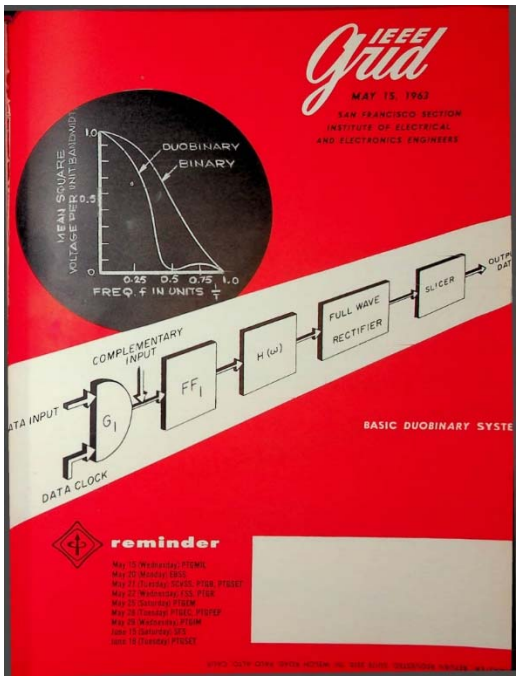
EDITOR'S PROFILE of this issue

from a historical perspective …

with Paul Wesling, SF Bay Area Council GRID editor (2004-2014)

May, 1963 (mid-month):

Cover: The duobinary coding/decoding system for data transmission demonstrates how to double the baud rate of a given channel. This is explored by Adam Lender of Lenkurt. This is the company I first worked for, out of college, starting in 1968. It takes its name from Len and Kurt, its founders, and (as part of GTE) developed telephone system hardware. One of the larger projects was engineering the private phone system for the Southern Pacific Railroad in the Central Valley, to get around AT&T's WATS tariffs before the Carterphone decision. The "SP" in Sprint stands for Southern Pacific; the Lenkurt system was part of the genesis of Sprint. More on page 8.



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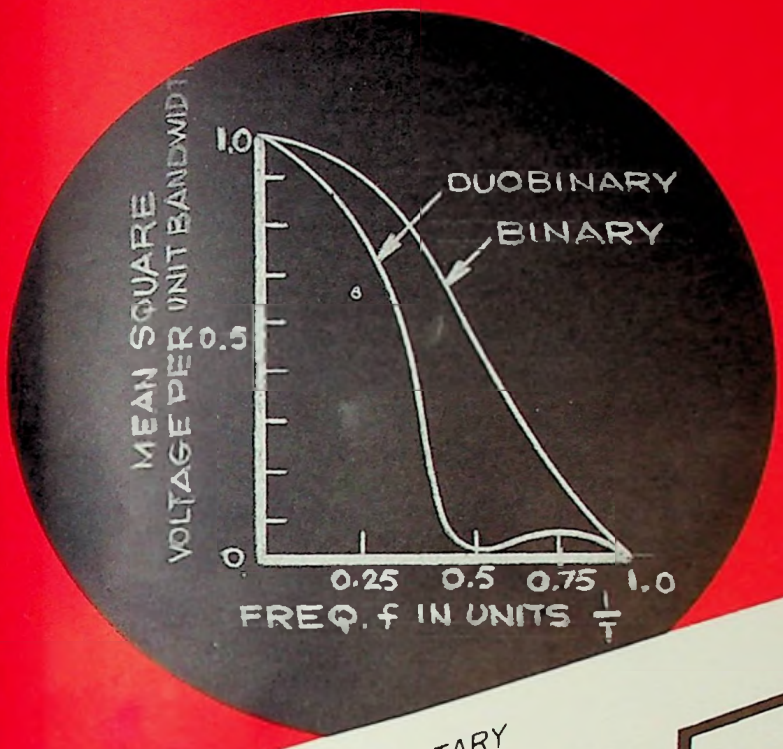
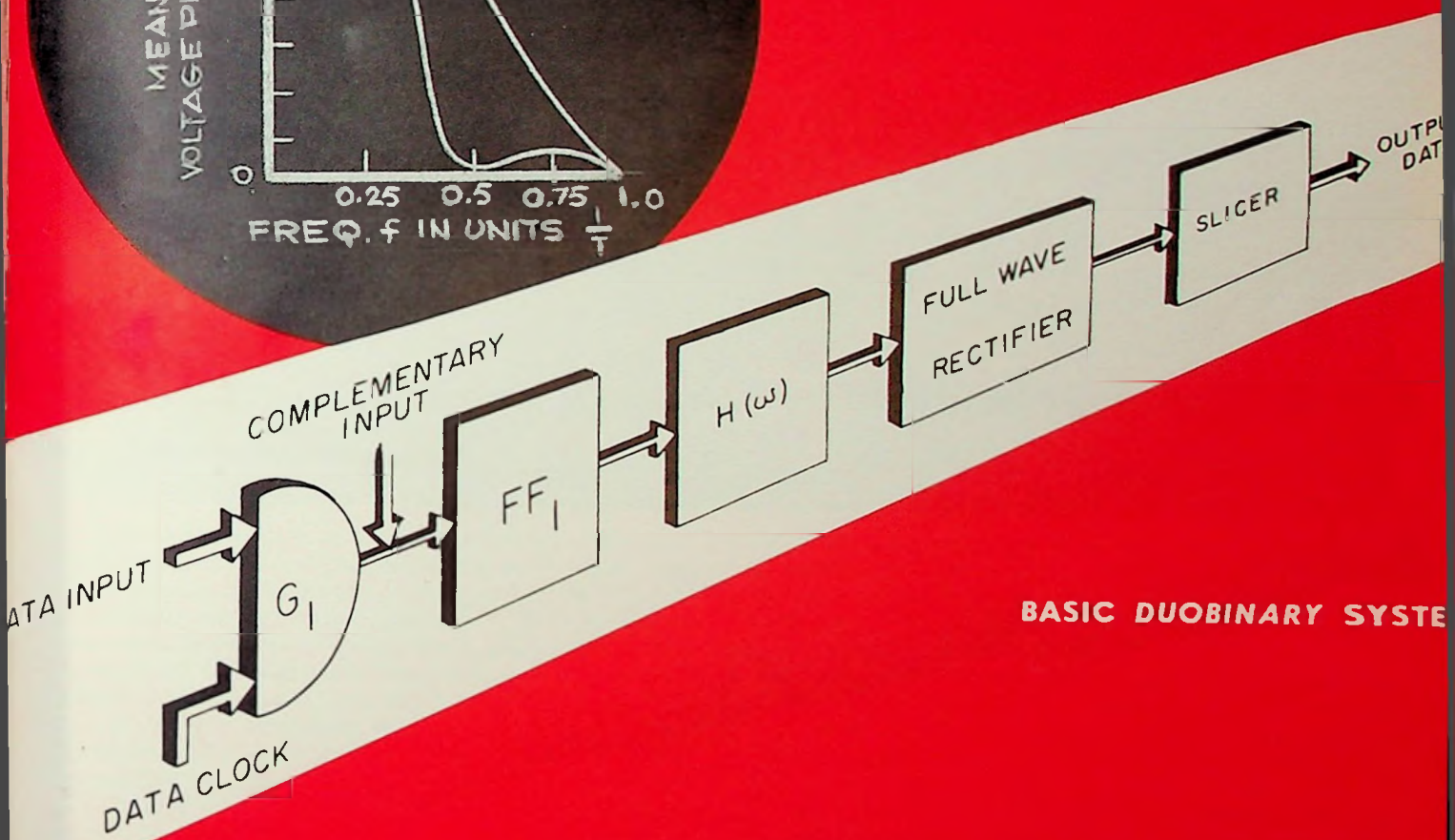
IEEE Grid

