM-6, and YeS [Unified System] computers. This new language includes means for operating with symbols and logic vectors, making it possible to develop programs that are not inferior in operating speed to programs written in autocodes; as a result, the new language can be used in the development of programming and operational systems, including those based on the dialog principle. The absence of complex constructs in this language makes it readily accessible to a broad community of users.

The book is designed for specialists in the automation of design work and for the developers of oriented programming systems.

The book contains 3 tables, 8 illustrations, and a bibliography of 12 items.

Reviewers: Candidate of Physical and Mathematical Sciences M. G. Gontsa,
Candidate of Engineering Sciences Yu. N. Pecherskiy,
Candidate of Physical and Mathematical Sciences A. A. Utkin

Foreword

The range of applications of computers is steadily widening. Recently it has been extended with increasing intensity to various problems of combinatorial logics whose principal source is the theory of logic design, or the synthesis of discrete devices of which the computer itself is a typical representative. The problem of logic synthesis breaks down into a number of more elementary logic problems: equivalent transformations of Boolean formulas, the solution of logic equations, certain problems of the logic-tree theory, coding theory, and combinational analysis, operations with symbol sequences, etc. Problems of a logic nature also arise in the examination of a number of economic and production problems associated with the selection of optimal variants in certain complex situations, the automation of translation from one language to another, the analysis of malfunctions in technical devices, the diagnosis of diseases in medicine, the compilation of weather forecasts, etc.

The solution of most of these problems requires an examination of a large number of variants whose sorting is, in principle, unavoidable, but can be to some extent reduced by improving the solving algorithms. The labor requirement of the calculations involved in the solution of these problems partially increases exponentially with the increase in their volume, and hence the solution of practical complex tasks is sometimes simply inconceivable without using computers.

A large number of algorithmic languages pretending to universality has become widespread, but they are chiefly oriented to problems of numerical calculations and are relatively ineffective for the solution of problems of combinatorial logic owing to their lack of economical means for the presentation of logic quantities and operation with these quantities. Of these languages the one most suitable for the solution of logic problems is the P1/I programming language, but owing to its universality it is so complex that the uncovery of all of its semantic potential and the complete exploitation of its potential in modern computers are difficult.

There exist known attempts to expand the existing algorithmic languages by including in them various means oriented toward the solution of logic problems, but these expansions, while convenient for programming, yield little to enhance the effectiveness of the process of the solution of logic problems.

Special-purpose algorithmic languages that are entirely oriented toward the solution of problems of a logic nature deserve special attention, since the use of these languages assures not only convenience in program compilation, but also an effective implementation of programs on modern computers equipped with appropriate translators. It should be noted that the development of a translator from an elementary special-purpose language costs incomparably less than does the development of a translator from a universal algorithmic language.

One of such special-purpose languages is the LYAPAS algorithmic language, whose development was begun toward the end of 1962 especially for the presentation of algorithms for the synthesis of discrete automata, with the first translator from that language having been completed as early as in 1963. The first widely used publication on that language was the anthology "Logicheskiy yazyk x dlya predstavleniya algoritmov sinteza releynykh ustroystv" [A Logic Language for the Presentation of Algorithms for the Synthesis of Relay Devices] (Nauka Press, Moscow, 1966). The present anthology contains a complete description of the LYAPAS language, of the Ural-1 and M-20 computer programming systems based on this language, and a set of algorithms in that language-solving a broad range of problems relating to the analysis and synthesis of discrete devices.

Subsequently the LYAPAS language has been expanded to cover computational operations with numbers of various types. The most widely used versions of LYAPAS to be developed in this connection were the LYAPAS-20 for the Minsk-22 computer and the LYAPAS-71 for the BESM-6 and M-220 computers. The latter version markedly develops the second and third levels of the language, assuring a convenient unit-by-unit compilation of programs. The mechanism of automatic segmentation developed in that version makes it possible to compile and use in a unified system programs containing several tens of thousands of instructions.

Following the publication of the English translation of the anthology named above (by Academic Press, New York-London, 1969), the LYAPAS language has become known abroad; an interpreter from this language has been developed in the United States, and translators from this language are used in Poland, Czechoslovakia, and the GDR.

In the course of its existence the LYAPAS has been sucessfully competing with other universal and special-purpose programming languages. It has been used as the basis for developing a number of systems for automated synthesis of discrete devices which are being used by many design organizations.

