rf design

ideas for engineers

January 1986

GHz-Speed GaAs ICs Break RF/Digital Barrier

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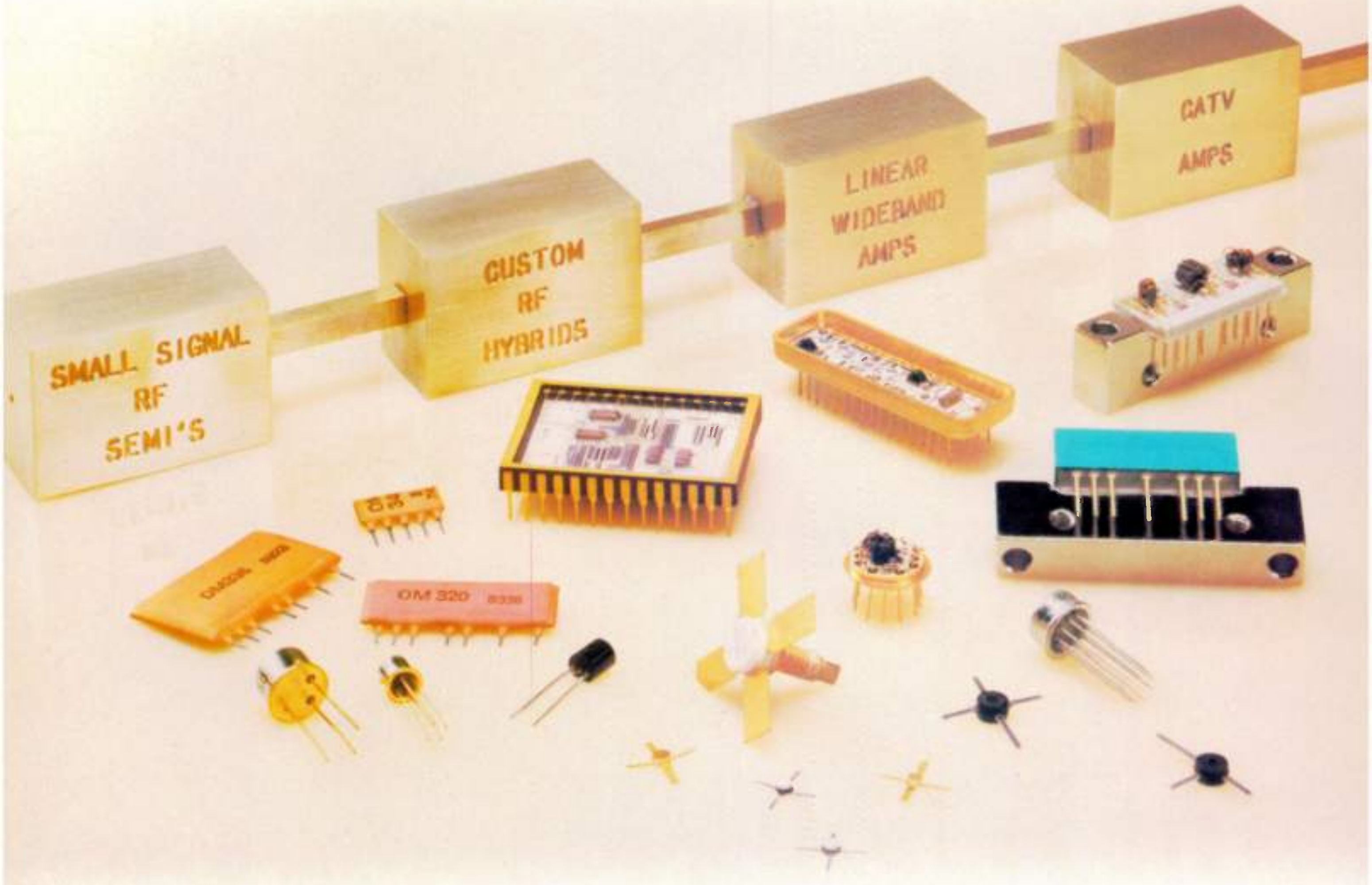

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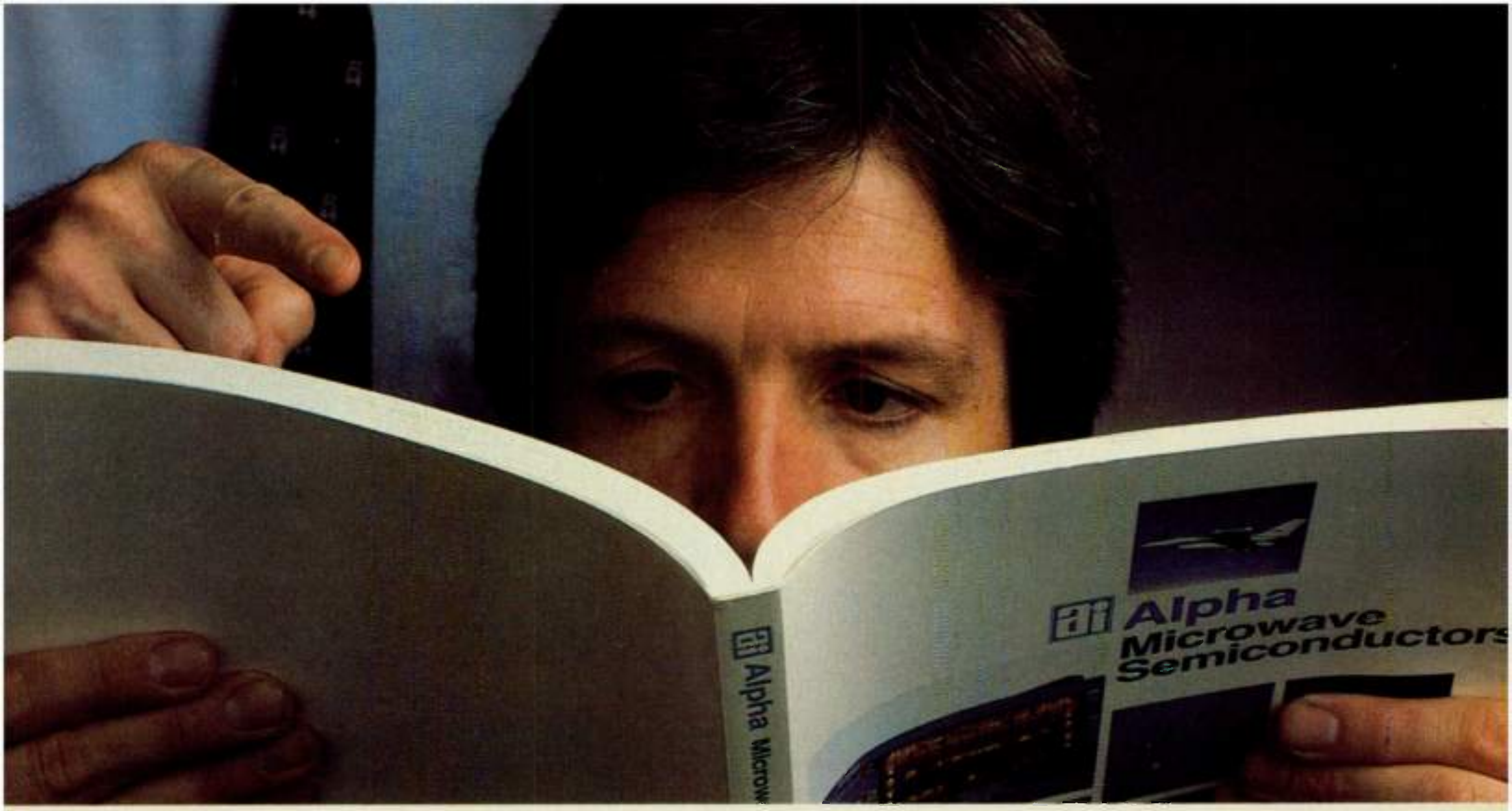
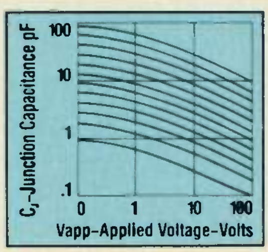


"Look...high Q GaAs Tuning Diodes that are Passivated."

As a major developer of GaAs abrupt tuning varactors, Alpha offers a wide range of devices in passivated chip form. These devices combine the advantages of "high Q" with a wide capacitance range, to accommodate any segment of the microwave spectrum, from low frequencies to millimeter waves. In addition, they offer square-law, broad-band tuning characteristics... and they demonstrate some of the lowest post-tuning drift levels available.

Electrical Specifications				
Model Number			CVE 7800	CVE 7900
GaAs Abrupt High Q Chips			25 Volt Series $C_0/C_{VB} = 3.7/1$	45 Volt Series $C_0/C_{VB} = 6/1$
Suffix	C_0	C_4	Q_4 (50 MHz)	Q_4 (50 MHz)
A	.4-.6	.20	15,000	10,000
B	.6-.8	.35	13,000	9,000
C	.8-1.0	.45	12,000	8,000
D	1.0-1.5	.60	10,000	7,000
E	1.5-2.0	.90	7,500	6,000
F	2.0-2.5	1.10	6,500	5,500
G	2.5-3.0	1.40	5,500	5,000
H	3.0-4.0	1.75	4,300	4,200

Alpha varactors can be used in conjunction with Impatt, Gunn, FET and bi-polar oscillators, as well as analog phase shifters, resonant filters and upconverters. Furthermore, they are compatible with microstrip, finline or suspended stripline circuits (for millimeter wave applications). And while they are able to meet a wide range of technical requirements and specifications, an extensive *custom design* capability is offered, to accommodate customers whose specifications do not match our standard components.



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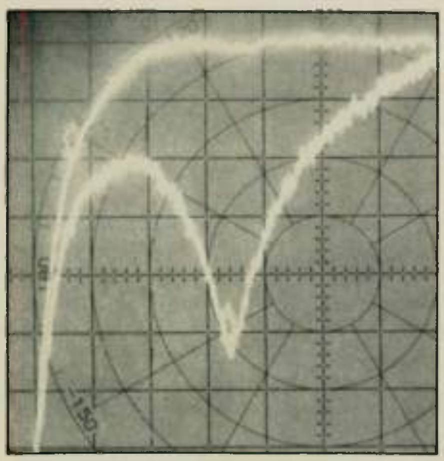
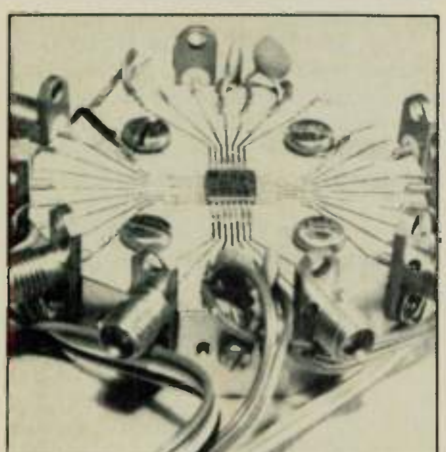
INFO/CARD 21

rf design

January 1986





Cover

This month's cover features GaAs digital IC technology from Harris Microwave Semiconductor. Gallium arsenide devices are rapidly emerging as versatile high-speed solutions to both RF and digital design requirements to 3 GHz and beyond.

Features

Departments

R F DESIGN (ISSN 0163-321X USPS 453-490) is published monthly plus one extra issue in August January 1986, Volume 9, No 1 Copyright 1986 by Cardiff Publishing Company, a subsidiary of Argus Press Holdings, Inc , 6530 S Yosemite Street, Englewood, CO 80111 (303) 694-1522. Contents may not be reproduced in any form without written permission Second-Class Postage paid at Englewood CO and at additional mailing offices Subscription office: 1 East First Street, Duluth, MN 55802, (1-800-346-0085). Domestic subscriptions are sent free to qualified individuals responsible for the design and development of communications equipment Other subscriptions are: $22 per year in the United States, $29 per year in Canada and Mexico, $33 (surface mail) per year for foreign countries Additional cost for first class mailing. Payment must be made in U S funds and accompany request. If available, single copies and back issues are $5.50 each (in the U S) This publication is available on microfilm/fiche from University Microfilms International, 300 N Zeeb Road, Ann Arbor, MI 48106 USA (313) 761-4700
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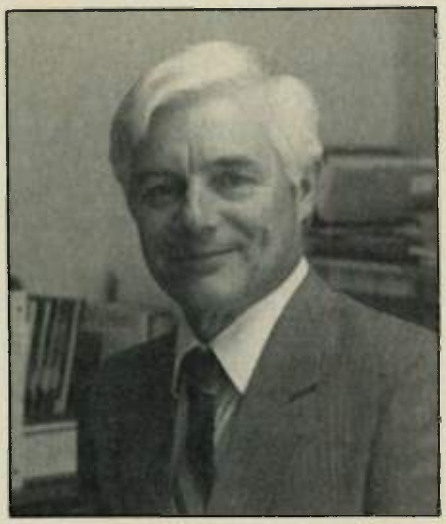
rf editorial

Expo 85 Was a Hard Act to Follow, But . . .



By James N. MacDonald
Editor

As this issue goes to press the Cardiff Convention Staff is processing registrations for RF Technology Expo 86, Jan. 30-Feb. 1, 1986. This is the second show sponsored by *RF Design*, and the response is greater than it was for the first one, last January. Registrations are running more than 50 percent ahead of this time last year.

We have made a number of changes in this year's program in response to suggestions received last year. To begin with, technical sessions will begin at 9:00 a.m., allowing more time for registration and breakfast. We are encouraging attendees to pre-register and steps have been taken to speed the registration process, but we are also allowing for a large late registration. We are allowing an hour and a half for lunch.

One of the major changes at this year's show is that the printed Proceedings will be available at the registration table. Attendees who pre-registered and ordered a copy will pick it up when they arrive. A number of extra copies will be available for purchase, but pre-purchase is recommended. We cannot promise to have enough extra copies on hand for all attendees who do not order one in advance. Since the book is expected to be about 350 pages and weigh more than three pounds, transportation is a problem. Attendees can purchase the Proceedings for $35. Those who do not attend and pick up the book will have to pay the full price, $95.

Another significant change is that each paper is scheduled to begin at a specific time. One hour has been allotted for each presentation to allow time for questions and answers. If the full hour is not needed, and we assume it usually will not be, the next paper will not begin until its scheduled time. This will allow attendees to go from session to session to hear specific papers. Since the session rooms are close to the exhibition area, attendees may also visit the exhibits between papers.

The Fundamentals of RF Design course was unexpectedly popular last year. Many on-site registrants had to be turned away. To avoid disappointment and congestion at the registration table, pre-registration is required for the course this year. We urge those who want to enroll in this course to register early. Seating is limited, and as of the end of November, the Wednesday course was 20 percent filled. Although the show begins Thursday, Jan. 30, the all-day Fundamentals course is offered Wednesday, Jan. 29, as well as Thursday.

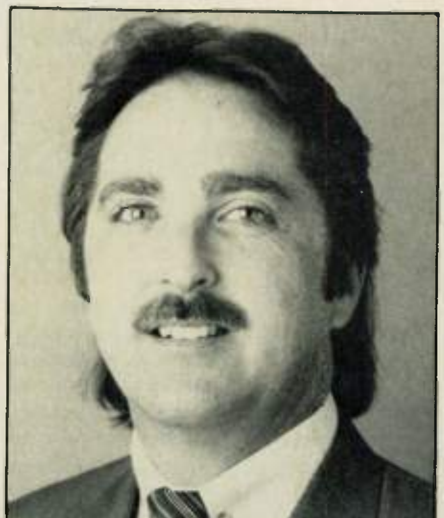
Since so many *RF Design* readers are amateur radio enthusiasts, several of last year's attendees suggested we originate some ham activities at Expo 86. We were not able to do that, but we do suggest that those who have handy-talkies bring them along. This communication capability may help hams get acquainted and organize informal meetings in the evenings.

It promises to be a great show for RF designers and we are looking forward to it.

James N MacDonald

rf viewpoint

Renting: A Lower Cost Alternative



By Leon O'Dell
National Marketing Director
Test Equipment Corporation

Today's high-tech environment requires an enormous capital outlay for test equipment, and staying on top technologically can be costly for many reasons other than financial. That's why more and more companies are turning to rentals as a practical alternative to purchased test equipment.

Equipment from companies like Hewlett-Packard, Tektronix, EIP Microwave, Wavetek and others is available for short or long-term rental, lease, rental/purchase option or for outright purchase of reconditioned used equipment. Whatever the equipment need, it's probably something that can be obtained quicker and for less money than purchasing from the factory.

Reasons to rent

There are numerous reasons for renting. These include:

Restrictions of capital budgets;
Long factory lead times — rentals are instant delivery;
Evaluation of equipment prior to purchase;
Risk of obsolescence by buying;
Higher utilization — equipment is paid for only when being used;
No calibration or maintenance costs;
Equipment for back-up duty;
Operational failures (down time);
Short-term projects — research, etc.;
Off-site testing;
Educational usage;
Better tax treatment — rentals are treated as operating expenses rather than capitalized. In fact, R & D expenses are currently receiving an additional 25 percent tax credit.

Now, with new tax proposals, it appears likely that the popular Investment Tax Credit (ITC) may be discontinued, changing corporate strategies on acquisitions.

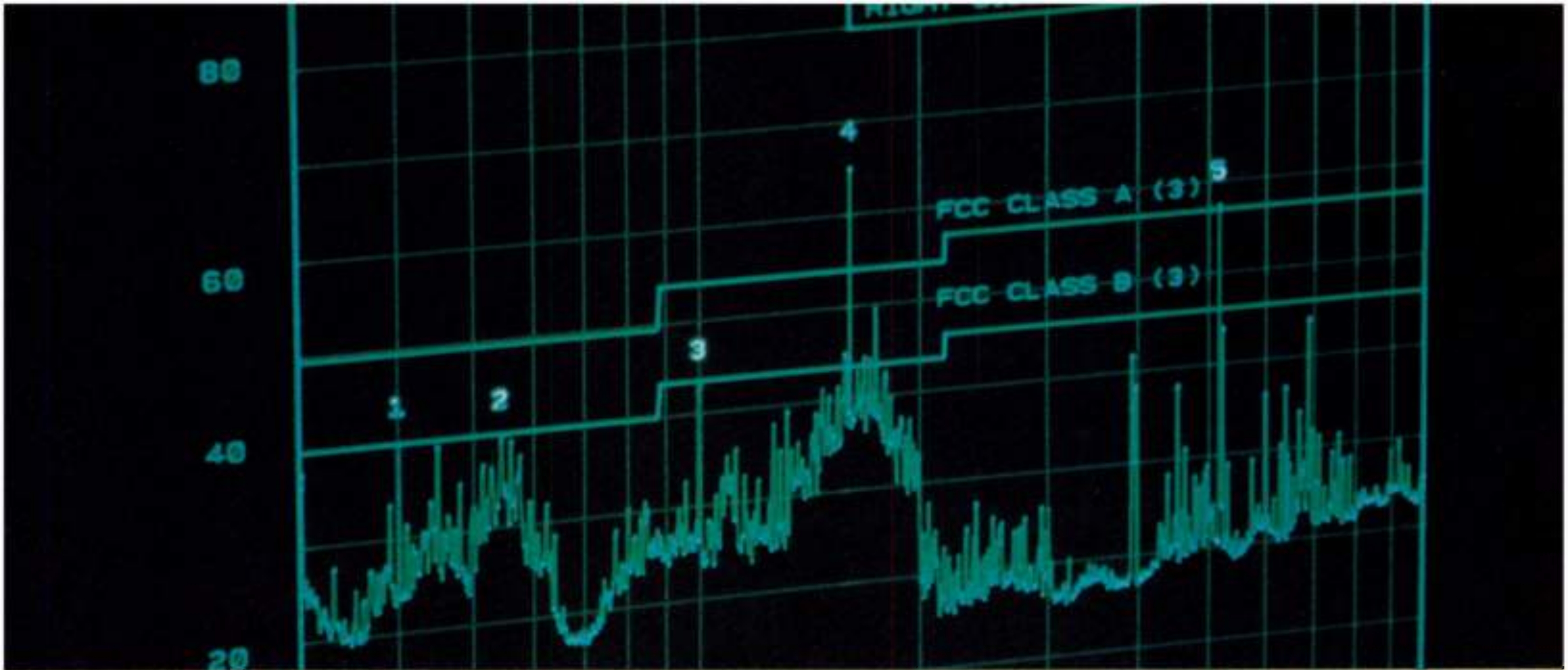
Today's businesses are in a fight for survival. Those that preserve capital and minimize expenses will succeed. Perhaps a good start toward preserving that capital is to explore the possibilities of renting. It has become a positive solution for equipment acquisition problems.

Leon O'Dell

This column is a forum for RF Design *readers in a position to have a broad view of the electronics industry. We invite company owners, executives and managers to use this space to share their opinions about the industry and how it functions.*

The space is equivalent to two pages or a little more, of double spaced typewritten copy. Material should be sent to the editor and include a photograph and the writer's signature in black ink.

Occasionally, one of the RF Design *staff may have a column in this space, too.*



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Perform open-site tests with confidence.

When it's time for final compliance testing, the same HP spectrum

analyzer used during the design and evaluation stages can be combined with the HP85685A RF Preselector and the HP85650A Quasi-Peak Adapter. The result is an EMI receiver system with the sensitivity, overload protection and ±2 dB amplitude accuracy you'll need for both indoor and outdoor compliance testing.

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*CISPR (Comite International Special Des Perturbations Radioelectriques) Publication 16 is the "CISPR specification for radio interference measuring apparatus and measurement methods."

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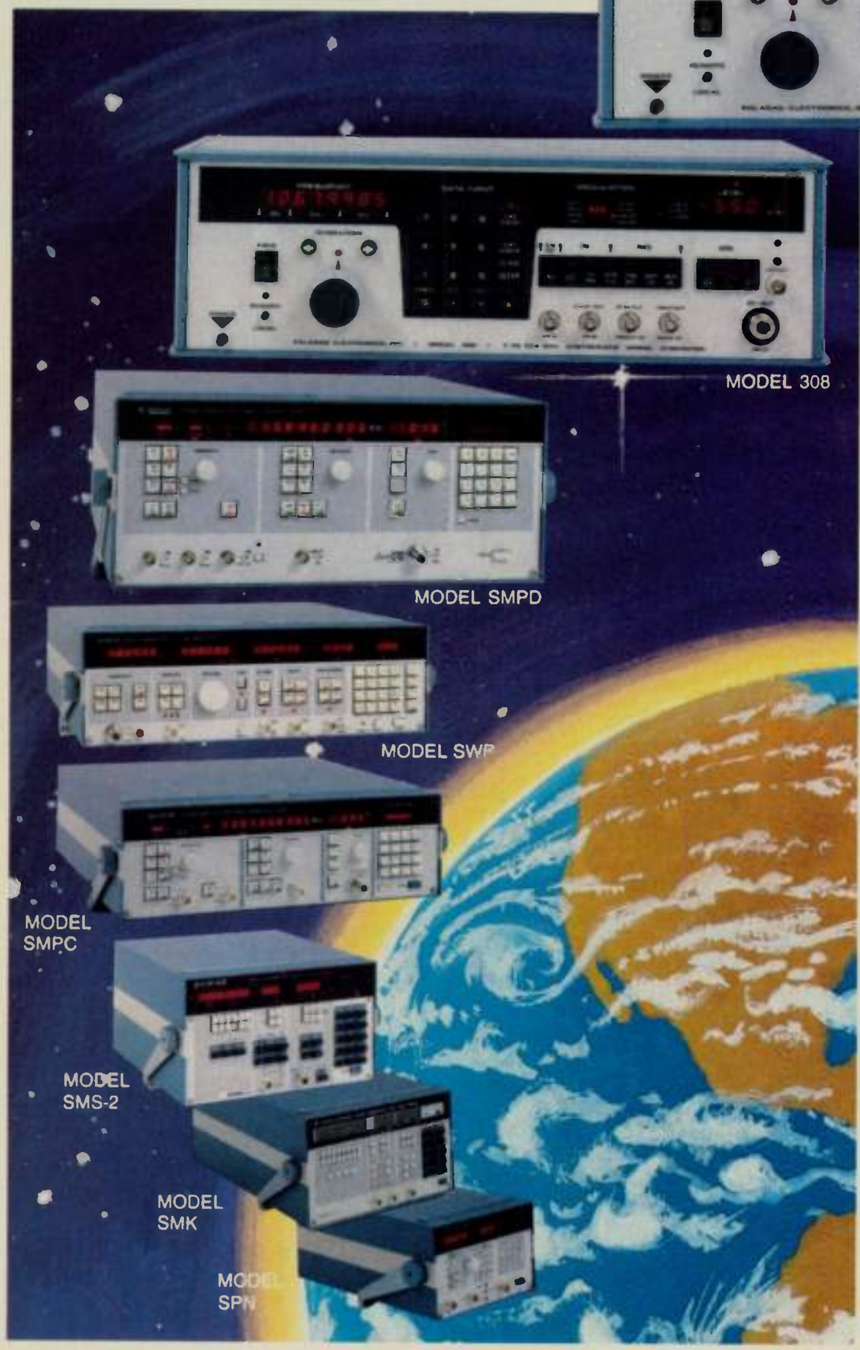

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INFO/CARD 8

rf letters

Editor:

The "Ultra-Lightweight HF Transmitter. . ." article can be best described with a single adjective: beautiful! This is the kind of notes "not serious enough" to appear in more "serious" microwave and RF publications, that is why I enjoy RF Design so much.

I would like to get some words across to the author:

- Thanks for the myths-denouncing paragraphs.
- It would have been nice to include his amateur license after his name.
- Having already taken a lesson from so-often-neglected tube technology, another idea can be borrowed from tube circuits, that of self-biasing with cathode resistors. This could eventually lead to the saving of bias potentiometers.
- A precious amount of DC power is wasted at the power supply just for the sake of not exceeding breakdown Vds. So. let's do away with the regulator and borrow another idea, this time from transistor audio power amplifiers: try a single-ended output stage. This way, with 300V of Vdd there's the warranty that no more than 300V will appear across any transistor. 350V MOSFETs are significantly cheaper than 450V models. In addition, load impedance is one-fourth the drain-to-drain value of a push-pull configuration, hence more comfortable to work with. As there are no complementary high voltage MOSFETs, two N-channels will be required, with T2 having two separate windings to drive each one. If coupling between primary and secondaries is good, and phase is correct, neutralization can be accomplished by a single variable capacitor from Q1 collector and output midpoint.
- The efficiency is so low. . . haven't you checked for VHF oscillations? Apart from this, some power MOSFETs' built-in gate-source zener is actually the emitter of a parasitic NPN whose collector is intrinsically connected to the drain. I couldn't get the IVN6000 data sheet, but should it have the zener, it could be responsible for the less-than-desired performance.
- The parts list would be welcomed.

Once more, thanks for the style of your magazine.

Daniel Perez,
Engineer
LU8AKN

Editor:

In your September 1985 issue (pp.29-32) an article appeared titled "Wide Dynamic Range Linear Detection." Mr. DeAgro of Hazeltine Corporation has explained very well to your readers the principles of operation of a variation of the precision rectifier techniques using an op-amp. A few minor captioning and typographical errors occurred, which I won't bother to bring to your attention, since they should become obvious to the persevering reader.

However, I should like to correct several notions and assertions concerning "wide dynamic range." The first point I will make is that even a hard limiter has an essentially infinite dynamic range, but not a very linear one. Hence, one must define "dynamic range" by some linearity (or usefulness) criteria. If one's definition is a 0.01 percent departure from a straight line relative to the full-scale value, then a 60 dB dynamic range which satisfies this definition would dictate that at 60 dB down from full scale, the detected output DC (or envelope voltage) must be also 60 dB down within 1 dB. This is a significant achievement! The approach suggested by Mr. DeAgro will not achieve this level of accuracy unless the input voltage offset of the op-amp is trivial, the diodes D2 and D3 are well-matched and thermally coupled, and the op-amp has 10,000 times more open-loop 3 dB bandwidth than the carrier frequency. (This occurs because the dynamic resistance of the feedback diode has increased 1000 times at 60 dB down signal relative to 0 dB signal current, and we must obtain 10 percent error, requiring the op-amp to produce 10,000 times more closed-loop gain, assuming that R1 and R4 are resistors chosen to be less than or equal to the diode resistance at 0 dB signal level).

