LASER DESIGN USING CHARTS
Recalls techniques used in microwaves

TUNNEL DIODES FOR Q-BAND
Millimeter oscillator employs X-band diode

ANY-LENGTH COUNTERS
Logic design ends trial and error

CRYOGENIC COOLER (finned unit in middle) reaches 25 deg K
FLEXIBLE PERFORMANCE

Prints up to 5 lines/second
Accepts data in just 2 msec
Plug-in programming for each column
Optional selection of several BCD codes
Dual input, 10-line code available

SPECIFICATIONS

Printing rate: 5 lines/sec maximum
Column capacity: 11 columns (12 on special order)
Print wheels: 0 through 9, a minus and a blank; other symbols available
Data input: Parallel entry; BCD (1-2-2-4, 1-2-4-8, 1-2-4-2) or 10-line; difference between "1" and "0" states may be between 4 to 75 volts
Reference voltages: BCD codes require both "0" and "1" state references; 10-line codes require reference voltage for "0" state; reference voltages may be up to ± 150 v to chassis; input impedance is approximately 270 K ohms
Print command: + or - pulse, 6 to 20 volts amplitude, 1 v/µs minimum rise time, 20 µs or greater in width, ac coupled
Transfer time: 2 ms for BCD codes
Paper required: hp folded paper tape, or standard 3-inch roll tape
Line spacing: Zero, single or double
Size: Cabinet, 20½" x 12½" x 18½"; rack mount, 19" x 10½" x 16½" deep behind panel
Price: Depends upon options; typically $1300 to $2000

Data subject to change without notice. Prices f.o.b. factory.

The performance-proved hp 562A Digital Recorder is unique for its combination of speed, input capability, programming versatility and dependable operation in thousands of applications.

It prints digital data as fast as 5 lines per second, with as many as 12 digits per line. A storage feature for each column permits data transfer in 2 msec, after which the source is free to collect new data.

In addition to four-line BCD codes, ten-line code (without the data storage feature) also is available with plug-in cards. The recorder also accepts dual input (optional) to print data simultaneously from two unsynchronized sources—even if coded differently.

Analog output is available as an option for 562's which have 1-2-2-4 or 1-2-4-8 BCD column boards installed. The option, which includes controls for recorder calibration and zero adjustment, provides accurate analog output for any three columns, even when not printing.

Call or write today for complete information on the basic hp 562A and detailed description of the many options available, together with a convenient order form that makes it easy to get the solid state recorder just right for your specific application.

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1501 Page Mill Road, Palo Alto, Calif. 94304, (415) 326-7000.
Sales and service in all principal areas. Europe, Hewlett-Packard S.A., 54 Route des Acacias, Geneva, Switzerland; Canada, Hewlett-Packard (Canada) Ltd., 8270 Mayrand St., Montreal, Que.
INFRARED COOLER. Cryogenic temperature down to 25 deg K needed by infrared devices, parametric amplifiers, special semiconductor devices and densely packed microcircuits is achieved by a device no larger than a football. Unit developed by Malaker Labs works on modified Stirling cycle. This closed-cycle system requires no valves or external gas supply. See p 46

TELCAN RECORDER. America got its first look last week at the home video tape recorder developed in Britain to sell for $160. Pictures aren’t studio quality, but they’ll do for the entertainment market. With the recorder goes a $160 tv camera, so the customer can make his own tv programs, just like home movies

DESIGNING LASERS. Pump-power chart relates pump power, wavelength and propagation direction for optically pumped laser oscillators, to provide an easier way of evaluating laser performance. Computation techniques permit evaluating power density, spectral brightness, beamwidth and bandwidth. The charts are reminiscent of those used in microwave design. There’s also a handy table of definitions for laser-parameter symbols.

By R. A. Kaplan, Wheeler Labs

NEAR-FIELD PLOTTER. This new design tool for microwave antennas makes use of a small near field as the resulting wave in the antenna feed line is measured as a function of probe location. The use of field recordings as a design tool is a modification of the spinning dipole method. The new technique is superior to direct field measurement at millimeter wavelengths. The procedure is used to refine initial design based on ray optics or first-order calculations.

