EDITOR’S PROFILE of this issue
from a historical perspective ...
with Paul Wesling, SF Bay Area Council GRID editor (2004-2014)

January, 1963:
Cover: As we learn more about HF propagation, the performance of HF networks can be optimized. More on page 8.
Page 7: Stanford’s dean of engineering, Joseph Pettit, writes an op-ed on the 4-year nationwide drop in freshman engineering enrollments. The same drop is felt at Stanford, though graduate engineering enrollment is increasing (the school ranks first in PhDs). Turns out that I joined Stanford in September 1962 as a declared electrical engineering student. Pettit goes on to become president of Georgia Tech.
Page 17: Eimac gets the contract to build the large klystrons for Stanford’s 2-mile linear accelerator (SLAC). These are the 50 kW driver klystrons; the final klystron amplifiers will have an output of 25 MW. The total cost of the accelerator should be $114 million.
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**TYPE OR PRINT**

<table>
<thead>
<tr>
<th>WHERE CAN YOU BE REACHED DURING INTERVIEW DAYS?</th>
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<tbody>
<tr>
<td><strong>HOME PHONE</strong></td>
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<tr>
<th><strong>PRESENT OR MOST RECENT EMPLOYER</strong></th>
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<tr>
<td><strong>OK TO RELEASE MY IDENTITY</strong></td>
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<tr>
<td>[ ] All but my present employer</td>
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</table>

| **YOUR NAME** | **HOME ADDRESS (PRESENT LOCATION)** |

The above confidential portion is not shown to employers.

| **CURRENT ANNUAL BASE SALARY $** | **TOTAL YEARS OF EXPERIENCE** |

| **EDUCATION** | **LAST DEGREE** | **COLLEGE** | **MAJOR FIELD** | **WHEN EARNED** |

| **POSITION DESIRED** |

<table>
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<tr>
<th><strong>EXPERIENCE</strong></th>
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<td>[ ] Present or most recent job</td>
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</table>

| **CITY & STATE** | **FROM** | **TO** | **JOB DESCRIPTION** |

Please enclose a personal résumé if available.

January 1, 1963
The waveform display represents four time-related functions—two trace-intensified by use of delayed sweep and two expanded presentations of these intensified portions. Four additional traces are available from this oscilloscope/plug-in combination.

Sweep-delay characteristics include delay interval range of 1 μsec to 50 sec, calibrated and continuously adjustable—with 0.5% incremental accuracy and wide-range, jitter-free magnification.

**PLUG-IN UNITS**

<table>
<thead>
<tr>
<th>AMPLIFIER UNITS TYPE</th>
<th>PASSBAND (3-dB down)</th>
<th>SENSITIVITY</th>
<th>PRICE</th>
</tr>
</thead>
<tbody>
<tr>
<td>2A60</td>
<td>dc−1 Mc.</td>
<td>50 mV/cm—30 V/cm 4 decade steps with variable control</td>
<td>$105</td>
</tr>
<tr>
<td>3A63—Differential (50:1 rejection ratio)</td>
<td>dc—300 kc.</td>
<td>1 mV/cm—20 V/cm 1-5 sequence with variable control</td>
<td>$130</td>
</tr>
<tr>
<td>3A1—Dual Trace (Identical Channels)</td>
<td>dc—10 Mc. (each channel)</td>
<td>6-cm linear scan</td>
<td>$195</td>
</tr>
<tr>
<td>3A2—Dual Trace (Identical Channels)</td>
<td>dc—650 kc. (each channel)</td>
<td>10 mV/cm—10 V/cm 1-5 sequence with variable control</td>
<td>$230</td>
</tr>
<tr>
<td>3A7—Four Trace (Identical Channels)</td>
<td>dc—2 Mc. (each channel)</td>
<td>10 mV/cm—20 V/cm 1-5 sequence with variable control</td>
<td>$250</td>
</tr>
<tr>
<td>3A7—Wide Band</td>
<td>dc—4 Mc.</td>
<td>50 mV/cm—20 V/cm 1-5 sequence with variable control</td>
<td>$175</td>
</tr>
</tbody>
</table>

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2 Identical Independent Sweep Systems
2 Vertical Amplifier Compartments
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Single-Sweep Operation
Rear-Panel Output Connectors
Rack-Mount or Cabinet Model

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January 1, 1963

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cover

Typical HF network is the stock in trade of Granger Associates and its advanced communications manager, Dr. R. D. Egan, who will address another joint meeting of SFS/PGCS/AIEE on January 15. For more on "Oblique Ionosphere Soundings," see the calendar and story—p. 8. Our thanks to Granger and West Assoc. for cover.

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Communicom specializes in the development of transmission systems, such as: data-multiplex, voice-multiplex, and related equipment for use on microwave or cable. Technical capabilities also include design of precision oscillators, discriminators, switching circuits, frequency multipliers, and the like.
MEETING CALENDAR

SAN FRANCISCO SECTION
(Joint meeting with PGCS and AIEE)
"Oblique Ionosphere Soundings and Radio Propagation"
Speaker: Raymond D. Egan, manager, advanced communications, Granger Associates
Place: Auditorium, Crown Zellerbach Bldg., Market and Sansome, San Francisco
Dinner: 6:00 P.M., Mirror Room, 2nd Floor, Veneto Restaurant, Mason and Bay, San Francisco
Reservations: Mrs. Doris Gould, DA 1-1332
(Parking available at restaurant and Zellerbach Bldg.)