Therefore, if the 0 dB maximum signal strength is small enough to cause diodes D2 and D3 to exhibit resistances higher than R1 and R4, or even significantly fractional relative to R1 or R4, a hopelessly non-linearizable case results. On the other hand, as R1 and R4 are chosen much much larger than diodes D2 and D3 resistances, respectively, then the diode, stray, or load capacitances may become an issue at high frequencies. Also, if the load resistance presented to an ordinary detector diode is made extremely large, then the current in the diode is small and its forward drop negligible, thus eliminating the need to linearize anyway (although envelope-following speed becomes the problem).

Therefore, the author's assertion that this topology will work up to 200 MHz is not based on reality.

I have described a circuit which yields slightly better performance, and does not require an op-amp with high gain at DC; in fact, the open-loop amplifier gain can be peaked in the vicinity of the carrier frequency and its sidebands. Such a circuit was detailed in my article in the Journal of the Audio Engineering Society 1981 July/August "Ultra-High Performance Amplitude and Frequency Modulation and Demodulation," page 494. The circuit is also immune to the input voltage offset of the open-loop amplifier.

Even this latter circuit improvement falls far short of the requirement for truly *linear* wide-dynamic range envelope detection, except at insultingly low carrier frequencies, say 200 kHz.

As president of a new company specifically engaged in designing and fabricating truly *linear* wide-dynamic range detectors up to 18 GHz carrier frequencies using patented circuit approaches, I can tell your readers that far better and more sophisticated detector technology is available. Our 3PPD envelope detector can, for example, achieve 0.01 percent full-scale linearity over the 10 kHz to 3 MHz carrier frequency range at 70 dB dynamic range (3200 millivolts peak-to-peak carrier down to 70 dB under that) and usable 60 dB dynamic range to 8 MHz. Our model 2A detector, using yet another patented circuit approach, yields 50 dB linear dynamic range to carrier frequencies from 10 MHz to 1 GHz at envelope bandwidths to 200 kHz, and our 1 GHz-18 GHz linear detectors afford comparable linearity and dynamic range at Amplitude Modulation envelope rates from DC to 10 MHz.

Your readers may wish to confirm the hopelessness of the approach recommended in your September issue at carrier frequencies above 10 MHz, even using highly state-of-the-art op-amps, such as the ones mentioned in the article, unless they have very robust 0 dB reference signal amplitudes.

I do not wish to give the impression that Mr. DeAgro's circuit is inadequate for certain applications. On the contrary, his approach is a variant of an "old standby" that has found applications at audio and low RF frequencies for many years, but will leave those engineers completely nonplussed who desire "ultimate" linearity performance at those frequencies, or just fair linearity at VHF/UHF frequencies.

Daniel Talbot, president
T-Tech
Hudson, Mass.

Editor:

One of your readers brought my attention to an article titled "EMI Susceptibility: Update on Test Methods." It was published in the November 1985 issue. I have no negative comments on the article. It is in fact a good article. What I do want to comment on is the base of contribution. All the contributors listed are indeed qualified to support the article. You will note that in this same issue, however, G&H Technology, Inc., has a full page advertisement for its Electromagnetics Laboratory. I would think that qualifies us to be solicited for information on shielding and testing. In fact, we believe we are preeminent in this field.

G&H has also published technical papers and is continuing to do so. In the future, please include us in your technical data base on EMC technology. You may contact the undersigned or Dr. Clinton Dutcher, (805) 484-0543, ext. 595.

Gerald E. Walters
Vice President
Marketing and IR&D
G&H Technology, Inc.

For information about G&H Technology please circle INFO/CARD #118. — editor

We receive many Comment Cards with helpful suggestions, responses to particular articles and requests for information. Our policy has been not to print Comment Cards in the Letters column because most of them are clearly not intended for publication.

This month we have selected a few to publish because they contain comments other readers may find interesting. We read these Comment Cards and often act on the suggestions they contain. We invite readers to respond to the suggestions or requests for information given here.

Generally, if you want your comments to be published, write us a letter. If not, use the Comment Card. — editor

Reader Requests

Help! I'm looking for a type SSMA push-on adaptor, and I can't even get manufacturers to call me back. Who *really* does "specials" rather than just talking about it?
James Rieger, Naval Weapons Center

Where does one look for GaAs Digital/Logic Device packaging, 1 to 3 GHz range; it is digital true but also microwave frequencies. Would appreciate any write up or literature.
V. Williams, Ford Aerospace

Quality assurance has become a #1 issue here at G.E. and our associate companies around the country. Design, production and quality have now unified and are no longer separate entities. This is a foreign influence; primarily Japanese. Comments and insights from companies would be interesting reading.
Stan Gualtier, General Electric

Suggestions

Editorially, your magazine is the most worthwhile of all those I receive. Useful content is exceptionally high. What's the fascination with Commodore programs, anyway? IBM PC programs would be much more applicable to most readers.
No name given

Glad to see that you are using the C-64 Basic language for the programs of your articles. Excellent! Your magazine is one of the best. Keep those C-64 programs coming.
Don Watts, Radar Technology, Inc.

Smith Chart articles in Jan./Feb. 82 and June 85 were super, especially applications for Commodore 64.
P. Schneeloch, Western Electric

Evaluations

It seems like every article in almost every issue we receive comes to solve a problem we are having or had in the past! Let's see: We haven't received the 6/85 number, with the first part of "Preventing Unwanted Oscillations...," but the 2nd part brought us a solution to an already existing problem like a telepathic calling. Please, more articles on HF and UHF circuits... I found very interesting the note on SAWFs, particularly because of the step-by-step illustrated explanation on how to get practical filters. As to the "Ultra-Lightweight HF Transmitter," please read the letter I have enclosed.
Daniel Perez, GTE International, Argentina

Articles about EMI/EMC testing and using EMI Test Equipment, using standards. This is one of the best electrical engineering periodicals because it has info we can apply. Keep it applicable — it's great.
Randy White, AT&T Technologies

"RF Circuits — Miniaturization" was an excellent article — out of all the RF-Microwave mags I get I really enjoy yours.
Steven Symes, Tau-Tron

Good Information! Would like to see more MBasic Programs backing up the design articles.
Bill Yotter, Cubic Corp.

An excellent magazine that bridges the gap between the heavy theoretical and everyday practice! Keep up the good work.
Richard Putz, Rich's Communication

Your publication is the best in its field, and is really the only publication that didn't water-down RF and analog with the computer craze. See you at the RF Expo in January 1986.
Dr. Berford A. Turke,
Audio Intelligence Devices

RF Design has improved greatly. One-page papers like page 53, October, "FM Tran" (plus Feb. issue) are *INVALUABLE*, WORTH GOLD! Everyone would like two or three pages like that in *EVERY ISSUE!* Best luck!
Dr. Harry E. Stockman

Article on Wide Dynamic Range Linear Detection was very good. Congrats to Mr. DeAgro.
H.L. Ebbeson, Shell Western E&P Inc.

I need an article on how to calculate and measure the parameter "antenna factor." Because this parameter "antenna factor" appears in the equation for converting microvolts measured at the input of the receiver to microvolt/meter. I generally use a dipole antenna tuned to the frequency I am investigating for FCC Class B EMI.
Leo DeZube, Anadex

"Antenna Factor" usually refers to a calibration which is specific to the antenna used, established by measurement in a known field. The general equation which can be used for an approximation is:

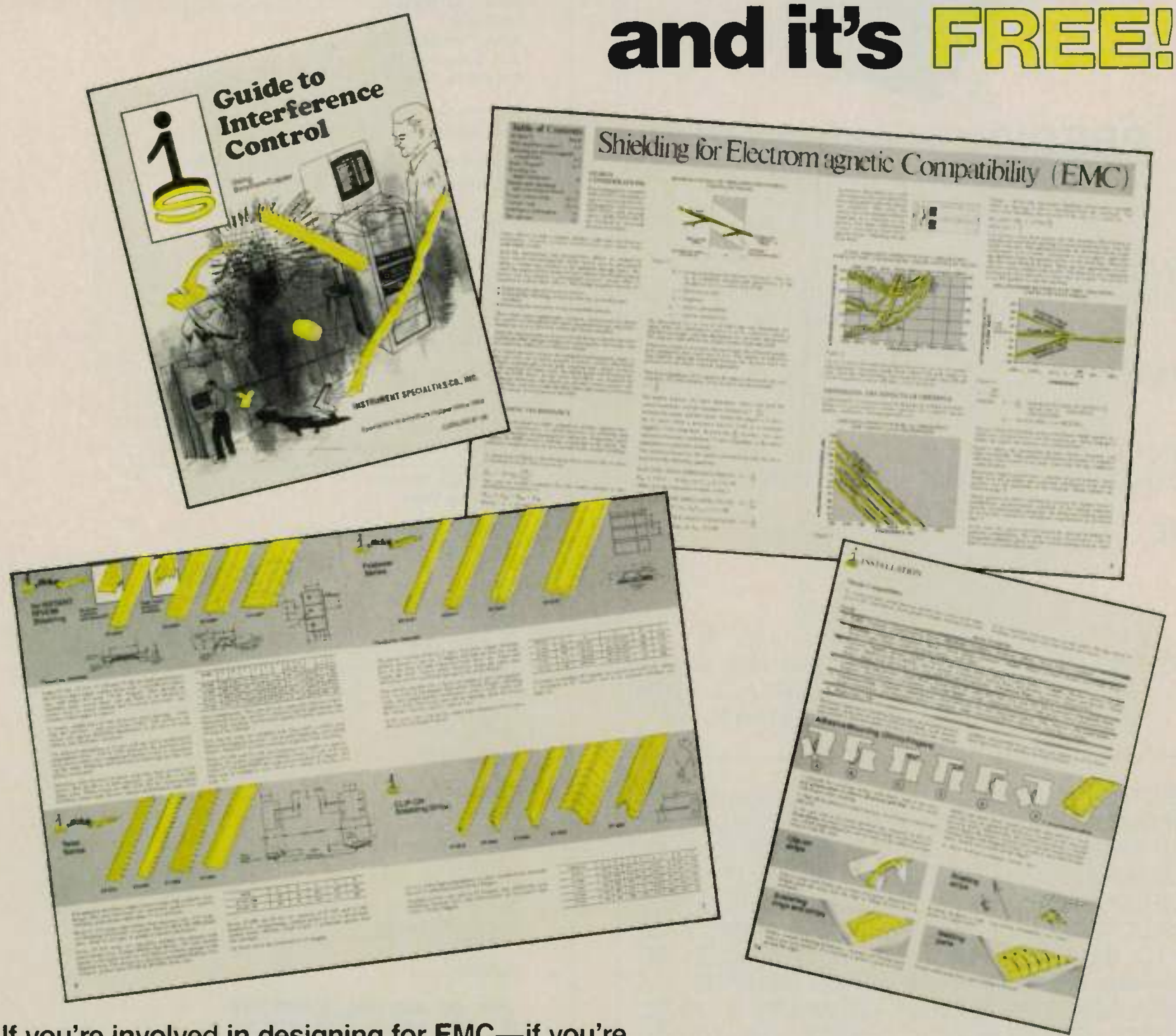
$$V = \frac{E\lambda\sqrt{R}}{53.7}$$

Where V = Volts across load
E = Field strength (V/m)
R = Dipole impedance (ohms)
λ in meters

From: NAB Engineering Handbook, *7th Ed., p. 2.7-207 — technical editor.*

Please have more articles on RF circuits on different substrates: Teflon copper, gallium arsenide, etc.
W. Beckett, TRW Systems

NOW! In one manual— all you need to know about EMC design and products— and it's FREE!



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rf calendar

January 21-23, 1986
Advanced Semiconductor Equipment Exposition and Technical Conference
San Jose Convention Center, San Jose, California. Information: Joyce Estill, ASEE '86 Show Manager, Cartlidge and Associates, Inc., 1101 South Winchester Blvd., #M259, San Jose, CA 95128; Tel: (408) 554-6644

January 21-23, 1986
Electrical Overstress Exposition
Anaheim Hilton and Towers, Anaheim, California. Information: Jim Russell, EOE, 2504 N. Tamiami Trail, Nokomis, FL 33555; Tel: (813) 966-3631

January 28-30, 1986
Systems Design and Integration Conference
Brooks Hall, San Francisco, California. Information: Electronic Conventions Management, 8110 Airport Blvd., Los Angeles, CA 90045; Tel: (213) 772-2965

January 30-February 1, 1986
RF Technology Expo 86
Anaheim Hilton and Towers, Anaheim, California. Information: Kathy Kriner, Cardiff Publishing Co., 6530 S. Yosemite St., Englewood, CO 80111; Tel: (303) 694-1522

March 11-13, 1986
Automated Design for Engineering for Electronics West
Moscone Convention Center, San Francisco, California. Information: Show Manager, ADEE WEST, Cahners Exposition Group, 1350 East Touhy Ave., P.O. Box 5060, Des Plaines, Illinois 60017-5060; Tel: (312) 299-9311

March 11-13, 1986
Southcon/86 High Technology Electronics Exhibition and Convention
Orange County Convention Center, Orlando, Florida. Information: Electronic Conventions Management, 8110 Airport Blvd., Los Angeles, CA 90045; Tel: (213) 772-2965

March 25-27, 1986
IEEE Instrumentation and Measurement Technology Conference
University of Colorado Events/Conference Center Hilton Harvest House, Boulder, Colorado. Information: Robert Myers, 1700 Westwood Blvd., Los Angeles, CA 90024; Tel: (213)475-4571

April 8-10, 1986
Test and Measurement World Expo
San Jose Convention Center, San Jose, California. Information: Meg Bowen, Conference Director, Test and Measurement World Expo, 199 Wells Avenue, Newton, MA 02159

April 9-16, 1986
World Market for Electronics and Electrical Engineering '86
Hannover Fairgrounds, Hannover, West Germany. Information: Hannover Fairs USA Inc., PO Box 7066, 103 Carnegie Center, Princeton, NJ 08540; Tel: (609) 987-1202

May 5-7, 1986
36th Electronics Components Conference
Westin Hotel, Seattle, Washington. Information: Tom Pilcher, Electronics Industries Association Tel: (317) 261-1592

rf courses

The George Washington University
Electronic Warfare Systems: Technical and Operational Aspects
March 10-14, 1986, Washington, DC

Spread Spectrum Communications Systems
March 3-7, 1986, Washington, DC

Modern Receiver Design
March 19-21, 1986, Washington, DC

Antennas and Arrays
March 17-21, 1986, Washington, DC
Information: Merril Ann Ferber, Assistant Director, Continuing Education Engineering Program, The George Washington University, Washington, DC 20052; Tel: (800) 424-9773

Georgia Institute of Technology
Elements of Phased Array Radar Design
March 18-21, 1986, Atlanta, Georgia
Information: Trish Stolton, Department of Continuing Education Georgia Institute of Technology, Atlanta, GA 30332-0385; Tel: (404)894-2547

Virginia Polytechnic Institute and State University
Antennas: Principles, Design, and Measurements
March 19-22, 1986, St. Cloud, Florida
Information: Ann Beekman, 1101 Massachusetts Ave., St. Cloud, FL 32769; Tel: (305)892-6146

Interference Control Technologies
Grounding and Shielding
January 14-17, 1986, Phoenix, Arizona
February 4-7, 1986, Orlando, Florida
February 18-21, 1986, San Antonio, Texas

EMC Design and Measurement
January 27,1986, San Diego, California

Tempest Design, Control, Testing
March 4-7, 1986, Washington, DC

Practical EMI Fixes
January 14-17, 1986, San Diego, California

ESD Control, Diagnosis, Design, Retrofit
January 21-22, 1986, San Diego, California

EMI Control in Computers and PCBs
February 4-7, 1986, San Jose, California

EMI Control in Power Supplies
January 21-23, 1986, San Antonio, Texas

EMP/SGEMP — Design and Testing
January 28-31, 1986, San Diego, California
Information: Penny Caran, Registrar, Interference Control Technologies, State Route 625, PO Box D, Gainesville, VA 22065; Tel: (703)347-0300

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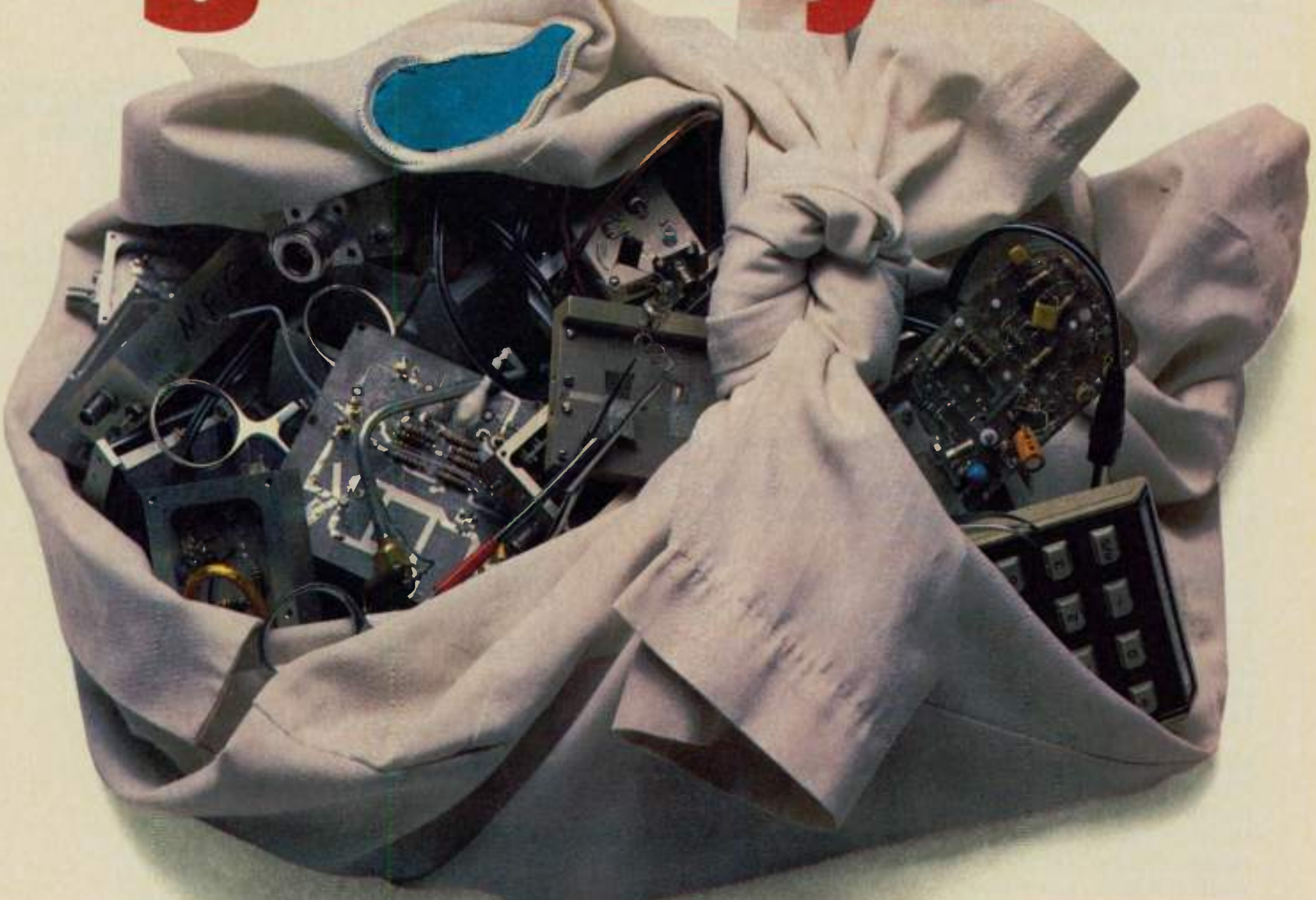

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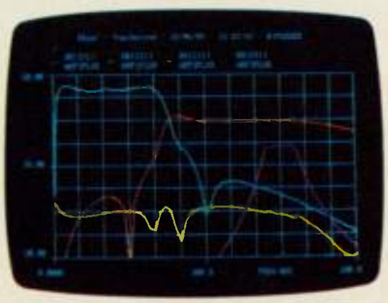
B Insertion loss and return loss of crystal filter analyzed over its narrow pass band

C Schematic diagram of the active triplexer analyzed above

D A log axis can be used for displaying very broad frequency ranges. This feed back amplifier operates over nearly a decade bandwidth



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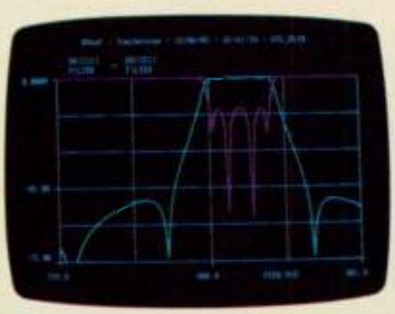

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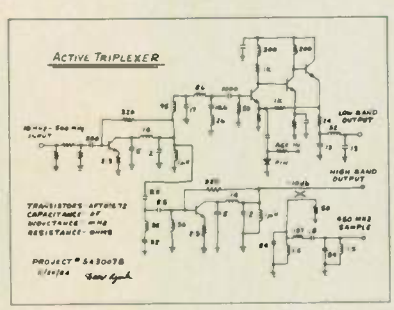

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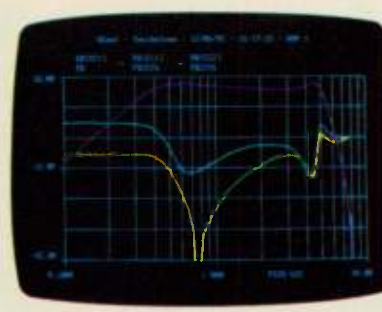

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Adams-Russell to Acquire RHG Electronics

Adams-Russell Company, Waltham, Mass., has entered into an agreement to acquire RHG Electronics Laboratory, Inc., Deer Park, New York. RHG is a leading manufacturer of RF and microwave components, including limiting and logarithmic amplifiers, microwave mixers and subsystems. The acquisition is scheduled to be completed in January 1986, for $17.5 million.

Adams-Russell is a major supplier of RF and microwave components, cable assemblies, antennas and microwave receivers. Jack Lynch, Adams-Russell President, said "RHG is technically strong and a quality manufacturer of products which complement Adams-Russell's RF and microwave component lines. The acquisition of RHG brings to Adams-Russell an excellent technology base and an operating pattern of quality and performance consistent with our other product lines. We expect to continue the expansion of RHG's facilities and employment on Long Island to meet the growing demand for their products. With the continued guidance of Ron Hirsch and Arnold Rubin, RHG's founders, we are confident that RHG will continue its successful operating record.

"The acquisition will become part of Adams-Russell's Electronics and Instrument Group, which consists of Anzac, a supplier of RF and microwave components, Microtel, a manufacturer of microwave surveillance receivers and test equipment, the newly formed Communications Programs Division, which produces high speed digital signal processors and space qualified RF and microwave components, and the A-R Semiconductor Center, a manufacturer of Gallium Arsenide monolithic microwave circuits."

RHG recently expanded to a new building, doubling its floor space. Hirsch said the company has a large amount of additional property for further expansion, which both companies anticipate soon after the acquisition.

Hirsch said nearly all RHG's work is for military systems. The company builds high technology components and subsystems for use in EW radar and guidance detection systems. The company has been unaffected by the recent slump in the semiconductor sector.

"Two years ago, our backlog was under $3 million and now our backlog is over $15 million," Hirsch said.

Adams-Russell has acquired several properties in recent years. Julian Parker, Manager of Component Marketing for the Electronic and Instruments Group (Anzac), said RHG fits nicely with that company's product line.

"They have an expertise in manufacturing log amps. They've been in business for 27 years, I believe," Parker said. "They also have a great deal of experience in microwave mixers. (With this acquisition) we are expanding our capabilities and our product line and our business center."

Dave McLachlin, Adams-Russell Vice-President for Finance, said RHG will provide Adams-Russell with a much broader product base to sell to their customers.

"We will keep RHG as a wholly owned subsidiary, and we will keep their name, because their name is well received in the marketplace." McLachlin said. "They will design and manufacture their existing product line, as will Anzac. Where we see the synergy is in a unified marketing effort, because we're going to the same customers.

"There is another reason we made the acquisition, and that is that the international business that RHG has is dominately in the Far East — in Japan — and we don't sell much to Japan. Anzac's dominate international business is in Europe, and RHG does not sell much to Europe. We hope to use their skill and knowledge of the Far Eastern marketplace and hope that they can use our knowledge of the European marketplace."

Adams-Russell recently hired a director of planning and acquisitions to coordinate future expansion. The company has a corporate objective of growing 20 percent each year, McLachlin said.

"Generally speaking, acquisitions will be on the electronic products side of the business," McLachlin said. "They will be in lines that broaden our product capability. They'll be more of a horizontal integration than a vertical integration. They will probably have a military flavor because we understand that business best. However, we would be looking at some commercial activity."

Company to Establish Public Domain Software Library

A public domain software library is being established to collect and distribute electronic design programs published in *RF Design* and other periodicals. Gerald S. Harrison is proprietor of E.E. Public Domain Library in Plainview, New Jersey. Harrison contacted RF Design with the proposal because of the difficulty in reproducing program listings in the magazine and the time required for the reader to copy them accurately.

Designers who have written programs will be asked to submit them to the library, where they will be available for distribution to other designers. The only charge will be $10 for handling and the cost of the disk. Only software in the public domain will be distributed by the library. Programs will be distributed for personal, non-commercial use.

The library will collect and distribute software covering all electrical disciplines, but programs will not be reviewed or evaluated. Users will contact authors when problems or bugs are discovered. Contributors will receive a limited number of free programs from the library.

Programs will be distributed generally on 5-1/4 inch floppy disks in IBM PC format, with some available on 8 inch floppy disk in CP/M format. Updated versions will be substituted as they are received.

Abstracts of programs available in the library will be published in *RF Design*. Inquiries about the library can be directed to this magazine or to Gerald Harrison, 36 Irene Lane East, Plainview, NJ 11803.

Harrison will be available at RF Technology Expo 86 to discuss the library with interested persons. Attendees are invited to bring programs on disk to get the library started.

NBS Evaluates 500 MHz Yagi Array for EMS Testing

The National Bureau of Standards has completed feasibility studies using a phased array of Yagi-Uda antennas for 500 MHz electromagnetic susceptibility (EMS) testing. A gap has existed in EMS test methods between 50 MHz and 1 GHz, where near field testing methods have not been developed. NBS researchers evaluated the Yagi-Uda array as a source of plane waves in the near zone to replace costly far field testing. Anechoic chamber testing of the array has shown excellent agreement between measured performance and theory and has provided hands-on experience in the

rf news Continued

control of amplitude and phase of array elements.

Although additional research will be necessary to make this method useful for EMS testing, the work to date has been published. The report, A Near-Field Array of Yagi-Uda Antennas for Electromagnetic Susceptibility Testing (TN 1082), is available for $3.00 from the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402. (Stock Number 003-003-02669-7).

NOAA to Build 405 MHz Wind Monitor Radar Network

The National Oceanic and Atmospheric Administration (NOAA) plans to build a network of atmospheric profile radar systems in the central U.S. over the next four years. The radar systems will operate at 405 MHz using recently developed technology in phased array antenna systems and atmospheric scattering analysis. For the first time, forecasters will have available continuous monitoring of the atmospheric wind profile with updates every half-hour, instead of the current twice-a-day balloon launchings. Developing storms and other weather systems can be monitored and tracked in their early stages, even before they can be picked up by current radar systems.