By P. Wolfert, Sylvania

TUNNEL DIODES AT Q-BAND. An impedance transformation technique allows a tunnel-diode intended for X-band operation to function at up to four times its rated frequency—at 33 to 50 Gc. One advantage of operating the diode above its theoretical frequency limit is that diode cost is lowered. This millimeter-wave oscillator makes use of principles previously employed to make S-band diodes function at X-band.

By S. V. Jaskolski and K. Ishii, Marquette Univ.

ARBITRARY-LENGTH BINARY COUNTERS. This article presents a simple set of rules that will save time in counter design. These rules can be used to produce a logic design that will permit a counter to count to some arbitrary length sequence with a minimum number of packages, and in which the required fan-in and fan-out of the gates used is minimized. It can supplant trial-and-error design procedures now widely used.

By B. W. Meyer, Signetics Corp.
Contents continued

“ELECTRONIC” HOSPITAL. An Alabama group has built a 22-bed hospital whose core is a patient-monitoring console. Equipment includes EKG telemetry, closed-circuit tv, a computer and data transmitters. The second of these experimental hospitals is scheduled for use at the New York World’s Fair

WEATHER READOUT. System developed for NASA automatically determines azimuth, elevation and slant range of weather balloon, processes the data transmitted by the radiosonde and prints out results. Data output can be punched on cards for computer analysis, or in a variety of other forms

DEPARTMENTS

Crosstalk. We approve, With Reservations

Comment. Cascade Follower

Electronics Newsletter. Eye Operation With Laser Successful

Meetings Ahead. Symposium on Mechanized Documentation

Washington This Week. Pentagon Trying to Reduce Contract Paperwork

Research and Development. Lensless Optical System Uses Laser

Components and Materials. Miniature Closed-Cycle Cooler Produces 25 K Reliably

Production Techniques. Programmed Machine Cuts Cost of Plastic Parts

New Products. Digital Q Meter

Literature of the Week

People and Plants. GT&E Elevates Two Executives

Index to Advertisers

Editorial Index, 1963
What's unique about these connectors?

- Insulation support crimp eliminates small wire flexing problems
- Closed entry prevents probe damage
- Independent cantilever-beam contact retention spring provides maximum conductivity and longer insertion/extraction life
- Pre-assembly plating of all parts assures greater corrosion resistance
- Alignment stabilizer
- Bell-mouthed socket permits easy pin alignment
- Wire range: 24-16 AWG
- 3 contact sizes—20, 18 and 16

This stamped and formed contact!

This is the AMPin-cert* TYPE III pin and socket contact—an exclusive development of AMP Incorporated. With it, you can now get reliable connector performance at a much lower initial cost... at the lowest applied costs in the industry. Consider these facts:

- Performance characteristics conform to all dimensional and mechanical requirements of MIL-C-8384A.
- Contacts are crimp, snap-in type for assured uniformity and quick, easy connector assembly.
- Strip-mounted, reel-fed termination with our automatic crimping machine provides rates of 1,600 uniformly crimped contacts per hour.
- Contacts are available for a wide range of housing block types and configurations—including AMPin-cert "M" (MIL-C-8384), "D" and "D-D" and "W" Series Connectors.
- Standard AMP Contact Plating: .00003" non-porous gold over .00003" nickel, special platings available on request.

Put an end to solder-pot uncertainties, hit-or-miss connections, production slow-ups due to time-consuming inspection steps. Get consistently reliable connectors and at the lowest applied costs in the industry. Specify AMPin-cert TYPE III contacts. There is no equivalent! Write today for more information.
CLEANING AS A WAY OF CUTTING REJECTS

Modern manufactured products, both consumer and industrial, are characterized by the ever-tightening specifications under which they must be made. This places a major burden on the quality-control function in manufacturing. While stringent specifications must be reliably maintained, increasing production costs will not allow many rejects. As a result, production cleaning of manufactured articles and components has become vitally important in many industries as a way to hold down rejects and thus control costs.

We are interested in the subject of cutting rejects through cleaning because we make FREON fluorocarbons, already familiar as refrigerants and aerosol propellents. From the same chemical family comes a group of FREON solvents with interesting cleaning properties. Because these FREON cleaning agents do such a thorough job, they have in many cases caused acceptable limits of rejects to be reset downward. Numerous companies have found that they were rejecting large quantities of product simply because their cleaning systems were inadequate.