SAN FRANCISCO SECTION
(Joint meeting with PGED, SFS, AIEE, and IRE-AIEE student branch, San Francisco State College)
"Electronic Engineering Support of a Weapons Test Program"
Speaker: Edward H. Hulse, head, electronic engineering dept., UC Lawrence Rad Lab, Livermore
Dinner-Meeting: 6:30 P.M., Cafeteria, San Francisco State College
Reservations: Mrs. Doris Gould, Section Office, DA 1-1332, for information and reservations

PROFESSIONAL GROUPS

Antennas & Propagation
8:00 P.M. • Wednesday, January 9
"Space Research Program from the Point of View of Education"
Speaker: Professor Samuel Silver, University of California, Berkeley
Place: Room 277, Cory Hall, University of California campus (Hearst Ave., NE corner of campus, off-campus parking recommended)
Dinner: 6:00 P.M., Men's Faculty Club, University of California campus
Reservations: East Bay—Ellen Fitzmorris, TH 5-6000, Ext. 3539; Peninsula—Darlene Wheeler, DA 6-6200, Ext. 2695

Audio
8:00 P.M. • Tuesday, January 8
(Joint Meeting with SMPTE and AES)
"New Techniques and Equipment for Sound Reinforcement"
Speaker: R. A. Isberg, chief engineer, television office, University of California, Berkeley
Place: 155 Sather Gate Hall, inside and left of Sather Gate, Berkeley campus
Dinner: 6:30 P.M., Golden Bear Restaurant, Room B, near Telegraph Avenue and Bancroft Way (left of Sather Gate), Berkeley, approx. cost: $2.00
Reservations: Call Menlo Park, DA 6-6200, Ext. 3584 or Berkeley, 845-6000, Ext. 25-35, by January 7

Automatic Control
8:00 P.M. • Thursday, January 31
"A Convex Programming Solution of Optimal Control Problems"
Speaker: Prof. J. B. Rosen, Visiting Professor, Stanford University
Place: Electrical Engineering 126, Stanford University
Dinner: 6:30 P.M. Place to be announced
Reservations: Mrs. Pauline Eckman, DA 1-3300, Ext. 268, by noon Wednesday, January 30, 1963
MEETING CALENDAR

Communications Systems
7:30 P.M. • Tuesday, January 15
(Joint meeting with San Francisco Section, IRE and AIEE, see above)

Electron Devices
6:30 P.M. • Tuesday, February 12
(Joint meeting with SFS, AIEE, and IRE-AIEE student branch, San Francisco State College, see above)

Engineering Management
8:00 P.M. • Wednesday, January 9
“Developing Our Human Resources”
Speaker: Harold Barrett, Jr., Bureau of Apprenticeship and Training, U.S. Department of Labor
Place: Stanford Room, Rickey’s Hyatt House, 4219 El Camino Real, Palo Alto
Dinner: 7:00 P.M., Stanford Room, Rickey’s Hyatt House
Reservations: Mrs. Doris Gould, DA 1-1332, by Friday, January 4

Information Theory
8:00 P.M. • Thursday, January 24
“Some Theory on Communication Through Unspecified Additive Noise”
Speaker: Dr. William L. Root, University of Michigan
Place: Philco Auditorium, Bldg. 56, 3825 Fabian Way, Palo Alto
Dinner: 6:00 P.M., Sakura Gardens, 2116 N. El Camino Real, Mountain View
Reservations: Mrs. Radi, YO 8-6211, Ext. 2460, 2522, or 2244

Military Electronics
8:00 P.M. • Wednesday, January 16
“Non-Space Application for Space Computer Technology” (nonclassified meeting)
Place: Lockheed Auditorium, Bldg. 202, 3251 Hanover Street, Palo Alto
Dinner: 6:00 P.M., Red Shack, 4085 El Camino Way, Palo Alto
Reservations: General Victor Conrad’s office, DA 6-4000, Ext. 2212

Space Electronics & Telemetry
8 P.M. • Tuesday, January 15
“LASERS”
Speaker: Dr. Anthony Siegman, associate professor of electrical engineering, Stanford
Place: Lockheed Auditorium, Bldg. 202, 3251 Hanover Street, Palo Alto
Dinner: 6:15 P.M., Sakura Gardens, 2226 N. El Camino Real, Mountain View
Reservations: Tom Linders, RE 9-4321, Ext. 28394 by noon January 15

SAN FRANCISCO SECTION OF AIEE
Communications Division
7:30 P.M. • Tuesday, January 15
(Joint meeting with San Francisco Section, IRE and PGCS, see above)

SAN FRANCISCO SECTION OF AIEE
6:30 P.M. • Tuesday, February 12
(Joint meeting with SFS, PGED, and IRE-AIEE student branch, San Francisco State College, see above)

THE CANDIDATE LAG

First in a series of articles contributed by deans of Bay Area engineering schools on a problem of increasing concern to the profession, Dr. Pettit is a fellow of IRE and was chairman of the Palo Alto Subsection in 1952.

Your editor has asked me to comment on the national phenomenon of declining engineering enrollments, as a member of a group of supposedly “worried deans.” I should like to commence by distinguishing between the national situation and the local one.

Nationally, it appears that the freshman enrollments in engineering are down about 2 percent compared to last year. This is a shrinkage in absolute numbers, in the face of an expanding population of college-age young people, and of an enlarging fraction of those who are going to college. Hence the decline in percentage of the college population is really continuing its four-year decline. Offsetting this, there appears to be a substantial increase in physical science and mathematics enrollments, although the impression I have gained from the statistics available is that the total of engineering, physical science, and mathematics is also declining as a fraction of the college-age population.

(Continued on page 12)
ADDITIVE NOISE

On January 24, Dr. William L. Root will address PGIT on "Some Theory on Communication Through Unspecified Additive Noise."

When the noise added by a communication channel is completely unspecified except that its energy content over a signaling interval is bounded, the concept of a maximum likelihood receiver cannot be used. However, a decision rule can be formulated from game theory concepts which will ensure a minimum receiver performance level regardless of the noise actually present. This is a maximum approach to detection theory.