The considerable experience gained in the practical use of the LYAPAS language as well as the advances in means of computer equipment showed the ways toward further refinements of that language. Toward the end of 1974 a new version of the language, called LYAPAS-M appeared. Improvements in the language proceeded in the direction of making its symbols close to the standard alphabets of domestic display devices and broadening the language by including in it the operations with symbols as well as with time measurement. The purely computational potential of the language has been expanded: operations with real numbers represented by floating-point decimal fractions have been included. Of major convenience to programming also are the operations with complexes (two-dimensional logic arrays) included in the language at the level of elementary operations. Modular programming devices have been further developed. The possibilities for using this language not only for the representation of synthesis algorithms but also for the solution of a broad class of problems of combinatorial logic, including the development of programming systems themselves, have been markedly expanded.

The presence of a means of operation with binary vectors, symbols, and bits in this language makes it close in effectiveness to computer-oriented languages, and makes it possible to write in this language programs that are not inferior in compactness and rapidity of action to programs compiled with autocodes, so that this language can be used to develop programming and operational systems. The exceptional simplicity of the syntax of this language makes possible the development of simple and effective interpreting systems convenient for the adjustment and editing of programs in the dialog regime. At the same time, the high speed of translation, which is a consequence of the language's simplicity, makes it possible to include the implementation of the translation process in the internal cycles of programs. This last circumstance can be successfully exploited when constructing effective dialog systems on the basis of LYAPAS-M language.

Within the framework of programming systems based on LYAPAS-M language, dialog devices designed to solve various problems are being developed. Problems of this kind primarily include the adjustment and editing of the compiled programs directly in PAPAS-M language and the analysis and synthesis of discrete devices. Both the designing of discrete devices and the development of the corresponding programs are markedly accelerated on using the dialog system of communicating with computers via extension terminals. Computer time is saved ("overhead expenses" on the performance of short specific tasks are reduced) and, which is particularly important, design time is reduced (the number of approaches to machine is reduced compared with the packet regime, and their frequency is increased).

This book offers a description of the LYAPAS-M language and its application in modern computers.

Chapters 1 and 2 are written by A. D. Zakrevskiy and Chapters 3 and 4, by N. R. Toropov. The Sections "Programming System for the BESM-6" and "Programming System for the YeS Computer" were written on the basis of material provided by I. G. Borisov and M. G. Golovchiner, respectively, while the section "Translator for the Minsk-32 Computer" was written by V. F. Tomashev.

The authors are indebted to the reviewers A. A. Utkin, Yu. N. Pecherskiy and M. G. Gontsa, as well as to S. V. Bykova, whose critical remarks and constructive comments served to improve the quality of this book.

Table of Contents Page

1386
CSO: 1870

PUBLICATIONS

SUBSCRIBER COMPUTER CENTERS

Moscow KUSTOVYYE VYCHISLITEL'NYYE TSENTRY in Russian 1978 signed to press 22 May 78, pp 3-6, 230-232

[Annotation, foreword and table of contents from book edited by V. I. Maksimenko, I. V. Kuz'min, Statistika, 15,000 copies, 232 pages]

[Annotation]

[Text] The book describes the purpose and classification of KVTs [subscriber computer centers], defines the place of KVTs in GSVTs [National Network of Computer Centers], discusses the design principles and the effectiveness and optimization criteria of KVTs. It also examines the principles for compiling the algorithm for the functioning of the informational and mathematical software, the organizational-legal facilities and the operating problems and problems of evaluating the functioning effectiveness of subscriber computer centers.

The book is designed for specialists working in the field of the design, construction and operation of subscriber computer centers and automatic control systems, and it also can be useful to students of VUZ's majoring in the corresponding fields.

Foreword

The 25th CPSU Congress has, on the basis of a profound scientific analysis and generalization of practical experience, stipulated the transition to the development of comprehensive programs of work on the most important technical and scientific problems. This represents a new stage in perfecting the planned management of the socialist economy.

Comprehensive programs are of a goal-oriented nature and provide for the implementation of the complex whole of operations connected with the accomplishment of the principal scientific-technical, economic, and social tasks within the framework of a unified national economic plan.

At present both in this country and abroad electronic computer equipment represents one of the most important directions of scientific and technical progress. Computers were originally conceived solely for the performance of computational operations, but now they have found broad application in many aspects of management, in industry, construction, trade, scientific research, medicine, transport, etc. Each year additional new applications are found for computers, while at the same time the range of their applications in all already known directions is broadening.

The introduction of qualitatively new Unified-Series computers (YeS EVM) in the industry of the CEMA member countries has placed before experts in the development and operation of automated control systems (ASU) tasks relating to the exploration of more effective ways of utilizing these new computers.