MAY 15, 1963

SAN FRANCISCO SECTION
INSTITUTE OF ELECTRICAL
AND ELECTRONICS ENGINEERS

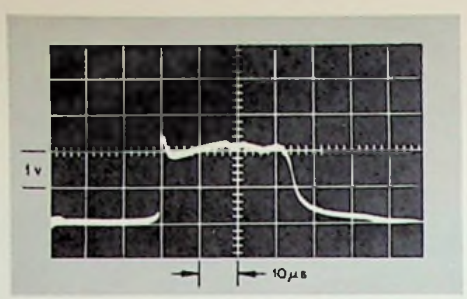




BASIC *DUOBINARY* SYSTE

reminder

May 15 (Wednesday) PTGMIL
May 20 (Monday) EBSS
May 21 (Tuesday) SCVSS, PTGB, PTGSET
May 22 (Wednesday) FSS, PTGR
May 25 (Saturday) PTGEM
May 28 (Tuesday) PTGEC, PTGPEP
May 29 (Wednesday) PTGIM
June 15 (Saturday) SFS
June 18 (Tuesday) PTGSET



Super-orbital entry of a space vehicle—one returning to earth from a planet, rather than from an earth-orbiting mission—would result in searing *radiative* heating in addition to the more familiar *convective* type. As a spacecraft nose enters atmosphere, it pushes the thin air aside. A boundary layer is formed next to the skin. Ahead of that is a compressed mass of air; fronting that, a shock wave. The air behind the shock wave becomes incandescent, ionizes, and radiates to the heat shield. Within the boundary layer, friction heats the nose cone by convection.

Lockheed scientists believe that at higher than escape speed a blunt-nosed vehicle may be unable to sustain the radiative heating. Consequently, a return to the previously discarded sharp nose is indicated. Fluid mechanicists are calculating the heat load, determining how rapidly the nose will ablate and how to keep it sharp. Current shock tube tests are providing some clues.

Another research project in Lockheed's Fluid Mechanics Laboratories relates to the flow of buoyant fluids. A typical study program is the determination of how liquid hydrogen, stored in a tank in space, stratifies. This, in turn, determines the level of pressurization required in order to extract all of the fluid. Scientists made a mathematical model of what they think occurs inside the tank. With this as a guide, an actual tank was constructed to obtain measurements and photographs of the flow to verify their theories.

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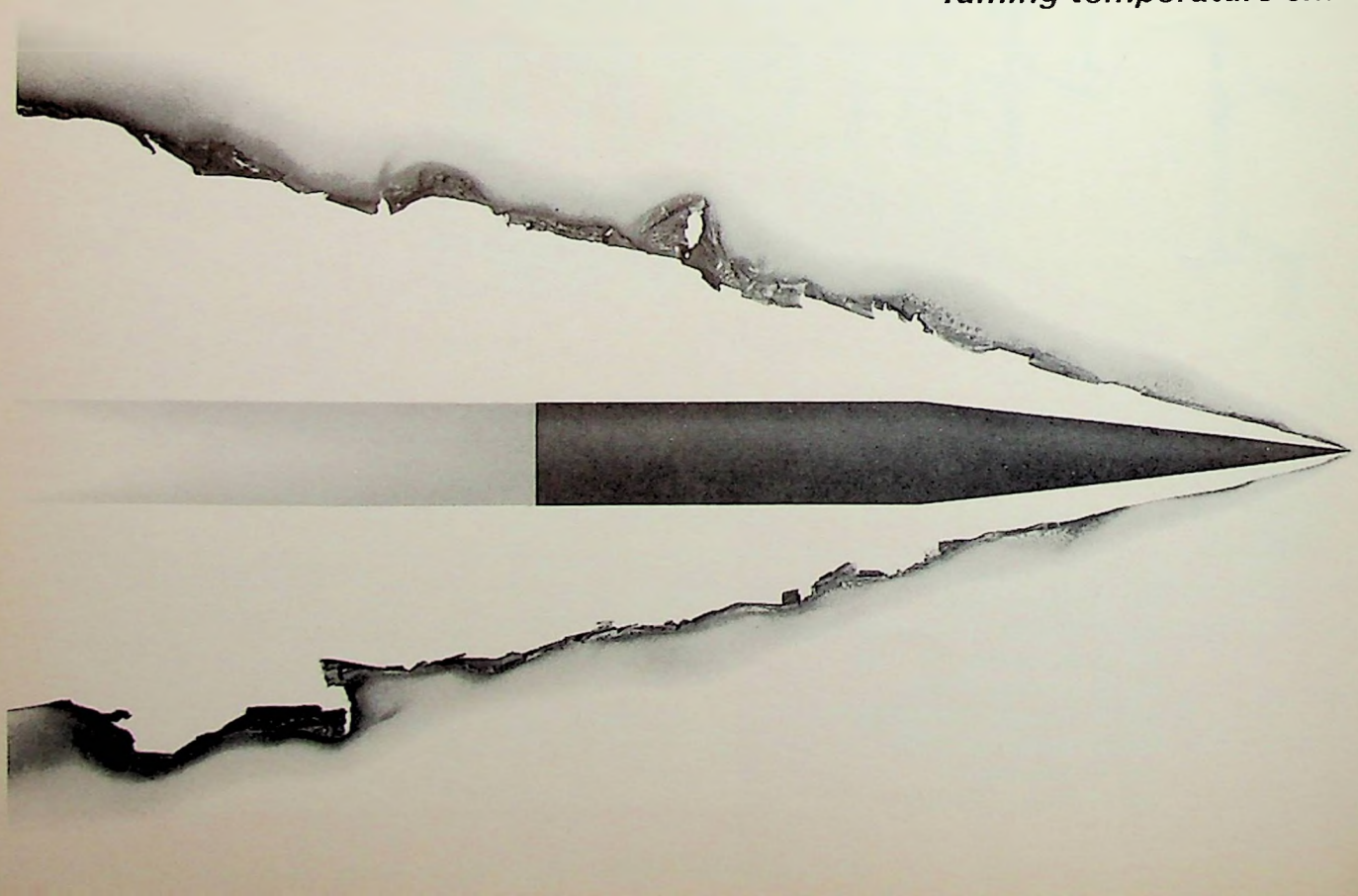
LOOK AT LOCKHEED IN FLUID MECHANICS:

Taming temperature extremes



Electronic Equipment Engineers

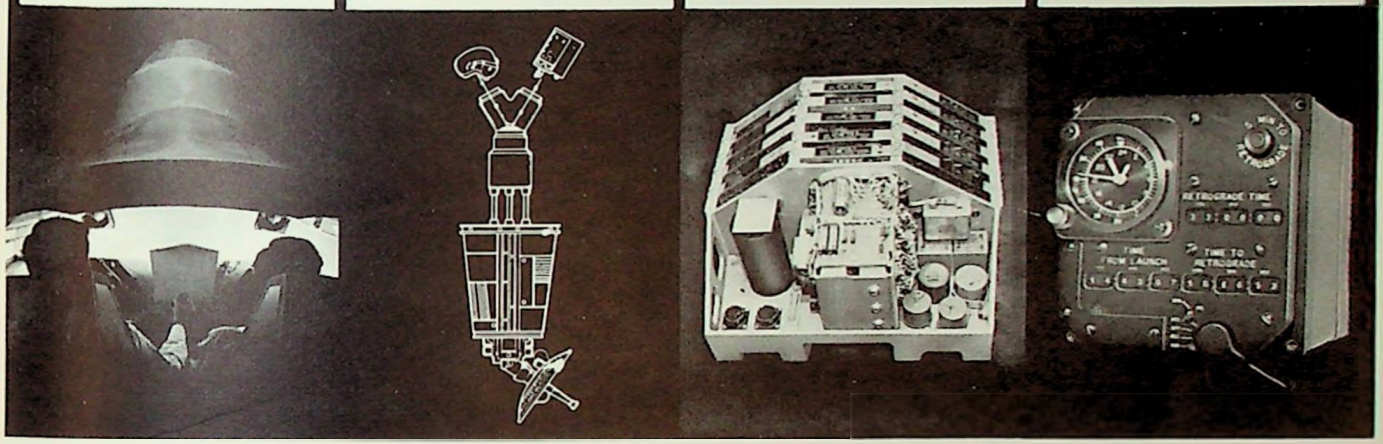
at MCDONNELL . . .

design the **Simulators** that will train astronauts to control Gemini from launch to landing.

design the control for the **Radar Scope Cameras** that are the recording eyes for McDonnell Phantoms.

develop **Flight Control Systems** for aeroballistic and surface-to-surface missiles.

design the **Precision Orbital Clocks** that keep time for spacecraft as they orbit the earth.



Early recognition of the inter-relationship between electronic innovation and aerospace development has been reflected in the historic achievements of McDonnell products in aeronautics and astronautics. To fill electronic requirements not met by standard equipment, McDonnell created its own electronic capability, now a separate division under the direction of a General Manager. The comprehensive capabilities of the Electronic Equipment Division (EED) are geared to provide advanced electronic equipment for ground, airborne and space applications.

EED is designing, developing and manufacturing products and systems which span the entire electromagnetic spectrum from subaudio control and ultrasonic equipment through microwave and infrared devices. Today, the efforts of more than 500 EED engineers are focused on such diversified projects as pre-flight simulators, master time reference systems, ground check-out equipment, message computers, recording devices, flight control, antennas, display systems, communication, guidance . . . more than 100 different electronic components, equipments and systems.

Continuing expansion of the Electronic Equipment Division is creating electronic engineering opportunities at all levels from Associate Engineer to Department Managers. Supervisory positions require advanced degrees; bachelors degree necessary for other positions.

For information about your opportunities in the Electronic Equipment Division at McDonnell, complete and mail, in confidence, the brief resume form below. For a comprehensive, immediate review of your qualifications, attach a complete resume of your education and experience.

Mail This Form To: D. F. Waters, McDonnell Employment, Dept. 62AM, Box 516, St. Louis 66, Mo.

Name_____ Home Address _____

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Education: EE____ ME____ Math____ Physics____ Chemistry____ AE____ Astronomy____ Other_____

Degree: BS_____ Date MS_____ Date PHD_____ Date Present Job Title_____

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IEEE Grid

volume 9, number 18

MAY 15, 1963

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contents

cover

The duobinary coding technique for digital communications requires only one-half that bandwidth of an equivalent binary system transmitting at the same bit rate. Error detection without introducing redundancy in the original binary data and equipment simplicity are additional features of this technique. The cover was created by Al Currier, Lenkurt microwave designer. More details on the system are given in the meeting review, page 8.

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(AIEE)
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MEETING CALENDAR

all those interested, members or nonmembers, are welcome

SAN FRANCISCO SECTION

7:30 P.M. • Saturday, June 15

Annual meeting, dinner-dance
Place: Diablo Country Club, Danville
Cocktails: 7:30 P.M. (no host)
Dinner: 8:30 P.M. (New York steak)
Dancing: 9:00 P.M. to 1:00 A.M. to the music of the "Stardusters"
Reservations: $7.50 per person. Limited to 400 persons. Tickets may be reserved through Mrs. Doris Gould, Section Office, DA 1-1332, DA 1-1333. No tickets sold after June 10.