Dr. Root received his B.S. in electrical engineering from Iowa State in 1940, his S.M. in electrical engineering from MIT in 1943, and his Ph.D. in mathematics from MIT in 1952. After active duty in the Marine Corps and fifteen years' association with MIT and Lincoln Laboratory, Dr. Root became professor of instrumentation engineering at the University of Michigan in 1961. He is a member of the American Mathematical Society and the Society for Industrial and Applied Mathematics, and a senior member of IRE.

Dr. Egan joined Granger Associates' engineering staff in January 1962, after serving as consultant to the firm since 1958 while on the staff of the radio science laboratory at Stanford University. As research associate since 1960, he has been engaged in ionosphere research directed primarily toward auroral effects on high-frequency radio wave propagation, as well as studying the solar-terrestrial relationships influencing these effects.

From 1955 to 1960, Dr. Egan was a research assistant in the laboratory, initially engaged in the design and development of fixed-frequency backscatter sounder instrumentation for the IGY ionospheric physics program. Following the installation of these ionospheric sounders, he was responsible for the analysis and interpretation of the vast amount of data collected. From 1959 to the present, Dr. Egan has supervised projects concerning transpolar radio propagation, ionospheric absorption, forward-oblique step-frequency sounding, as well as continued backscatter research.
**meeting review**

**SECOND-HAND SATELLITE**

Dr. D. A. Chisholm, member of the technical staff of Bell Telephone Laboratories, addressed the November 27 joint meeting of PGCS, PGAP, and Communications Division of AIEE on the Telstar experiment, introducing his talk with a description of the kind of experiment Telstar is designed to be.

He developed the reasons why the Bell Telephone Labs chose the particular kind of satellite for this experiment and pointed out that this means of communication would be the most attractive to transmit bulk traffic across the Atlantic. The satellite was designed to remain in orbit for at least three years, and all component parts were developed to optimize this objective.

Dr. Chisholm made the statement that only "used" components were put into orbit; by this, meaning, of course, that all parts were preaged to detect and remove any that might be marginal. By doing this, the component reliability was improved by about two orders of magnitude.

Because of the success of Telstar and the abundance of information that has been returned via telemetry, plans for launching a second satellite have been indefinitely postponed. Van Allen radiation has not seriously affected component life; however, at the present time the satellite fails to respond to commands to turn on its communications system. The telemetry equipment is still operating normally, and it is expected that information derived from this channel will offer a clue as to the type of trouble in the communication circuit.

Dr. Chisholm concluded his talk with descriptions of both the ground equipment and the space craft itself. He and his staff at Bell developed the highly sensitive amplifiers used at the ground stations at Andover, Maine, and near Bordeaux, France. In addition, they produced the traveling wave tube used in the satellite itself.

MAURICE H. KEBBY

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**DETECTING FOULED-UP SIGNALS**

On November 29, Dr. Robert Price, visiting professor at the University of California, Berkeley, addressed a PGIT audience of forty in the Philco auditorium on the optimum detection, in the presence of strong white noise, of a pulsed signal that has been corrupted by passage through a fluctuating multipath medium.

Here "detection" refers to determining whether the signal is present or absent, given the form of the transmitted signal, the noise level, and the statistics of the medium. This is the radar-astronomical problem or the problem of on-off telegraphy through a tropospherically scattering link.

The optimum decision as to the presence of the signal turns out, under a wide variety of criteria of optimality, to depend on whether some functional of the received waveform exceeds an appropriate threshold. The optimum detector, then, is a device that computes this functional—or any monotonic function of it. Determining its form is a difficult problem, but the leading term of the solution of an

(Continued on page 10)

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**more db for audiences**

Sound reinforcement, an increasing concern in the design and remodeling of auditoriums, theaters, and classrooms as the population explosion calls for larger and larger facilities, will be the subject of the January 8 meeting of PGA, meeting jointly with SMPTE and AES.

R. A. Isberg, chief engineer, television office, University of California at Berkeley, will discuss new techniques and equipment in the field of audio systems. Demonstrations will be given of directional linear array loudspeakers, frequency shift feedback stabilizers, and the new RCA directional microphone developed by Rettinger, the latter the partial subject of a presentation last year in San Francisco before the same societies.

The frequency shift feedback stabilizer was designed by Schroeder of Bell Telephone Laboratories and is now manufactured by a firm in Detroit. This equipment shifts the frequency of the audio signal fed to the loudspeaker by approximately 5 cycles, thereby overcoming some feedback resonances between the speaker and microphone. The resulting over-all benefit permits approximately 6 db greater sound volume than without feedback. The linear array loud-speaker, or line radiator, essentially compresses sound in the vertical plane and radiates the energy directly toward the listening audience.

**meeting review**

**THIN-FILM COMPUTER**

A. S. Zukin of the Hughes Aircraft Company delivered an interesting and well-documented talk on the HCM-202 thin-film computer at the September meeting of PGEC.

The computer is fabricated from circuit boards which use thin-film deposited resistors, capacitors, and "wire." The HCM-202 computer is a parallel and highly modular computer system which is capable of using a number of different memories. These include magnetic drums, cores, and thin-film memories. The memory cycle is six microseconds. The basic circuit component used in the fabrication of the system was a diode transistor "nor." Each 3" by 4" circuit board contains 32 "nor" elements. The resistors and capacitors used were deposited on a substrate by using photomask techniques.

Although the use of deposited passive circuit elements greatly reduced the system size, the main advantage claimed for the technique was that it greatly increased the reliability of the system and would ultimately reduce the fabrication cost.

W. H. DAVIDOW

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**January 1, 1963**
measuring review
RELIABLE MINUTEMAN

At the November joint meeting of PEGM and PGRQC, L. L. Schneider, associate reliability manager, Minuteman Program, Space Technology Laboratory, Los Angeles, discussed management control for the Minuteman reliability program.