"The Main Directions in the Development of the National Economy of the USSR for the Years 1976-1980" provide for: "...assuring the further development and raising of the efficiency of automated control systems at computer centers; and the consequent combining of them into a single national system for the retrieval and processing of information needed for planning, accounting and control. Collectively shared computer centers should be established" /1/.

The technical base of the OGAS [National Automated Control System] is represented by the GSVTs [National Network of Computer Centers] and by the YeASS [Unified National Automated Network].

The basis of the TSVTs is represented by the major collective-use territorial computer centers (TVTsKP) designed to satisfy the demand of many customers regardless of their administrative jurisdiction makes it possible to sharply reduce the number of small and uneconomical computer centers. The National Network of Computer Centers also include subscriber computer centers, individually used computer centers, and numerous subscriber terminals.

What do the subscriber computer centers (KVTs) represent? The KVTs are collectively shared computer centers, and they are established to improve the efficiency of utilization of computer equipment by the ministries and departments of the industrial and nonindustrial sectors of the national economy. They are under the jurisdiction of these ministries and departments, and they are designed to perform data processing operations and assure the functioning of the ASU's of the medium and small enterprises and organizations (subscribers) of the concerned ministries and departments. By contrast with the collective-use territorial computer centers, the subscriber computer centers are of limited capacity and can service not more than 10 to 20 subscribers of a single ministry (or department) located in the same city or within relatively short distances from each other.

The KVTs may perform the following functions: implementation of data processing operations for subscribers on a unified technical, informational, program, and organizational-legal basis; establishment and conduct of data banks for subscribers; development of applied routines to satisfy the needs of subscribers; participation in the development and introduction of automated control systems for subscribers; centralized servicing of data-processing and -transmitting facilities installed among the subscribers.

The establishment of the KVTs produces savings (in per-subscriber terms) of capital outlays on the compilation of routines and reduces the expenditures on the operation of computer equipment and on servicing personnel.

The subscriber computer centers should be equipped with computers and data transmitting facilities belonging in the Unified Series to an extent tailored to the needs of the subscribers regarding the packet, inquiry-answer, and dialog modes of information processing.

The subscribers will be provided with subscriber terminals (AP) equipped with facilities for the collection, preparation, and transmission of data to the KVTs as well as for the reception of data from the KVTs and their transmission to the subscriber.

The complex whole of the facilities installed at the KVTs and among the subscribers represents the subscriber computational information network (KIVS).

Subscriber computer centers may be established either as financially autonomous organizations (enterprises) belonging to specialized branch (department) associations or as structural subdivisions of individual enterprises or organizations having the necessary material base.

At present more than 120 subscriber computer centers operated by various branches and departments exist in this country. The experience gained in the design and operation of KVTs's for the assurance and automation of control processes at enterprises, organizations, and institutions has demonstrated the high economic effectiveness of the use of computer equipment on this basis as compared with the individual computer centers of enterprises and organizations. It is thought that the capital investments in ASU created on the basis of a KVTs are reduced by 50-60 percent, while operating expenditures then diminish by a factor of two to three /67/.

A great deal of work to establish KVTs's is being performed by the ministries of the machine-building and instrument-making industry and the chemical, gas industries and a number of other branches. One of the first KVTs's to be accepted for industrial operation by a state commission is the Khar'kov KVTs of the Ministry of the Machine Tool Industry which services 14 enterprises and organizations of the branch. The KVTs of the Ministry of Petroleum and Gas Facility Construction in Tyumen' is functioning successfully. During the 10th Five-Year Plan it is expected that more than 100 subscriber computer centers will be established, and that their number will sharply increase during the subsequent five-year-plan periods. Under these conditions the utilization of experience in the theory, methodology and construction of subscriber computer centers is extremely topical and actual. The book offered here to the reader examines the premises for the establishment of KVTs's and determines the place of the KVTs in the National Network of Computer Centers. The book contains methodological material concerning the optimization of the structure of a KVTs network, the determination and formalization of criteria for the effectiveness of a KVTs, and an algorithm for the functioning of the KVTs as a computer system.

The book also examines the principles and algorithm for the selection of the structure and parameters of a KVTs, and definitions of a rational structure and topology of the data transmission network for an arbitrary number of levels of commutation points.

Considerable attention is devoted to the informational facilities of the problems being solved by subscribers with the aid of KVTs's, as well as to the software of the KVTs and its subscribers, the operating features of the technical base of KVTs, the relationship between the KVTs and the subscribers, and the implementation of the technological process of information processing. In the solution of the above problems, the three years of operating experience of the Khar'kov Subscriber Computer Center also have been taken into account.