Bids have been accepted, and negotiations with low bidders are underway to establish criteria for a final bid and subsequent award, expected by March 1986. Russell Chadwick, NOAA Project Engineer, said two prototype units should be operational by mid-1987, with the first production units delivered in 1988. The system should be completed in 1989, Chadwick said, with 24 sites in a hexagonal pattern covering the central part of the country from Colorado to Illinois and from South Dakota to Texas. Contracts will allow up to 70 radar systems to be purchased, giving other government agencies an opportunity to obtain systems for other applications.

Gould to Produce High Electron Mobility Transistor

Gould Inc., Microwave Products Division, announced production of the first commercially available low-noise High Electron Mobility Transistor (HEMT). The

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INFO/CARD 18

MPD H503 uses a superlattice structure of aluminum gallium arsenide to achieve three times the speed of conventional gallium arsenide devices.

The MPD H503 is designed to replace similar geometry gallium arsenide devices in amplifier and oscillator designs that require very low noise levels at high frequency, such as satellite systems, radar and electronic warfare systems, the company said. It has an identical .5 micron by 280 micron gate structure and S-parameters similar to DXL-2503 and DXL-0503. The 1.8 dB noise figure and 9.5 dB associated gain at 18 GHz, gives improvement in amplifiers without extensive redesign, according to company literature. For information circle INFO/CARD #120.

Electronics Applications Sourcebook Published

McGraw-Hill Book Company has announced publication of the Electronics Applications Sourcebook, 1986 Edition. The 3,200 page, two-volume set is a collection of application notes from more than 20 leading manufacturers.

According to McGraw-Hill, the books include authoritative discussions of common problems, design techniques, effective limits of each device and design considerations for special circumstances. With cross-indexing, it is designed for on-the-job use by electronics engineers and specialists. Price is $250 for the set. For information circle INFO/CARD #119.

Boeing Creates High Technology Center

Boeing Electronics Company has formed a High Technology Center to be housed at the Boeing Computer Services complex in Bellevue, Wash. The center will conduct research aimed at producing prototypes of new or highly advanced electronic devices or products with applications for Boeing programs. Dr. Edith W. Martin, formerly Deputy Under Secretary of Defense for Research and Advanced Technology, will be the center's director.

"We'll conduct efforts that range in focus from as short as three to five years to longer term, perhaps in the five-to-ten year span," Martin said.

Facilities are not expected to be occupied until March 1986, but Boeing said a small nucleus of researchers is already identified and working as the start-up team for the center. The center will employ a technical team of experienced researchers with advanced degrees, recruited within the company and outside.

Andersen Labs Establishes England Design Center

Andersen Laboratories, Bloomfield, Conn., established a design center in Swinden, England, Dec. 1, to design SAW devices.

Tom Lewis, Director of Sales and Marketing, said the move gives Andersen Labs the largest engineering resource for SAW design in the world.

"They will be doing primarily design of SAW devices there," Lewis said. "They will have a VAX computer and equipment to test prototypes for doing iterations. Initially they will be specializing in filter designs, and later on they may get into work with pulse compression/pulse expansion types of subsystems."

Merrimac Components Help Locate Hijackers

Merrimac Industries, Inc., West Caldwell, N.J., recently played an important role in capturing the four Achille Lauro hijackers. An E-2C Hawkeye command control plane — equipped with more than 30 electronic components manufactured by Merrimac — located the Egyptian airliner carrying the four hijackers and proceeded to communicate with seven F14A Tomcat fighters who directed and escorted the airliner to a U.S. Naval Airbase in Sicily.

In addition to the onboard electronic equipment, Merrimac Industries, Inc. also manufactured a sophisticated analyzer which was used to test many of the electronic systems.

Motorola Phasing Down NMOS

Motorola is phasing down its investment in and production plans for the NMOS 256K dynamic random memory (DRAM) device. The company said its future DRAM activities will be limited to CMOS technology. Work will continue on the 256K CMOS version, scheduled for sampling in early 1986; and the 1-Megabit device, which is scheduled for first silicon (initial processing) in the first quarter of 1986. The company will also continue its major emphasis on high density CMOS fast static RAMs and CMOS non-volatile memories.

Motorola's decision to limit its DRAM participation to higher density CMOS devices is the result of severe attrition in selling prices of NMOS memories, and its current market position for those products. The company said that the catastrophic price reduction for the 256K DRAM — the recent industry standard — and the equally drastic reduction in the pricing of the 256K DRAM even in its first year of moderate volume availability, has set price levels that do not offer a reasonable potential to recover costs and profit from such products.

Price is normally determined by supply versus demand set within some reasonable range of the cost of efficient production. Current DRAM prices have been abnormally determined and slashed as a result of demands significantly softened from previous expectations, as well as abnormal capacity emplacement, exaggerated inventory builds, and the pricing practices with predatory consequences of many Japanese suppliers. These are currently the subject of dumping charges before the federal government.

Although Motorola feels that their withdrawal as a manufacturer of 256K NMOS DRAMS is in the best interests of the company, officials are not encouraged by the implications for U.S. leadership in world industrial markets. Motorola has warned for more than ten years of the dangers to our national economy and security if Japanese trade and competitive prices eventually result in dependence for certain products by U.S. equipment producers on foreign sources of supply, a company spokesman said.

Motorola said that if excess capacity and predatory pricing by Japanese manufacturers is ameliorated, then the company would reconsider its position in the 256K NMOS market, with compensatory prices based on competitive costs.

GE Combines Analog Devices, Digital Circuits

General Electric researchers have developed a refinement to their 1.2-micron very-large-scale integration CMOS process that enables them to incorporate analog devices on otherwise digital VLSI circuits.

The breakthrough, scored by a team from GE's Research and Development Center in Schenectady, N.Y., will provide increased flexibility for circuit designers — allowing them a wider choice of tradeoffs in the design of VLSI chips. Employing the experimental processing technique, the GE research team already has designed and built a number of functional analog/digital test circuits including amplifiers, filters, and data converters.

GE's processing innovation was described in a paper presented at the 31st International Electron Devices Meeting by Dr. Dale M. Brown, an R&D Center physicist. The paper was coauthored by Sow T. Chu, Dr. Manjin J. Kim, Dr. Miran Milkovic, Takashi Nakagawa, Dr. Thomas I. Vogelsong, and Bernard Gorowitz, also from the R&D Center.

Four possible methods of adding analog devices — e.g., isolated capacitors — to VLSI circuits were investigated by the research team. These involved capacitor plates made of 1) first and second-level metal; 2) first-level metal with a polysilicon gate; 3) a structure using first-level metal and an additional layer of metal sandwiched between it and the second-level metal, and; 4) two layers of polysilicon.

For the study, each of these combinations was built atop a thick layer of oxide laid down on the silicon wafer with a special mask set containing a 6 x 6 array of capacitor groups. Each group was composed of a different capacitor type with capacitor element sizes ranging from 8 microns x 8 microns to 64 microns x 128 microns.

The researchers employed oxide-nitride dual dielectric on the capacitors with a polysilicon base plate because studies have shown problems with thin thermal oxides grown on polysilicon. Capacitors with the thin oxides exhibit high leakage and low breakdown unless the polysilicon grain size is large and high temperature oxidation conditions (1,000°C) are used. Those conditions were not considered compatible with fine line VLSI gate processes.

In tests of the various configurations, the all-metal capacitors displayed better properties than those fabricated with polysilicon. For example, they had a very low voltage coefficient and loss angle.

The metal-to-metal design was found to have numerous processing advantages. For one thing, these capacitors can be made with fewer processing steps than are required to make polysilicon capacitors. In addition, the metal-to-metal capacitors allowed more accurate patterning because the first layer to be put down on the wafer is metal. Also, their combination of low resistivity and insensitivity to electromigration allows the circuits to be laid out in a compact format.

The GE scientists have successfully fabricated and tested several analog circuits employing the metal-to-metal capacitors and molybdenum resistor patterns. These circuits include flash analog-to-digital converters, which transform signal voltage waveforms into digital data that are further processed digitally on the chip. The researchers also have implemented very high frequency amplifiers and switched capacitor filters.

Army Awards Piranha Modification to AEL

American Electronic Laboratories, Inc. has been awarded a contract for $1.2 million by the U.S. Army to design, develop and manufacture a modification kit for AEL's Piranha jeep-mounted jammer. The modification will enable the Army to install the Piranha on its new Commercial Utility Cargo Vehicles, Chevrolet Blazers and GMC Jimmies, instead of Jeeps, being phased out of service.

The Army has already accepted five prototype Piranhas and shipment of the remaining 222 units is expected to begin shortly. The prototype units were tested at Fort Carson, CO. rf

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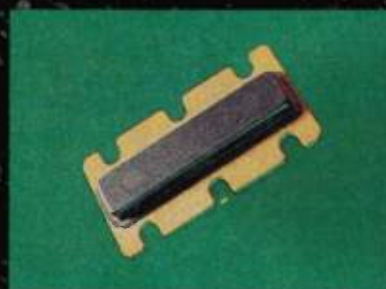

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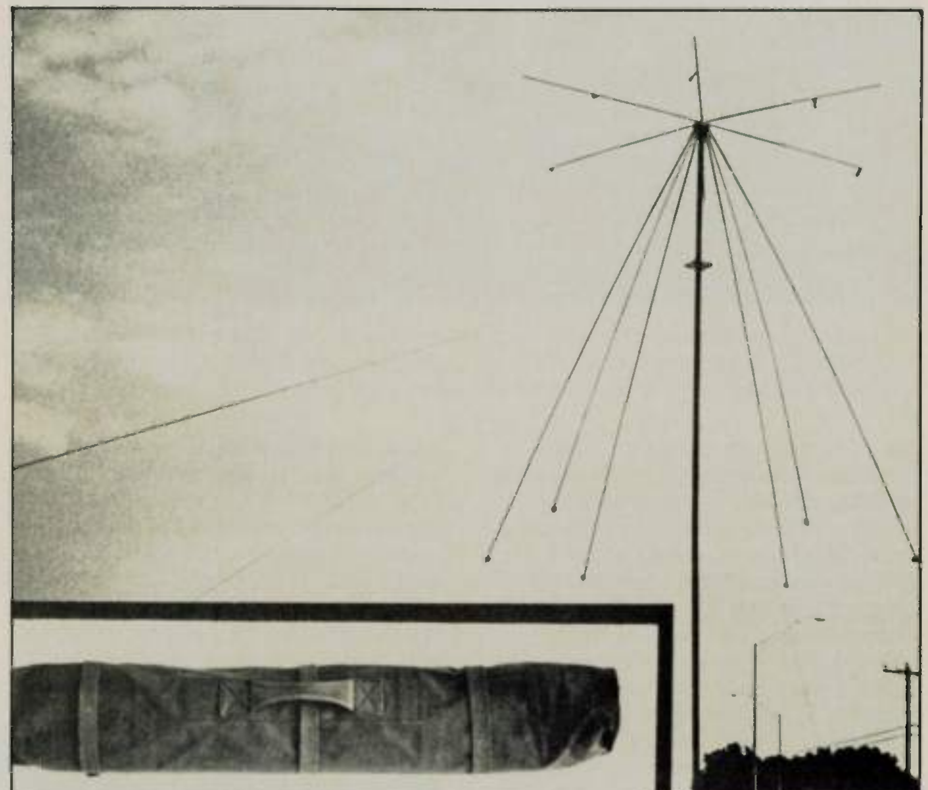
INFO/CARD 22

Antennas: The Key to Effective Transportable Communications

By Gary A. Breed

The glint of sunlight reflected from the blade of a villager's machete as he labored in the tropical heat. The landing strip would be cleared soon. The famous archeologist summoned two native boys and took a suitcase from the back of the Land Rover. From it he took a reel of wire and some stout cord. As the boys started up two nearby trees, he opened the hood of the Rover and clamped the power cable to the battery terminals. He had to move fast, word would soon get to the Frenchman that the jungle had given up another treasure. Inside the suitcase, the radio came to life as the archeologist dialed in the prearranged frequency and encryption codes. The boys finished their work and in a few seconds the automatic antenna tuner did its work. The archeologist smiled as he spoke into the microphone, "We're ready, send the plane." He knew he had beaten the Frenchman this time. . .



Covering 26-87 MHz, the Jasco International OCD 26/87 discone antenna packs into a canvas bag weighing 5.19 kg, 60 cm long. the Mark IV mast it is mounted on adds only another 11 kg.

To put an entire communications system in a suitcase, the design engineer's challenge is for minimum size and weight, plus rugged survivability. Unlike the more typical goals of electronic performance, the physical constraints of transportable equipment force designers to explore new methods of packaging, new materials, and ways to deal with the compromises that may be necessary to achieve the desired configuration.

Antennas present the greatest problem, especially at HF and VHF, where efficient antennas are relatively large and the frequency span needed for flexible operation may be several octaves. Small antennas are inefficient, although some applications demand their use. More often, the designers have chosen to package a larger antenna for rapid assembly and minimum transport weight. Among some of the solutions to the antenna dilemma:

Simple wire or mast with tuner — Here is a solution that transfers the problem to the electronics. Manual or automatic tuners, combined with vertical whip or mast antennas, or with wire antennas of various designs, can provide the required frequency coverage and adjustment flexibility needed for many situations. If the tuner is automatic, this arrangement is the simplest for untrained operators, such as the adventurer portrayed in the introduction.

The main advantage of this method is the mechanical simplicity. Many standard vehicle- or ground-mounted masts are available in lightweight aluminum or fiberglass, including standard military models. Wire antennas can be packaged in a very small space, and can range from a random length to be tossed over a tree or other convenient support, to a dipole or similar configuration that has been designed for optimum interface with its companion tuner.

The use of unsophisticated antennas gives the designer the major challenge of creating a flexible tuner that can handle the anticipated impedances, RF currents and voltages. If the tuner is automatic, control circuits have to be fast and reliable. Manual operation requires special attention to layout and operation of controls. An example of an automatic tuner is the RAT-100 from Trans World Communications, Inc., which uses high speed relay switching of inductors and capacitors, with vacuum relays in high voltage portions of the circuit. Microprocessor control with a special algorithm to speed up the tuning process is the "brains" of the tuner. A rugged case completes the package.

Broadband antenna systems — The reverse of the above option is to avoid the

Transportable aviation communications is provided by the Milcom International TB 100V1-28/AC transportable base stations. Units cover the 116-152 MHz and 225-400 MHz AM frequencies, plus the 30-88 MHz and 138-174 MHz FM channels.

use of a tuner by using an inherently broadband antenna system such as a log periodic, discone, or broadbanded wire antenna. The design concern becomes mechanical: how to make a larger antenna readily transportable, especially for the lower part of the HF spectrum where these antennas can be very large.

Different approaches to the log periodic antenna have been taken. Electrospace Systems, Inc., Model 42A-2 uses aluminum elements which fold up for transport. The 42A-2C has a motorized mechanism for folding the longer elements automatically, useful in a vehicle-mounted system with a telescoping mast, where complete disassembly is not needed for transport. This approach results in a rugged antenna capable of handling high power.

Another method is used by Jasco International, Inc., to achieve maximum transportability of their Model LP 24/87 T3. This antenna has a fiberglass center boom, plus an additional fiberglass frame which holds wire elements in a traditional log periodic configuration. Bearing a vague resemblance to an umbrella frame when deployed, the antenna dismantles for transport into a canvas bag 1.3m × 0.23m × 0.2m, and weighs only 6.8 kg. Power handling is rated at 200 watts. Electrospace and Jasco both make discone antennas for omnidirectional coverage, with design objectives similar to the log periodics.

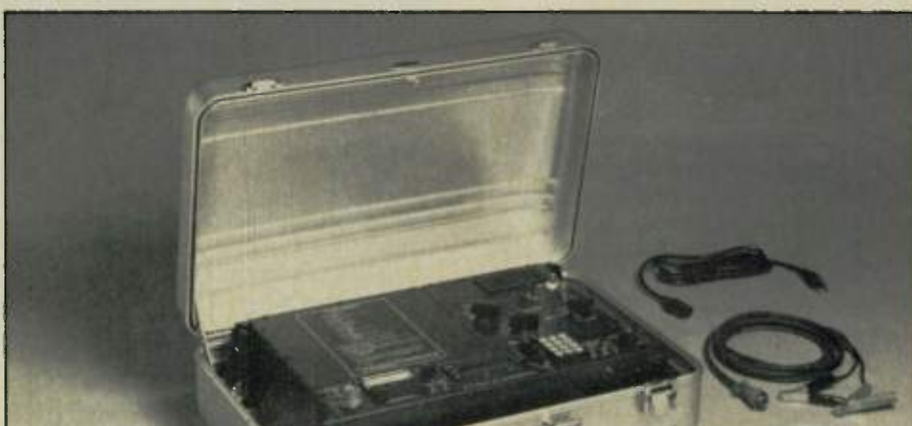
Another method of broadbanding antennas is the design of special compensating networks for dipole antennas. The original Snyder antenna from Snyder Communications Corporation increases the bandwidth of a dipole to greater than ±10% of center frequency, allowing a single antenna to be used without a tuner over a segment of HF frequencies. Other companies make "fat" dipoles using multiple wires to increase the bandwidth.

Still another broadbanding method involves resistive loading of a dipole, or transformer coupling which dumps mismatched energy into a resistor at non-resonant frequencies. These methods guarantee a matched feed to the transmitter at the cost of efficiency at non-resonant frequencies. These methods are somewhat controversial, as they result in performance nowhere near optimum. However, they do provide simple and reliable operation in situations where radiation efficiency is secondary to broad bandwidth operation without the use of a tuner.

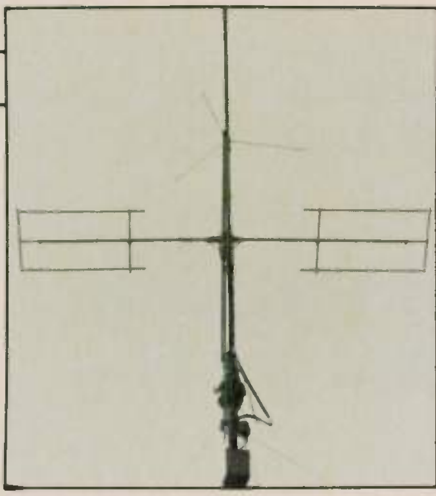
Low HF antennas — Frequencies below approximately 10 MHz present a special problem for designers of transportable systems. With the longer wavelengths, physically small antennas are not efficient radiators and larger antennas are not as readily transportable. In addition, broadbanding is difficult because changes in frequency at low HF represent large *percentage* changes. This leaves only a few options: A large antenna that is harder to transport, a small inefficient antenna, or a compromise in between.

Where performance needs outweigh portability, field-deployed rhombics, vee-beams, or large vertical radiators are often used. They certainly cannot be described as truly portable, but many uses require temporary communications for a period of days or weeks, and extra effort for erection is offset by the improved performance of a large installation.

For maximum mobility, the option of lower efficiency is usually required. Sur-



The Trans World Communications "Fly-Away" radio system and accessories. This system covers 1.6-30 MHz SSB/CW with 125 watts power.



Adaptable for portable use, the latest antenna from Snyder Communications is a space-saving ½-size dipole, using the "egg-beater" sections on the ends to compensate for the shorter overall length.

prising results can often be obtained using short antennas as many ham operators can attest from their mobile operations. One of the better compromises is a vertical whip or mast. Standard military vehicle-mount whips are approximately 8 ft., 16 ft. and 32 ft. long. The larger sizes can be used to 1.6 MHz with most available tuners. Sunair Electronics, Inc., offers a fiberglass mast (Model TAS-100) which can be field-erected as either a 16-foot or 32-foot antenna. Packaged with all installation tools and guy ropes, the system weighs 43 lbs. and can be utilized from 1.6 to 30 MHz with the proper tuner.

Signature Antenna Systems has a tunable monopole antenna system using adjustable helical loading for 2-30 MHz coverage without a tuner. The antenna can be readily set up and dismantled for portable use. Al Henderson of Signature has also developed a simple, broadband counterpoise system for portable vertical radiators for improved impedance match and radiation efficiency.

The rest of the system — Whether military Manpack radios, or disaster emergency systems, it takes more than an antenna for a communications system. Radios, amplifiers, power supplies, support masts, and other components all have a share in the challenge to the designers of transportable systems.

Cubic Communications and Trans World offer complete systems in a suitcase which meet airline regulations for carry-on baggage. Cubic's "Ambassador" has a 100-watt SSB/CW transceiver covering 1.6-100 MHz, universal AC/DC power supply, antenna kit, and the necessary microphone, headset, and telegraph key. Also available is a battery pack in a matching suitcase which allows operation anywhere in the world, regardless of available power.

The Trans World TW100F "Fly-Away" radio includes a 120/240 VAC power supply, or operates directly from 12.5 VDC. Supplied with an antenna kit, handset and power cords, the TW100F has 125 watts power and covers 1.6-30 MHz. Both this unit and the Cubic "Ambassador" have built-in manual antenna tuners.

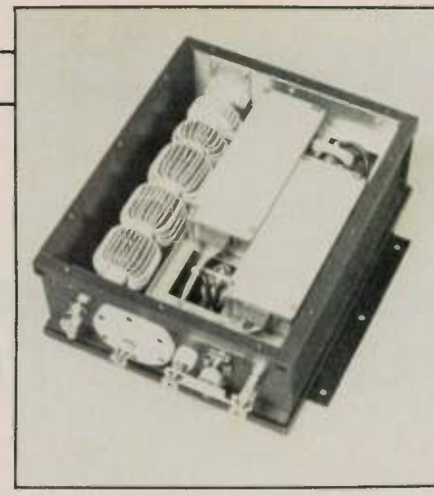
Sunair offers tactical-oriented radio systems including transceivers, generator sets, TTY modems, and high power amplifiers, all in high-impact transport cases. All of these companies offer many optional accessories for their systems, including a variety of antennas, teletype terminals, even kilowatt amplifiers.

Quite a different aspect of transportable communications is approached by Milcom International. This company specializes in aviation-related portable base stations, for temporary ground-to-air or ground-to-mobile communications. The principal use for this equipment is military or quasi-military temporary air field communications.

Applications — Who uses transportable communications at HF and VHF? The biggest user by far is the military, but many others have need for such systems, including:

Law enforcement — police, Federal marshalls, FBI, Border Patrol, drug enforcement.

Cubic Communications' "Ambassador" 1.6-100 MHz transportable system. An optional battery pack is available in a matching suitcase.



The Trans World RAT-100 automatic antenna tuner. Note the toroidal inductors on the left, which save room and do not have stray magnetic fields.

Government agencies — embassies, Forest Service, National Park Service, State Department, CIA.

National Guard and Reserve units.

Scientific expeditions and research operations.

Red Cross and other emergency services.

Oil and mineral exploration teams.

Ranchers and traders in remote areas.

International shipping and aviation.

Missionary schools and hospitals.

Whether transportable or fixed, emergency or routine, communications at HF and VHF is growing again as the medium to long-range reliability of these frequencies is once again appreciated. Hopefully, by presenting some companies' responses to the design challenges of transportable systems, other designers will become aware of new ways to meet the needs of their assigned projects. rf

For additional information about the products and companies mentioned in this article, circle the following INFO/CARD numbers:

Trans World Communications, Inc.	INFO/CARD #109
Electrospace Systems, Inc.	INFO/CARD #108
Jasco International, Inc.	INFO/CARD #107
Snyder Communications Corporation	INFO/CARD #106
Sunair Electronics, Inc.	INFO/CARD #105
Signature Antenna Systems	INFO/CARD #104
Cubic Communications	INFO/CARD #103
Milcom International, Inc.	INFO/CARD #102

NBS' Laboratory Accreditation Program: "Consumer Protection" for EMC Testing

By Gary A. Breed

The National Bureau of Standards (NBS) has established a program to accredit laboratories that perform electromagnetic compatibility (EMC) and telecommunication equipment testing. The program was announced in the Federal Register on September 25, 1985 as a new addition to existing programs in other industries, within the NBS' National Voluntary Laboratory Accreditation Program (NVLAP).

At the request of five EMC testing laboratories, the new Laboratory Accreditation Program (LAP) has been established for testing in the following specific areas:

Conducted emissions, power lines, 450 kHz to 30 MHz, using FCC methods.

Radiated emissions, 30 MHz to 1000 MHz, using FCC methods.

Terminal equipment compatibility, using FCC Part 68.

Terminal equipment compatibility, hearing aid compatibility, using FCC Part 68.

It is likely that future accredited test areas will be requested, including EMC testing to military standards.

Under this program, laboratories wishing to become accredited are subjected to an evaluation by the NBS, involving a review of the laboratory's history, resumes of supervisory personnel, and qualifications required for staff technical positions. In addition to these human resources, the facilities are reviewed, including a listing of equipment available for use, and the maintenance and calibration practices followed. An on-site visit will be made by an NBS representative to verify information submitted in the laboratory's application. The proficiency of the laboratory to perform the testing for which it seeks accreditation will then be evaluated, using specific test samples with known characteristics. Finally, the laboratories will be required to take any necessary corrective action to meet the standards of the LAP. After receiving accreditation, periodic monitoring visits will will be made to the laboratory by NBS Technical Experts to assure that LAP requirements are maintained.

With well-defined evaluation procedures backed by the unbiased expertise of NBS, accreditation has several advantages for EMC testing laboratories. According to Walter Poggi of Retlif Testing Laboratories, one of the companies requesting creation of this LAP, there were two major reasons for seeking an EMC program: international recognition of U.S. testing facilities, and establishment of recognized standards in a time of rapid growth in EMC testing.

International recognition of U.S. laboratories and testing methods has been a high priority of industry groups involved in EMC testing, as well as manufacturers trying to improve their export markets. European and Australian EMC standards have been developed at the same time as U.S. standards with a limited, but encouraging level of cooperation with the U.S. and other countries. Japan traditionally has resisted efforts to market electronic equipment made in the U.S., and testing has been a significant part of the barrier. However, the Wall Street Journal recently reported that ". . . the Japanese are now close to the U.S. position that U.S. makers themselves should certify that their equipment meets Japanese standards," rather than submitting the equipment to the Japanese testing authority. Without inside information about trade negotiations, it is not possible to know whether the recent introduction of the electromagnetics LAP has had any effect on international trade so far, but we may see its effects in the near future.

The domestic value of the LAP is more immediate, and should be highly visible within the electronics industry. EMC and telecommunications testing requirements mandated by recent FCC regulations have created a growing market for testing services, resulting in the start-up of many new laboratories. Old and new companies alike welcome the "seal of approval" which accreditation gives their facility. Although the LAP has specific prohibition of consumer-oriented advertising of accredited testing of products, it encourages promotion of accredited status by the laboratory itself in the trade press, client communications, even on the company letterhead and advertising brochures. The clear intent of NVLAP is to encourage the program within the industry and prevent its misrepresentation to the general public.

The overall purpose of the entire accreditation concept is included in the NVLAP Program Summary Statement, which states the following goals:

Provide national recognition for competent laboratories.

Provide laboratory management with a quality assurance check.

Identify competent laboratories for laboratory users.

Provide laboratories with guidance from technical experts to improve their performance.

In the short time since the announcement of the LAP, several laboratories have already applied for accreditation, and others have received application information. If the stated goals of the program are to be taken seriously, many more laboratories will seek accreditation in the near future.

Information on the EMC and Telecommunications LAP can be obtained from:
NVLAP
National Bureau of Standards
Room A531, Building 101
Gaithersburg, MD 20899
(301) 921-3431

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Available now from your source for the finest EMI test equipment and accessories.

Antenna kits that meet your specifications of high quality and frequency response, and that are also responsive to your demands of portability and easy use. A.H. Systems offers nine different kits that fill the bill. Each comes in a single, lightweight case. Just one kit can contain all the antennas, probes and cables to perform E-Field 1KHz-18GHz, H-Field 20Hz-50KHz and conducted 20Hz-100MHz testing. Antenna factor calibrations are provided with each antenna.