The goal was assurance that the 1.5 million dollars per day being spent would result in a reliable system. Criteria of the reliability program were:

- Heavy emphasis on reliability at the outset of the program, rather than an "after the fact" evaluation.
- An easily understood program status summary that pointed to potential problems in organization, parts selection and approval, design, review, etc.
- A positive corrective action follow-up system.
- Definitive reliability requirements and what constitutes having met them.
- A well-defined reliability management organization, both at STL and the contractor organizations, with clear policy and direction.
- Management visibility and feedback.
- A parts reliability improvement program.

Results of such a program were an initial successful firing, continued flight test success, the ability to demonstrate rocket motor reliability based on static tests, improved industry standards, and an order of magnitude of improvement in parts reliability.

Mr. Schneider concluded that through such a positive program Minuteman has been able to advance the reliability state of the art. He reiterated the most important aspects of the program as:

- Early emphasis.
- Improved definition and direction.
- Improved management methodology.

W. WAHRHAFTIG

MORE REVIEW

Integral equation gives a good approximation to the optimum, viz.,

$$D = \int \int \int z(t)z(t)w(s)w(t)ds dt,$$

where w(t) is the received waveform, z(t) is the received signal, assumed zero-mean nonstationary Gaussian, and the bar denotes the mathematical expectation. This expression can be described as the cross-correlation between the true and the observed correlation functions.

When the received signal is known exactly for amplitude, i.e., when the medium does not fluctuate in time, D becomes simply the square of the cross-correlation between the received signal and the received waveform, in agreement with Woodward's solution for that case. At the opposite extreme, where the received signal is stationary and the (fictitious) transmitted signal is a sinusoid, as in the radio-astronomical case, D becomes simply a measure of received energy, with each frequency in the spectrum weighted in proportion to the received signal's expected spectrum.

The best fixed-energy waveform to transmit, subject to certain reservations, can be found by maximizing the output signal-to-noise ratio. In a simple case, it turns out that the optimum pulse length is the geometric mean of the multipath spread and coherence time (reciprocal of bandwidth). It can then be shown that the detectability deteriorates as the ratio of multipath spread to coherence time increases.

Much of Price's talk is based on work appearing in his MIT Lincoln Laboratory technical report No. 234 and in a chapter he has contributed to the forthcoming book on radar astronomy in the McGraw-Hill Lincoln Laboratory series.
Why Don’t Operators Need Gloves with Gudelace?

Gloves are often standard equipment for tying round lacing cord—but not for Gudelace! The diagram below shows why:

When round tape is pulled, it creates a cutting edge on the side touching the operator’s hand. The tighter the pull, the sharper the cutting edge.

Gudelace is different! Gudelace is flat braided and impregnated with microcrystalline wax. When Gudelace is pulled, stress is distributed evenly over the full width of the tape with the wax acting as a “cushion” between the operator’s hand and tape. This wax is soft and spreads when the tape is pulled. Thus, operators can tie Gudelace without gloves!

Write for free samples of Gudelace and our Technical Products Data Book. It will explain why Gudelace and other Gudebrod lacing materials provide real economy and better profits for you.

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MORE DEANS

This decline persists in spite of evidence on all sides of expanding employment opportunities, and presumably, therefore, in an economy in which supply and demand can operate, the problem should correct itself in time. Much is being done by employers, engineering societies, etc., to shift the tide by appropriate (though in some cases inept) publicity. Whether these efforts are truly responsive to the as-yet-undiagnosed sociological phenomenon which is taking place, and whether they will be effective, is certainly not yet clear.

It does appear that we may have to get along for some time with fewer engineers, which is certainly possible if the quality is good. There is no evidence as yet that the quality is in any way declining. We shall also have to get along with a larger fraction of pure scientists compared to engineers, which may also be appropriate to the national needs for the years just ahead.

Locally, now, as far as Stanford is concerned, our freshman engineering enrollment has been declining at a greater rate than the national trend, although our percentage of freshman men in engineering is about twice the national percentage. The quality is better every year. Part of the loss is going into science, particularly mathematics, and another part is going into an increasing fraction of the freshman class who are not initially declaring their major field of interest. At Stanford we admit a fixed number of freshmen without regard to field of interest, nor do they have to declare their major until the end of the sophomore year. We have at the same time a steadily growing graduate enrollment in engineering, which last year overtook the undergraduate enrollment.

As I would see our future, we will continue to turn out a small group of top-quality undergraduates who will have had the experience of four years at a moderate-sized residential university. Hopefully, this will be a leadership group, but not one which will be numerically significant in the state or national scene. At the graduate level, however, we will continue to grow, and will strive to be a significant producer in both quality and quantity. We are already in the top five U.S. schools in output of graduate degrees, particularly at the Ph.D. level, where in electrical engineering we rank first.

There is one troublesome aspect, nevertheless. The concern is not that we are losing undergraduates to mathematics, for instance, when the need for more mathematicians is obvious, but whether students are deciding against engineering for inadequate or incorrect reasons. I think we must continue to try to reach the high-school students with an adequate picture of the diverse opportunities in engineering. The years just ahead should increase the attractiveness of engineering if the projected scarcity results in substantial improvements in salaries and other aspects of employment.

J. M. PETTIT
DEAN, SCHOOL OF ENGINEERING
STANFORD UNIVERSITY

grid returns

Editor, the Grid:

You may find it interesting to learn an indirect effect of a Grid story, which may indicate its readership effectiveness.

The March 15, 1962, issue of Grid reported the results of a meeting of the Professional Group on Military Electronics in a review entitled "PERT for the Engineer." In a sense, this was a "scoop" story which directly resulted in many inquiries about PERT and the PERT-O-GRAPH which I had designed for helping implement PERT for the smaller industrial programs typical of the electronics industry.

Since then, the story has spread to many other publications, including "Electronic News," "Aviation Week," and "Business Week." The resulting thousands of requests indicate that (1) many of the industries have similar problems in "program management," and that (2) they want to learn of the practical newer techniques such as the scaled-down version of PERT.