In conclusion, the book offers recommendations on the phases and stages of the designing of branch KVTs's. This book does not, of course, completely resolve the problem of setting up an efficient functioning KVTs. However the exposition of methodological and organizational problems and the experience in establishing subscriber computer centers is extremely useful to a broad circle of readers, and primarily, to experts working on the establishment of KVTs's.

This interesting and needed book on the new forms of the utilization of computer equipment in the national economy is offered to the readers. Here it should be mentioned that the collective forms of computer use have a great future.

Contents

1386
CSO: 1870

PUBLICATIONS

UDC 681.3.06:621.39

SOFTWARE FOR DATA TRANSMISSION NETWORKS

Moscow MATEMATICHESKOYE OBSEPECHENIYE SETEY PD (Software of Data Transmission Networks) in Russian 1978 signed to press 14 Nov 77 pp 2-6, 158

/Annotation, foreword, introduction and table of contents from book by Aleksandr Mikhaylovich Kryukov, Yuriy Mikhaylovich Martynov (editor), Vladimir Leonidovich Razgon, "Svyaz'", 5,000 copies, 158 pages/

/Text/ The book is devoted to the statement of questions of the software of data transmission networks. The tasks being solved by programs of the software of the main elements of the network, the interrelation of the modes of their operation with the indicators of the efficiency of the network, the structure of the software of general-purpose and specialized computers in the part of the programs, which accomplish the exchange of information through communications channels, are examined. An approach to the creation of the software at different stages of planning is set forth. The peculiarities of the composition of the software of the communications centers in networks with different structures are examined.

The book is intended for scientists in the field of data transmission and the developers of the software of computers.

Foreword

One of the main problems of domestic science and technology at the present stage is the creation of data transmission networks, which ensure the automatic exchange of information between territorially dispersed sources and receivers. A typical trait of the operation of the networks is the change of the intensity of the external influence and internal structure of the network in the process of operating. Here these changes are of a random nature. The efficient operation of the network under these conditions is achieved by the use of adaptive operation algorithms, which realize various processes of information processing depending on the state of the network. The use of technical means with program control, particularly the use of computers, is the economically most feasible, and in a number of cases the only possible method of realizing adaptive algorithms in networks. The aggregate of the mathematical methods, models, algorithms and program means, which ensure the efficient operation of all the elements and the network as a whole, is called the software /matematicheskoye obespecheniye/ of the network or its corresponding elements. The specific program realization of these methods, models and algorithms is called the software /programmnoye obespecheniye/. The program realization of the operation algorithms of the network depends on the skills of the programmers, on their knowledge of the structure and principles of the operation of the network as a whole, its elements and hardware, which are used in the network. In connection with this precisely the operation algorithms of systems, and not their specific program realization, are of the greatest interest to the developers of systems.

In this book, on the basis of the analysis of foreign and domestic works, an attempt is made to cover questions of the software of data transmission networks. Of course, in one book it is impossible to cover all aspects of this problem. In connection with this the most urgent and the most common questions for a broad class of networks were selected. Among them, in the opinion of the authors, there are, first of all, the algorithms of the control of information flows in the network, which are realized by terminal and nodal objects. It was proposed to cover questions of the modeling of networks. However, in the process of writing the manuscript the authors became convinced that this problem requires independent examination. The authors declined to examine the questions of software, which are oriented toward ensuring the great reliability of the information being issued to recipients. This is explained primarily not by the fact that in the literature (particularly periodical literature) this problem has already received some coverage, but by the fact that this function of the network in many instances is realized by equipment, and even with program realization its specific embodiment in algorithms largely depends on the specific nature of the network.

The Introduction and Chapter 1 were written by Yu. M. Martynov, Chapters 2, 4 and 5 were written by V. L. Razgon, while Chapters 3 and 6 were written by A. M. Kryukov.

Comments on the book should be sent to Izdatel'stvo "Svyaz'" at the address: Moscow 101000, Chistoprudnyy bul'var, 2.

Introduction

A data transmission netowrk is a system which ensures the automatic exchange of information between remote sources and recipients of a single or several systems of automated data processing, as which there might be automated control systems (ASU's) which have been constructed on the basis of computers (EVM's).

The main purpose of the computer in an ASU is the processing of large amounts of information for the purpose of solving specific problems. The current level of the development of technology enables the numerous users of an ASU to solve problems while at a considerably distance from the computer. The user feeds in the initial data and receives the results of the solution of the problems by means of terminal equipment. Here data transmission systems, which ensure the exchange of data through communications channels, are used for the transmission of the data to the computer and back. The solution of problems in systems with remote users is usually called teleprocessing. The use of a computer by numerous territorially dispersed users with the optimum distribution of the resources of the computer can, in particular, be carried out within the computer systems created on the basis of third generation computers of the Unified Computer System. In this case the hardware and software, which accomplish the exchange of data over a distance, are called a teleprocessing system. This system is closely linked with the set of programs, which ensures the solution of the problems on the computer.