As the basis of a reliable cleaning system, FREON solvents have these unique properties for cutting reject rates of manufactured products:

**They’re Thorough**—FREON solvents effectively remove dust, lint, dirt, scale, grease, oil, chips and other contaminants. And they penetrate the tiniest openings and spaces because their surface tension is lower than that of other solvents. So they’ll make your product consistently pass the tightest cleanliness specifications.

**They’re Selective**—Despite their thorough cleaning action, FREON solvents have no deleterious effect on metallic and non-metallic materials of construction, such as elastomers, plastics, paints and finishes. So delicate tolerances are never harmed.

**They’re Pure**—FREON solvents are among the purest chemical compounds in commercial production today. As such, they leave no residue on or in parts being cleaned, when they vaporize. And FREON can be easily repurified in a simple still or filter unit.

FREON solvents have already been successfully used in cutting reject rates in the electronic, electrical and aerospace industries. We think they might be able to do the same in your own manufacturing operation. They’re priced at $7.50/gallon, but if their properties are applicable to your situation, they could easily save you hundreds of times your original investment. Also, FREON solvents are very stable, so you can use them over and over for maximum economy.

Write us for full details. If you wish, we’ll send a specialist to analyze your current cleaning setup. Du Pont Company, FREON Products Div., N-2420E-12, Wilmington 98, Del.
We Approve,
With Reservations

THERE IS a move afoot in Washington to broaden government support of research. Behind the move are reasons that can be called both positive and negative. We salute the positive reasons and thumb-down the negative ones.

The positive approach holds that there are numerous social and scientific problems that have not been solved. Greater funding of programs in, for example, pollution control, medical research, meteorology and oceanography, and studies of such problems as the impact of automation, are being urged.

Acceleration of research in such fields would be socially, scientifically and economically rewarding. The electronics industry, in particular, could anticipate greater opportunities to diversify into nonmilitary product areas—diversification that would aid its growth and long-range stability.

It is, therefore, an attractive proposal. But our enthusiasm is tempered by some of the negative reasoning behind the proposal.

The strongest backing seems to come from those concerned about slowdowns in military research. They want a program to maintain the impetus that military research has given the economy and technology—as a substitute for military research.

If the proposal is accepted on this basis there is danger that the program will never get off the ground. Worse, promoting nonmilitary research as a substitute for military research can build up pressures to decrease military research solely for the purpose of increasing nonmilitary research. It could easily go too far.

This sort of reasoning is highly undesirable because it could stigmatize government-funded nonmilitary research as a sort of scientific WPA that would have to compete with pork-barrel projects for appropriations. It would be very difficult at present to build an effective case for programs to forestall a depression in the “business” of R&D. One recent survey (ELECTRONICS, p 18, Dec. 6) predicted that R&D expenditures in the U.S. next year would total $20 billion, reflecting a $1.1-billion increase in government funding and $500-million increase in industry spending.

If the object of the proposal is to pump money and technology into the economy, rather than to get a job of work done, then there is no necessity for shifting from military to nonmilitary research.

It seems clear, therefore, that government support of nonmilitary research should be supported on the merits of projects proposed. To cite just one example, air pollution: It has been estimated that air pollution costs the nation over $11 billion a year in money and perhaps 19,000 deaths a year. Problems such as this are well worth solving for their own sake.

Coming In Our January 3 Issue

THE NEW YEAR. Our next issue contains our annual electronics markets special report. It probes the electronics industry and highlights areas of profit, plateau or penury—in detail. We've developed the outlook for 1964, and beyond, through interviews with government, military, industrial, scientific and marketing specialists. The men we spoke to not only know fairly accurately what is going to happen, in many cases they make it happen. They are in the top echelon of our industry, and their comments reflect the best information obtainable on where the dollars will be spent. In text and figures, we've brought informed order to much of the disparate information we gathered. Join us next week for an inside view of the year ahead.
This versatile instrument is a highly sensitive interference locator—with the widest frequency range of any standard available. Model 500 tunes across the entire standard and FM broadcast, shortwave, and UHF-TV spectrums from 550 kc. to 220 mc. in 6 bands.

It’s a compact, portable, rugged, versatile instrument—engineered and designed for most efficient operation in practical field use. It features a transistorized power supply, meter indications proportional to carrier strength as well as sensitivity of 5 microvolts minimum for 5% meter deflection over entire tuning range.