All this has opened up a fabulous new opportunity to share the knowledge and experience of "PERT for the Engineer" now as a management consultant. My thanks to the Grid for that original story which indirectly helped launch a broad new career for me.

JAMES HALCOMB
JAMES HALCOMB ASSOCIATES
495 CALIFORNIA AVE.
PALO ALTO, CALIF.

January 1, 1963
SWEPT SIGNAL SOURCES

Exclusive...1000 hour Wave Tube Warranty for most models...indicated by built-in Elapsed Time Meter

Specifications

**SWEEP**
- Width...Single control for continuous adjustment from a few megacycles to the entire frequency range of the instrument. Center frequency selected with single continuously adjustable control. Vernier controls enable precise adjustment of both sweep width and center frequency.
- Rate...0.01 to 100 cps, continuously variable. Sweep Rate Range Extender provides additional slow sweep rates to hours. Wide range permits flicker-free scope presentation or graphic recording.
- Selector...Recurrent, Single or External.
- Single Sweep Control...Triggered by front panel button or external signal >20 volts.
- External...Programmable sweep, 200 volts negative required for full sweep width. DC to 10 Kc/s response. Stable 300-volt rear panel output provided for use with external voltage divider for programming or remote control.
- Output...Both constant amplitude and proportional amplitude linear sawtooth voltages provided for synchronized scope or recorder presentation.

Oscilloscope Blanking...+50 volts pulse provided blanking oscilloscope during retrace.
RF Blanking...Switch selects RF ON or RF OFF during retrace. RF ON position, desirable for recorder operation, allows normal RF output during retrace. RF OFF position desirable for oscilloscope operation, provides zero RF output during retrace.
CW Mode...Continuously adjustable or five fixed preset frequencies.

**AMPLITUDE MODULATION**
- Internal Square Wave...RF output is alternately 0 to unmodulated CW value, adjustable from 800 to 1200 cps.
- External...+100 volts maximum signal decreases RF output from maximum to zero. Response: dc to approximately 500 Kc/s.
- Residual FM...Typically less than .0025% peak.
- Size...7" rack panel for 850 series.
- 12" rack panel for 851 series.
- 20" rack panel for 852-858 series.

High Power Leveled Signal Sources
- 1-10 Watts Leveled Output
- Excellent Leveling Characteristics

Internally Leveled Signal Sources
- Excellent Leveling Characteristics
- Available With or Without Microwave Sampling Components

PM Focused TWT AMPLIFIERS

- Gain...30 dB minimum
- Noise Figure...35 dB nominal
- Modulation...focusing element capacitatively coupled to front panel "BNC" jack
- For Closed Loop Applications...optional modulation, from dc to approx. 500 Kc/s on control grid, available.
- Size...5¼" relay rack panel
- Weight...45 lb.

Solenoid Focused TWT AMPLIFIERS
- Noise Figures...to 4.0 db
- Output Power...to 10 Watts

<table>
<thead>
<tr>
<th>Model No.*</th>
<th>Frequency (Mc/s)</th>
<th>Min. Power Output (MW)</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>L975A</td>
<td>1.0-2.0</td>
<td>1.0</td>
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<td>S975A</td>
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<tr>
<td>H975A</td>
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<td>1.0</td>
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<td>1.0</td>
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<tr>
<td>U975A</td>
<td>12.4-18.0</td>
<td>1.0</td>
<td>4,700</td>
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*Specifications and prices of custom TWT Amplifiers in other frequency ranges and at various power levels available on request.

LOW POWER

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MEDIUM POWER

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<thead>
<tr>
<th>Model No.*</th>
<th>Frequency (Mc/s)</th>
<th>Min. Power Output (Watts)</th>
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<tbody>
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SWEPT SIGNAL SOURCES

Exclusive...1000 hour Wave Tube Warranty for most models...indicated by built-in Elapsed Time Meter

Specifications

SWEEP
• Width...Single control for continuous adjustment from a few megacycles to the entire frequency range of the instrument. Center frequency selected with single continuously adjustable control. Verner controls enable precise adjustment of both sweep width and center frequency.
• Rate...0.01 to 100 cps, continuously variable. Sweep Rate Extender provides additional slow sweep rates to hours. Wide range permits flicker-free scope presentation or graphic recording.
• Selector...Recurrent, Single or External.
• Single Sweep Control...Triggered by front panel button or external signal >20 volts.
• External...Programmable sweep, 200 volts negative required for full sweep width. 10 Kc/s response. Stable 300 volt rear panel output provided for use with external voltage divider for programming or remote control.
• Output...Both constant amplitude and proportional amplitude linear sawtooth voltages provided for synchronized scope or recorder presentation.

Oscilloscope Blanking...+50 volts pulse provided for blanking oscilloscope during retrace.
RF Blanking...Switch selects RF ON or RF OFF during retrace. RF ON position, desirable for recorder operation permits normal RF output during retrace. RF OFF position, desirable for oscilloscope operation, provides zero RF output during retrace.
CW Mode...Continuously adjustable or five fixed presettable frequencies.

AMPLITUDE MODULATION
• Internal Square Wave...RF output is alternately 0 and unmodulated CW value, adjustable from 800 to 1200 cps.
• External...+100 volts maximum signal decreases RF output from maximum to zero. Response: dc to approximately 500 Kc/s.
• Residual FM...Typically less than .0025% peak.
• Size...7” rack panel for 850 series 12” rack panel for 851 series 20” rack panel for 852-858 series

PM Focused TWT AMPLIFIERS

Gain...30 db minimum
Noise Figure...35 db nominal
Modulation...Focusing element capacitively coupled to front panel "BNC" jack
For Closed Loop Applications...optional modulation, from dc to approx. 500 Kc/s on control grid, available.
Size...5½” relay rack panel
Weight...45 lb.