So order one to go, with everything, or one of our other tantalizing specials.

MODEL #	FREQ. RESP.	DESCRIPTION
SAS-200/510	300 - 1800 MHz	Log Periodic
SAS-200/511	1000 - 12000 MHz	Log Periodic
SAS-200/512	200 - 1800 MHz	Log Periodic
SAS-200/518	1000 - 18000 MHz	Log Periodic
SAS-200/530	150 - 550 MHz	Broadband Dipole
SAS-200/540	20 - 300 MHz	Biconical
SAS-200/541	20 - 300 MHz	Bicon'l Collapsible

MODEL #	FREQ. RESP.	DESCRIPTION
SAS-200/542	20 - 300 MHz	Biconical, Folding
SAS-200/550	.001 - 60 MHz	Active Monopole
SAS-200/560	per MIL-STD-461	Loop - Emission
SAS-200/561	per MIL-STD-461	Loop - Radiating
BCP-200/510	20 Hz - 1 MHz	LF Current Probe
BCP-200/511	100 KHz-100 MHz	HF/VHF Crnt. Probe

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Chatsworth, CA 91311
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Telex: 182 640 WKVG

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INFO/CARD 23

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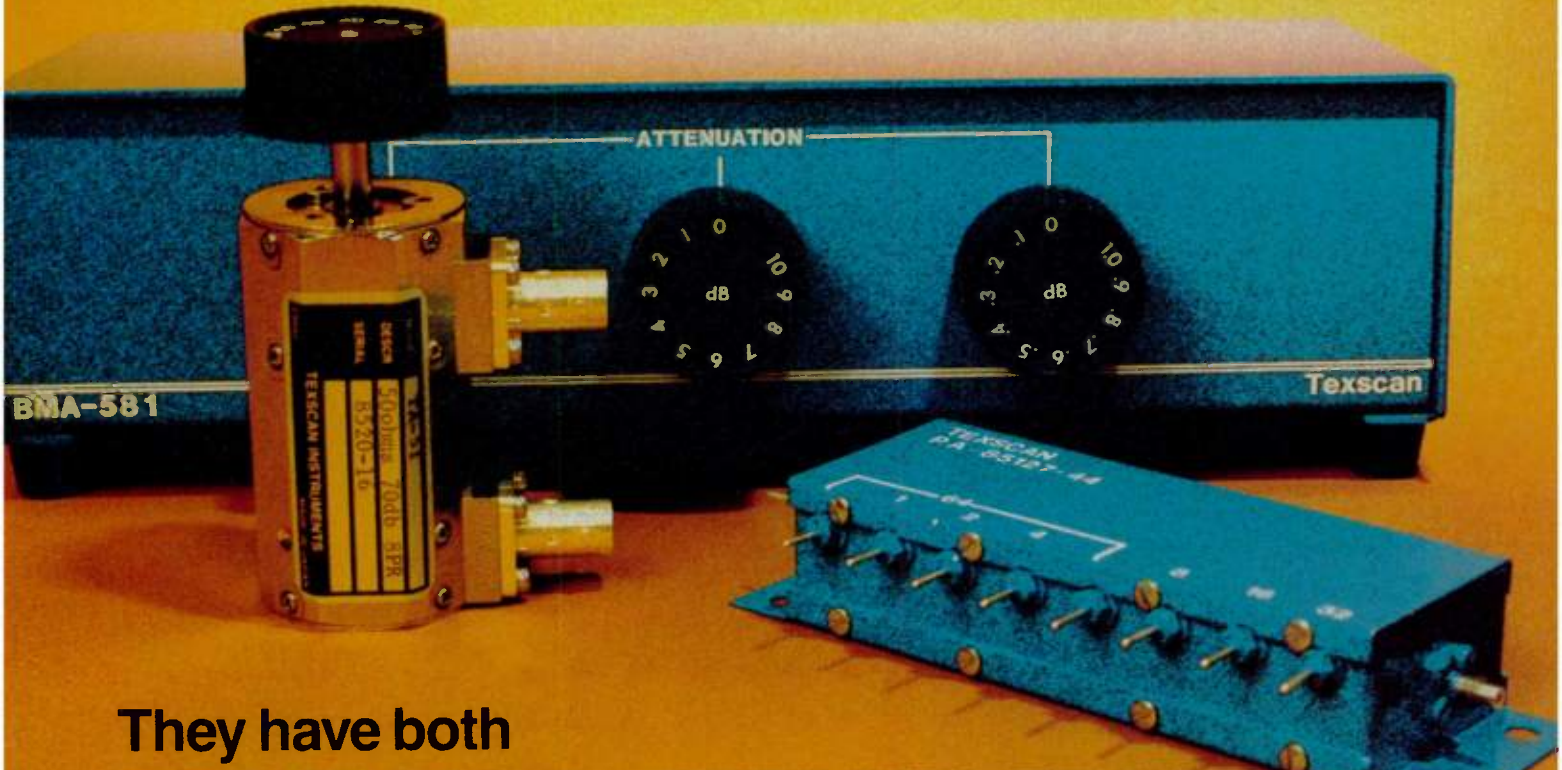
Texscan's new attenuators eliminate the choice between good specifications and a good price



They have both

	BENCH MOUNT		PROGRAMMABLE		ROTARY		
	BMA 580 780	BMA 581 781	PA 85127	PA 6563	TA 50 70	TA 51 71	TA 53 73
IMPEDANCE	50 75 ohm	50 75 ohm	50 ohm	50 ohm	50 75 ohm	50 75 ohm	50 75 ohm
STEP	1 dB	0.1 dB	1 dB	1 dB	1 dB	10 dB	0.1 dB
ATTENUATION	80 dB	81 dB	127 dB	63 dB	10 dB	70 dB	1.0 dB
FREQUENCY	DC-2 1GHz	DC-1 GHz	DC-1 GHz	DC-1 GHz	DC-2 1GHz	DC-2 1Ghz	DC-1 GHz
CONNECTORS	BNC, SMA or N		BNC, SMA or SMB		BNC or SMA		
PRICE (U.S. DOMESTIC)	$290	$450	$360	$260	$79 BNC $89 SMA	$79 BNC $89 SMA	$79 BNC $89 SMA

OTHER STEP AND ATTENUATION VALUES AVAILABLE TO SPECIAL ORDER

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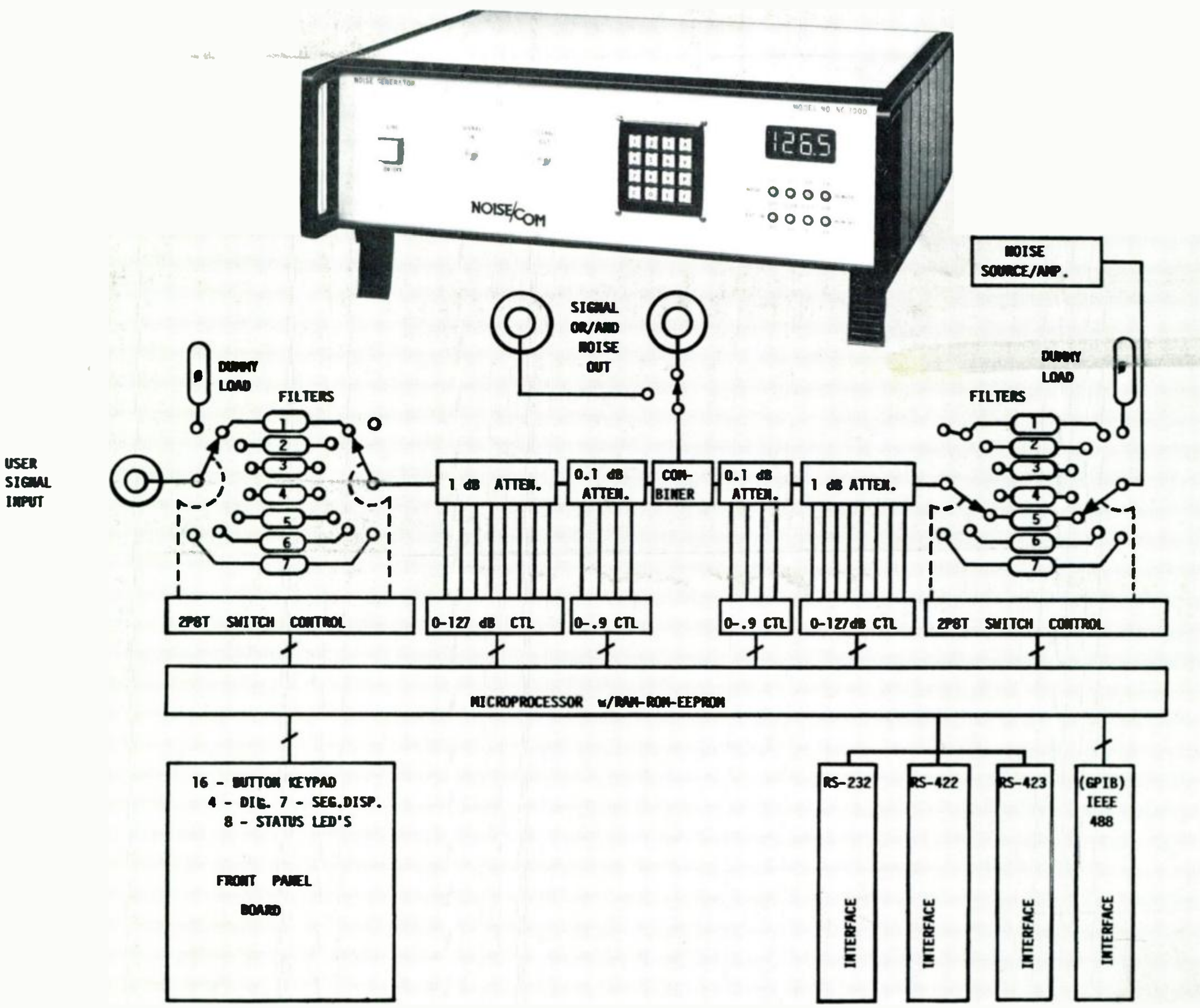
IF

NOISE TEST SET

PROGRAMMABLE NOISE GENERATOR

FOR BIT ERROR RATE MEASUREMENT

100 Hz - 1500 MHz



NOISE/COM

IF
NOISE TEST SET
PROGRAMMABLE NOISE GENERATOR
FOR BIT ERROR RATE MEASUREMENT

100 Hz - 1500 MHz

- **High Frequency, Broadband**
- **IEEE (GPIB) and other bus interfaces**
- **Adjustable signal to noise ratio**

NC 7600 SERIES

This noise test set, combining internally generated white gaussian noise with externally provided signal in various proportions, is controlled locally or remotely via IEEE-488 (GPIB) or RS-232 or RS-422 or RS-423 bus.

Noise Features:
- 100Hz - 1500 MHz, +10DBM, ±1DB Flat.
- White gaussian, broad band & symmetrical.
- Crest Factor 5:1.
- Attenuation: 0 - 128DB with 0.1DB steps.
- Switchable to seven discrete bands.

Signal Path:
- Attenuation: 0 - 128DB with 0.1DB steps.
- ±1DB Flat from 100Hz to 1500MHz.
- Switchable to seven discrete paths.

Output Terminals:
Dual output terminals to receive signal and/or noise output from either of the two terminals.

Remote Indicators:
Power On/Off
Control Local/Remote
Noise On/Off
Signal On/Off
Noise Attenuator
Signal Attenuator

Amplified Noise Modules

These modules provide high output white noise and contain integral lowpass filter to cut off noise output above the band.

NC 1000 Series
Audio, VHF & UHF

50 OHM LOAD IMPEDANCE:

MODEL	FREQUENCY RANGE	OUTPUT				CASE	OPTIONS
		Flatness	DBM/Band	DBM/Hz	uV / √Hz		
NC1101A	10Hz – 20KHz	±.75DB	+13	–30	7071	1	1, 2, 3
NC1102A	10Hz – 100KHz	±.75DB	+13	–37	3162	1	1, 2, 3
NC1103A	10Hz – 500KHz	±.75DB	+13	–44	1414	1	1, 2, 3
NC1104A	10Hz – 1MHz	±.75DB	+13	–47	1000	1	1, 2, 3
NC1105A	10Hz – 10MHz	±.75DB	+13	–57	316	1	1, 2, 3
NC1106A	100Hz – 25MHz	±1DB	+13	–61	200	1	1, 2, 3
NC1107A	100Hz – 100MHz	±1DB	+13	–67	100	1	1, 2, 3
NC1108A	100Hz – 500MHz	±1.5DB	+10	–77	31.6	1	1, 2, 3
NC1109A	100Hz – 1000MHz	±2DB	+10	–80	22.4	1	1, 2, 3
NC1110A	100Hz – 1500MHz	±2.5DB	+10	–81.8	18.3	1	2, 3

For other special specifications consult factory.

FEATURES:

- **Symmetrical White Gaussian Noise**
- **168 Hour Burned-In Noise Diodes**
- **Crest Factor 5:1 Min.**
- **Operating Temp.: – 35°C to 100°C**
- **Storage Temp.: – 65°C to 150°C**

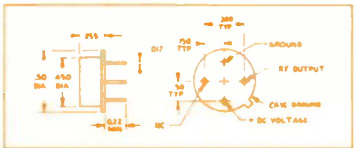
Power requirements: +28 Volts standard
Options: 1 – +15 Volts
2 – +24 Volts

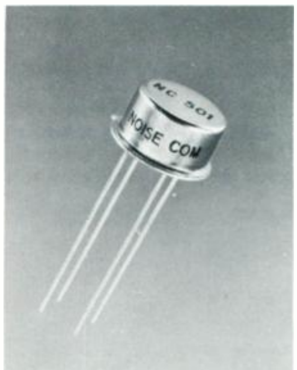
Connector: SMA (F)
Option: 3 – BNC (F)

Self Energized Drop-In Noise Modules for BITE

NC 500 Series

White Gaussian Noise Sources are ideal for self testing of receivers. Series NC500 are Noise Modules containing complete energizing circuit packaged in popular TO-8 metal can at economical prices.





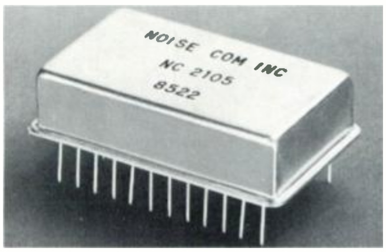
SPECIFICATIONS:

Power:	28V, 5 ma (Also available 15V, 2 ma)
Impedance:	50 Ohms
Crest Factor:	5:1 Min.
Operating Temp.:	–55°C to 85°C
Storage Temp.:	–65°C to 175°C
Output:	31 - 35 DB ENR
Temp. Coefficient:	0.01 DB/°C

MODEL	FREQUENCY RANGE	OUTPUT ENR (MIN.)		FLATNESS	1-9 PIECES
NC501	0.2MHz-500MHz	31 DB	–56 DBM	±1.0 DB Max ±0.5 DB Typ	$39.00
NC502	0.2MHz-1000 MHz	31 DB	–53 DBM	±1.5 DB Max ±1.0 DB Typ	46.00
NC503	10MHz-2000MHz	32 DB	–44 DBM	±2.0 DB Max ±1.5 DB Typ	57.00

FOR OTHER FREQUENCY RANGES, OPERATING VOLTAGES AND HIGHER OUTPUT LEVELS, CONSULT FACTORY.

Plug-In Amplified Noise Modules



NC 2000 Series

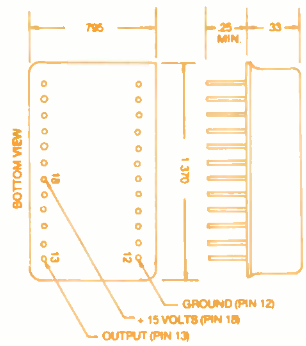
100 Hz to 20 MHz amplified noise modules that can be fitted on to a circuit board.

FEATURES:

- **Symmetrical White Gaussian Noise**
- **168 Hour Burned-In Noise Diode**
- **Crest Factor 5:1 min.**
- **Operating Temp. – 55°C to 85°C**
- **Storage Temp. – 65°C to 125°C**
- **Temp. Coefficient 0.025 DB/°C**
- **High End Roll Off 6 DB/Octave**
- **24 Pin Hermetically Sealed Package**

MODEL	FREQUENCY RANGE	OUTPUT			LOAD[1] IMPEDANCE	INPUT POWER
		FLATNESS	V/BAND	uV/√Hz		
NC 2101	100Hz – 20KHz	±0.75 DB	150 mv	1061	2.2K	+15V,[2] 40 ma max
NC 2102	100Hz – 100KHz			474	2.2K	
NC 2103	100Hz – 500KHz			212	2.2K	
NC 2104	100Hz – 1MHz			150	1.0K	
NC 2105	100Hz – 10MHz	±1.0 DB		47.4	1.0K	
NC 2106	100Hz – 20MHz		100mv	22.4	1.0K	

(1) For 50 OHM output load impedance units consult factory.
(2) Certain models available with +12v.

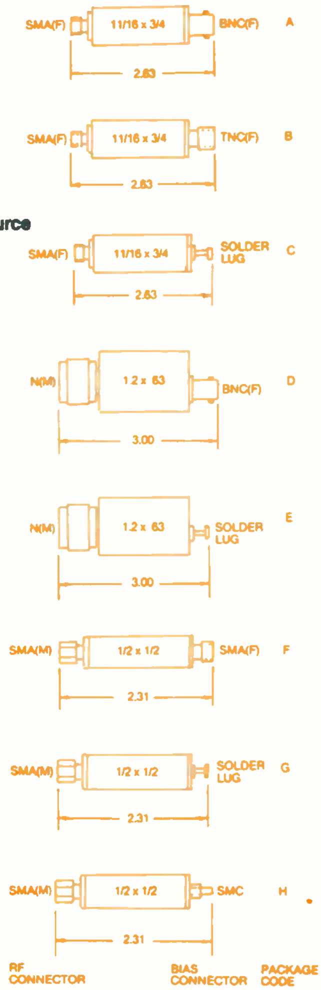


Precision Calibrated Coaxial Noise Sources 10 KHz to 18 GHz

NC 3000 Series

FEATURES:

- Input power +28 volts, 25 ma. max.
- Noise output variation with temperature less than 0.01 DB/°C
- Noise output variation with voltage less than 0.1 DB/%V
- Operating temperature range -55°C to +85°C
- Calibration points are listed on each noise source
- Noise output rise time and fall time <1 usec
- Noise diode is hermetically sealed
- Calibration charts are supplied with each noise source



NOISE FIGURE METER COMPATIBLE TYPES:

MODEL	FREQUENCY RANGE (GHz)	NOISE OUTPUT ENR (DB)	VSWR MAX	PACKAGE CODE*	CALIBRATION FREQUENCIES
NC 3101	.01 – 8	15.5 ± .5	1.2 on/off		.01, .1, 1.0 & 1GHz steps
NC 3102	.01 – 12.4	15.5 ± .5	1.2 on/off	A	
NC 3103	1 – 12.4	15.5 ± .5	1.2 on/off	to	1GHz steps
NC 3104	1 – 18	15.5 ± .5	1.35 on/off	H	
NC 3105	12 – 18	15.5 ± .5	1.35 on/off		

HIGH NOISE OUTPUT TYPES:

MODEL	FREQUENCY RANGE (GHz)	NOISE OUTPUT ENR (DB)	NOISE OUTPUT FLATNESS	PACKAGE CODE*	CALIBRATION FREQUENCY
NC 3201	10 KHz – 1.1GHz	30 – 35	± 1DB		.01, .1, .5, 1.0
NC 3202	.001 – .6	30 – 35	± 1DB		.01, .1, .6
NC 3203	1 – 2	30 – 35	± 1DB	A	1, 1.5, 2.0
NC 3204	2 – 4	30 – 35	± 1DB	to	1GHz STEPS
NC 3205	4 – 8	30 – 35	± 1DB	H	
NC 3206	8 – 12	28 – 33	± 1DB		
NC 3207	12 – 18	26 – 32	± 1DB		
NC 3208	1 – 18	26 – 32	± 1DB		

*Specify package code

OPTIONS

1. Housing A-E can be supplied with threaded mounting holes.
2. SMA connectors standard as shown. Alternate sex may be specified.
3. Input voltages as low as 15 volts are available in some models - consult factory.

Precision Calibrated Waveguide Noise Sources-18 GHz-50 GHz

NC 5000 Series

FEATURES:

- Input power +28 volts, 25 ma. max.
- Noise output variation with temperature less than 0.01 DB/°C
- Noise output variation with voltage less than 0.1 DB/%V
- Operating temperature range -55°C to +85°C
- Calibration charts are supplied with each unit
- Calibration points are listed on each noise source
- Noise output rise time and fall time <usec
- Noise diode is hermetically sealed

NOISE FIGURE METER COMPATIBLE - FULL BAND:

MODEL	FREQUENCY RANGE (GHz)	NOISE OUTPUT ENR (DB)	VSWR TYPICAL	MATING FLANGE	CALIBRATION FREQUENCIES	WAVEGUIDE
NC 5142	18 – 26.5	15.5 ± .75	1.3	UG595/u	1 GHz STEPS	WR-42
NC 5128	26.5 – 40	15.5 ± .75	1.3	UG599/u	2 GHz STEPS	WR-28

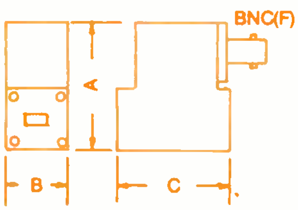
WAVEGUIDE	A	B	C
WR 42	1.72	.88	1.55
WR 28	1.5	.75	1.25
WR 22	1.5	1.13	1.25

HIGH NOISE OUTPUT - FULL BAND:

MODEL	FREQUENCY RANGE (GHz)	NOISE OUTPUT ENR (DB)	NOISE OUTPUT FLATNESS	MATING FLANGE	CALIBRATION FREQUENCIES	WAVEGUIDE
NC 5242	18 – 26.5	25.0	± 1.5DB TYP ± 2.0DB max	UG595/u	1GHz STEPS	WR-42
NC 5228	26.5 – 40	23.0	± 2.0DB TYP ± 3.0DB max	UG599/u	2GHz STEPS	WR-28
NC 5222	33 – 50	21.0	± 2.0DB TYP ± 3.0DB max	UG383/u	2GHz STEPS	WR-22

HIGH NOISE OUTPUT - NARROW BAND:

MODEL	FREQUENCY RANGE (GHz)	NOISE OUTPUT ENR (DB)	NOISE OUTPUT FLATNESS	MATING FLANGE	CALIBRATION FREQUENCIES	WAVEGUIDE
NC 5342	18 – 26.5 One GHz BAND*	25	± .5DB	UG595/u	MINIMUM	WR-42
NC 5328	26.5 – 40 One GHz BAND*	23	± .5DB	UG599/u	CENTER	WR-28
NC 5322	33 – 50 One GHz BAND*	21	± .5DB	UG383/u	MAXIMUM	WR-22
NC 5442	19.9 – 23.1	25	± .6DB	UG595/u		WR-42



OPTIONS:

1. Input voltages as low as 15 volts are available in some models. Consult factory.

NOTES: * Bandwidths of one GHz may be specified anywhere in the band. Other bandwidths may be specified, however, wider bandwidths may result in a different flatness specification.

Broadband Noise Generating Instruments

NC 6000 Series

Noise generating instruments supply a stable source of high level white noise. Standard units contain an amplified noise source, a power supply, an attenuator, on-off switch with indicator and line cord to plug in to line voltage.

50 OHM LOAD IMPEDANCE

MODEL	FREQUENCY RANGE	OUTPUT DBM/BAND	OUTPUT FLATNESS	OUTPUT DBM/$\sqrt{Hz}$	uv/$\sqrt{Hz}$	VSWR MAX	OPTIONS
NC 6101	10Hz – 20KHz	+ 13	± .75DB	– 30	7071	2.0	1 5
NC 6102	10Hz – 100KHz	+ 13	± .75DB	– 37	3162	2.0	1 5
NC 6103	10Hz – 500KHz	+ 13	± .75DB	– 44	1414	2.0	1 5
NC 6104	10Hz – 1MHz	+ 13	± .75DB	– 47	1000	2.0	1 5
NC 6105	10Hz – 10MHz	+ 13	± .75DB	– 57	316	2.0	1 5
NC 6106	100Hz – 25MHz	+ 13	± 1.0DB	– 61	200	2.0	1 5
NC 6107	100Hz – 100MHz	+ 13	± 1.0DB	– 67	100	2.0	1 5
NC 6108	100Hz – 500MHz	+ 10	± 1.5DB	– 77	31.6	2.0	1 5
NC 6109	100Hz – 1000MHz	+ 10	± 2.0DB	– 80	22.4	2.0	1 5
NC 6110	100Hz – 1500MHz	+ 10	± 2.5DB	– 81.8	18.3	2.0	1 5
NC 6111	1GH – 2GHz	+ 10	± 2.5DB	– 80	22.4	2.0	1 5

Power: 115 volt, 1/2 AMP 60 cycle
Crest Factor: 5:1 Min.
Operating Temperature: – 10°C to + 60°C
Attenuator: 10DB in 1DB STEPS
Case size: 8.5W x 5H x 12.25D

1 Watt (+30 dBm) Broadband Noise Generating Instruments

NC 8000 Series

These Noise Instruments are ideal to test the susceptibility of electronic instruments and systems to outside interference. The parameters that might be measured include unwanted emission levels, bit error rate, and signal to noise ratio.

They also find useful military applications as broadband jammer drivers, and to secure communications channels.

SPECIFICATIONS:

Power	115 V, 2 A, 60 cps
Impedance	50 ohms
Crest Factor	5:1
Operating Temperature	– 10°C to + 60°C
Attenuator	100 DB in 10 DB steps
Case size	17"W, 5.25"H, 13"D

OPTIONS:
1—Alternate attenuator, 10 DB in 1 DB steps.
2—Line power, 230 V, 50 Hz.

NOTE:
For other frequencies and specifications consult factory.

MODEL	FREQUENCY RANGE	FLATNESS	RF OUTPUT
NC8103	500Hz–500 KHz	± 2 DB	– 27DBM/Hz
NC8104	500Hz– 1MHz	± 2 DB	– 30DBM/Hz
NC8105	500Hz– 10MHz	± 2 DB	– 40DBM/Hz
NC8106	2KHz– 25MHz	± 2 DB	– 44DBM/Hz
NC8107	250KHz–100MHz	± 2 DB	– 50DBM/Hz

Programmable Broadband Noise Generating Instruments

NC 7000 Series

The NC7000 Series is a family of sixteen Microprocessor-based Solid State Programmable Noise Instruments. It implements the IEEE-STD-488 (GPIB) interface as a standard feature. It can also be supplied to interface to RS-232 or RS-422 or RS-423.