EAST BAY SUBSECTION

8:00 P.M. • Monday, May 20

"Instrumentation for Nuclear Testing"
Speaker: Edward H. Hulse, head, electronics engineering dept., UC Lawrence Radiation Lab, Livermore
Place: Livermore High School, Choral Road, 600 Maple St., Livermore
Meet-the-students-and-speaker Dinner: 6:15 P.M., Haps Restaurant, 122 West Neal St., Pleasanton ($3.00, including tax and tip for steak dinner and extensive salad bar)
Reservations: Pat Mann, Sandia Corp., 447-5100, Ext. 2641, or Winnie Veeder, Lawrence Radiation Lab, Berkeley, 843-2740, Ext. 5434

FRESNO SUBSECTION

8:00 P.M. • Wednesday, May 22

(Joint meeting with the Fresno State College Student Branch of the IEEE)
Subject: Presentation of papers by Fresno State College engineering students
Place: Room 101, Industrial Arts Bldg., S.E. corner of Barstow Ave. and Campus Dr., Fresno State College campus
Parking: F.S.C. students must use regular student parking areas. Special arrangements have been made for all others to park in the "Restricted-Faculty Only" area immediately west of the Engineering Bldg., which is just south of the Industrial Arts Bldg. Enter area at Barstow Ave. and Campus Dr.
No dinner

SANTA CLARA VALLEY SUBSECTION

8:30 P.M. • Tuesday, May 21

"The Microscope as an Optical Measuring Tool"
Speaker: Marcel Vogel, IBM, San Jose
Place: Berry Farm Restaurant, 2825 El Camino Real, Santa Clara
Dinner-Meeting: Happy Hour, 6:30 P.M.; Dinner, 7:30 P.M. (Berry Farm Fried Chicken Dinner, $2.75)
Reservations: Mrs. George, RE 9-5840

PROFESSIONAL TECHNICAL GROUPS

Broadcasting

8:00 P.M. • Tuesday, May 21

"Transistor Symposium"
Speaker: Ben Wolfe, KPIX
"Automatic Transmitter Logging"
Speaker: Paul Gregg, Bauer Electronics
Place: Engler's, 20 - 10th St., San Francisco
Dinner: 6:30 P.M., Engler's, 20 - 10th St., San Francisco
Reservations: Paul Gregg, Bauer Electronics, 591-9456, or Jim Gabbert, KPEN, KL 2-1013, by Monday, May 20

Electronic Computers — 8:00 P.M. • Tuesday, May 28

"Designing Real Time-Control Computers for Efficient Programming"
Speaker: Emil R. Borgers, mgr. programming, Scientific Data Systems, Santa Monica
Place: Lockheed Auditorium, 3251 Hanover St., Palo Alto
Dinner: 6:00 P.M., The Red Shack, 4085 El Camino Way, Palo Alto

Engineering Management — 9:00 A.M. • Saturday, May 25

Program: Management Decision-Making Game (special PTGEM meeting)
Place: IBM, San Jose
Reservations: W. D. Bolton, 227-7100, Ext. 2711

Instrumentation & Measurement — 8:15 P.M. • Wednesday, May 29

Lecture No. 5: "Instrumentation for Man in Space"
Speaker: Dr. Peter Simpson, sr. research engineer, Lockheed Missiles and Space Co.
Place: Lockheed Auditorium, Bldg. 202, 3251 Hanover St., Palo Alto
Dinner: 6:15 P.M., L'Omelette Restaurant, 4170 El Camino Real, Palo Alto
For additional information call Mrs. Renda Blackler, 948-8233

Military Electronics — 8:00 P.M. • Wednesday, May 15

"Design Reliability"
Speaker: H. K. Burbridge, reliability engineer, Lockheed Missiles and Space Co.
Place: Lockheed Auditorium, 3251 Hanover St., Palo Alto
Dinner: 6:30 P.M., Red Shack, 4085 El Camino Way, Palo Alto
Reservations: Vic Conrad, DA 6-4000, Ext. 2212

Product Engineering & Production — 8:00 P.M. • Tuesday, May 28

Technical Lecture and Plant Tour
"Manufacture of Magnetic Disc Storage Units" by the staff of the IBM Manufacturing Engineering Department
Place: IBM Education Center Auditorium, San Jose
Packaged Evening: Transportation, Dinner, and Technical Program—leaves Palo Alto at 6.00 P.M. and returns at 11:00 P.M.
Dinner at IBM facilities
Reservations: Miss Marie Sharp, DA 4-3311, Ext. 45821, by 4:30 P.M., May 27

Reliability — 8:00 P.M. • Wednesday, May 22

"The Testing of Electronic Parts in a Nuclear Radiation Environment"
Speaker: Edwin A. Smith, research engineer, Lockheed Missiles and Space Co., Sunnyvale
Place: Physics Lecture Hall, Room 101, Stanford University
Dinner: 6:30 P.M., Ed's Chuck Wagon, Mountain View
Reservations: Jean Cravens, YO 8-6211, Ext. 2126, by May 21

Space Electronics and Telemetry — 8:00 P.M. • Tuesday, May 21

Election of Officers
"Advances in Solid-State Microwave Receivers for Satellite Applications"
Speaker: Robert F. Domboski, project engineer, Philco Corp., WDL
Place: Lockheed Auditorium, Bldg. 202, 3251 Hanover St., Palo Alto
Dinner: 6:15 P.M., El Camino Bowl, 2625 El Camino Real, Mountain View
Reservations: Tom Linders, RE 9-4321, Ext. 28394 or 28453, by 1:00 P.M., May 21

Space Electronics and Telemetry — 8:00 P.M. • Tuesday, June 18

"Parametric Amplifiers"
Speaker: Dr. George Matthaei, Stanford Research Institute, Menlo Park
Place: Lockheed Auditorium, Bldg. 202, 3251 Hanover St., Palo Alto
Dinner: 6:15 P.M., El Camino Bowl, 2625 El Camino Real, Mountain View
Reservations: Tom Linders, RE 9-4321, Ext. 28394 or 28453, by 1:00 P.M., June 18

Leifer *Herold*

wescon news

NEW DIRECTOR

Edward W. Herold of Varian Associates, Palo Alto, has been appointed an interim Section-WESCON director representing the San Francisco Section on the board of directors. The action by Peter Lacy, chairman of the San Francisco Section (IRE), followed the recommendation of a nominating committee consisting of Bernard M. Oliver, John V. N. Granger, and Albert J. Morris and was confirmed by actions of the operating committee and the executive committee (IRE).

Dr. Herold replaces Meyer Leifer, who submitted his resignation to accept the position of technical director, systems engineering and management organization, Sylvania Electronic Systems, Waltham, Mass. The remainder of the term will run through November, 1965.