Solenoid Focused TWT AMPLIFIERS
• Noise Figures...to 4.0 db • Output Power...to 10 Watts

851 Series

850 Series

852-858 Series

LOW POWER

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</table>

*Specifications and prices of custom TWT Amplifiers in other frequency ranges and at various power levels available on request.
### POWER SUPPLIES

**TO POWER BWO'S/CARCINOTRONS...**

The Model 812 was designed specifically to fulfill the stringent power supply requirements of the American Radio Company (French CSF) carcinotron millimeter oscillators, including the recently developed COE 07. In addition, it finds wide application as a source of power for higher voltage microwave tubes. Logic circuitry provides ultimate in absolute electrical protection for microwave tube.

#### 10KV with Unparalleled Tube Protection

- **Line Supply...** 3-10 KVdc, 100 ma, 30 mv rms ripple, ±0.005% regulation
- **Anode Supply...** 0.1-3 KVdc, 5 ma, 3 mv rms ripple, ±0.05% regulation
- **Grid Supply...** 0-200 Vdc, 10 ma, 1 mv rms ripple, ±0.5% regulation
- **Heater Supply...** 0-10 Vdc, 5 amps, 100 mv rms ripple, ±0.5% regulation

$8,800

---

#### UNIVERSAL MODULES...

Highly versatile, individual power supply modules can be combined to operate low and medium power Klystrons, BWO's, TWT's, VTM's and Carcinotrons. All modules insulated to 10 KV.

---

#### Frequency Range (Gc/s) | Min. Power Output | Power Output (Leveling) Variation* (±db) | Model No. | Price
--- | --- | --- | --- | ---
0.4-1.2 | 50 MW | P850B | ±0.1% regulation | $2950
100 MW | L850B | 2975
100 MW | L851B | 3350
1.0-2.0 | 1 Watt | L852B | ±0.05% regulation | 5975
2 Watts | L854B | 6500
10 Watts | L858B | 8950
1.0-2.3 | 1 Watt | B850B | ±0.005% regulation | 3250
1.6-3.2 | 80 MW | N850B | ±0.01% regulation | 3750
70 MW | S850B | 2850
70 MW | S851B | 3250
1 Watt | S852B | 5600
2 Watts | S854B | 6900
10 Watts | S858B | 8850
2.4-4.7 | 50 MW | T850B | ±0.1% regulation | 3700
3.6-7.2 | 20 MW | W850B | ±0.01% regulation | 3900
15 MW | W851B | 4750
4.0-8.0 | 20 MW | C850B | ±0.01% regulation | 2750
20 MW | C851B | 3250
1 Watt | C852B | 6750
10 Watts | C858B | 8280
7.0-11.0 | 2 Watts | H854B | ±0.01% regulation | 8350
10 Watts | H858B | 9550

---

#### Frequency Range (Gc/s) | Min. Power Output | Power Output (Leveling) Variation* (±db) | Model No. | Price
--- | --- | --- | --- | ---
7.0-12.4 | 20 MW | H850B | ±0.1% regulation | $3375
1 Watt | H852B | 8850
12.0-16.0 | 5 Watts | H856B | ±0.005% regulation | 9500
8.0-12.4 | 1 Watt | H858B | ±0.01% regulation | 2850
2 Watts | H854B | 8475
8.2-12.4 | 5 Watts | X851B | ±0.01% regulation | 3450
10 Watts | X854B | 4250
10.0-16.0 | 10 MW | D850B | ±0.005% regulation | 3285
12.4-18.0 | 10 MW | U850B | ±0.01% regulation | 3250
8 MW | U851B | 4250
2 Watts | U852B | 9600
2 Watts | U854B | 10400
15.0-20.0 | 10 MW | Y850B | ±0.01% regulation | 3750
18.0-26.5 | 5 MW | Y852B | ±0.01% regulation | 4150
4 MW | K851B | 5150
26.5-40.0 | 3 MW | V850B | ±0.01% regulation | 4850
2 MW | V851B | 5950
40.0-50.0 | 3 MW | Q850B | ±0.01% regulation | 6900
50.0-60.0 | 3 MW | M850B | ±0.01% regulation | 6900

---

*Maximum variation over complete instrument frequency range. Narrow band leveling typically ±0.1 db.

---

Image: "parodynamics"
HIGH POWER

Microwave Signal Source

Model X890A is a versatile source of high power pulsed energy for the popular 8.500 to 9.600 Mc/s frequency spectrum. It utilizes a tunable magnetron oscillator and hydrogen thyratron line-type modulator.

- Peak Power Output . . . 5 to 50 kW, continuously variable
- Average Power Output . . . 0 to 50 Watts, continuously variable
- Pulse width . . . 0.6 μsec or 2.1 μsec
- Pulse Repetition Rate . . . 450, 1000, or 1500 pps
- Sync Output . . . +5 to 20 volts
- External Trigger . . . ± 15 volts, min.
- Modulator . . . type 6587 hydrogen thyratron
- Size . . . 8¾" relay rack panel
- Weight . . . 50 lb.

$2,590

*Also available for S, C and Ka bands.

a paradynamics Exclusive

SERIES 273 PRECISION REFLECTOMETER

...for VSWRs from 1.01 to 1.1

Paradynamics Precision Microwave Reflectometer utilizes specially modified Series 850 Swept Signal Sources and recently developed broadband 60 db directivity "magic tees" to achieve measurement speed and accuracy hitherto unobtainable in the measurement of extremely low VSWRs.

Slotted line techniques, in addition to yielding only point-to-point, data are relatively slow and inaccurate for measurements of low VSWRs in the range of 1.02. Swept reflectometers using directional couplers, while providing continuous frequency coverage, do not have sufficient directivity to resolve such low values of VSWR. However, with directivities greater than 60 db, accurate VSWR measurements in this range are readily achievable.