Send for brochure IL-106,

SPRAGUE ELECTRIC COMPANY

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### COMMENT

**CASCODE FOLLOWER**

I noted with interest the excellent article by R. W. Johnson entitled, The Cascode Follower, which appeared in your Dec. 6 edition (p 69).

The application note at the bottom of the page suggested that a transistor version of this circuit should be possible. You may be interested in the fact that a transistor version of this circuit was published in the Second Edition of the General Electric Transistor Manual as a “hi-fi” amplifier of low output impedance for directly driving loudspeakers. The work that I did on this transistor circuit was, in turn, suggested by Dr. R. A. Stasior who had become acquainted with a similar tube circuit in his student days in Canada. In looking up the tube circuit, we found that it was published, strangely enough, in *Electronics* magazine in November of 1946 (p 206).

Perhaps the only conclusion that can be drawn from this is that there should be some technique for making useful circuits available so that it is not necessary for an engineer to “re-invent the wheel.” The only suggestion I have is for some publisher like McGraw-Hill to classify circuits somewhat in the form of a dictionary so a person could, for example, find the “cascode follower” circuit with a minimum of difficulty.

H. R. LOWRY

**FIELD EFFECT DEVICE**

I read with interest the *Research and Development* article, New Field Effect Device May Aid Integrated Circuit Design, in the Nov. 29 issue (p 44). I would be interested in obtaining one of these devices for experimental purposes. I would appreciate any information or help that you could give me in this matter.

WALTER MAUDERLI

**REVERSED DIODE**

At the risk of being called a “nit picker,” I should like to point out what I feel is a discrepancy appearing in your Electronics Color Code chart (p 37, Nov. 15). At the head of the column describing diode coding, a schematic symbol of the diode appears. However, since the sample color coding of the diodes shown below it infers that the triangle end of the diode symbol is also the cathode, and the bar end the anode. I am lost—shouldn’t it be the other way?

Being heavily involved in solid-state logic circuitry for the last few years and having used the bar end of the diode symbol as the cathode with remarkable success, I feel the symbol should be turned around to agree with the color coding shown. Don’t you agree?

Seriously though, the chart is a beautiful one, which I will keep for reference until the standards change and a new one will be issued (hopefully).

M. ARNAUTOFF

**Sprague Electric Company**

- The United States Patent Office is working on a system for classifying patented transistor circuits with digital codes, to simplify the processing of incoming patent applications.

H. R. LOWRY

- For further information, write to H. C. Nathanson (one of the inventors) at Westinghouse Research Laboratories, Pittsburgh 35, Pennsylvania.

WALTER MAUDERLI

- We agree. That diode symbol should be turned around.
Downtime's nemesis, rugged and reliable as a purebred workhorse—that's Mincom. Common denominator of dependability in all four basic Mincom Recorder/Reproducers is the exclusive Mincom DC Top Plate. Here's a tape transport built with beautiful simplicity: Only 12 moving parts with four easy adjustments, full dynamic braking, instant six-speed pushbutton control, seven or fourteen tracks—plus tape speed accuracy within ±0.005% using Mincom's Cyclelock®. Whether your specifications call for wideband predetection at 1.5 mc, or a comfortable 120 kc at 60 ips, there's a reliable Mincom workhorse to meet your facility's needs. Write today for details.
GENERAL FEATURES

Fan-Out: Guaranteed fan-out is 4 from —55°C to +125°C. Buffer element increases fan-out to 30.

Speed: Guaranteed worst-case propagation delay of 40 nanoseconds per node.

Power: Average dissipation per function varies from 4 milliwatts to 10 milliwatts. Typical, 2 milliwatts per node.

Application: Simple design rules permit rapid application and insure compatibility between functions.

Functional Complexity:
Shifting and counting can be done with a single element. Other elements are also of high complexity.

The average element consists of 4 NOR functions, thus permitting the use of twosided printed circuit board for element interconnection and resulting in exceptionally high packaging density.