FEATURES:

- **White Gaussian, Broadband Symmetrical Noise.**
- **High Crest Factor, 5:1 Min.**
- **Manual and IEEE-488 (GPIB), RS-232 or RS-422 or RS-423 Interface.**
- **Non-Volatile Memory to Retain Various Programmed parameters.**
- **0-127 DB Atten. with 1 DB incr., and Optional 0-128 DB Atten. with 0.1 DB increments.**
- **Bench Type or 19" Rack Mounted Compact Size.**

NC 7100 SERIES, +10DBM OUTPUT

MODEL	FREQUENCY RANGE	OUTPUT				VSWR MAX	OPTIONS
		DBM/BAND	FLATNESS	DBM/√Hz	mV/√Hz		
NC7101	10Hz – 20KHz	+13	± .75DB	– 30	7071	2.0	1-7
NC7102	10Hz – 100KHz	+13	± .75DB	– 37	3162	2.0	1-7
NC7103	10Hz – 500KHz	+13	± .75DB	– 44	1414	2.0	1-7
NC7104	10Hz – 1MHz	+13	± .75DB	– 47	1000	2.0	1-7
NC7105	10Hz – 10MHz	+13	± .75DB	– 57	316	2.0	1-7
NC7106	100Hz – 25MHz	+13	± 1.0DB	– 61	200	2.0	1-7
NC7107	100Hz – 100MHz	+13	± 1.0DB	– 67	100	2.0	1-7
NC7108	100Hz – 500MHz	+10	± 1.5DB	– 77	31.6	2.0	1-7
NC7109	100Hz – 1000MHz	+10	± 2.0DB	– 80	22.4	2.0	1-7
NC7110	100Hz – 1500MHz	+10	± 2.5DB	– 81.8	18.3	2.0	1-7
NC7111	1GH – 2GHz	+10	± 2.5DB	– 80	22.4	2.0	1-7

NC 8200 SERIES, +30 DBM (1 WATT) OUTPUT

MODEL	FREQUENCY RANGE	FLATNESS	RF OUTPUT	VSWR MAX	OPTIONS
NC8203	500Hz-500KHz	± 2DB	– 27DBM/Hz	2 0	1-7
NC8204	500Hz- 1MHz	± 2DB	– 30DBM/Hz		
NC8205	500Hz- 10MHz	± 2DB	– 40DBM/Hz		
NC8206	2KHz- 25MHz	± 2DB	– 44DBM/Hz		
NC8207	250KHz-100MHz	± 2DB	– 50DBM/Hz		

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RF Technology Expo '86 Technical Sessions

Thursday, Jan. 30 (Morning)

Session A-1 — Oscillators (Huntington Room A-C)

9:00 — Application Notes for Doubly Rotated Quartz Crystal Resonators
Lynn C. Heishman, Piezo Crystal Company
An overview of the electrical parameters of the more widely used SC and IT cuts with data collected from production runs during the past three years. Comparisons between SC and the conventional AT cut quartz resonators include phase noise, fast warm-up and vibrational sensitivity.

10:00 — Practical Considerations for Modulating or Pulling the Frequency of a Quartz Crystal Oscillator.
John B. Fisher, Standard Crystal Corporation
A simplified Pierce transistor oscillator is analyzed from a small signal standpoint. Circuit characteristics that enhance linear frequency modulation are considered and techniques the Application.

11:00 — Choosing the Right Crystal and Oscillator for the Application.
Brian Rose, Q-Tech Corporation
Design guidelines cover such crystal oscillator requirements as frequency stability, aging, noise, environmental sensitivity and overtone mode.

Session B-1 — Power Amplifiers I (Capistrano Room A-B)

9:00 — Average Efficiency of Power Amplifiers
Frederick H. Raab, Green Mountain Radio Research Company
Since instantaneous efficiency of a power amplifier depends on signal amplitude relative to peak envelope power, average efficiency depends on type of amplifier and type of signal. This paper shows how to predict average efficiency, power consumption and power dissipation for a variety of common signals.

10:00 — High Voltage HF/VHF Power Static Induction Transistor Amplifiers
Scott J. Butler and Robert J. Regan, GTE Laboratories, Inc.
Static induction transformers operated in a common-source configuration can provide very high gain at HF, VHF and lower UHF frequencies if parasitic drain-to-gate capacitance is neutralized. The broadband neutralization scheme presented is similar to the cross-neutralization scheme successfully used for push-pull triode vacuum tube amplifiers.

11:00 — Harmonic Wave Shaping for High Efficiency Power Amplifiers
William McCalpin, Microwave Modules and Devices
High efficiency power amplification is achievable by using harmonic wave shaping techniques to control collector voltage and current waveforms. The device collector-voltage product is minimized and efficiency is increased. This paper describes an amplifier operating at 425 MHz with a gain of 8.1 dB and a collector efficiency of 83.1⁄at 50 watts power output.

Session C-1 — Receivers and Transceivers (El Capitan Room A-B)

9:00 — Intermodulation, Phase Noise and Dynamic Range in Receivers
Peter Chadwick, Plessey Semiconductors, Ltd.
A discussion of these basic aspects of receiver design.

10:00 — A Microwave Integrated Receiver for the Morelos Mexican Satellite System
A. Serrano, J.L. Medina and D. Hiriart, CICESE Research Center
The Morelos Mexican Satellite System receiver works a Ku band and provides a 0.9 - 1.4 GHz signal to the modem. This paper describes the characteristics and design of the system, expected to be operational in early 1986.

11:00 — Improve Synthesized Transceiver Performance and Reliability by Simple Screening of the VCO Active Device
Jaime A. Borras, Motorola Inc., Communications Sector
This paper describes the effect of 1/f noise from high frequency bipolar junction transistors on the performance of a synthesized transceiver and offers an explanation of the origin of noise. A simple screening technique to improve transceiver performance and reliability is explained.

Session D-1 — Circuits and Components (Avila Room A-B)

9:00 — A 140 MHz Lumped Element Hybrid
R. Chattopadhyay and I.K.L.N. Murtha, Indian Telephone Industries Ltd. and S.K.R. Nayar, Delhi University
This paper describes a 140 MHz, lumped element, branched line hybrid that is compatible with planar technology and to which filters can be added to shape the output response.

10:00 — The Schottky Diode Mixer
Jack H. Lepoff, Hewlett Packard, Microwave Semiconductor Division
Schottky diode mixing efficiency is related to diode and circuit parameters. This paper discusses the diode parameters: capacitance, resistance and barrier voltage, and the circuit parameters: DC bias and load resistance. Harmonic response and third order two tone intermodulation are studied, also.

11:00 — PIN Diode Attenuators and Vector Modulators at Intermediate Frequencies
N.R.W. Long, Consultant
A review of the design of matched attenuators with readily available discrete components and techniques for making bi-phase attenuators, phase shifters and vector modulators. This paper includes two new vector modulator designs recently developed at University College, London.

Session E-1 — Filters I (San Simeon Room A-B)

9:00 — Design of Coaxial High-Pass Filters Having Various Transfer Properties
Dick Wainwright, Cir-Q-Tel Inc.
This paper discusses the design and construction cost of various high pass filters, such as pseudo-elliptic and all-pole Butterworth, Chebishev, Gaussian and others.

10:00 — An S-Band High Performance Combline Filter
V.K. Lakshmeesha, ISRO Satellite Center
This paper describes an improved high performance combline filter at S-Band for the input/output of a transponder. Tunable from 2 to 2.4 GHz, the filter is qualified for spaceborne applications at 1 watt RF power.

11:00 — High Power Filter Design Considerations
Dick Wainwright, Cir-Q-Tel Inc.
This paper discusses information designers often fail to furnish when specifying filters, such as harmonic content of transmitter power output relative to fundamental power, compatibility of specified connectors, available surface area for heat conduction and realistic VSWR specifications.

Thursday, Jan. 30 (Afternoon)

Session F-1 — SAW Circuits (Huntington Room A-C)

1:30 — SAW Accelerometers: Integration of Thick and Thin Film Technology
Tim B. Bonbrake, Magnavox Electronics Systems Company, and Carl A. Erickson, Andersen Laboratories
This paper presents the design, fabrication and test results of prototype SAW accelerometers intended for missle applications sensing +/- 100 Gs. The device integrates thick and thin film technologies in a small, connectorized package. Three SAW delay lines are used with hybrid electronics to obtain DC and RF outputs proportional to acceleration.

2:30 — Evolution Into SAW Resonators
Ronald J. Coash, Notifier Company, Emhart Electrical/Electronic Group
A discussion of factors involved in the use of SAW resonators in short range wireless data communications, such as the low power security system manufactured by Notifier.

3:30 — Harmonic Filtering of a 500 MHz SAW Resonator Oscillator
Phillip Snow, Tektronix, Inc.
The resonant properties of a quarter-wavelength transmission line used as a re-entrant (periodic) tuned circuit are explained as they relate to band pass and band reject filtering. The design procedure for a 500 MHz SAW resonator oscillator using quarter-wavelength distributed transmission lines in a simple, cost-effective shunt configuration is described.

Session G-1 — Amplifiers (Capistrano Room A-B)

1:30 — The Q Factor of a Microwave Matching Network in RF Class C Amplifier Design
P. Gonord, S. Kan and J.R. Ruaud, Institute D'Electronic Fondamentale, Universite Paris-Sud

The Q factor of an impedance matching network incorporating microstrips as inductances has a bounded value. This paper shows how strip lengths as a function of Q are evaluated numerically with greater accuracy than with a Smith chart graphical construction. A 162 MHz, 100 watt, Class C amplifier is used as an example.

2:30 — Limiting Amplifier Design on High "K" Soft Board
Steve Chambers, Acrian Inc.
Receivers used for FSK, FM or PM signals use discriminators as the means of detection, but discriminators are susceptible to instantaneous amplitude perturbation. It is necessary to limit peak amplitude swings of the carrier while establishing the receiver dynamic range and signal to noise ratio. This paper describes the design of the limiting amplifier on high "K" Duroid.

3:30 — Basic MODAMP MMIC Circuit Techniques
Bill Mueller, Avantek Inc.
This paper describes the Avantek MODAMP silicon bipolar monolithic microwave integrated circuits intended for use as general purpose 50 ohm gain blocks. The internal structure of the MODAMP is a Darlington connected pair of transistors with resistive feedback and a simple resistive biasing scheme.

Session H-1 — Systems (El Capitan Room A-B)

1:30 — A Broadband, Lumped Element Variable Attenuator
R. Chattopadhyay, I.K.L.N. Murtha and Eshwarappa, Indian Telephone Industries Ltd.
This paper describes the design of a bridged-T variable attenuator in the 1 MHz to 500 MHz band, with an attenuation range of about 13 dB and a return loss of 21 dB.

2:30 — A Tracking Impedance Measurement System
Virgil L. Newhouse, Rockwell International, High Frequency Communication Division
This paper describes a Tracking Impedance Measurement System for actual in-line impedance measurements. The TIMS operates over a wide frequency and power range but generates virtually no noise or spurious signals. Digital outputs are updated rapidly and may be used to calculate impedance, reflection coefficient, VSWR, etc., in real time.

3:30 — An S-Band Butler Matrix Feed Network
V.K. Lakshmeesha, ISRO Satellite Center
This paper presents the development of a compact microstrip Butler Matrix feed network at S-band for an 8-element linear array. The entire feed network is incorporated on a 10-inch by 10-inch, high dielectric constant soft substrate, incorporating broadband hybrids and phase shifters.

Session I-1 — Antennas (Avila Room A-B

1:30 — A Spherical Delectric Antenna
S. Pal, ISRO Satellite Center
A study of near field and far field characteristics of a dielectric sphere antenna excited by a circular metal waveguide operating in its dominant TE11 mode. The system can be used as a microwave applicator, spotbeam antenna or feed for a Cassegrain reflector.

2:30 — Reliable Obstructed Path Coverage Determination
Bruce Ziemenski, City of Fresno, Electronics and Communications Division
When VHF or UHF terminals are so widely separated that line-of-sight communication is not possible, the presence of a sharp, ridgelike obstruction between the terminals may improve the signal. The signal strength results from diffraction over the sharp obstacle and may exceed that of a normal path. This paper provides information for determining the best obstructed path coverage.

3:30 — Extending the Bandwidth for a Helical Antenna
Al Henderson, Signature Antenna
(Paper not received by press time.)

Session J-1 — EMC/EMI (San Simeon Room A-B)

1:30 — How to Make Simple and Not So Simple Test Equipment in Your Own Lab
Jim Weir, Radio Systems Technology
Do-it-yourself tips for the engineer on a low budget.

2:30 — Simple Approaches for Limiting Radiation From Foil-Shielded Computer Cables
Howard C. Rivenburg, Atlantic Research Corporation
Radiation from cables in large communications centers can increase bit-error rates for data transferred between equipment. A 55-conductor and a 26-conductor foil-shielded cable were used to demonstrate that the radiation profile from such cables can be reduced greatly with easily implemented installation procedures.

3:30 — Design Clean Filters — Minimize EMI
J.A. Sachdev and S. Jayaraman, Defence Electronics Research Laboratory (India)
This paper discusses the design and realization of filters for EMC applications. Selection of components, mounting technique, layout, etc., are discussed in detail from a practical point of view, with the goal of attaining clean filters with good out-of-band attenuation.

Friday, Jan. 31 (Morning)

Session K-2 — Computer Aided Design (Pacific Ballroom D)

9:00 — The Poor Man's Engineering Work Station, or Cheap CAD
Richard B. Kolbly, Lockheed-California Company
Although many engineers have access to microcomputers, not many have good software specifically for design engineers. This paper shows how to achieve sophisticated interactive RF and microwave design aid from a personal computer, by using software available in listing form from trade and professional journals, government publications and other public domain sources.

10:00 — An Evolution of Optimization and Synthesis Programs for Personal Computers
Stephen E. Sussman-Fort, State University of New York at Stony Brook
Two personal computer programs for RF/microwave applications have been substantially revised since they were explained at RF Technology Expo 85. CIAO, for analysis and optimization, is now more powerful with rapid sparse-matrix techniques, a choice of three optimization algorithms and high resolution graphics output. DESIGN, for matching network synthesis, is now able to synthesize lumped and distributed matching networks with response errors of a small fraction of a dB.

11:00 — Computer Aided Design of a Monolithic Microwave Amplifier
Bernard D. Geller and Gary G. Hawisher, Comsat Laboratories

The design of a monolithic microwave integrated circuit amplifier for the 3.7 to 4.2 GHz satellite band is explained in tutorial fashion from concept to fabrication, including an overview of the facilities at Comsat Labs used to design and produce the circuit. Emphasis is placed on the analytical design and the computer tools used to model and optimize the circuit.

Session L-2 — Advanced Techniques I (Huntington Room A-C)

9:00 — An Automatic Network for Characterization of RF Circuits in the Time Domain
M. Dragoman, R&D Institute for Semiconductors (Romania)
A new automatic network for characterization of RF circuits in time domain processes the output and offers the pole chart, transfer function and input impedance and tests physical realizability conditions. Only one measurement in time domain is necessary for complete characterization in the frequency domain.

10:00 — Mathematics of the Linvill Stability Criteria
Robert B. Gunderson, Hughes Aircraft Company
Programs for the HP 15C pocket calculator yield the Y-parameter model of the power output transistor, development of a Smith chart and equations for the stability factor, "C" value, angle of gain circles and output power levels.

11:00 — Spectral Shaping of Radio Frequency Waves
Jerry J. Norton, Applied Automation Inc.
This paper presents a method of spectrally shaping a quadrature phase shift keyed signal using baseband techniques applied to an RF signal. The method does not require linear modulators or amplifiers or expensive bandpass crystal filters. A constant amplitude signal allows the use of Class C amplification without spectrum spreading, intermodulation distortion or inter-symbol interference.

Session M-2 — Packaging (Capistrano Room A-B)

9:00 — An RF Plastic Package Comparison Study
Lance Ulik and Kamil Gresko, Motorola Inc., Semiconductor Products
This paper considers the differences in RF performance that can be attributed to package styles for plastic encapsulated silicon bipolar transistors. Packages considered include TO-92, SOT-89, SOT-23 and SOT-143. Power dissipation capabilities of these packages are discussed.

10:00 — Packaging Considerations for RF Transistors
Norman E. Dye, Motorola Inc., Semiconductor Products
This paper discusses the Stripline Opposed Emitter (SOE) package, common emitter TO-39 and TO-220, plastic macro-T and macro-X low power packages, ceramic structures like the 100 mil hermetic package, internally matched packages and such other special types as the isolated collector. Recent package innovations to improve performance and reduce cost and a possible new high power package aimed at minimizing the need for beryllium oxide will be described.

11:00 — SORF — An RF Low Power SMD Alternative Package
Harry J. Swanson, Motorola Inc., Semiconductor Products
This paper introduces the Small Outline RF (SORF) package with the same mechanical case outline as the SOIC SO-8. The SORF package is described and its performance compared with the macro-X package.

Session N-2 — Filters II (El Capitan Room A-B)

9:00 — Dielectric Resonator Filters for UHF and Microwave Applications
Marian L. Majewski, Royal Melbourne Institute of Technology
This paper describes a simplified method for dual and single-mode operation dielectric resonator band pass and band reject filters, with practical examples of temperature compensated filter realizations for land mobile and satellite direct broadcast reception applications.

10:00 — Design of Combline and Interdigitated Bandpass Filters
Dick Wainwright, Cir-Q-Tel Inc.
This paper describes comb-like and interdigitated bandpass structures with annular ring-like resonators using spacing, angular rotation and, possibly, tilting-yaw orientation of adjacent resonators to control coupling coefficients.

11:00 — A PC Mountable Miniature Helical Filter
V.K. Lakshmeesha, ISRO Satellite Center
This paper presents the development of a miniature printed circuit board mountable helical filter in the UHF/VHF range. The filter was developed for a spaceborne S-band transponder. It is 45 x 14 x 14 cubic mm, has an insertion loss of about 1.6 dB and is tunable from 260 to 400 MHz.

Session O-2 — Circuits and Components (Avila Room A-B)

9:00 — The PIN Diode — Uses and Limitations
Jack H. Lepoff, Hewlett-Packard, Microwave Semiconductor Division
Because the resistance of the PIN diode can be controlled by the current through the intrinsic layer it is useful as a switch, attenuator or modulator. By choosing the proper diode and driving circuit switching can be completed in a few nanoseconds. Topics discussed include modulation frequency limitations, distortion, effect of voltage on capacitance, package limitations, frequency limitations due to diode capacitance and diode models.

10:00 — A Microstrip Miniature Transfer Switch
Rajeswari Chattopadhyay, Indian Telephone Industries Ltd.
A microstrip miniature transfer switch developed for the 675 MHz digital microwave system of Indian Telephone Industries Ltd., using PIN diodes, has replaced the bulky coaxial switch that used relays. An isolation of more than 50 dB is obtained at two isolated ports with an minimum of 15 dB return loss at all four ports. The switch is TTL compatible.

11:00 — RF and Microwave Transistor Bias Considerations
Gary Franklin, Hewlett-Packard, Microwave Semiconductor Division
This paper presents an overview of the advantages and disadvantages of some common bias circuits. Resistive, diode and active bias circuits are compared for effectiveness in stabilizing the transistor bias point against DC parameter changes caused by temperature and device-to-device variations.

Session P-2 — RF Power Designs (San Simeon Room A-B)

9:00 — High Power Wideband Modules Using Silicon FETs
Lee B. Max and Robert A. Samsel, Microwave Modules and Devices

This paper describes the design, development and manufacturing of four high power FET modules; 500 watts from 1.6 to 30 MHz, 600 watts from 88 to 108 MHz, 150 watts from 1 to 150 MHz and 350 watts from 20 to 110 MHz. Performance targets, design trade-offs and final performance are discussed, with comparison data for FET modules and bipolar transistor versions.

10:00 — Unequal Power Splitter Hybrid Couplers
S. Pal, ISRO Satellite Center
Design techniques for an unequal power splitting hybrid branch line coupler are described. The typical application for the device is in UQPSK modulators for high bit rate data transmission. Nomograms are presented for different output coupling levels.

11:00 — Practical Wideband RF Power Transformers, Combiners and Splitters
Roderick K. Blocksome, Rockwell International, High Frequency Communications Division
This paper describes the design and fabrication of wideband RF power transformers used in modern solid state HF power amplifiers. Emphasis is on bandwidths greater than four octaves at power levels over 100 watts and insertion losses of a few tenths of a dB. Various configurations are compared, with performance data and practical design examples.

Friday, Jan. 31 (Afternoon)

Session Q-2 — Basic Techniques (Pacific Ballroom D)

1:30 — The Basics of RF Power Amplifier Design
Daniel Peters, Falcon Communications
An explanation of the basics as they apply to solid state, two meter communications amplifiers build with discrete components.

2:30 — Understanding RF Transistor Data Sheet Parameters
Norman E. Dye, Motorola Inc., Semiconductor Products
This paper describes how maximum ratings for an RF transistor are determined. Thermal, DC and functional specifications are discussed with special emphasis on such unique parameters as load mismatch stress. Procedures for obtaining impedance data and thermal data are described.

3:30 — New Insights Into "Old" Network Analysis Applications
Lorenzo Freschet, Hewlett-Packard, Network Measurements Division
Recently developed techniques in network measurements for RF frequencies have enhanced the traditional ones of gain, attenuation, impedance and match. They are discussed using measurement application examples on transistors, SAW devices and fiber optic components, with particular emphasis on problems in measurement and their solutions.

Session R-2 — Oscillators II (Huntington Room A-C)

1:30 — Oscillator Design Using the Device Line and Load Pull Method
Gary Franklin, Hewlett-Packard, Microwave Semiconductor Division
This paper describes the design of an oscillator using the concept of a negative resistance one port. Methods of transforming the transistor into a negative resistance one port and the device line and load pull methods of measuring load resistance required for oscillation are discussed.

2:30 — Low Phase Noise VHF Quartz Crystal Oscillators — Measurement, Specifications and Applications
Kim Peck, Microsonics, Inc.

3:30 — Maximizing Crystal Oscillator Frequency Stability
Brian Rose, Q-Tech Corporation
The important parameter determining the frequency stability of a crystal and circuit combination is the slope and stability of phase versus frequency in the closed loop. This parameter is related to the unloaded crystal Q, but how the crystal is used in the circuit is important. This paper explores this topic using analysis, computer simulation and breadboard results.

Session S-2 — Power Amplifiers II (Capistrano Room A-B)

1:30 — Power Amplifiers Using Pulse Duration Modulation (cancelled)
2:30 — Automatic High Power RF Characterization
David Wandrei, M/A-Com Advanced Semiconductor Operations
This paper describes a novel automated high power RF test stand with error corrected active load and input impedance capability, designed to meet the rigors involved in quick device characterization for packaged and chip FETs.

3:30 — Design Considerations for a 1 kW Solid State L-Band Power Amplifier
Orville B. Pearce, Microwave Modules and Devices
Starting with the amplifier block diagram, this paper discusses the power amplifier architecture, the high power combiners and selection of transistor die and package. The heart of the power amplifier is a 300 watt, 50 ohm module. The 1 kW unit uses five modules.

Session T-2 — Test and Measurement (El Capitan Room A-B)

1:30 — A 405 MHz Phased Array Antenna for Atmospheric Wind Measurement
Daniel C. Law, NOAA Wave Propagation Laboratory
This paper outlines the steps involved in the antenna design, including performance requirements, computer aided design via antenna pattern simulation and actual measurements of the resulting antenna pattern. Emphasis is placed on the utility of computer simulations to optimize design parameters and the economic tradeoffs of different levels of available technology.

2:30 — Testing of Narrowband Communication Receivers — ACSB and SSB
Malcolm Levy, Racal-Dana Instruments Inc.
A discussion of the effects of adjacent channel, reciprocal mixing and intermodulation performance on narrowband amplitude compandored sideband or single sideband receivers. A test procedure is given to evaluate this performance and signal generator specifications are discussed relative to the tests.

3:30 — Broadband HF Antenna Testing
David L. Faust and Moray B. King, Eyring Research Institute
Current numerical electromagnetic modeling programs are limited in their treatment of ground interactions in the HF region. The relative comparison problem is significant when buried or low profile ground interactive antennas are addressed. The broadband antenna test system described in this paper provides accurate performance comparisons and design feedback, and reduces the complete evaluation period for an antenna system from months to a few weeks.

Session U-2 — Designs (Avila Room A-B)

1:30 — Temperature Compensation Circuits for Data Transmitters
S. Pal, ISRO Satellite Center
This paper presents a simple technique for temperature compensation in spacecraft through automatic gain adjusting circuits associated with temperature sensitive components.

2:30 — A Phase Noise Analyzer Using A Low Noise PLL Crystal Oscillator Demodulator
William Ress, Teletec Inc.
This straightforward, practical, yet sensitive phase noise analyzer measures low noise stable signal sources such as crystal oscillators and frequency stabilizers. It uses a low noise 9.7 MHz phase locked loop crystal oscillator demodulator to measure noise floors of -130 dBc/Hz at 100 MHz from the carrier to -155 dBc/Hz at 10 kHz from the carrier.

3:30 — Design of a Delectrically Stabilized Oscillator Using Feedback Techniques
M.L. Sharma and R. Partha, Indian Telephone Industries Ltd.
This paper presents the design of X and Ku band fundamental oscillators stabilized with a dielectric resonator that also forms the feedback path. A step by step analysis leading to the final oscillation condition is explained. The FET circuit design and optimization is based on S-parameter analysis and a simple program is used to determine the impedances and microstrip line lengths.

Session V-2 — Medical Applications (San Simeon Room A-B)

1:30 — RF Technology for Nuclear Magnetic Resonance
Otward Mueller, Dimitrius Vatis, William Edelstein and Paul Bottomly, General Electric Company, Corporate Research and Development
This paper reviews the NMR system with emphasis not on the physics of the nuclear magnetic resonance effect but on the RF technology required to make it operate. Some special RF problems occuring in NMR will be discussed, especially RF signal and kilowatt power processing.

2:30 — Principles of RF Hyperthermia
Paul R. Stauffer, University of California, Radiation Oncology Research Labs
An introduction to the use of RF radiation for body heating with emphasis on the RF technology.

Saturday, Feb. 1 (Morning)

Session V-3 — Computer Aided Design II (Pacific Ballroom D)

9:00 — A Computer Aided Noise Temperature Measurement System
George Peter and William T. Gentner, Cornell University, National Astronomy and Ionosphere Center
The system described improves speed and accuracy of testing RF amplifiers for noise temperature and gain vs. frequency and plots the results in graphic and tabular form. It incorporates a closed cycle helium refrigerator and dewar assembly for testing devices at cryogenics temperatures. This paper describes the necessary formulas, procedures, software and hardware to achieve intended results.

10:00 — Aiding Computer Aided Design — Curve Fitting With Any Number of Variables
Al Pergande — Martin Marietta Aerospace
This paper discusses a simple, direct method of fitting an arbitrary multi-variable function to a set of data by the least squares method. The resulting functions can be used for design and optimization of circuits employing elements difficult to analyze or measured "black box" data.

11:00 — Interactive Computer Aided Graphics Applied to RF Circuit Design
Alan Victor, Motorola Inc., Portable Products Division
The several programs presented use the interactive graphics capability of a desktop computer to aid the RF circuit designer. High frequency design of Class A power amplifers and low noise design and stability analysis are discussed. A program that computerizes the Smith chart and aids in broadband matching is demonstrated.

Session W-3 — Advanced Techniques II (Huntington Room A-C)

9:00 — Modulation Techniques for Biotelemetry
Robert W. Vreeland, University of California, Research and Development Laboratory
Biotelemetry is a means of wireless transmission of physiological data by radio, infrared or ultrasound. Frequencies range from DC for temperature telemetry to several thousand Hertz for muscle voltage monitoring. Direct FM transmitters can be detuned when a person moves his hand near the tank coil. This paper describes techniques for avoiding "movement artifact" and for minimizing battery drain.

10:00 — Use of a Computer Model to Determine the Complex Parametric Relationships of Crystal Oscillator Circuits
Gregory L. Weaver, Piezo Crystal Company
This paper presents a computer model to examine the phase and gain of an open-loop Pierce oscillator circuit. The model uses complex variable algebra and S-parametric relationships to break down the circuit parameters into functional gain blocks. Among other factors, the drive on the crystal oscillator is derived.

11:00 — Time Delay vs. Frequency Variations Due to Impedance Mismatched Effects
Donald J. Lanzinger, Goodyear Aerospace Corporation
Multiple channel receivers, ECCM circuits and phased arrays for beam steering are among the circuits that typically use time delay vs. frequency. This paper discusses the causes and effects of time delay vs. frequency variations and how to compensate for both narrow and wide frequency bands.

Session X-3 — Power Amplifiers III (Capistrano Room A-B)

9:00 — High Power UHF Pulsed Push-Pull Amplifier Design
Joseph J. D'Agostino, Jr.
This paper simplifies the nebulous areas that make a push-pull amplifier different from a single-ended or parallel amplifier.