Along with this it can be noted that the realization of the functions of the exchange of data through communications channels in the main computer along with its positive features also has its bad sides. First of all this is the need to allocate considerable resources of the computer in the interests of the exchange of information, which is especially appreciable when tens of communications channels are tied into the computer. Here, as practice shows, the time of the solution of the problems of users increases substantially. Moreover, the creation of numerous systems of teleprocessing with centralized control requires great expenditures on the creation of a network of communications channels.

An escape from this situation was the creation of general-purpose data transmission networks and so-called distributed networks, in which a portion of the specific functions on the transmission and special processing of information is removed from the main computer and entrusted to the processor of the data being transmitted (a communications processor), which is constructed usually on the basis of a minicomputer. Moreover, in such networks a portion of the functions of preprocessing and exchange is performed by the terminal data equipment, which in connection with this is made more complicated, in particular programmable subscriber points appear.

The diversity of the functions of the data transmission systems and the need to decrease the transmission time of the ever increasing flows of information with great realiability led to the need to automate the processes of data exchange. For this purpose within the data transmission networks computers are used, which perform special functions, for example the communication of reports. General-purpose computers, particularly the computers of the Unified Computer System, can also operate in the mode of the communication of reports. However, with a large number of tied-in communications channels the delay time of reports is significant. This is explained by the following circumstances: first, the operational systems of the Unified Computer System basically are designed for ensuring the package processing of data at the computer centers, second, the operational systems of the Unified Computer System were created as general-purpose ones, on the basis of which the users can solve the most diverse problems, therefore their operation in the mode of the communication of reports is accompanied by considerable systems time lags. In this connection the development of special algorithms and software for the computer performing the functions of control in the data transmission networks is a very important task.

In the software of data transmission networks it is possible to single out two main classes of algorithms, which ensure the normal operation of the system. The first is the algorithms of the control of information flows, which ensure the delivery of the reports with tolerable time lags. Here belong the operation algorithms of the terminal objects in the area of the preparation and feeding in of reports into the network, the operation algorithm of transit objects (nodes of communication) in the area of the processing of incoming and outgoing flows of reports. The second class of algorithms (which is especially typical precisely for data transmission networks) is the algorithms which ensure the required degree of reliability of the information being transmitted in the network. These algorithms are realized in all the elements of the network. However, if at the nodes of the network they are secondary, this is the main function for the data transmission channel. The examination of the software oriented only toward the first class of algorithms is the task of this work.

Table of Contents — Page

7807
CSO: 1870

PUBLICATIONS

UDC 550.83

TABLE OF CONTENTS FROM JOURNAL 'EXPLORATION GEOPHYSICS'

Moscow RAZVEDOCHNAYA GEOFIZIKA in Russian No 80, 1978 signed to press 9 Feb 78 pp 171-172

[Table of contents of journal published by All-Union Scientific Research Institute of Geophysical Exploration Methods, USSR Ministry of Geology, and Central Geophysical Trust, RSFSR Ministry of Geology, Izdatel'stvo Nedra, 2,700 copies, 177 pages]

[Text] TABLE OF CONTENTS Page

11746
CSO: 1870

PUBLICATIONS

UDC 550.83

TABLE OF CONTENTS FROM JOURNAL 'EXPLORATION GEOPHYSICS'

Moscow RAZVEDOCHNAYA GEOFIZIKA in Russian No 81, 1978 signed to press 29 Dec 77 pp 160-161

[Table of Contents of journal published by All-Union Scientific Research Institute of Geophysical Exploration Methods, USSR Ministry of Geology, and Central Geophysical Trust, RSFSR Ministry of Geology, Izdatel'stvo Nedra, 2,700 copies, 168 pages]

[Text] TABLE OF CONTENTS Page

11746
CSO: 1870

PUBLICATIONS

UDC 550.83

TABLE OF CONTENTS FROM JOURNAL 'EXPLORATION GEOPHYSICS'

Moscow RAZVEDOCHNAYA GEOFIZIKA in Russian No 82, 1978 signed to press 13 Jan 78 pp 162-163

[Table of contents of journal published by All-Union Scientific Research Institute of Geophysical Exploration Methods, USSR Ministry of Geology, and Central Geophysical Trust, RSFSR Ministry of Geology, Izdatel'stvo Nedra, 2,700 copies, 168 pages]

[Text] TABLE OF CONTENTS — Page

11746
CSO: 1870

END