Dr. Herold is vice president, research, of Varian Associates, where he directs the central research laboratory concerned with such fields as coherent light, solid-state devices, plasma physics, direct head conversion, and allied research activity. He was chairman of the WESCON technical program in 1961 and is a fellow and former director of IEEE. He assumes Leifer's responsibilities as convention director for 1963 until next November.

Leifer was formerly chief engineer and manager of the video/instrumentation division of Ampex Corp., Redwood City. He is a fellow of IEEE and was chairman of the San Francisco Section in 1958.

Another new director was recently named by the Los Angeles Section, when Ralph A. Lamm, section chairman (IRE), was elected to complete the term of Dr. Lester Van Atta when the latter moved from Hughes in Southern California to Lockheed in Palo Alto. Lamm is plant manager of the electronics center of Bendix Pacific division at Sylmar.

Edward H. Hulse

Robert F. Domboski

Edwin A. Smith

meeting ahead

EBSS: HULSE & STUDENTS

Edward H. Hulse, head of the electronics engineering dept., UC Lawrence Radiation Lab, Livermore, will address the East Bay Subsection on May 20. Instrumentation for nuclear testing, a description of equipment used for nuclear testing, and attendant problems of people and equipment will be covered. A new color film on the forward area in Nevada will be shown.

The program will also feature two student paper presentations culminating the 1963 paper competition for prospective engineers which was inaugurated this year in the Livermore High School by the subsection. Judges will complete their work after hearing the presentations, and the winner will receive a prize of $75.00; the runner up, a prize of $25.00.

Mr. Hulse is co-chairman of the student chapter committee. He is also a member-at-large of the executive committee of the San Francisco Section (AIEE).

meeting ahead

SOLID-STATE ADVANCES

The May 21 meeting of PTGSET will be devoted to a presentation of technical and reliability advances in solid-state microwave receivers for satellite applications.

The speaker, R. F. Domboski of the Philco Corp., was project manager for the development and production of a high-performance FM microwave receiver which has a 90 percent probability of survival for one year's operation in a satellite.

He will discuss the electrical, mechanical, thermal, radiation and reliability design, and trade-off considerations required for small, rugged, high-performance, high-reliability receivers. Methods of testing the design adequacy, the results of life tests to date, and potential advances in the field will also be reviewed.

Chapter officers for the coming year will be elected at the meeting.

meeting ahead

PART TESTING IN RADIATION

At the May 22 meeting of PTGR, Edwin A. Smith will describe methods of approach and testing techniques required for radiation tests. The problems involved, principally as they apply to test reactors, will be discussed. The damage mechanisms in semiconductors and their manifestations in device parameters will be considered with the implications for the design engineer.

A use of data, obtained in an irradiation testing program, which may serve as a guide to parts selection and reliability will be outlined.

The speaker has been with Lockheed Missiles and Space Company as a research engineer since August, 1962, working on nuclear aerospace programs. After four years in the Air Force, he returned to UCLA to finish his education and received the B.S. degree in applied physics in January, 1962, while working as an electronics engineer at Del Mar Engineering Laboratories, Los Angeles. While at Del Mar, since 1957, he was engaged in the design of target training systems and electronic instruments for medical research.

meeting ahead

LAST ON MAN IN SPACE

The concluding presentation in the PTGIM space instrumentation series will be a discussion by Dr. Peter Simpson on the subject, "Instrumentation for Man in Space."

Earlier meetings in the series explored the problems of determining space environmental parameters. Once sufficient knowledge of the extraterrestrial environment is gained, man might proceed to explore it personally. With all the effort to understand and to reduce the hazards of such a personal venture, there remains the attendant need to convey the explorer's conscious (and unconscious) needs to observers on earth. Additionally, he must be provided

with the ability to sense and to respond to conditions (hopefully anticipated) alien to the previously earth-bound human. What is being done about it is the area of Dr. Simpson's concern.

Dr. Simpson, a member of the newly formed bio-astronautics department at Lockheed, addresses the problem with a Doctor of Medicine degree from the University of Berlin and a Doctorate in science from the University of Danzig.

Dr. Simpson came to the United States in 1949. Since that time, his efforts and contributions have been in the field of fetal physiology (cardiovascular instrumentation). At Lockheed, he is a senior research engineer working on bio-instrumentation for life support systems.

Diablo Country Club, Danville, where the first merged San Francisco Section IEEE annual meeting, a dinner-dance, will be held Saturday, June 15. No-host cocktails, 7:30; New York steak dinner, 8:30: dancing from 9 to 1 to the music of the Stardusters. Early reservations, limited to 400 at $7.50 a person, are recommended. Call Mrs. Doris Gould in the Section Office and follow this by mailing a check to be sure that your tickets are reserved.

meeting ahead

PHOTOMICROGRAPHY

The microscope as an optical measuring tool will be covered by Marcel Vogel, IBM, San Jose, at the May 21 meeting of the Santa Clara Valley Subsection.

The speaker's slide presentation and lecture might be called "A Fantasy in Crystal Structure and Color," for it is as enjoyable from an esthetic point of view as it is technically interesting.

Mr. Vogel's work has taken him into the areas of:

- noncontact interferometry of metal and plastic surfaces;
- interference contrast photomicrographs of evaporated metal layers;
- polarized light photocolor micrography of growth processes in polymeric materials; and
- phase contrast photomicrography.

The subject is vitally important to multilayer solid-state circuitry and will give a good insight to new techniques in this field.

meeting review

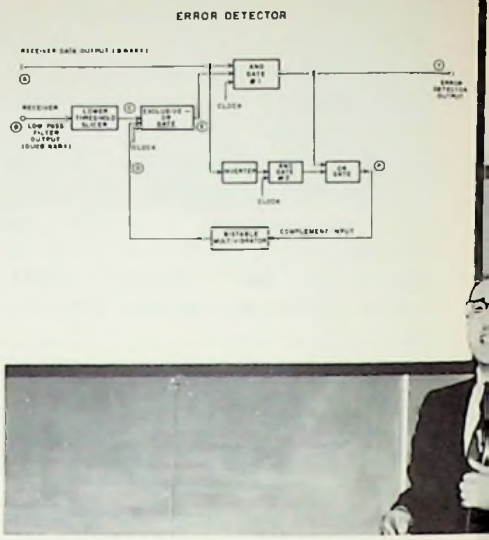
MORE DUOBINARY

Adam Lender of Lenkurt Electric Co., Inc., presented an interesting discussion of the duobinary technique for digital communications at the April 18 joint meeting of the PTGCS and the TDC.