10:00 — New Hybrid Power Amplifier Modules Speed RF Systems Design
Eric Ulrich, Microwave Modules and Devices
Because of thermal problems, TO-8 amplifier modules have been limited to about one-half watt power output. MMD has developed a family of power amplifier modules that cover the range of 5 MHz to 2 GHz, with power output up to 2 watts at the 1 dB gain compression point. The designs are described in this paper.

11:00 — Two Power MOSFETs Deliver 1 kW RF (Cancelled)

Session Y-3 — Circuits and Components II (El Capitan Room A-B)

9:00 — A 350 MHz Dual Gate FET Frequency Doubler
Gordon Olsen, Rockwell International, Avionics Group
This paper describes a dual gate FET frequency multiplier with 13 dB conversion gain for an output frequency of 350 MHz. The bias on the second gate provides gain control in excess of 40 dB while maintaining better than 20 dB return loss.

10:00 — A CAD Program for Analysis of Electro-Thermal Coupling in High Power RF Bipolar Power Transistors
Antonio Morawski and Boris Hikin, TRW, RF Devices Division
The sophisticated thermal analysis program for CAD and CAE with high frequency bipolar power transistors presented in this paper agrees with experimental observations of phenomena associated with RF transistor operation. Temperature and current density distributions are analyzed and presented as a function of power density, RF and DC operation, total emitter ballasting, ambient temperature and cell splitting.

11:00 — Practical Active Frequency Multiplier Design
Geoffrey Giese, Microwave Modules and Devices
This paper describes the parameter tradeoffs among various frequency multiplier concepts and gives a proven design procedure for stable active multipliers that readily cascade into multiplier chains. The design meets critical communications and EW demands and has been used in production up to 4 GHz.

Session Z-3 — General Topics (Avila Room A-B)

9:00 — Characteristics of Iron Powder Cores
Rich Barden, Micrometals Inc.
A general discussion of iron powder cores.

10:00 — Wide Band, High Dynamic Range, Integrated Front End Circuitry for an AM Radio
Ernst H. Nordholt and H.C. Nauta, Delft University of Technology (Netherlands)
This paper presents the bipolar integrated input amplifier and frequency conversion circuitry of an AM up-conversion front end for car radio receivers. Tuned pre-selection filters can be omitted, eliminating the need for adjustments and reducing production costs. Tuning is easily accomplished by varying only the oscillator frequency.

11:00 — A Commutation Double-Balanced Mixer of High Dynamic Range
Ed Oxner, Siliconix Inc.
Common to the diode and the FET is their square-law characteristic so important in maintaining low distortion during mixing. Equally important for high dynamic range is the ability to withstand overload, a cause of distortion in mixing. This paper examines a new FET mixer where commutation achieves high dynamic range without the anticipated penalty of increased local oscillator drive. Third order intercept points upward of +39 dB (input) have been achieved with only +17 dBm of local oscillator drive.

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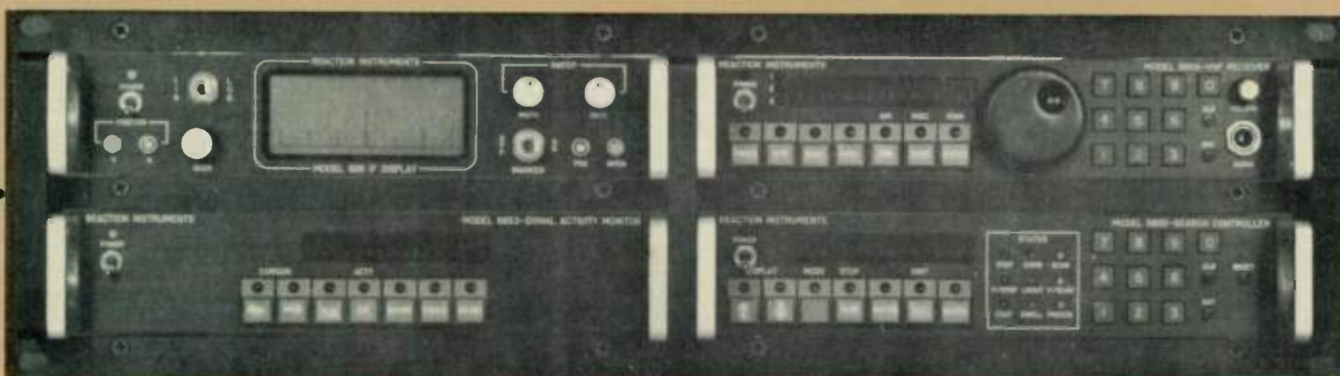

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IF Display	**Signal Activity Monitor**
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The amplitude and group delay functions for the recursive elements are:

$$H(\omega) = \frac{1}{1+2A\cos\omega\tau+A^2} \tag{3-3}$$

$$T(\omega) = \frac{A\,(A+\cos\omega\tau)}{1+2A\cos\omega\tau+A^2} \tag{3-4}$$

For a filter composed of N feedback sections:

$$H(\omega) = \left(\frac{1}{1+A_1e^{-j\omega\tau_1}}\right)\left(\frac{1}{1+A_2e^{-j\omega\tau_1}}\right)\ldots\left(\frac{1}{1+A_ne^{-j\omega\tau_n}}\right) \tag{3-5}$$

As the number of sections in the filter is increased, the number of inverse sample points increases and the signal correction improves. If a given three ray amplitude minimum ω_0 is located between two adjacent sections, the signal correction is proportionately shared between them.

Feedback is used once again to control the amount of correction applied in the overall network (Figure 5). Individual bandwidth segments are monitored by bandpass filters (tuned circuits), and the integrated detected output of these filters controls the amount of feedback in the recursive filter elements. Each filtered output is used to control the recursive element whose amplitude maximum occurs at the center frequency of it's bandpass filter.

The integrators driving the individual elements must track a given fade with enough speed and accuracy to correct variations in the channel during the most rapidly varying fade conditions. Individual recursive element responses should be adjusted to have 10-90 percent risetimes in the 20 millisecond range.

Recursive equalizer test signatures for three and five pole systems are given in Figures 6 and 7. These curves were measured using a system containing a 45 megabit 16 QAM modem with an α of 0.5 and a 70 MHz interface. The modem was evaluated with a three ray simulator for both minimum and nonminimum fading conditions. These plots indicate that the five section equalizer minimum fade performance is adequate for almost all types of frequency selective fading. The equalizer slope performance (both nonminimum and minimum) is also adequate. When a nonminimum fade notch occurs inband,

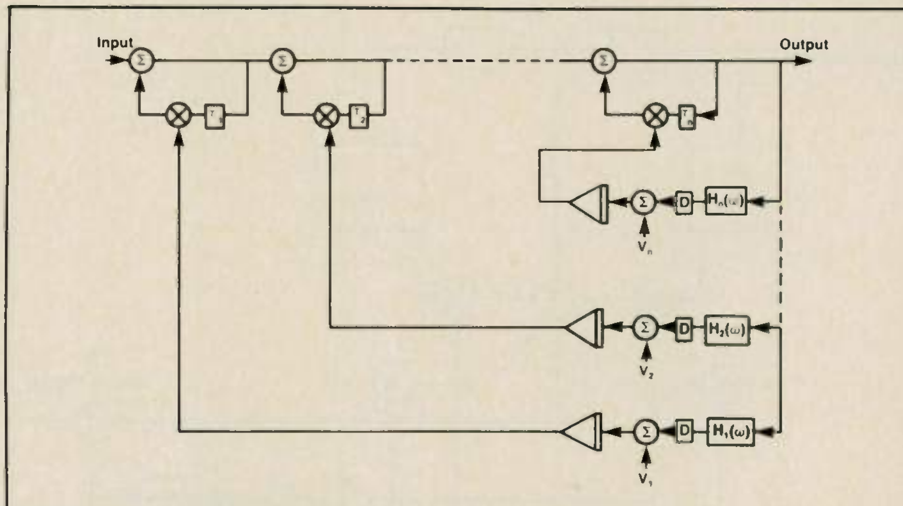

Figure 5. Block diagram of a recursive filter IF equalizer

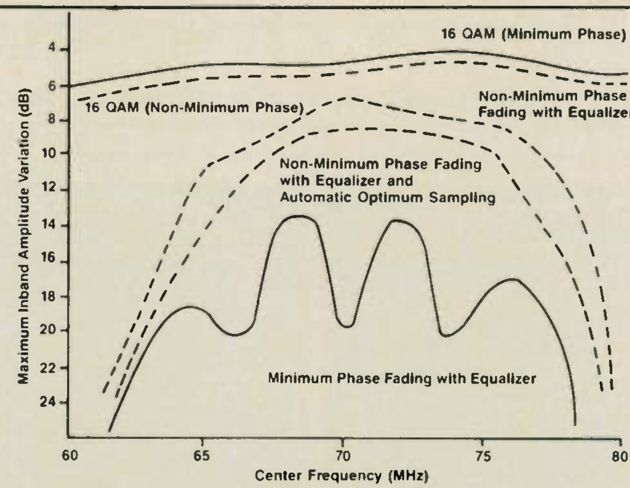

Figure 6. Inband amplitude variation vs. frequency (45 mbs, 16 QAM, BER = 10^{-6})

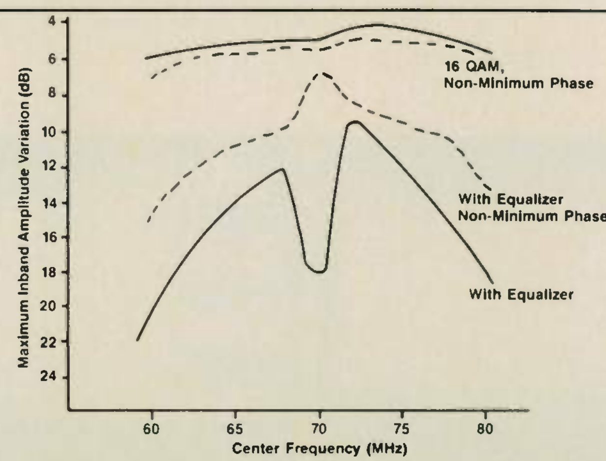

Figure 7. Inband amplitude variation vs. frequency (45 mb/s, 16 QAM, BER = 10^{-6})

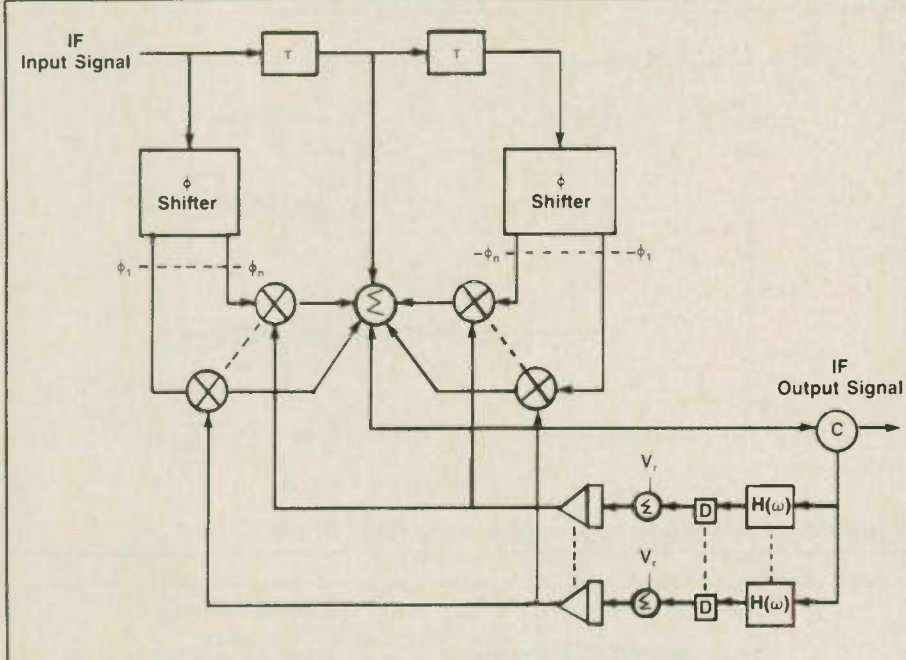

Figure 8. An n-element linear phase adaptive cosine filter

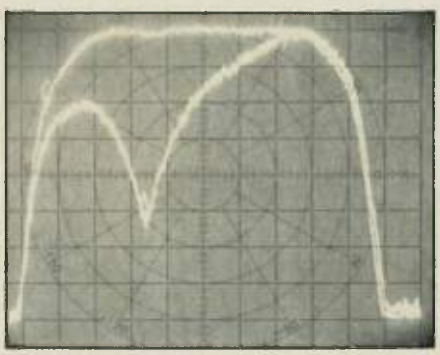

Figure 9.

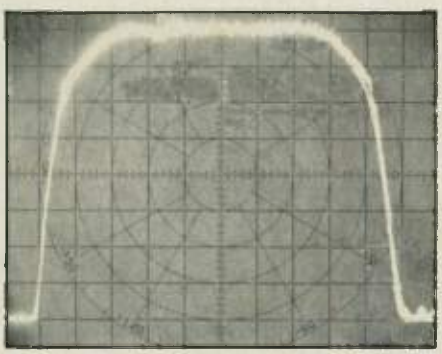

Figure 10.

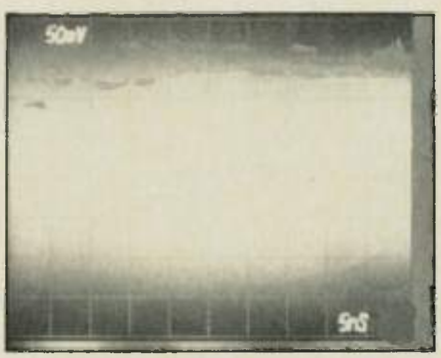

Figure 11.

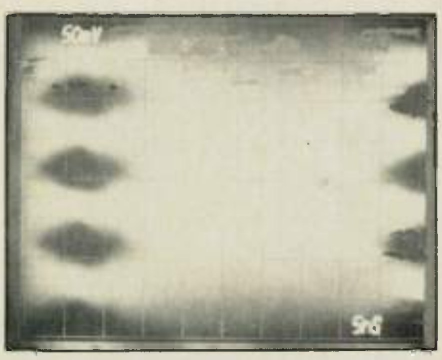

Figure 12.

however, considerable degradation occurs over the minimum phase case. This is because the group delay variation is approximately doubled and the amplitude correction is not sufficient to overcome this effect.

Linear Phase Cosine Adaptive Filtering

A linear phase amplitude-only equalizer may be developed from transversal cosine sections. Each transversal section is composed of two taps which are separated in time from a center tap by $\pm\tau$. An amplitude bump is generated by increasing the magnitude of the right pair of cosine coefficients. If individual filters and detectors are used for controlling the corresponding bump, a block diagram (Figure 8) may be developed. The filter transfer function will take the form:

$$H(\omega) = 1 + \sum_{n=1}^{N} A_n \cos(\omega\tau + \phi_n) \qquad (4\text{-}1)$$

This equation has all real terms and therefore will generate a linear phase response. If the cosine terms are separated and represented as delta functions, the transfer function will have symmetrical coefficients. The value of τ must be carefully selected so multiple maxima do not occur inband. A similar problem also occurs with the recursive filter and limits the Q in the correction circuits.

The cosine sections offer better performance for nonminimum phase fade notches of all types. These fades are believed to occur much more frequently than the deeper minimum phase notches where the recursive filter will outperform the cosine device. One disadvantage of the cosine filter is that two matched PIN diode attenuators are required for each element. Symmetrical coefficients are required in order to generate a linear phase response. Fortunately, this disadvantage is offset by the inherent stability of the feedforward transversal sections, unlike the recursive sections which become less stable with increasing amplitude correction.

The three ray test results indicate that the recursive equalizer will significantly improve the outage performance of a 16 QAM or other type of digital radio. This equalizer has excellent slope and inband minimum phase notch correction. Nonminimum inband notch performance limits the performance of this device. Fig. 9-12 indicate the spectral and eye pattern improvement after recursive filter correction of an inband minimum phase notch.

The linear phase response of the cosine equalizer will provide better inband nonminimum phase notch correction than the recursive structure. The inherent stability offered by the transversal cosine sections offers a major implementation advantage over the recursive design. rf

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About the Author

Richard Merwin is a consultant with considerable experience in IF correction techniques. He has a BS in mathematics, MSEE, and is completing further post-graduate EE study. Dick can be reached at 50 East Middlefield #26, Mountain View, Calif. 94043, or by telephone at (415) 453-7037.

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GaAs Digital ICs Improve Efficiency of the Stanford Linear Accelerator

By Nelson Frick
Harris Microwave Semiconductor

Gallium arsenide (GaAs) digital integrated circuits have extended the range of digital processing into the GHz frequency range, blurring the boundary between RF and digital realms. As a result, system designers may see GaAs digital components replacing traditional analog mixers, filters and amplifiers. Engineers at Stanford Linear Accelerator Center (SLAC) have recently used GaAs ICs to make a dramatic improvement in the electron yield to their Positron Electron Project (PEP) storage ring, implementing an electron "bunching" scheme. Digital techniques allowed SLAC to maintain frequency phase coherence of the Linear Accelerator (LINAC) and synchronization of the PEP trigger. This article tells the story of the work at SLAC and Harris Microwave Semiconductor that made these improvements possible.

Stanford Linear Accelerator Center is involved in elementary particle research, using their famous two-mile linear accelerator and positron-electron storage ring. Electrons are injected into the LINAC by a klystron electron gun, and accelerated using a 2856 MHz electric field. SLAC researchers wanted to improve the density of the electron "bunches" that are injected into the PEP ring by pre-bunching with a lower frequency field. This field had to be a phase-coherent subharmonic of 2856 MHz, and had to be synchronized with the PEP trigger. To accomplish this, SLAC needed to divide the 2856 MHz reference frequency by 16.

Prior to evaluating Harris' GaAs digital divider products they had been unable to identify a simple means of accomplishing the task. Harris pointed out that they could utilize an available 3.0 GHz divide-by-2 prescaler (HMD-11301-2) and the divide by 8 output of the 2/4/8 divider (HMD-11016-1) in cascaded form. For synchronization, the prescaler could be inhibited by using the clear function available on this device.

Aerial view of Stanford Linear Accelerator (SLAC) facilities.

SLAC purchased several devices and began their circuit development. After some initial difficulties, SLAC and Harris were able to develop and demonstrate a divide by 16 digital output from a 3.0 GHz sinewave by linking together two evaluation kits, with two Harris GaAs IC dividers in a cascade configuration. To accomplish the cascade SLAC and Harris selected a divide-by-2 prescaler capable of processing 3 GHz inputs. The Q output of the prescaler was connected to a 2 GHz 2/4/8 divider. Using the divide-by-8 output, SLAC produced a divide by 16 that worked from DC to 3 GHz.

This approach resulted in a flexible higher-order dividing function, capable of accomodating a wide range of input fre-

The Advantages of GaAs Material

The higher electron mobility and velocity of GaAs allow devices to operate several times faster than those based on silicon. The low electric field electron mobility of GaAs (for n = 10^{17}/cm^3) is 6000 (cm^2/Vsec.), but for silicon is 1000. GaAs achieves this higher mobility rating and a respective electron velocity ratio >2 at electric fields used in typical device geometries. GaAs ICs using buffered FET logic metal semiconductor field effect transistor (BFL MESFET) technology do not have the disadvantages of ECL devices. High speed ECL circuits can self-oscillate when no data or clock signals are present, and they can have "holes" (frequency dropouts) below 100 MHz. The inherent high speed of GaAs circuits make it possible to operate from DC to maximum speed without frequency dropouts or oscillation.

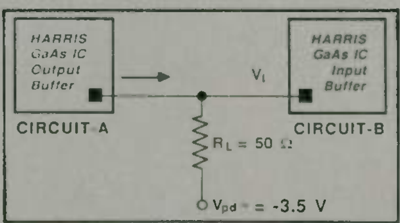

Fig. 1 GaAs interconnection biasing scheme.

Circuit characteristics

A designer would notice many similarities between GaAs and ECL devices, but must keep four important differences in mind. First, the power supply voltages are different for GaAs, +5Vdc and −3.5Vdc, both referenced to ground. However, since GaAs has a semi-insulating substrate, the on-chip ground need not be absolute (although it is internally connected to the package) and can be floated with respect to the earth ground. Second, the faster edge rates (125-picosecond fall times) require that all signal lines be treated as microwave transmission lines. Third, the inputs to the GaAs circuits are MESFETs and must be protected from static charge and provided with good voltage regulation. Finally, some medium-scale integrated (MSI) devices require a separate reference voltage to fine tune performance.

Despite these differences, using the devices alone or connecting them to ECL ICs is reasonably straghtforward. The GaAs output buffers drive 35 to 65 Ω terminating resistor loads and up to 1 pF of capacitance at 125-picsecond edge rates.

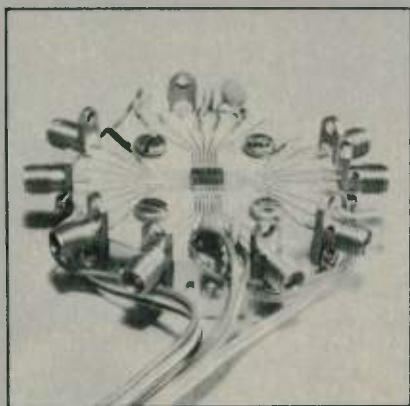

Fig. 2 Harris GaAs IC evaluation kit.

Circuit layout is critical

Since these chips perform at up to 4 GHz, careful board layout must be done to preserve their 125 picosecond edge rates. The rules that govern the use of ECL also apply to GaAs and the best performance requires a parallel terminating resistor, R_T, that matches the transmission line's characteristic impedance. The resistor is typically 35 to 65 Ω, preferably 42 to 52 Ω. One device can drive as many as three other ICs if R_T terminates the transmission line at only one point and any unterminated stub-lengths are kept under 0.25 inches. Keeping the stub to that length restricts spurious transmission line frequency components to above 10 GHz, too fast to trigger the GaAs circuit. In addition, when GaAs ICs are connected together, the terminating resistor must be connected to the negative supply of −3.5 Vdc (Fig. 1). This will provide the proper threshold voltage to achieve ECL logic levels. Even though GaAs and ECL ICs can be easily connected in the same circuit, the GaAs ICs are more sensitive to static discharge, and the same precautionary techniques for handling MOS devices are recommended. Further, because their inputs are designed to draw only a few microamperes of DC current, bias at positive potentials or a more negative level than −2.5 Vdc can be destructive.

Like ECL devices, GaAs circuits require adequate heat-sinking. They consume about 20 to 40 mW per gate (about the same power as the fastest ECL) independent of operating frequency. The device should be mounted to a heat-sink of copper or aluminum through an opening in the printed circuit board. The heat is removed through the package base so for forced air cooling, the device can be mounted with its base facing upward and attached to a small cooling tower.

Compatibility with microwave circuits

GaAs digital ICs require device packaging compatible with microwave frequencies. A package study demonstrated that a glass metal hybrid package was very effective. These hermetic flat-packs permit bond wire lengths to be kept to a minimum, which is important since long bond lengths can cause clock feed-through and edge rate degradation. Package lead widths are nearly the same as 50 Ω MIC transmission line on a high dielectric substrate (ϵr = 10). The IC evaluation circuits from Harris are made using this MIC technique (Fig. 2).

The use of microwave-style packages and microstrip circuit techniques allows integration of GaAs digital ICs into RF and microwave circuits.

Driving with analog signals

The input signal requirements for Harris GaAs digital ICs are ECL-compatible levels, −0.8 V to −1.8 V peak-to-peak. As a result, when using analog signals, GaAs device inputs must be AC-coupled and DC-offset to the ECL level. This can be accomplished using a bias network or "tee" with suitable bandwidth. GaAs MSI and SSI IC outputs are also at ECL logic levels, allowing high-speed inputs to other ECL compatible logic devices.

quencies, although SLAC's application required consistent, no-jitter division of only one frequency.

An alternative approach

Concurrent with Harris' efforts, Jim Judkins at SLAC was experimenting with a GaAs D type master-slave flip-flop (HMD-11131-2). He was attempting to accomplish a divide by 2 function by feeding back the $\overline{Q}$ output to the data input of the flip-flop (Figure 3). Instead of producing a divide by 2 output, he found that his circuit was dividing by 4. The D type flip-flop requires 2 clock transitions to pass clock data through it, which means that it will inherently divide by 2 when connected in a feedback configuration. However, if the feedback length is long enough to delay the feedback an even multiple of the clock period, different divide ratios can be achieved. This provides a fixed division ratio over a relatively narrow bandwidth, perfectly acceptable for a single stable frequency such as SLACs. The different divide ratios will always be multiples of two as a result of the two clock transitions required to move data through the flip-flop.

Through experimentation, SLAC developed the general equation for the required delay time (tpd) of the feedback line as a function of frequency and divide ratio.

$$\text{Delay time period (tpd)} = \frac{N-1}{2\,fo}$$

Where: N = Divide ratio
fo = Divide frequency

Using the SLAC requirement as an example, where N = 16 and fo = 2856 MHz:

$$tpd = \frac{16-1}{2(2856X10^6)} = 2.63 \text{ nsec}$$

To determine the physical line length for the required delay time, the dielectric constant of the circuit insulator must be known. If the designer uses a printed circuit board with a ground plane (micro-strip line), the following equation should be used:

$$tpd = 1.017\sqrt{0.475\,\epsilon r + 0.677} \quad \text{nsec/ft}$$

For coaxial and stripline transmission media:

$$tpd = 1.017\sqrt{\epsilon r} \quad \text{ns/ft}$$

where ϵr = dielectric constant of the insulator:

Again using the SLAC requirement as an example, if we use coaxial cable with an ϵr of 2.3:

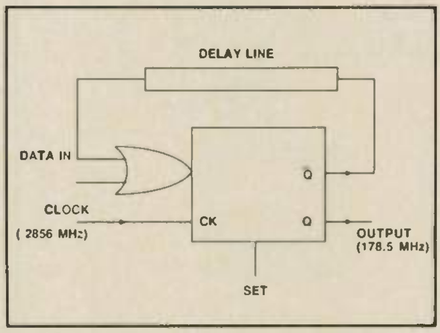

Figure 3. SLAC attempted to produce a divide by 2 by feeding back to the data input the Q output from the flip-flop. Instead, this circuit divided by 4.

$$tpd = 1.017\sqrt{2.3} = 1.54 \text{ ns/ft}$$

$$\frac{\text{coax.}}{\text{length}} = \frac{2.63 \text{ ns}}{1.54 \text{ ns/ft}} = 1.71 \text{ ft}$$

are coincident, the Gun is fired producing a 4-nanosecond Gaussian bunch containing 10^{11} electrons (Figure 4A). The electrons had been bunched into approximately ten 2856-MHz wave crests (350 picoseconds apart). The larger portion of electrons were in the center bunch (Figure 4B). At the end of the 10,000-foot LINAC the electrons are injected into the PEP ring. The PEP capture window is 800 picoseconds. Therefore, only two of the 10 bunches could be injected into PEP and the others were lost (Figure 4C).

Implementing the Subharmonic Bunchers (SHB) for PEP increases the electron yield. This requires a 178.5-MHz SHB frequency, phase coherent to the LINAC 2856 MHz and synchronized to the PEP trigger (Figure 5). This can now be accomplished through the use of gigahertz speed logic devices. Phase coherence is provided by dividing the 2856-MHz by 16 to 178.5 MHz. Synchronization is done by resetting the divider.

Figure 4. Diagram of SLAC electron bunching (before).