Cost is not linearly proportional to functional complexity, but is related primarily to die size. Additional elements of like complexity can be produced on a custom basis at a comparable price. For example, in quantities of 49-200:

<table>
<thead>
<tr>
<th>Elements</th>
<th>R</th>
<th>D</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transistors</td>
<td>15</td>
<td>4</td>
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<tr>
<td>Resistors</td>
<td>21</td>
<td>6</td>
</tr>
<tr>
<td>Die area</td>
<td>2500 mil²</td>
<td>1600 mil²</td>
</tr>
<tr>
<td>Price</td>
<td>$33.15 ea.</td>
<td>$16.25 ea.</td>
</tr>
</tbody>
</table>

E = X + Y + Z (Positive logic)
F = A + B + C + D

E = CD (Positive logic)
F = (A + B) C (B)

DUAL 2-INPUT GATE ELEMENT, D

E = C + D (Positive logic)
F = E + F

DUAL 3-INPUT GATE ELEMENT, D

H = X + Y + Z (Positive logic)
D = E + F

EXCLUSIVE OR ELEMENT, HALF ADDER, H

E = (A + B) C + D (Positive logic)
F = (A + B + C) D

BUFFER ELEMENT, B

E = X F (Positive logic)
F = E + B

EXPERAND GATE, E

The E element is used to increase the fan-in capabilities of the family. The E is similar to the D element except that the output node resistors are omitted. The E can extend the fan-in of any other element, except the Buffer, up to a maximum of 4 additional inputs without exceeding the guaranteed electrical performance of the other elements.

ELECTRICAL PERFORMANCE

(Worst case) Vcc = 3V, —55°C to +125°C

Input Loading - Pins A, B, C, D
Fan-Out - Pins E, F
Signal Propagation Delay - Pins E, F
Power Consumption* 5.0 mW

DUAL 4-INPUT GATE ELEMENT, H

E = X + Y + Z + W (Positive logic)
F = (A + B) C (B)

ELECTRICAL PERFORMANCE

(Worst case) Vcc = 3V, —55°C to +125°C

Input Loading - Pins A, B, C, D, E, F
Fan-Out - Pins G, H
Signal Propagation Delay - Pins G, H
Power Consumption* 5.0 mW

EVENT IDENTIFIER, R

The R element is a synchronous clock gated flip-flop with asynchronous set and reset. This element can be used both as a full shift register stage or as a complementing binary flip flop. The complementing function is achieved by coupling back D to R. Data at C are entered during a one-to-zero transition of CP. The data bit C must be present a minimum of 70 nsec before, and 40 nsec after the 50-percent point of a one-to-zero transition of CP.

ELECTRICAL PERFORMANCE

(Worst case) Vcc = 3V, —55°C to +125°C

Input Loading - Pins A, B, C, D, E, F
Fan-Out - Pins G, H
Signal Propagation Delay - Pins G, H
Power Consumption* 12.5 mW

NOTES:
1. Synchronous entry of data. When data are being entered through the D input, the 50-percent points of the D and C waveforms shall occur within 120 nsec of the one-to-zero transition of CP.
2. Asynchronous set and reset: When the R element is set or reset through the R and S inputs, the 50-percent points of the D and C waveforms shall occur within 70 nsec of the 50-percent point of the R as pulse.
3. The maximum signal propagation delay is defined for the entire temperature range of —55°C to +125°C and any combination of the rated loading. Measurement is made between 50-percent points input-output with a 6 element as a driver.

Maximum fan-out.

December 27, 1963 electronics
General Micro-electronics Inc. offers its first Multi-Log set, a family of low-power logic functions designed for critical military applications at milliwatt power levels. The devices are manufactured by modern planar epitaxial processes and the latest masking technology which, coupled with simplicity of circuit design, provides the customer with the following advantages:

- High Performance
- High Reliability
- Prompt Delivery
- Low Cost

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The elements are immediately available in standard TO-5 type header with low-silhouette cap, 8 and 10 leads. Hermetically-sealed flat pack will soon be available.

QUALITY ASSURANCE
The best assurance that a product is reliable is through careful evaluation of extensive data. Hence, in addition to the standard MIL-STD-19500 Lot Acceptance Life Data, General Micro-electronics will provide up-to-date product distribution, operating life, storage life, stress-to-failure and MTBF calculations on a continuous basis for every product.

For detailed Electrical Specifications and Design Rules Handbook, contact Mr. Earl Gregory, Manager, Semiconductor Device Marketing.
Home Tv Tape Recorder—It Really

By ALEXANDER A. McKENZIE
Associate Editor
DAN SMITH
Assistant Editor

British device gives picture adequate for entertainment purposes

NEW YORK—At an offhand demonstration last week, the American press got its first glimpse of the much-publicized Telcan home video tape recorder (p 19, Sept. 13; p 7, Aug. 23; p 7, Aug. 16; p 8, July 5).