By calibrating a dc oscilloscope at desired values of return loss (VSWR) with a precision attenuator, effects of component nonlinearity are made virtually insignificant. With directivity and nonlinearity effects so reduced, system accuracy now depends upon such factors as calibration and attenuator accuracy, and the reflection effects of a movable termination. Utilizing readily obtainable 2% accuracy rotary vane attenuators, and high quality, low reflection terminations, it becomes possible, for the first time, to make measurements of extremely low values of VSWR with the same speed and precision previously obtainable for VSWRs above 1.1.

Prices and detailed specifications for the complete instrumentation system, or the individual components, are available on request.

PARADYNAMICS

WAVEGUIDE FEEDER SYSTEMS... VSWRs < 1.1

Utilizing novel machining and brazing techniques, coupled with extreme care in fabrication, Paradynamics has produced thousands of feet of precision feeders, with overall waveguide assembly (i.e. 100-400 feet) VSWRs averaging 1.07! *

*Measured continuously throughout the waveguide bands with Paradynamics Series 273 Precision Reflectometers.

Prices and specifications subject to change without notice.
accelerating an accelerator

Driver klystrons for the two-mile linear accelerator at the Stanford Linear Accelerator Center (Project M) will be built by Eitel-McCullough. U.S. Atomic Energy Commission has concurred in the award of the contract by Stanford University for the work.

Announcing the initial contract for $170,000, Louis Martin, Eimac marketing director, said the tube firm will deliver the first of the klystrons this year.

Designed to deliver 50 kilowatts peak, 50 watts average, power at S-band, the Eimac driver klystrons are of wholly new design. They are unusually light in weight, using periodic permanent magnets for beam focus. They are among the first power klystrons to use the PPM principle.

Martin noted that this is the first production order the university has released for klystrons for the two-mile accelerator. The giant final amplifiers, which will be driven by the Eimac klystrons, will deliver a peak power of 24 megawatts. The linear accelerator, estimated to cost $114,000,000, is being built under Atomic Energy Commission contract.

events of interest

IRE MEETING SUMMARY


NON-IRE

BALLANTINE Wide-Band VTVM
Measures 300 µV to 300 V
at frequencies 10 cps to 11 Mc

Logarithmic scales with high precision and constant accuracy at any point

Usable as 100 µV null detector, or as wide-band amplifier to 20 Mc

Binding post, or coaxial input to reduce ground current error

Cathode follower probe has high input impedance of 10 MΩ—7 pF

model 317
Price: $495. with probe

A stable, multi-loop feedback amplifier with as much as 50 db feedback, and 10,000 hour frame grid instrument tubes operated conservatively, aid in keeping the Model 317 within the specified accuracy limits over a long life. Its uses extend from simple audio frequency measurements to accurate RF measurements made directly in the circuit using the low-loading cathode-follower probe. Individually calibrated logarithmic scales provide uniformly high accuracy over their entire length. Accuracy is 2%., 20 cps to 2 Mc; 4%, 2 Mc to 4 Mc; 6%, 4 Mc to 11 Mc.

Write for brochure giving many more details

BALLANTINE LABORATORIES INC.
Boonton, New Jersey
CHECK WITH BALLANTINE FIRST FOR LABORATORY AC VACUUM TUBE VOLTMETERS, REGARDLESS OF YOUR REQUIREMENTS FOR AMPLITUDE, FREQUENCY, OR WAVEFORM, WE HAVE A LARGE LINE WITH ADDITIONS EACH YEAR. ALSO AC/DC AND DC/AC INVERTERS, CALIBRATORS, CALIBRATED WIDE BAND RF AMPLIFIER, DIRECT-READING CAPACITANCE METER, OTHER ACCESSORIES.

Represented by Carl A. Stone Associates, 800 North San Antonio Road, Palo Alto, California

— Since 1932 —
grid swings

IT IS REPORTED:
John W. Scheck has been appointed to the newly created position of divisional marketing manager of the Donner Division, principal operating division of Systron-Donner Corp.

Richard W. Loren has been named to the new post of advertising and sales promotion manager for Ultek Corp., Palo Alto, after serving as acting advertising manager at Fairchild Semiconductor, Mountain View.

pgrq news

RQC SF MEET JAN. 22-24
"f(R) = customer • producer • user team" is the theme of the ninth national symposium on reliability and quality control to be held at the Sheraton-Palace Hotel, San Francisco, January 22-24. Technical session topics include general management, research and training, program management, systems analysis, fabrication and assembly, mechanical aspects of electronic design, electronic parts, inspection and screening, statistics, design review, quality assurance, design testing, and maintenance and operation. Symposium headquarters will be located in the French Room on the second floor. Registration will take place in the Ralston Room, 5 to 10 p.m., on January 21, and 8 a.m. to 4:30 p.m., on January 22.

pmnil news

WINTER CONVENTION JAN. 30-FEB. 1
A total of 87 papers in twenty sessions, two of which are classified secret, will comprise the technical program of the fourth annual winter convention on military electronics in Los Angeles, January 30-February 1. The secret sessions will be on guidance and navigation, and antisubmarine warfare. In addition, two confidential sessions on radar and tactical warfare systems will be held, and two invited panel meetings on displays and space environmental simulation and testing will highlight the program. All classified sessions will be held at the Institute of Aerospace Sciences building in Los Angeles, while other sessions and displays will be located at the Ambassador Hotel, convention headquarters.

Advanced Work in H-F Communications

Granger Associates specializes in advancing H-F communications technology. The emphasis is on proprietary development. Excellent opportunities exist for engineers with experience in:

IONOSPHERE SOUNDERS
RECEIVERS
TRANSMITTERS
FREQUENCY SYNTHESIZERS
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VIDEO DISPLAYS

Please contact our Personnel Manager. Local interviews by engineering staff are possible.