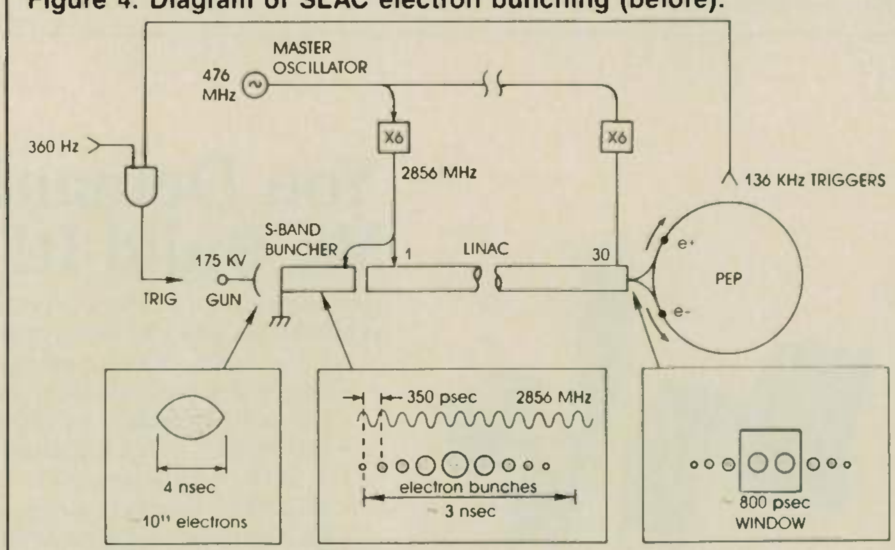

Figure 4a **Figure 4b** **Figure 4c**

SLACs use of a GaAs flip-flop

Harris Microwave Semiconductor's GaAs type flip-flop circuit is being used in a Subharmonic Buncher which is part of the electron gun system for the LINAC. The LINAC supplies 16 GeV electrons and positrons to the PEP storage ring.

The electrons and positrons rotate in opposite directions around the 1.4-mile PEP ring at 136 kHz (Figure 4). When the PEP 136 kHz triggers the LINAC 360 Hz

The longer ½ wave period of 178.5 MHz (2.8 nsec) can capture the 4 nsec electron bunch from the gun into one 2856 MHz wave crest (Figure 5A). The electrons at the rear of the bunch are accelerated by the positive electric field, while electrons at the front are decelerated by the negative field. Nearly all of the 10^{11} electrons can fit into one 2856 MHz wave crest and be injected into PEP for more efficient loading of the ring.

Figure 5. SLAC electron bunching (after)

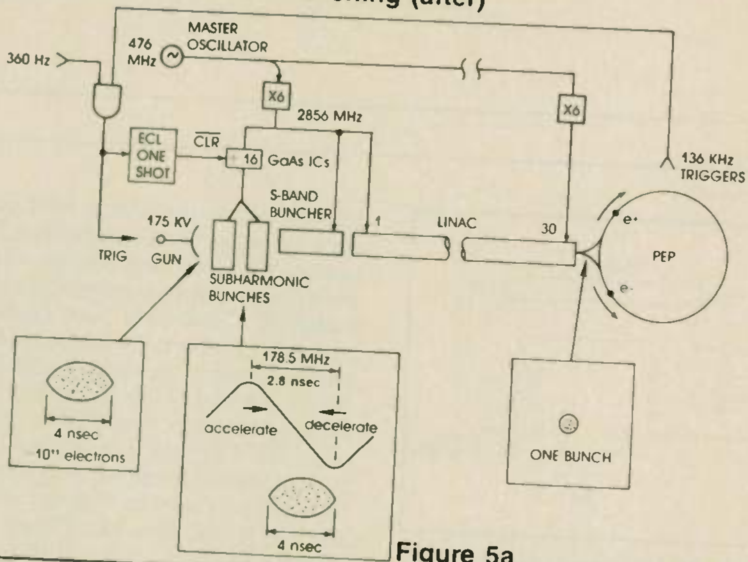

Figure 5a

Results

When SHB circuits were installed at SLAC and tested in parallel with the original S-band buncher, a 10 picosecond jitter was found in the 136 kHz PEP frequency source that had been undetectable before. As a result, SLAC is now working on improving oscillator stability.

Because the RF signal is digitally processed, unwanted frequency components which would result from diode mixers are reduced. Also, phase noise in this application was reduced by an order or magnitude. As a result of the improved stability and accuracy of the LINAC/PEP ring interface, SLAC has decided to incorporate more Harris flip-flops in its next experimental program: The Stanford Linear Collider (SLC). The concept is to collide positrons and electrons from the LINAC at an equidistant point from each end. For proper performance, the SLC must achieve a higher degree of trigger accuracy, which can be achieved by the use of GaAs digital ICs.

The author would like to thank Jim Judkins of SLAC, Bruce Hoffman, Joseph Barrera, and Steve Nordblom of Harris for their contribution and support in the writing of this article rf

References

1. Packages Study for High-Speed (GHz) Commercial Products. GaAs IC Symposium 1982 Digest, authors N. Frick et. al.
2. Jim Judkins, Al Wilmunder and Mark Ross of SLAC.
3. Digital Designer's Handbook, Motorola, Inc. (MECL® Devices), p.45.

About the Author

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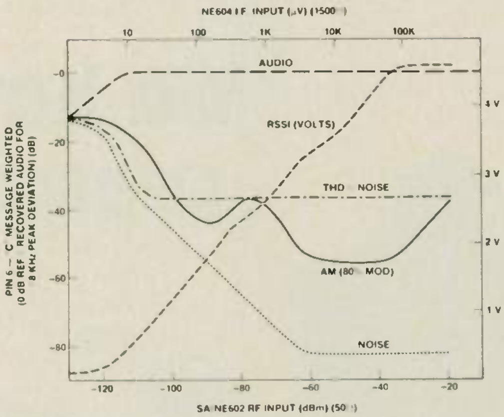
SIGNETICS LINEAR PRODUCTS

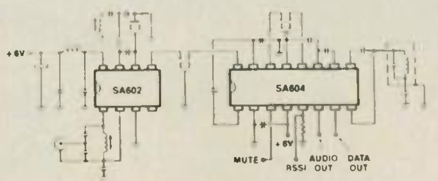
SA602/SA604
High Performance with 5 mA

SA602
Low Power VHF Mixer/ Oscillator

FEATURES:
- VHF operation with 2.4 mA supply current
- Excellent gain, intermodulation, noise figure, and sensitivity specs
- Few external parts; internal DC bias
- Oscillator operation to 200 MHz; mixer to 500 MHz

APPLICATIONS:
- Cellular radio mixer/oscillator (2nd IF)
- VHF transceivers and RF data links
- HF/VHF frequency conversion
- Direct or dual quadrature conversion





SA604
Low Power FM IF System

FEATURES:
- Low power: 2.4 mA supply current, typical
- Logarithmic signal strength indicator
- Separate data and muted audio output
- Excellent sensitivity: typically 1.5 μV across input pins (0.27 μV into 50Ω matching network) for 12 dB SINAD at 455 kHz

APPLICATIONS:
- Cellular radio
- Communication receivers
- Remote control
- RF or audio level meter

TDD1742T
CMOS Frequency Synthesizer

The TDD1742T is designed to be used as a basis for a high performance programmable frequency synthesizer.

FEATURES:
- Microprocessor controllable
- On-Board phase modulator
- High performance phase comparator with low phase noise
- Fast locking
- Low power requirements
- Surface mount package
- Low cost

APPLICATIONS:
- Instrumentation
- Cellular radio
- UHF/VHF mobile radio
- Portable communication radio
- LAN network

NE5205
Wideband High Frequency Amplifier

FEATURES:
- 650 MHz bandwidth
- 20 dB insertion gain
- 4.8 dB (6 dB) noise figure $Z_0 = 75\Omega$ ($Z_0 = 50\Omega$)
- Input and output impedances matched to 50/75Ω systems
- Surface mount package

APPLICATIONS:
- Cable TV decoder boxes
- 1V p-p composite video
- Signal generators
- Frequency counters
- Oscilloscopes
- Signal analyzers
- Broadband LAN's
- Fiber optics
- Modems
- Mobile radio
- CB radio
- Telecommunications

See us in Booths 302 & 304 at RF Technology Expo '86 in Anaheim, CA

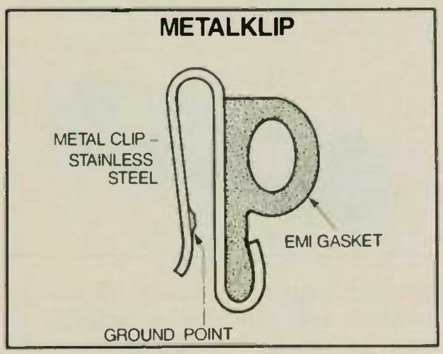
signetics Signetics Corporation 811 E. Arques Avenue MS60 Sunnyvale CA 94088-3409 Telephone 408/991-4571

INFO/CARD 34

RF Technology Expo '86 New Products on Display

Metalklip Gasketing from Chometrics — booth 519

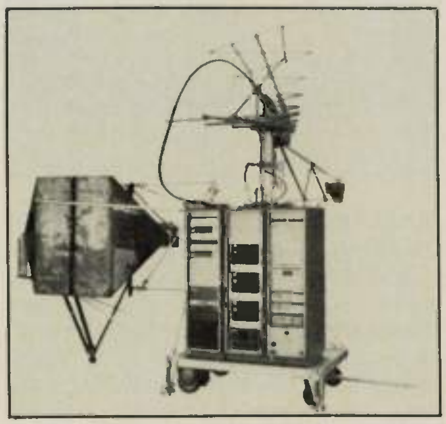
Metalklip gasketing is a new way of mounting EMI gasketing to an enclosure. A spring stainless steel clip secures the shielding material, which may be either a carbon-filled elastomer, knitted wire mesh, or a Chomerics conductive elastomer, to the edge of a door or cabinet frame. Grounding through the painted



surface is achieved by a series of sharp teeth or tines located inside the clip to ensure electrical continuity. When using Metalklip gasketing on an enclosure, consideration should be given to shielding the mating surface with Chomerics Cho-Mask™ EMI Foil Tape with Peel-off Mask. Cho-Mask tape eliminates the need for plating the steel cabinet before painting. **Chomerics, Inc., Woburn, Mass. INFO/CARD #176.**

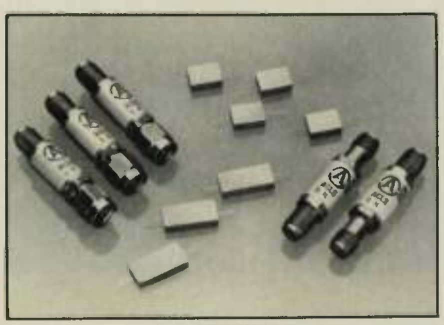
Electromagnetic Radiated Susceptibility Test Set from LogiMetrics — booth 303-305-307

LogiMetrics, Inc., announces the Model RS1018 Robotic Electromagnetic Field Generating Susceptibility Test Set which features an operating frequency range from to kHz to 18 GHz with field strengths up to 200 Volts/Meter. The RS1018 Test Set includes radiated field intensities to 200 V/M, full programmability, field leveling, full modulation capability, variable field intensity levels, IEEE-488, GPIB programmability, manual/automatic control, microprocessor based control circuitry, safety interlocks, robotic positioning, integrated signal sources and user friendly software. **LogiMetrics, Inc., Plainview, N.Y. INFO/CARD #175.**



Advanced Control Components' Limiter Schottky Detectors — booth 303-305-307

A new series of Limiter Schottky Detectors is now available from Advanced Control Components. The high sensitivity of broadband Schottky Detectors is combined with Limiters to protect them from high power RF inputs. The standard units can withstand input powers of 2 watts CW or 100 watts peak power. The typical usable range is from + dBm down to the tangential signal sensitivity (TSS) level.



The standard output polarity is negative, but positive models are available. Protection at the video port is standard and prevents damage to the Schottky Diode from video transients, or static voltages. These components are built in hermetic modules. They may be used directly in microstrip, stripline or other TEM structures. Cylindrical module versions may be placed in housings with SMA connectors. **Advanced Control Components, Clinton, N.J. INFO/CARD #174.**

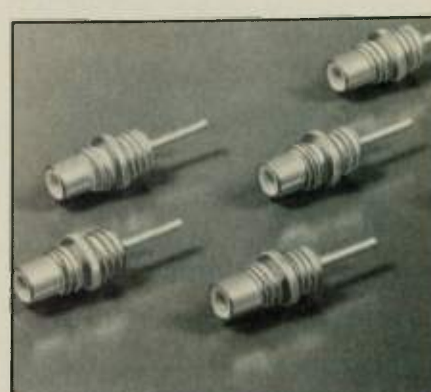
Microwave Semiconductor Corporation — booth 703

A six page data sheet fully describes the CGY-40 GaAs broadband amplifier MMIC introduced by MSC. Included are curves which describe the AGC capacity of the device. Other curves show NF versus Freq., output power at the 1 dB compression point versus frequency and NF, Power gain versus Temperature.

Microwave Semiconductor Corp. also announces that it now markets Siemens dielectric resonator material. The available frequency range is 2-18 GHz with temperature coefficients of –3ppm/°C to +9ppm/°C. Special low frequency material for cellular radio application is available as well as hi-dielectric substrate for hybrids. **Microwave Semiconductor Corp., Somerset, N.J. INFO/CARD #173.**

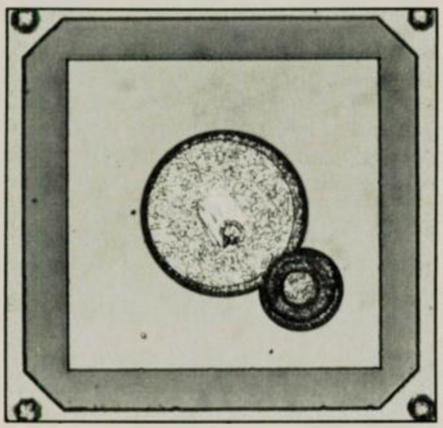
A.E.P. Sealed Receptacle "SMC" Subminiature Connectors — booth 816

A new group of "SMC" subminiature coaxial connectors featuring hermetically sealed receptacles is now available from Applied Engineering Products. The new entries feature gold-plated stainless steel bodies; "Kovar" pins; Teflon insulators; and glass (Corning 9013) seals to meet Mil-Spec-"C"-39012. Available in a variety of contacts and mounting surface configurations, the new A.E.P. "SMC" connectors offer DC to 4 GHz Frequency Range and a leak rate of less than 1 x 10^{-8} cc per second at 15 psig pressure differential. **Applied Engineering Products, New Haven, Conn. Please circle INFO/CARD #172.**



H-P Offset Junction Schottky Chips — booth 715

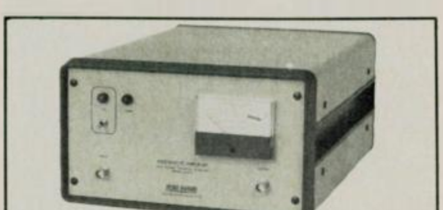
Three new Schottky diode chip families from Hewlett-Packard Company, the HSMS-0001, -0002, and -0003, are designed for analog and digital hybrid applications requiring thermocompression or thermosonic bonding techniques. These devices' two major innovations are a large centered bond pad and an offset Schottky junction. Typical functions for these Schottky chips are mixing, detecting, switching, gating, sampling and waveshaping. Batch-matched chips are available for applications requiring close elec-



trical characteristics between diodes, such as balanced mixers, detectors and temperature compensation circuits. **Hewlett-Packard Components Group, San Jose, Calif. INFO/CARD #171.**

Kalmus MOSFET RF Amplifier — booth 713

Kalmus Engineering International Ltd. introduces a new family of high-performance MOSFET RF Power Amplifiers. One of these units is the Model 210LC. Its broadband frequency range covers 7 KHz to 230 MHz at a minimum power output level of 10 watts, Class "A" Linear. Harmonics are down typically by 30 dB at 10 watts out. Gain is 40 dB minimum, ±1.5



dB flatness. Delivery is from stock to two weeks. Other models are available up to 1 Kw. **Kalmus Engineering International, Kirkland, Wash. INFO/CARD #169.**

ENI Linear Pulse Amplifier For MR Imaging — booth 712-714-716

ENI announces the LPI-10 high power linear solid state amplifier for Magnetic Resonance Imaging and Analytical NMR applications. With a linear pulse power output in excess of 1000 watts and a frequency coverage of 10 to 86 MHz, the LPI-10 incorporates extremely low pulse-off output noise without the use of external diodes, output power linearity in excess of 60 dB, minimum gated rise and fall times, immunity from damage due to mismatched loads, duty cycle cutoff to limit patient exposure, peak RF power meter, and built-in diagnostic test equipment. Operating features include external bias gating with a fall time of 4 microseconds, full remote control with fault sensing and reset capability, and both forward and reflected power metering. **Electronic Navigation Industries, Inc., Rochester, N.Y. INFO/CARD #168.**

75 Ohm Power Sensor From Marconi Instruments — booth 408-410

Marconi Instruments has added a 75 ohm impedance power sensor to the extensive range of 50 ohm detectors used with their 6960 (digital) and 6950 (analog) power meters. This growing series of lightweight power sensors has a total frequency coverage of 30 kHz to over 20 GHz and a power range from −70 dBm (0.1 nW) to +20 dBm (100 mW). The new 6919 sensor has 50 dB dynamic range from −30 dBm to +20 dBm and covers 30 kHz to 3.0 GHz. The thermal sensing element can withstand input powers up to +25 dBm (300 mW) CW and +42 dBm (15W) peak with a 2us pulse width. VSWR values do not exceed 1.2:1 from 100 kHz up to 3.0 GHz and stay as low as 1.1 from 300 kHz to 2.0 GHz. **Marconi Instruments, Allendale, N.J. INFO/CARD #170.**

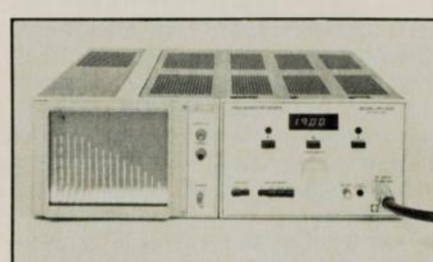
Daden Interdigital Bandpass Filters — booth 712-714-716

Interdigital bandpass filters Series ID covers the frequency range from 1 GHz to 26.5 GHz, with bandwidths from 2% to over 50%. Four to 20 sections are available to give symmetrical stopbands. This

compact rugged construction affords low insertion loss, and can be designed to meet full range of military or space environments including temperatures form −62°C to +125°C. **Daden Associates, Inc., Laguna Hills, Calif. Please circle INFO/CARD #167.**

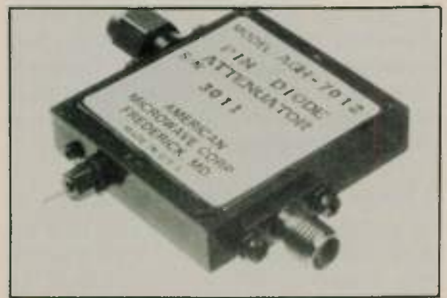
Integra Microwave — booth 712-714-716

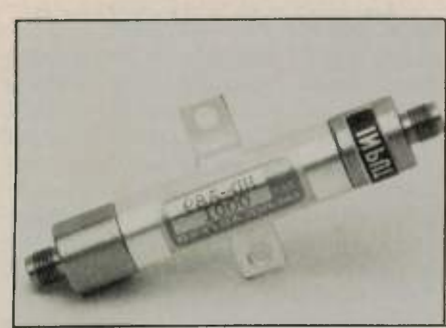
Integra Microwave has just released its PR-5000 series of panoramic receivers that provide greater dynamic range than a spectrum analyzer when sweeping wideband. The PR-5000 series features push-button selection of all functions and provides a 2 to 26 GHz spectrum display with a 60 dB dynamic range. Signals are displayed on a CRT calibrated in absolute power, flat within ±1.0 dB from 2 to 20 GHz or ±1.5 dB from 2 to 26.5 GHz. It's useful for both CW and Pulse applications. **Integra Microwave, Santa Clara, Calif. INFO/CARD #166.**



Absorptive PIN Attenuator From American Microwave — booth 813

Model AGH-6012 absorptive PIN Diode Attenuator operates over the 6-12 GHz band with 2.3 dB max insertion loss, 2.2:1 maximum VSWR and 0-60 dB attenuation at 70 mA maximum current. The size is 1.30 inches x 1.40 inches x 0.30 inches exclusive of connectors. RF connectors are SMA female (male type optional) and the bias connector is a filtercon with solder pin. Other models are available in 3:1 bandwidths from 1 GHz to 18 GHz with and without linearizer. **American Microwave Corporation, Frederick, Md. INFO/CARD #165.**



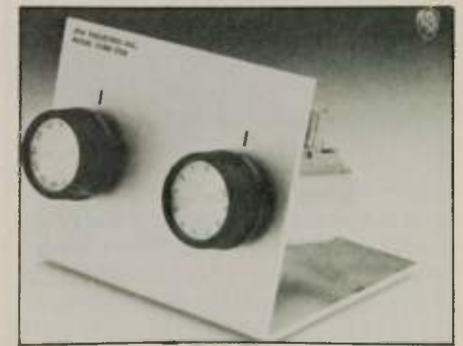


Microlab/FXR Tubular High Pass Filter — booth 712-714-716

The HD-A89 Tubular High Pass Filter has been introduced by Microlab/FXR, with a cutoff frequency (F_c) of 10 GHz. Principal specifications include a passband of 1.0 F_c to 2.0 F_c, maximum passband insertion loss of 0.7 dB, 25 dB insertion loss at 0.8 F_c, and 50 dB insertion loss at 0.5 F_c. The HD-A89 has an average power rating of 50 watts (4 kW peak), and is supplied with female input and output connectors. The impedance is 50 ohms. **Microlab/FXR, Livingston, N.J. INFO/CARD #164.**

JFW Rotary Attenuators — booth 901

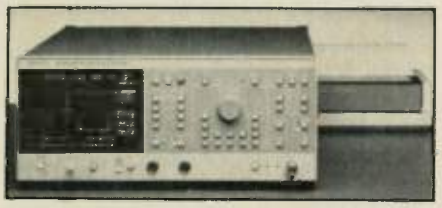
JFW Industries, Inc. introduces their new line of 50 ohm low cost Bench Mount Rotary Attenuators with models 50BR-008 and 50BR-009. Model 50BR-008 has an attenuation range of 0-80 dB in 1 dB steps and a frequency range of DC-2000 MHz. Model 50BR-009 has an attenuation range of 0-110 dB in 1 dB steps and a frequency range of DC-1000 MHz. The cost is $245.00 for the 50BR-008 and $260.00 for the 50BR-009. **JFW Industries, Inc., Indianapolis, Ind. INFO/CARD #163.**



rf products

New Wiltron RF Analyzers

Two new RF Analyzers make precision transmission, return loss, and absolute power measurements over the 1-1000 MHz (Model 6407) or 10-2000 MHz (Model 6409) range. This portable (35 lb.) microprocessor-controlled system integrates in one instrument a crystal-derived swept signal source, a scalar network analyzer, and an external precision detector and SWR Autotester measurement compo-



nents. Both units include autoscaling with which a fully annotated display is automatically selected. With crystal-based frequency stability circuitry (patent applied for), narrowband devices can be measured on a drift-free display with an accuracy of 100 kHz, 10 kHz resolution, and 0.003 dB amplitude resolution. The Model 6407 is $9,430, and the Model 6409 is $11,040. **Wiltron Company, Morgan Hill, Calif. INFO/CARD #162.**

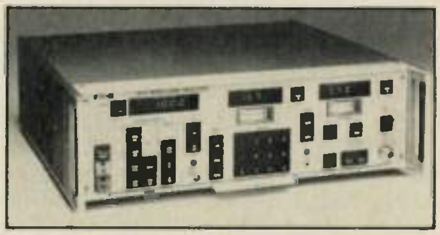
4mm Chip Variable Capacitor

A new 4mm surface mount variable capacitor featuring the world's lowest profile at 1.8mm is now available from Kyocera International, Inc. With overall dimensions of 4.5mm × 3.2mm, the Kyocera series CTZ chip variable capacitor is 50 percent smaller than equivalent discrete

components. The Kyocera multilayer variable capacitor is available in five standard capacitance ranges from 1.5-5.0 pF to 5.0-40.0 pF in temperature coefficients of NPO and N750. All are rated at 25 VDC with a temperature range of –25°C to +85°C. **Kyocera International, Inc., San Diego, Calif. INFO/CARD #161.**

Eaton Noise-Gain Analyzer

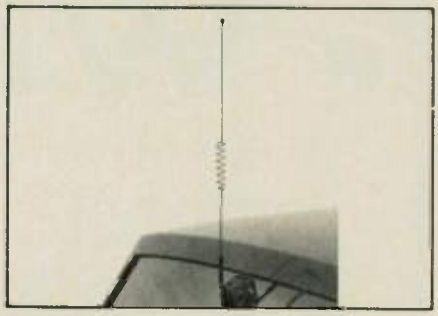
The Electronic Instrumentation Division of Eaton Corporation (ETD) has introduced the Eaton 2075-2A, an extended frequency Noise-Gain Analyzer which operates to 1900 MHz, with full specifications to 1850 MHz. The 2075-2A is an en-



hanced version of the field-proven Eaton 2075 Noise-Gain Analyzer which has been marketed by the division since 1983. Like the 2075, the Eaton 2075-2A has accuracies within 0.05 dB at noise figures below 12 dB. The Eaton 2075-2A is fully-programmable via the general purpose interface bus (IEEE-STD-488-1978), and is therefore suited for both laboratory and systems applications. **Eaton Corporation, Electronic Instrumentation Division, Los Angeles, Calif. Please circle INFO/CARD #160.**

Larsen "On-Glass" Antennas

Larsen Electronics has announced the first in a series of KuLGLASS™ antennas: Model KG-825, an 806-896 MHz "on glass" antenna for cellular telephones or other two-way radio applications in that frequency range. The KuLGLASS antenna permits quick installation with no hole-



drilling. It exhibits the required 3 dB gain with a half-wave collinear resonant design that does not require a ground plane to attain low VSWR and low radiation angle. The antenna kit is supplied with fourteen feet of dual shielded low-loss coax, with a crimp TNC male connector. Other connectors are available. **Larsen Electronics, Vancouver, Wash. INFO/CARD #159.**

Broadband Noise Sources

International Microwave Corporation's broadband coaxial solid state Noise Source provides high ENR from 1 to 18 GHz and eliminates the need for separate noise source for each band. The Broadband Noise Source has a wide range of measurement applications including amplifier gain and noise figure tests, and on-line monitoring. Noise output flatness is

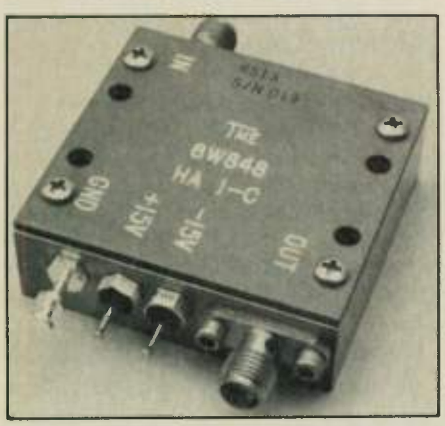
±0.5 dB over a temperature range from −55°C to +85°C. A built-in current regulator assures excellent output stability with voltage and temperature variations. The IMC Broadband Noise Source is compatible with widely used noise instrumentation. **International Microwave Corporation, Stamford, Conn. Please circle INFO/CARD #158.**

Microstrip Design Software

MSTRIP+ from Microwave Software offers near Bryant-Weiss accuracy in single and coupled line microstrip, single and coupled stripline derived from the work of Cohn, a never before published program for suspended substrate based on the derivation by Yamashita. In addition, MSTRIP+ will generate tabular data and hi-res plots of many transmission line parameters. These plots may be dumped to a graphics capable printer using built-in software. MSTRIP+ joins Sceptre and Smithmatch in Microwave Software's line for the Apple II+, IIe and IIc from Apple Computer Corp., and compatibles. **Microwave Software, San Juan Capistrano, Calif. INFO/CARD #157.**