The conventional methods for attaining maximum bit rate per cycle of bandwidth employ multilevel code elements. Because of considerable noise penalty and intersymbol interference, which goes up exponentially with the increasing number of levels, these techniques are restricted usually to four independent signaling elements. The duobinary coding, combined with appropriate signal shaping, results in a time function consisting of a series of dependent pulses. As a consequence, the bandwidth of the original binary pulse train is compressed by a factor of two, so that the speed capacity of the duobinary technique is the same as for quaternary systems without the necessity of employing four levels. At the same time, detection of errors is accomplished in a simple manner by taking advantage of the correlation properties of the duobinary time function. Any violations of the duobinary rules are sensed at the receiver, so that almost all bursts of errors are detected without introducing redundancy into the original binary data. The effectiveness of this error-detection process has been verified experimentally.

Any modulation method can be used in a duobinary system. Considering that the most likely transmission media for digital data-transmission systems are voice-band telephone lines and high-frequency radio, a suitable modulation method is FM.

In the FM duobinary system two frequencies, f_1 and f_2, are keyed in a binary manner. The separation between these two frequencies (in cycles per second) is numerically equal to one-half the input data rate. At the output of the keying circuit, the signal wave still is in binary form, with ZEROS being represented by changes between f_1 and f_2 and ONES either f_1 or f_2. The transmitting bandpass filter following the keying circuit converts the modulated wave to a duobinary form. Since the BP filter passes only signal frequencies between and including f_1 and f_2 during, for example, a steady ZERO condition, all sidebands are eliminated and a frequency which is an average of f_1 and f_2 will appear. A ONE condition is represented by either f_1 or f_2. Thus, the waveform on the line is duobinary FM, although actually only two frequencies are generated in the equipment. At the receiving end, standard FM demodulation techniques are used. However, the bandwidth of the low-pass filter following the FM discriminator has a nominal pass band of one-fourth the data bit rate. Recovery of the two-state binary signals from the duobinary wave is accomplished with full wave rectifier and regenerator.



Adam Lender and error detector

With the single exception of a rectifying stage at the receiving end, the duobinary FM system has the same amount of circuitry as a straight binary FM system. When compared to systems having equal speed capabilities—for example, an efficiently implemented differentially coherent four-phase modulation system — a duobinary FM system requires only approximately one-half of the circuitry. From the point of view of performance, only a 3-db difference exists between a duobinary system and a binary system. A typical normalized signal-to-noise ratio for a duobinary FM system is 15 db, with a resulting error rate of one error bit per one million transmitted bits.

MAURICE H. KEBBY

MULTIVARIATE PREDICTION

On February 28, Dr. Frederick J. Beutler of the University of Michigan addressed PTGIT on "Multivariate Prediction."

Dr. Beutler's presentation was concerned with the optimum linear prediction of a multivariate random process, $[x_1(t), \ldots, x_n(t)]$, where each $x_i(t)$ is a complex-valued, possibly nonstationary, stochastic process, for which the n^2 covariance functions, $E[x_i(s)\overline{x_j(t)}]$, are known.

It was shown that a Hilbert space, H, can be constructed to include all n x n matrices of the form, A(t)x(t), where A(t) is an n x n matrix of complex, nonstochastic functions of time, and x(t) is the (vector) random process described above, written, however, as an n x n matrix with zero entries everywhere except in the first column. In this space, the inner product (y,z), of $y(s) = A(s)x(s)$ and $z(t) = B(t)x(t)$, is defined as the trace (sum of diagonal entries) of the matrix, $A(s)P(s,t)B^*(t)$, where $B^*(t)$ is the complex conjugate transpose of B(t) and P(s,t) is the expected value of $x(s)x^*(t)$. Hence P(s,t) is simply the covariance matrix, assumed above to be known for the random process, x(t). The square of the norm of y is then (y,y), as usual.

The basic prediction problem is to form an estimate for x(u), optimum in some sense, when x(t) is known for some preceding value (or values) of t. An important special case occurs when the process, x(t), is a wide-sense Markov process. This situation occurs whenever, for any $s \leq t \leq u$, we have $\hat{E}[x(u)|x(s), x(t)] = \hat{E}[x(u)|x(t)]$, where $\hat{E}$ is the optimum estimate; thus the optimum estimate of x(u) then depends only on the most recent known value, x(t). (Similarly, in the discrete-time Markov process, the transition probabilities depend only on the present state.)

The subsequent discussion assumed that linear estimation is used with a minimum mean-square-error criterion. Hence an "optimum estimate" is taken to mean a linear, least-squares estimate. For any z(t) belonging to H, it is well known that such an estimate, y(t), exists. This optimum estimate satisfies the orthogonality condition:

$$[z - y, A(s)x(s)] = 0$$

for all A(s) belonging to H, and all s

belonging to T, a segment of time over which x(s) is known.

Thus, the optimum estimate for x(t), given x(s) at a single instant of time s, is

$$\hat{E}[x(t) \mid x(s)] = R(t,s)x(s)$$

where R(t,s) is an n x n matrix to be determined from the known statistics of the process x(s). This matrix, R(t,s), can be found by using the orthogonality condition. Thus, putting A(s) = I,

$$[x(t) - R(t,s)x(s),\ x(s)] = E[(x(t) - R(t,s)x(s))x^*(s)] = O.$$

Upon expansion,

$$E[x(t)x^*(s)] - R(t,s)\,E[x(s)x^*(s)] = P(t,s) - R(t,s)P(s,s) = O.$$

Now if P(s,s) is a nonsingular matrix, then R(t,s) is found immediately as $P(t,s)P^{-1}(s,s)$. However, even if it has no inverse, one can write $P(s,s) = C^*DC$, where D is a diagonal matrix having the eigenvalues of P(s,s) along the diagonal; some of these eigenvalues will be zero. Replace these zero eigenvalues, arbitrarily, by ones to form a new, nonsingular, diagonal matrix, E. It can then be shown that

$$R(t,s) = P(t,s)C^*E^{-1}C.$$

A process is wide-sense Markov whenever either $R(u,s) = R(u,t)R(t,s)$,

Frederick J. Beutler

or $R(s,u) = R(s,t)R(t,u)$ for $s \leq t \leq u$. These conditions are also necessary, as may be seen from the orthogonality of $x(u) - \hat{E}[x(u) \mid x(t)]$ to x(s), and the fact that x(—t) is a wide-sense Markov process whenever x(t) is.