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ASSISTANCE TO ELECTRONICS FIRMS FOR BUSINESS INSURANCE PLANNING

WEN BROWN, M.B.A., Stanford.
Eight years' electronics experience.
- Profit Sharing
- Pensions
- Deferred Compensation for Executives
- Group Hospitalization and Surgical
- Group Life and Accidental Death
- Weekly Payments for Sickness or Accident
- Major Medical Coverage
- Disability Income
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- Key Man Insurance
- Stock Redemption
- Business Continuation
- Self Proprietor Partnership
- Corporation
- Estate Cost Reimbursement
- Salary Continuation
- Personal Estate Planning

701 Welch Road, Suite 2222
Palo Alto, California
DA 6-1554

THE NATIONAL PRESS
850 Hansen Way • Palo Alto, California
Telephone 325-3294-3295

January 1, 1963
Geoffrey C. Winkler has been appointed manager of manufacturing for the tube division of Huggins Laboratories, Inc., Sunnyvale, and will be in charge of planning, administration, and technical direction of all TWT production activities.

Ted Morcott has been appointed chief engineer of Moore Associates, Inc., San Carlos, and will be responsible for all engineering activities, including new-product development, in a long-range product research and development program, continuing the scientific work of Laurence Moore, chief scientist.

grid returns

Editor, the GRID:

All of us involved in planning the recent sixth national conference of PGPEP wish to express our appreciation to you and the Grid for the excellent coverage given to this event. The October 1 special issue was especially valuable. The comprehensive treatment of PGPEP background and field of activities was very helpful in placing the conference program in proper perspective.

The Grid was distributed to exhibitors and others who attended. These included the national PGPEP chairmen and representatives from the Boston chapter who will host next year's conference. Their reaction can be summed up by the latter's statement, "The Boston section will be hard pressed to match this fine issue of the Grid."

I feel the Grid was our most useful publicity medium and contributed materially to the conference's success.

A. P. KROMER
GENERAL CHAIRMAN
SIXTH NATIONAL CONFERENCE

FOR AN AFFAIR WITH FLAIR... Not only does the new Cabaña offer the Peninsula's most extensive banquet rooms, but also the finest in food and service.

PALO ALTO
CABAÑA
Palo Alto, California, 4290 El Camino Real, DA 7-0800 • San Francisco, EX 7-2717

DINING-OUT Definitions

trav'eling wave (trav'eling wāv), n. fem. Peripatetic member of naval forces; more attractive versions often seen with escorts at Veneto's. Also refers to farewell gesture made by engineers as they depart for R&D [refreshment and dining] at Veneto's and adj. Gondola Room.

Veneto
RESTAURANT

Just moments away at MASON & BAY
SAN FRANCISCO YUKON 6-4553

Tung-Sol
Press-Fit
Silicon Rectifier
Assemblies

For Applications requiring 3 amps to 75 amps, Tung-Sol production techniques can deliver attractively economical, production-ready rectifier assemblies employing press-fit diodes. Availability of rectifiers in both polarities makes it possible to mount more than one diode on a single heat sink, resulting in assemblies that are the lightest weight available for any given power capacity. For more information about Tung-Sol rectifier assemblies, or press-fit diodes for use with your own heat sinks, write for Bulletin CT-17.

Why don't you get the benefit of Tung-Sol component knowledge and experience too? Tung-Sol components—whether transistors, tubes or silicon rectifiers—fill virtually every military, commercial and entertainment requirement with unexcelled dependability. For quick and efficient technical assistance in the application of all Tung-Sol components, contact:

Your Tung-Sol Representative:
ED DAVENPORT
Menlo Park, California
DA 2-6971

Your stocking distributors:
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ELMAR ELECTRONICS
140 11th St.
TE 4-3311
SAN FRANCISCO
PACIFIC WHOLESALE
1850 Mission St.
LIN 1-3743
SAN JOSE
SCHAD ELECTRONICS
499 South Market St.
CY 7-5858

TUNG-SOL
ELECTRON TUBES • SEMICONDUCTORS
MANUFACTURER/REPRESENTATIVE INDEX

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Ad-Yu Electronics Labs. Inc. Peninsula Associates
Aircom, Inc. Components Sales California, Inc.
Airflow Products Company Richard A. Strassner Co.
Alen Electronics Tech-Ser, Inc.
Ammon Instruments, Inc. Tech-Ser, Inc.
Applied Technology, Inc. Mason Electronics
Astrodata, Inc. Mason Electronics
Astron (Skuttle Electronics) Corp. Long & Assoc., Inc.
AVM Instrument Corp. W. K. Geist Co.
Ballantine Labs., Inc. Carl A. Stone Assoc., Inc.
Barnes Engineering Company Costello & Co.
Baxter Electric Company Tom G. Maier Company
Bausch & Lomb Tech-Ser, Inc.
Bay State Electronics Corp. Perlim Electronics
Beckman/Berkeley Division V. T. Rupp Co.
Beihman/Sherwin Electronics Corp. T. Louis Snitzer Co.
Boonshaft & Fuchs, Inc. W. K. Geist Co.
Boonton Electronics Corp. O'Halloran Associates
Boonton Radio Corp. Neely Enterprises
Burr-Brown Research Corp. W. K. Geist Co.
Burroughs Research Corp. Tech-Ser, Inc.
California Technical Industries Perlim Electronics
Cascade Research Mason Electronics
Chalco Engineering Corp. Walter Associates
Clair Corporation Ault Associates
Climax Corporation T. Louis Snitzer Co.
Clary Arithmetic Centres American Wireless
Components Engineering & Mfg. Co. Premco
Computer Instruments Corp. Components Sales Calif.
Computer Measurements Co. Mason Electronics
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Continental-Wirt Electronics Corporation Tom G. Maier Company
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