Tektron Video Amplifier

The HA-1 from Tektron Micro Electronics, Inc. is a low-noise video amplifier specifically designed to interface with double-balanced mixers in applications where a noise close to DC is of prime importance (i.e., Doppler and Homodyne Radars). The HA-1 is designed for 50 ohm



source impedance applications and is several orders of magnitude better than existing video amplifiers in the DC to 10 MHz area. **Tektron Micro Electronics, Inc., Linthicum Heights, Md. Please circle INFO/CARD #156.**

UL-Listed EMI Facility Filters

UL-listed EMI facility power filters for shielded enclosures and facility installations, designed to reduce conducted EMI and unwanted power line transmissions, have been introduced in a 100 dB and 60 dB series by Genisco Electronics Division. Listed as UL-1283 EMI Facility Filters, the 100 dB and 60 dB series are available up to 675 amps per wire when tested with extended buffer networks down to 13 kHz. Applications include power filtering into shielded rooms, military installations and other secure environments. Both 100 and 60 dB series include discharge circuits to reduce shock hazards, continuous seam-welded steel construction for shielding effectiveness, and an RF tight chamber for isolation within the enclosure. Both filter series are manufactured to the latest revision of MIL-F-

15733 and UL-1283. **Genisco Electronics Division, Rancho Dominguez, Calif. INFO/CARD #155.**

Low Cost 75 Ohm Attenuators

Elcom Systems, Inc., announces the availability of a series of 75 ohm attenuators, model AT-75, usable over the frequency range of DC to 1500 MHz. Unique internal construction is utilized to achieve high frequency operation of MIL high reliability resistive elements. The attenuators are available in 2, 3, 5, 6, 7, 10, 14 and 20 dB steps as stock items. They have a typical VSWR of 1.2:1, with a maximum of 1.5:1 at 1500 MHz, and can dissipate ½ W CW or 500 W peak RF power up to an ambient of 70°C. They are available in BNC, TNC, N or SMA connectors with silver, gold or nickel MIL plating. **Elcom Systems, Inc., Boca Raton, Fla. INFO/CARD #154.**

Radial Power Combiners

Flam & Russell, Inc., has announced that their radial power combiners are available on a build-to-order basis. The FR radial power combiners have low insertion loss, outstanding amplitude and phase balance, high power handling capability, large number of inputs, and small size. Additionally, the FR combiners tolerate individual module failures without using isolators or internal resistors, and allow "hot replacement" (device or module replacement while the system is on the air). Flam & Russell is an engineering, manufacturing, and marketing firm specializing in RF electronic and antenna measurement systems. **Flam & Russell, Inc., Horsham, Pa. INFO/CARD #153.**

Precision Power Splitter

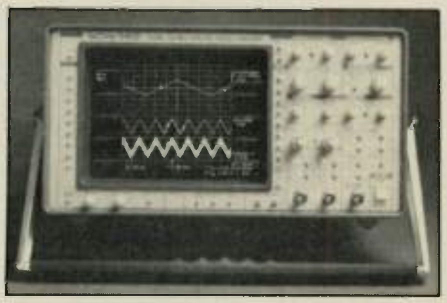
The Harris Corporation, Government Support Systems Division, PRD Type 20320 Broadband Precision Power Splitter features extremely accurate tracking (0.25 dB) between output arms from DC to 18 GHz. Insertion loss is 6 dB nominal (input to either output) and maximum input power is +27 dBm (0.5 w). Precision type "N" connectors and highest quality components are used throughout for maximum stability and repeatability. **Harris Corporation, Government Support Systems Div., Syosset, N.Y. Please circle INFO/CARD #152.**

Software Package for Commodore 64

The Commodore 64 Matrix Software Package is a collection of eight machine language subroutines that perform various mathematical and utility operations on arrays and vectors. By implementing these operations in machine language, there can be a 10 to 50 times increase in execution speed compared with same routine in BASIC. These routines are called through the BASIC USR function. This software package allows you to clear an array (replace contents with zeros), copy one array to another, add two arrays, subtract two arrays, multiply the contents of an array by a scalar quantity, multiply two arrays together, calculate determinants, and includes routine to solve simultaneous equations. The program is supplied on a disk along with a 10 page user guide. Price is $20.00. **64 Engineering Software, Beaverton, Ore. INFO/CARD #151.**

LeCroy 9400 Adds Waveform Processing

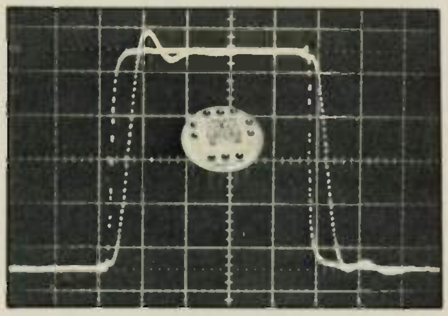
A Waveform Processing Package, WPO1, has been released for the Swiss-made LeCroy Model 9400 Digital Oscilloscope. The 9400 features 125 MHz bandwidth, 32K × 8-bit waveform memories, 100 megasample/sec ADCs, 5 gigasample/sec random interleaved sampling and



full programmability. Additional hardware and software includes summation averaging up to 1,000,000 sweeps, continuous averaging of an infinite number of waveforms with weighting factors adjustable between 1 and 128, arithmetic processing of single and dual wafeforms and digital filtering to clean single events of noise, spikes and glitches. Other functions in the WPO1 Waveform Processing Package are: multiplying, dividing, adding, subtracting and square of stored and live acquired signals. **LeCroy Research Systems Corp., Spring Valley, N.Y. INFO/CARD #150.**

165 MHz Buff-Amp TM

A new high-speed amplifier from Comlinear Corporation, the CLC231 Buff-Amp TM, offers a solution to the problem of high-speed amplification at low gains. Designed specifically for use at gains of ±1 to ±5, the CLC231 is a low-gain design alternative to low-precision open-loop buffers and oscillation-prone conventional op



amps. Key specifications include: DC-165 MHz −3 dB bandwidth, 12 ns settling to 0.1%, 15 ns settling to 0.05%, gain-settings from ±1 to ±5, internal compensation with guaranteed stability, and true 0.1% linearity. The CLC231 is packaged in a 12-pin TO-8 package and is available in both commercial/industrial (−25°C to +85°C) and high-rel/military (−55°C to +125°C) versions. **Comlinear Corporation, Fort Collins, Colo. Please circle INFO/CARD #149.**

SOT-23 Small Signal Devices

Siemens Components, Inc., is introducing three small signal devices in SOT-23 packages. The BB 801, a varactor (tuning diode) is designed specifically for tuning applications in the 2 GHz range. Characteristics include 28 V reverse voltage (peak reverse voltage of 30 V), 20 mA for-

ward current, 9 pF maximum diode capacitance, reverse current of 20 nA, and 1 ohm typical series resistance. The BF

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INFO/CARD 39

770 is a bipolar silicon NPN designed for linear broadband RF amplifier and oscillator applications in the 2 GHz range. These devices are also ideal for use in filter amplifiers. Device dissipation is 280 mW, DC current gain h_{FE} 30, and f_T of 4.5 GHz. The BF 775 is a bipolar silicon NPN suitable for linear broadband RF amplifier, oscillator and mixer applications. Total device dissipation is 280 mW, DC current gain of h_{FE} 25, and f_T of 3.5 GHz. **Siemens Components, Inc., Iselin, N.J. INFO/CARD #148.**

5-200 MHz One-Watt Switches

Two new terminated SP2T switches handling one watt of RF power and covering a frequency range of 5-200 MHz are available from Daico Industries. Part Number DS0492 is a 14 pin DIP, and Part Number 100C1692 is an SMA connectorized device 2 × 3 × 0.7 inches. Both feature RF operating power of +30 dBm with 0.1 dB maximum compression, +20 dB maximum into 50 ohm terminations, 20 microseconds maximum switching speed, isolation of 55 dB minimum (5-32 MHz), 40 dB (32-200 MHz), 0.8 dB maximum insertion loss, single line internal TTL driver, and DC power requirement of +5 Volts at 30 mA, –15 Volts at 30 mA. **Daico Industries, Inc., Compton, Calif. Please circle INFO/CARD #147.**

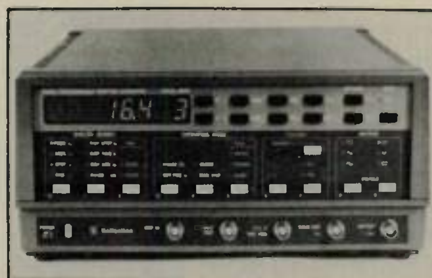
Surface Mount Grabber

ITT Pomona Electronics has introduced a test clip that readily adapts to the .050 inch centers of surface mounted devices. The SMD Grabber™ test clip, designated model 5243, features gold plated stainless steel contacts. The contacts are de-

signed so that the clips can fit side-by-side on either gull wing or "J" leaded devices such as SOIC, SOJ, SOT and PCC/PLCC chip carriers. ITT Pomona Electronics has a full line of test accessories for surface mount devices. **ITT Pomona Electronics, Pomona, Calif. INFO/CARD #146.**

Ballantine Function Generator

Ballantine introduces the Model 6200A Programmable Function Generator, an under-$2,000 microprocessor-based 20 MHz function generator. The 6200A offers rapid parameter setup, digital control of waveform symmetry, a burst mode, a high resolution LED digital display and a full IEEE-488 instrumentation bus interface



for all modes and parameters. Ballantine Model 6200A measures 5.5 × 11.8 × 13.6 inches, weighs 11 lbs. and operates from either 115 or 230 VAC, 60 watts maximum. Output waveforms are provided at a low impedance 50 ohm port. **Ballantine Laboratories, Inc., Boonton, N.J. INFO/CARD #145.**

RLC Diode Switches

RLC Electronics announces a new line of solid state diode switches which cover a range of .020 to 18 GHz. These standard units are designed for low power and moderate speed applications. Two independent TTL drivers are included for maximum versatility. The power of these switches is rated at 1 Watt maximum with a switching speed of 50 nanoseconds maximum. Supply voltage is +5 at 50 mA and –15 V at 30 mA. These diode switches are available with RF SMA female connectors. **RLC Electronics Inc., Mt. Kisco, N.Y. INFO/CARD #144.**

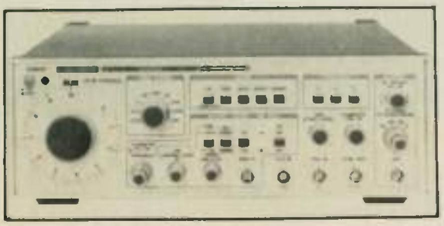
Circuit Diagram Software

Electro Bits is a graphics tool that employs the MacPaint™ function to draw circuit diagrams using the Apple Macintosh™. A large selection of electronic elements and computer symbols is available to the user. The program is comprised of two main sections: Hardware and Software. The Hardware section consists of an Analog and a Digital module. The Analog module holds the Amplifier, Audio, Capacitor, Filter, Miscellaneous, Resistor, Semiconductor and Analog Sample folders. The Digital module contains the Gates, Flip-Flops, ICs, PCB Assembly and Digital Sample documents. The Software section consists of the Flow Chart Symbols and Flow Chart Sample

modules. Electro Bits is available in English or Spanish, priced at $22.95. **Medina Software, Orlando, Fla. Please circle INFO/CARD #143.**

10 MHz Sweep/Function Generator

Leader Instruments Corporation has introduced a new full featured 10 MHz Sweep/Function Generator, Model LFG-1310. Signals provided by the LFG-1310 are sine, square and triangle, pulse and



ramp waves. Operating modes include continuous wave, triggered, gate, burst and linear and logarithmic sweep modes. The output may also be frequency or amplitude modulated by an external signal. **Leader Instruments Corporation, Hauppauge, N.Y. INFO/CARD #141.**

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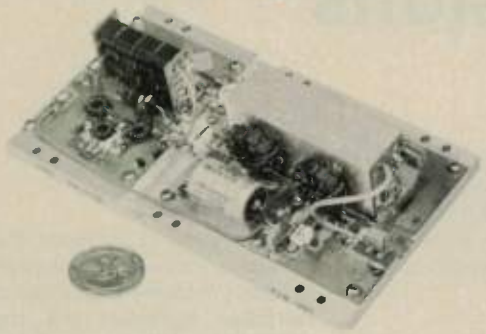
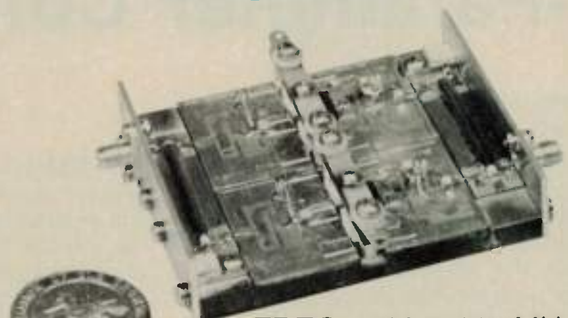


FREQ.: 1 - 150 MHz. PWR: 150W.

AVIONICS



FREQ.: 960 - 1215 MHz.
PWR: 1000W pulsed.

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FREQ.:
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PWR:
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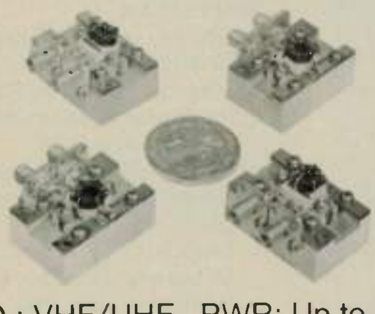

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INFO/CARD 43

Common-Base or Common-Collector S-Parameter Conversions

By Peter Vizmuller
Motorola Canada

Common-base or common-collector configurations are sometimes more desirable in certain applications, such as oscillators. This article describes how to convert the manufacturer's common-emitter s-parameters into common-base or common-collector s-parameters. The same technique can be applied in converting FET common-source into common-gate or common-drain s-parameters.

The most general and also quite complicated method of parameter conversion is to convert the two-port s-parameters into three-port s-parameters (1), perform the necessary transformation and convert back to two-port s-parameters. Another method, suggested by an article in the May 1985 issue of *RF Design* (2) is far simpler: convert the given s-parameters into y-parameters, perform the required calculations that result when a two-port is inverted and rotated (3), then convert back to s-parameters.

Common-collector transformation

y11' = y11
y12' = –(y11+y12)
y21' = –(y11+y21)
y22' = y11+y12+y21+y22

Common-base transformation

y11' = y11+y12+y21+y22
y12' = –(y22+y12)
y21' = –(y22+y21)
y22' = y22

In the above expressions, the unprimed variables represent the original, common-emitter y-parameters, while the primed variables represent the transformed, common-collector or common-base y-parameters. Conversion of the primed y-parameters back into s-parameters yields the required result.

Example: MRF 580 at V_{ce}=10V, I_c=50 ma, f=1.5 GHz, common-emitter s-parameters supplied by manufacturer:
s11 = .53/131
s12 = .31/63
s21 = 1.71/47
s22 = .11/–147

Common-base s-parameters generated by the above procedure are:

s11' = 1.33/127
s12' = .34/110
s21' = 1.69/–92
s22' = 1.21/–89

It is immediately apparent that the common-base configuration is more suitable for an oscillator, since it is already unstable in a 50-ohm system (i.e. |s11'|, |s22'|>1).

References

1. Bodway, G.E., "Circuit Design and Characterization of Transistors by Means of Three-Port Scattering Parameters," Microwave Journal, Vol. 11, #5, May 1968.
2. Novak, S., "Transistor Parameter Conversion," *RF Design*, May 1985, p.49.
3. Giacoletto, L.J., ed., "Electronics Designers' Handbook," McGraw-Hill Company, New York, 1977, ch. 5.

About the Author

Peter Vizmuller is a staff engineer at Motorola Canada, 3125 Steeles Ave. E., North York, Ontario, Canada M2H 2H6.

rf literature

P.C. Boards and Parts Kits

Printed circuit boards and parts kits for electronic projects are described in the latest literature from A&A Engineering. Projects described include frequency synthesizers, receivers, facsimile interfaces, plus other RF and digital devices for amateur or professional experimenters. **A&A Engineering, Buena Park, Calif. INFO/CARD #125.**

RF Test Devices

Product Catalog #186 contains data on 1-900 MHz RF test instruments and devices. Easy to read charts allow for rapid comparison of various models. Products include RF impedance bridges, terminations, RF amplifiers, RF analyzers, divider/combiners, RF switches, etc. **Wide Band Engineering Company, Inc., Phoenix, Ariz. INFO/CARD #124.**

Power Line Disturbances

A 16-page Dranetz technical publication, "How To Correct Power Line Disturbances," provides a comprehensive discussion of protective devices. Included are descriptions and characteristics of typical isolation transformers, line voltage regulators, line conditioners, motor-generator sets, and uninterruptible power supplies. **Dranetz Technologies, Edison, N.J. Please circle INFO/CARD #123.**

Japanese Transistor Cross Reference

The Communications Catalog/Cross Reference Guide from RF Gain Ltd. contains a comprehensive list of Japanese (2SC) transistors for Midland, Yaesu, Force and Icom. **RF Gain Ltd. Div., Richardson Electronics, Ltd., Rockville Centre, N.Y. Please circle INFO/CARD #122.**

Industrial Strength Meters Brochure from Fluke

John Fluke Mfg. Co., Inc., announces a new 8-page brochure detailing the newly expanded Fluke 20 Series line of ruggedized analog/digital multimeters (DMMs). Fluke 20 Series DMMs have several features that make them suited to rugged, industrialized situations. All inputs feature extensive overload protection, including the fused 10 amp input on the Fluke 23, 25 and 27. All four meters in the 20 Series are encased in rugged, drop-proof cases. In addition, the Fluke 25 and 27 are totally sealed against moisture, dirt, dust and airborne contaminants. Besides being extremely rugged, Fluke 20 Series DMMs are highly accurate, with 0.1% basic DC accuracy. **John Fluke Mfg. Co., Inc., Everett, Wash. INFO/CARD #121.**

Coaxial Cable Assemblies

A 24-page catalog features a full line of coaxial cable, coaxial adapters, coaxial connectors, coaxial terminations and coaxial cable assemblies. Pricing on over 1,000 standard catalog items as well as technical specifications are included. **Pasternack Enterprises, Irvine, Calif. INFO/CARD #120.**

RF Products Catalog Update

This 16-page catalog provides updated information on RF Products' lines of HF/VHF/UHF filters and multicouplers. Electrical, mechanical, and environmental specifications are listed. Applications for air, sea, and ground-based aerospace programs are outlined for each product. Brief product descriptions and photographs are included. **RF Products, Inc., Camden, N.J. Please circle INFO/CARD #119.**

MIL-STD 461B Measurements Note

Hewlett-Packard Company offers EMI measurement software that automates the HP-8567A, -8566B and -8568B spectrum analyzers for EMC testing to meet regulatory-agency specifications. A new application note explains the use of this software package with a spectrum analyzer to make measurements specified in MIL-STD-461B. Application Note 330-1, "Automatic MIL-STD EMI Testing Using the HP-85864A/B EMI Measurement Software," is a 22 pages long, with 26 illustrations depicting menu tables, test setups, sample programs, and CRT responses. Procedures

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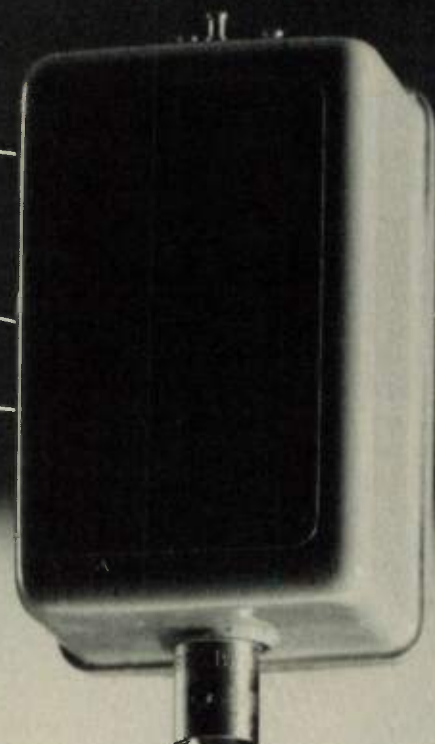

Let's face it. Even in a digital world, many of your design problems are still analog. Like the need to match transmission lines of different characteristic impedances. Or to eliminate ground-loop currents in video lines. Or to filter out common-mode noise in data lines. Applications like these call for specialized signal transformers.

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INFO/CARD 49

rf literature *Continued*

used are general in nature and also apply to other MIL-STD and electromagnetic interference measurements. **Hewlett-Packard Comopany, Palo Alto, Calif. INFO/CARD #118.**

ESD Measurement Notes

KeyTek Instrument Corp. has introduced two new application notes dealing with the extremely difficult task of measuring the nanosecond current impulses associated with human ESD (Electrostatic Discharge). The first, Application Note AN-161, describes methods used to accurately measure individual current impulses having sub-nanosecond rise times, and to verify that the measurements made are correct. The second, Application Note AN-162, uses computer modeling to explain the effects of oscilloscope bandwidth when making pulse duration measurements in the low nanosecond range. (For example, a 100 MHz scope shows only one-half of the true peak discharge curent.) **KeyTek Instrument Corp., Burlington, Mass. INFO/CARD #117.**

Pressure Window Catalog

The new M/A-Com Waveguide Pressure Window Catalog offers the circuit designer a wide variety of vacuum and pressure tight seals for any waveguide system. The windows are ideally suited to seal antenna systems, resonant cavities, gas discharge, vacuum tubes, and ferrite components. Installation instructions are also detailed. **M/A-Com Microwave Components, Inc., Burlington, Mass. INFO/CARD #116.**

Electronic Components Catalog

Frederick Components International, Ltd., (FCI), has released a short-form catalog on their standard and custom electronic components. Detailed in this 4-page brochure are FCI's line of AC and DC fans, switching power supplies, custom cable assemblies, connectors, customer transformers and custom keyboards/keypads. **Frederick Components International, Ltd., Chatsworth, Calif. INFO/CARD #115.**

Surface Mounted Inductor Literature

A bulletin on surface mountable inductors is now available from Delevan Division of American Precision Industries Inc. The new 4-page bulletin provides all of the current operational parameters and physical characteristics of the Delevan line of surface mountable RF coils. They are available in unshielded designs from .10 to 1,000 microhenries. Shielded designs are available up to 560 microhenries. **Delevan Division, American Precision Industries, Inc., East Aurora, N.Y. INFO/CARD #114.**

Hand Tool Catalog

Utica Tool Company has recently published a new 120-page catalog for its extensive line of Utica-Swiss® precision electronic hand tools. Emphasis is on Magic Line cutters, pliers and IC tools. The book is intended to serve as a technical reference manual for production and manufacturing engineers concerned with the application of specialized hand tools and related productivity on electronic assembly lines. **Utica Tool Company, Inc., Orangeburg, S.C. INFO/CARD #113.**

Semiconductor Thermal Characterization Manual

"Thermal Characterization and Die Attachment Evaluation of Semiconductor Devices" provides both manufacturer and end users of diodes, transistors, and IC devices with fast, easy and economical junction temperature guidelines. Written by Mr. Bernard Siegal, President of Sage Enterprises, Inc., the manual contains copies of seminar slides, technical articles and information on thermal testing, test method comparison and data interpretation as well as case histories. The price is $95.00 (US). **Sage Enterprises, Inc., Mountain View, Calif. INFO/CARD #112.**

Inexpensive Quality Software

MultiPath, Inc., offers the most powerful, latest versions of public domain programs on floppy disks at low cost of copying. Its large library of MS(PC)-DOS, CP/M-80 and CP/M-86 software is updated from bulletin boards located nationwide. All popular 3½, 5¼ and 8 inch disk formats are supported. Out of the 15,000 public domain programs for personal computers, most are amateurish, serve little useful purpose or have been superseded by better works. However, the few hundred which stand out for their power, professionalism and versatility have been identified and are offered on floppy disks by MultiPath. The catalog sells for $6.00 and clearly describes the function of each program. It also includes a list of public domain software bulletin boards. **MultiPath, Inc., Montville, N.J. INFO/CARD #111.**

Metal Foil Resistors Catalog

A catalog featuring its new line of metal foil resistors has been published by Wilbrecht Electronics. These resistors offer ultra-precision at competitive prices. The catalog contains complete specifications on the company's six model categories in the new line, including configurations and dimensions. Other information available in the publication includes testing data, power derating curves and complete ordering information. **Wilbrecht Electronics, St. Paul, Minn. INFO/CARD #110.**

Cera-Mite Capacitor Catalog

A comprehensive 24-page catalog from Cera-Mite® Corporation provides information about the selection and use of a wide variety of ceramic capacitors. Many types of ceramic disc capacitors are described including general purpose, Hypercon® ultra-high capacitance, A-C rated, high voltage, very high voltage and precision. Other types of ceramic capacitors such as heavy-duty high-voltage and feed-through are also defined. **Cera-Mite Corporation, Grafton, Wis. INFO/CARD #101.**

Five New Catalogs From Equipto Electronics

1985-86 catalogs describing the full line of modular electronic racks, instrument cabinets, consoles and electronic desks and stands now are available from Equipto Electronics Corporation. These five new catalogs show Equipto's line of products, and are filled with photos and drawings of features, assembly and mounting details, simplified parts number charts, ordering information, and other details. **Equipto Electronics, Aurora, Ill. INFO/CARD #100.**

PEMS Technology Brochure

A new brochure describing porcelain enameled metal substrate (PEMS) technology and production techniques is now available to designers of printed circuit boards. The brochure was produced by Ferro-ECA Electronics Company of Erie, Pa. The brochure offers designers a closer look at the advantages of PEMS, compared to non-metal substrates. **Ferro-ECA Electronics Company, Erie, Pa. INFO/CARD #99.**

Centurion Antennas and Batteries

Centurion International, Inc. has published new literature on their product lines of portable radio antennas, specialized communications and electronic batteries, cordless telephone replacement antennas and batteries, and their new Ear Com system. **Centurion International, Inc., Lincoln, Neb. INFO/CARD #98.**

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Antenna Design Eng. — A BSEE or BS of physics with 3 years (min.) experience will qualify you. A strong background knowledge in monopulse, phased arrays helpful. Salary DOE.
RF Engineer (microwave circuitry) — Top manufacturer of CATV products is in need of your expertise. Area of responsibility to cover design of new equipmment (receiver only) from 3 GHz and up for commercial & consumer market. To qualify, you must have a bachelor of EE and 2-5 years experience. Salary open. DOE.
RF Engineer (intermediate level) — Qualified professional needed to perform assigned projects dealing with overall design of new CATV products for commercial application. To qualify, you should have a BSEE with at least 2-3 years in RF design area. Salary open.
Engineer (control) — Areas of responsibility to cover execution of engineering spec's to respective departments. 2-3 years digital design and microprocessor experience. Qualification for this position will require you to possess a bachelors degree in EE or CS. Effective communication skills a must. To mid 40's.
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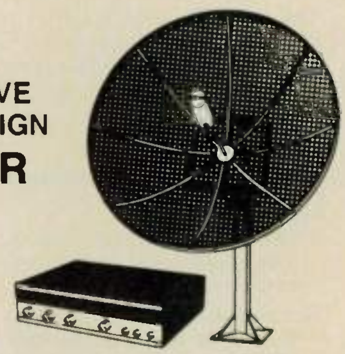

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INFO/CARD 55

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Both MDO Series oscillators benefit from proprietary thick film hybrid design, automated manufacturing, and reduced discrete component counts.

This achieves not only smaller size and lower cost, but also improved field reliability, as documented in longer MTBF.

These devices can be tuned using an external potentiometer or electronically tuned for AFC capability. And the all-metal welded packages with full hermetic seals minimize RF radiation.

To find out how the MDO-2 and MDO-3 can give your new or existing products a performance advantage, send for samples and complete literature.

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