Allowing for conditions, which were terrible, two observers from ELECTRONICS agreed that the British device probably does live up to its advance billing. It should provide adequate recordings of television programs and vidicon-camera signals, and at its price—$160 for the model to be sold in the United Kingdom beginning in March—may find a wide market among ordinary TV viewers.

The demonstration, held in a basement room of a local Cinerama theater, was bad on two counts. TV reception was poor at the location, so that the signals fed to the recorder were weak and fuzzy, and interference, probably from stray TV signals, played hob with the recordings.

Michael Turner, a director of Nottingham Electronic Valve Co., Ltd., of England, developer of the device, said the interference problem in Manhattan had been overlooked in planning the presentation. The trouble, he said, could be easily corrected with proper shielding of the recorder. To illustrate his point, he moved his hand back and forth near the recorder head, producing a visible change in the interference displayed on the TV screen.

Picture Quality—Deterioration is another matter, Turner said. Some is always present between the signal picked up by the TV receiver and that reproduced by the recorder. The deterioration was evident in the demonstration, but, because of the interference and the poor quality of the TV signals, it was impossible to judge exactly how good a picture Telcan can deliver.

However, this much could be told. The pictures that actually were reproduced probably would have been found adequate—if barely so—by most viewers, but the degree of deterioration makes it unlikely Telcan can be used for any purpose other than entertainment. Pictures taken with an inexpensive vidicon camera, which the company also plans to sell for about $160, were reproduced more clearly by the tape recorder.

Price Is Right—The announced price of the tape recorder, which has been greeted with some skepticism in the press, will be no trouble to meet, according to Turner. But a more sophisticated version than the one planned for the British market might be selected for the U. S., he said, with a consequent increase in price. Nottingham Electronic will make the recorder for the United Kingdom market. A new company, jointly owned by Cinerama and Nottingham, will manufacture the devices for sale in the western hemisphere. These won’t reach the U. S. in any quantity until next fall, Turner said.

Major innovations in the tape recorder, Turner said, have to do with actual recording methods—the setting of the tape, for instance. Nottingham Electronic is reluctant to discuss these because it presently holds only a British provisional patent on the device. However, Turner did supply many technical details.

Overall System—The recorder is connected to the detector circuit of the home TV set and records whatever signal is tuned in on the set. Alternatively, it records signals from a home camera. In this case, the NEV camera feeds r-f output into the antenna input of the TV receiver. On playback, the recorder works into the detector-output point of the TV set and the signal, amplified by the video stages, is normally displayed.

Recorder—The recorder has one motor to operate the tape-drive capstan, and, through a pulley and belt arrangement, the tape supply and tape takeup reels. Tape speed...
Works

is 120 inches per second. Tape used is ¼-inch, ½-mil Mylar. Machine can handle up to 11½-inch diameter reels. Transport is capable of handling thinner tapes that would give up to 30 minutes on a side but such tape is not presently available.

With present reels and tapes, 22 minutes of recording are possible on each side of tape, or a total of nearly 45 minutes. With automatic tape turning, a continuous performance of 45 minutes might be possible. The tape-turning mechanism is not yet available.

As received by the recorder— which handles the picture processing —the composite video signal is split into synchronizing and video information, amplified and fed into the one video recording head. On replay, a preamplifier separates sync and video signals and feeds them into the appropriate receiver circuits. Bandwidth is better than 2 Mc but the equipment has a 3-Mc rise time and its resolution depends upon noise. Resolution in the highlights is better than in the blacks. Resolution is enhanced between mid-gray and peak white.

The high-resolution heads are not expensive nor are they long-lasting. They are expected to be serviceable for about 100 hours after which they can be replaced for about $2, like a record stylus.

Recorder circuits are transistor and the driving transistor delivers about 1 watt to the recording head. The signal off the tape is about 1 to 1.5 volts and a divider across the output maintains that level. The volume control on the tv set, therefore, is operated normally. In the future, color can be accommodated (at half the playing time per tape—driving the tape in one direction only) by using one of the 18-mil signal tracks for color difference signals.