For stationary processes, the necessary and sufficient condition is simply that

$$P(t,s) = P(t-s) = \exp[C(t-s)], \quad \text{for } t-s \geq O,$$

where C is a matrix of constants with negative real parts. It can also be shown that the solution of the differential equation,

$$\dot{x}(t) = A(t)x(t) + M(t)n(t), \quad \text{with } x(O) = O$$

is a wide-sense Markov process, when n(t) is random noise excitation with convariance matrix, $\delta(s-t)I$, that is, when the input noises, $n_1(t), \ldots, n_n(t)$

are all white and uncorrelated with each other.

A problem related to the basic prediction problem discussed above is the prediction of a functional of a random process. For example, if the (wide-sense Markov) process $x(t)$ is known for $a \leq t \leq b$, one may desire to obtain an optimum estimate for the functional,

$$z(t) = \int_{-\infty}^{t} W(t,s)x(s)ds.$$

The optimum (least-squares linear) estimate, $\hat{E}[z(t)]$, for $t>b$ is readily found to be given by

$$x(a)\int_{-\infty}^{a} W(t,s)R(s,a)ds + \int_{a}^{b} W(t,s)x(s)ds + x(b)\int_{b}^{t} W(t,s)R(s,b)ds$$

since for $-\infty<s<a$, $\hat{E}[x(s)] = R(s,a)x(a)$, while for $b<s \leq t$, $\hat{E}[x(s)] = R(s,b)x(b)$.

A paper on this subject by Dr. Beutler will be published in the next few months in the "Annals of Mathematical Statistics."

BERNARD ELSPAS
CHARLES H. DAWSON

election notes

FROM THE FLOOR

PTGIM officers for 1963-64 will be elected at the May 22 meeting. N. L. Pappas, Iconix, Inc., 1175 O'Brien Dr., Menlo Park, has been appointed chairman of the nominating committee. Members may wish to write suggestions to him.

All chapters and subsections must conclude their elections in time for the June 15 annual meeting, according to section bylaws. Already conducted by ballot card have been elections for PTGAP, PTGR, PTGIT, PTGEM, PTGED, PTGEC, PTGPEP, and PTGMIL. Others, having passed the deadline for preparation of ballot postcards by headquarters, will evidently elect their officers from the floor, as will the Santa Clara Valley Subsection at its May 21 meeting.

national notes

REACTOR CONTROL

J. Forster, manager of application engineering for General Electric's nuclear electronics products section, San Jose, has been appointed chairman of the subcommittee on reactor control and instrumentation of IEEE.

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events of interest

IEEE

June 11-13—**Nat'l Symp. on Space Electronics and Telemetry.** Los Angeles, Calif. Exhibits. Program. John R. Kauke, Kauke & Co., 1632 Euclid St., Santa Monica, Calif.

June 19-21—**Joint Automatic Control Conf.** Univ. of Texas, Austin, Texas. Exhibits: none. Program: Otis L. Updike, Univ. of Virginia, Charlottesville, Va. Proceedings. DL, 9-30-62.

July 22-26—**Fifth Internat'l Conf. on Medical Electronics.** Liége, Belgium. Exhibits. Program: Dr. L. E. Flory, RCA Labs., Princeton, N.J.

Aug. 20-23—**WESCON (Western Elec. Show and Convention).** Cow Palace, San Francisco, Calif. Exhibits: WESCON, 3600 Wilshire Blvd., Los Angeles, Calif. Program: same.

Aug. 27-Sept. 4—**Second Cong., International Fed. of Automatic Control.** Basle, Switzerland. Program: Dr. Gerald Weiss, EE Dept., Polytechnic Inst., 333 Jay St., Brooklyn 1, N.Y. Proceedings. DL, 6-1-63.

Sept. 9-11—**Seventh Nat'l Conv. on Military Electronics.** Shoreham Hotel, Washington, D.C. Exhibits: L. D. Whitelock, 5614 Greentree Rd., Bethesda 14, Md. Program: John J. Slattery, The Martin Co., Friendship Internat'l Airport, Md. Proceedings.

Sept. 18-19—**Twelfth Annual Industrial Electronics Symp.** Michigan State Univ., E. Lansing, Mich. Exhibits: none. Proceedings: IEEE TRANSACTIONS on Industrial Electronics after conference.

Sept. 24-27—**Internat'l Telemetering Symp.** London, England. Program: Dr. L. L. Rauch, Dept. of Aero Engr., Univ. of Michigan.

historical notes

PERHAM FOUNDATION

Members of the section historical committee serving on the board of directors of the Perham Foundation are Earl Goddard, Varian Associates, president; Ralph Heintz, Jr., Stanford Research Institute, vice president; John Shaw, Stanford University, secretary; and Tom Atherstone, treasurer.

The historical committee has embarked on a project to document the Perham collection and recently called for volunteers interested in assisting. For further details call Heintz at SRI, DA 6-6200.

Bandes

Corolis

grid swings

IT IS REPORTED:

Dr. Herbert Bandes has been appointed director of research for Eitel-McCullough, Inc. He was formerly senior staff member with Arthur D. Little, Inc., at the San Francisco western region headquarters. Dr. Bandes will supervise the activities of the firm's three research groups: advanced research headed by Oskar Heil; special studies headed by Donald H. Preist; and the process and materials laboratory headed by Robert Culbertson.

Nicholas J. Corolis has been appointed defense programs marketing representative for Motorola's military electronics division new defense programs marketing offices for the San Francisco area, with offices at 701 Welch Rd., Palo Alto.

Meacham

Perrine

David D. Meacham has been appointed sales manager of General Capacitor Co., Palo Alto, and will direct the marketing of the firm's high-power pulse components. He was formerly a project engineer with the company.

C. D. Perrine, executive vice president, General Dynamics, Pomona, will be chairman of the 1964 National Winter Convention on Military Electronics at the Ambassador Hotel, February 5, 6, and 7.

James D. Tupac, head of computing services, the RAND Corp., has accepted chairmanship of the 1963 Fall Joint Computer Conference to be held November 12-14 in Las Vegas.

the section

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Forster

Loeber

Following are the names of members who have recently been transferred to a higher grade of membership as noted:

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ARMS CONTROL

To the scientific mind the subjects of arms control and disarmament present a compelling challenge. Under the U.S. Arms Control and Disarmament Agency, SES-West is meeting this challenge... evaluating many areas of arms control, including inspection systems to verify various possible arms control and disarmament measures.

Other phases: analyzing and evaluating future space weapons concepts, studies of sensor capabilities, design of international security systems.

Openings for key men now exist in information collection systems, operations analysis, analysis of future space technology, and data processing methods. If you are interested, inquire in confidence to Sylvania Electronic Systems-West, attention: Ed Quattrocki.

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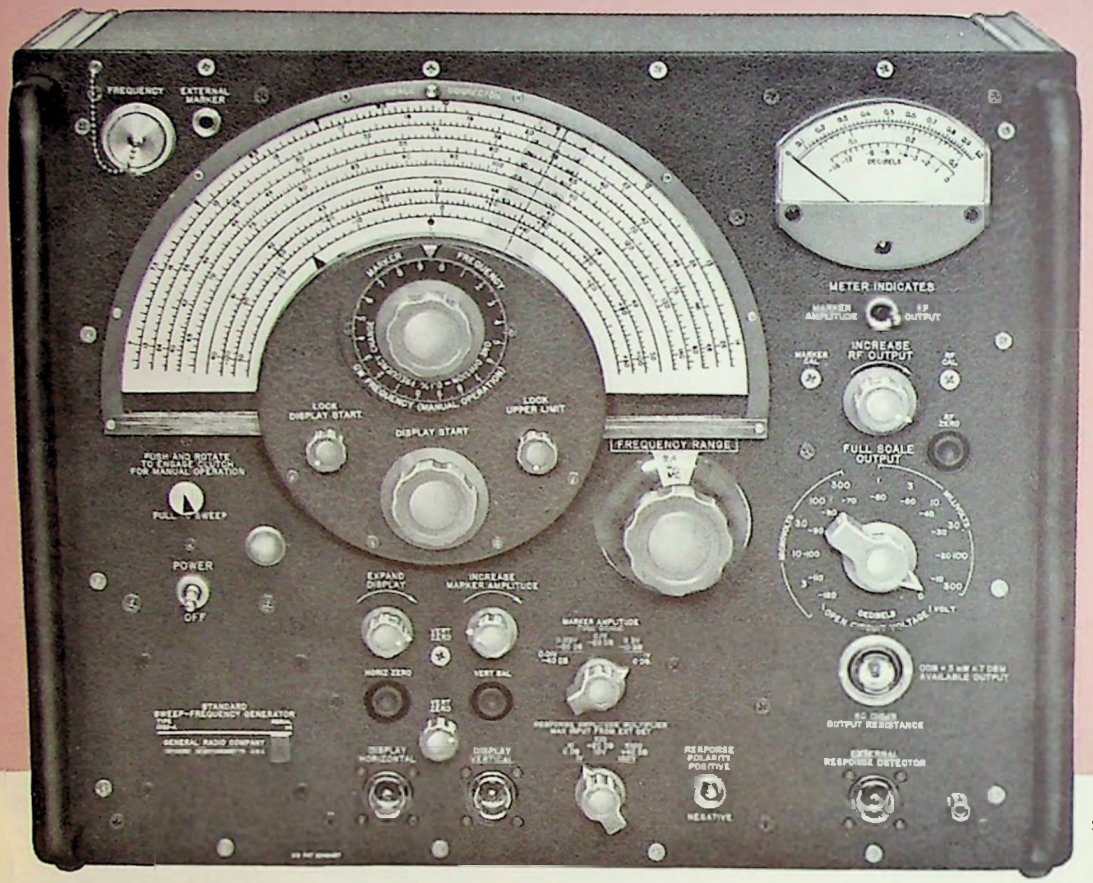
8157

New STANDARD
Sweep-Frequency Generator



Sweep Generator

CW Generator

Marker Generator

Attenuator

and Output Meter

Type 1025-A Standard Sweep-Frequency Generator
Price: $3250 in U.S.A.

... *In One Instrument* ... *Everything you need for Quantitative Frequency Response Measurements*

Ranges:		
0.7-1.4 Mc	4-8 Mc	40-80 Mc
1.3-2.6 Mc	7-14 Mc	65-140 Mc
2.4-4.8 Mc	13-26 Mc	100-230 Mc

Bandspread Ranges: 400 to 500 kc and 10.4 to 11 Mc. Other ranges available on special order.

Sweep Width: Entire selected range is swept. However, visual presentation of swept range can be expanded to permit full oscilloscope display of portions of range as small as 10% with EXPAND DISPLAY and DISPLAY START controls.

Selected range is swept from low end to high end in 22.2 msec twenty times a second. Output is blanked off during return sweep. A saw-tooth sweep voltage is provided which is synchronized with frequency, and adjustable in starting point and amplitude (DISPLAY START and EXPAND DISPLAY controls, respectively).

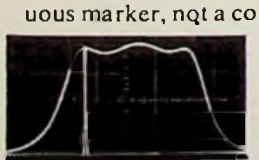
Stability: Drift less than ±0.1% for frequency for 5 hours after one-hour warm-up. Frequency dial accuracy is within ±0.5%.

Marker: Continuously adjustable from 3mv to 1v; multiplier effectively extends range to 100v. Accuracy of indication is typically better than ±10%. Shape and width of marker permit resolution to better than ±0.1% of indicated frequency.

RF Output: Adjustable from 0.3μv to 1v behind 50 ohms (−123 to 7 dbm power into 50 ohms.) Output is flat to within ±1% up to 100 Mc and within ±3% up to 230 Mc. RF amplitude indicated to a typical accuracy of better than ±10%.

★ Covers 0.7 to 230 Mc in ten overlapping octave ranges plus two bandspread ranges (400 to 500 kc and 10.4 to 11 Mc).

★ Has the "perfect marker" . . . continuously adjustable both in frequency and amplitude . . . accurately calibrated in frequency and amplitude . . . lets you take data directly from display . . . does not interfere with response display . . . a single unambiguous marker, not a confusing string of pips.



★ Marker permits frequency measurements to 0.5% directly from display.

★ Instantly converts from sweep to cw operation for accurate point-by-point measurements *without* changing adjustments or connections. Separate output drives frequency counters directly for accurate measurements of low-level devices.

★ Meter measures both rf input and detected output of device being tested.

★ Accessory high-impedance detector probe supplied with instrument simplifies response measurements — minimizes circuit loading.

"What signal generators are to oscillators this instrument is to sweep generators"

★ Accurate—frequency calibration ±0.5% of reading.
★ Stable . . . no annoying drift of displayed response. Low residual fm permits investigations of steep response slopes.
★ Motor-driven capacitor produces a high-level swept signal free from harmonic distortion and spurious outputs.
★ No awkward interactions between controls.
★ Low leakage permits measurements to 0.3 μv.
★ Accurate, 120-db attenuator has low 1.01 VSWR.

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