Camera—The vidicon camera’s circuits are all-transistor. It delivers about 30 millivolts to the antenna terminals of the receiver. Tv camera techniques (no shutter needed) allow putting most of the money into good optics. An f 1.9 lens is used.

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CIRCLE 11 ON READER SERVICE CARD

electronics December 27, 1963
NEW... hi-voltage regulated DC Power Supply under $400.

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<thead>
<tr>
<th>Brand</th>
<th>Volts</th>
<th>Current</th>
<th>Regulation (Combined line &amp; load)</th>
<th>Price</th>
</tr>
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<tr>
<td>K</td>
<td>0-325</td>
<td>0-200 MA</td>
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<tr>
<td>S</td>
<td>0-500</td>
<td>0-200 MA</td>
<td>2.0%</td>
<td>400.00</td>
</tr>
<tr>
<td>Electro RB-500</td>
<td>0-500</td>
<td>0-250 MA</td>
<td>0.03%</td>
<td>395.00</td>
</tr>
</tbody>
</table>

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December 27, 1963 electronics
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December 27, 1963 electronics
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By the way, there are engineering laboratories in Santa Monica, Chicago, and Union, N. J. as well as in Kokomo to assist you in circuit design or modification.

<table>
<thead>
<tr>
<th>IC (MAX.)</th>
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<th>Vebo (MAX.)</th>
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<td>50V</td>
<td>1.0V @ 12A</td>
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electronics December 27, 1963 CIRCLE 15 ON READER SERVICE CARD 15
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ComSat Proposals Due Feb. 10

WASHINGTON — Industry proposals for the first commercial communications satellite system (p 20, Dec. 20) are due Feb. 10. Design specifications for the system were detailed this week by the Communications Satellite Corp.

The corporation wants designs for both intermediate-altitude and high-altitude synchronous satellites and may choose either or both for six-month follow-on studies. Intermediate satellites would be ready for launch in 1966, with initial global coverage in 1967; synchronous system launch would begin in 1967, for global coverage in 1968.

The satellite system is to permit one-way monochrome television to be transmitted on an alternate basis with two-way 4-kc channels. There is to be a capability of 270 two-way channels in 1966 to 1968; 400 two-way 4-kc channels in 1969; 600 in 1970, 800 in 1971 and 1,200 in 1972.

The corporation wants 18 satellites for a random intermediate-altitude system; 12 satellites for a phased intermediate-altitude system, or 6 satellites for a synchronous-altitude system. Frequencies specified include 5,925 to 6,425 Mc for the up-link and 3,700 to 4,200 Mc for the down-link.

ComSat Corp. also plans to launch an earlier, experimental synchronous satellite, independent of these design requests, in 1965 to link the U.S. and Europe. Bandwidth and power capability would provide for either TV facsimile or telegraph message traffic, or up to 240 two-way telephone channels. Purchase of these satellites will be negotiated directly with Hughes, developer of the Syncom satellites.

Experts Lay Groundwork For World-Wide Dialing

GENEVA — Telecommunication experts have quietly given the go-ahead for world-wide direct dialing.

Omega Approved For Use in Fleet

NAVY Bureau of Ships says the Omega long-range navigational system has been proved feasible and eventually should be installed throughout the fleet, possibly by 1969 (p 17, Dec. 20). About $9.5 million will be spent on the system during the 1963 fiscal year.

"An improved aircraft receiver will be ready to test fly very shortly," a spokesman said. "Development of data necessary for preparation of world-wide charts is proceeding on schedule. The British government is cooperating and in October, Omega test transmissions were started at Criggion, Wales."

Dielectric Speeds Up Integrated Circuits

SUNNYVALE, CALIF. — Low-capacitance dielectric, with breakdown voltage near 1,000 v, should in-

Patient Says Laser Healed Eye

MENLO PARK, CALIF.—First human patient operated on by laser for a detached retina says the treatment was a success (p 17, Sept. 13 and p 30, April 19). His physicians are more cautious. The patient is Donald Scheuch, director of the Electronics and Radio Sciences Division of Stanford Research Institute. He suffered the injury while playing ball and received his first laser treatment about Sept. 1 from Dr. H. Christian Zweng and Dr. Milton Flock. Two subsequent treatments were given.

Scheuch reports he is leading a normal, active life and the retina has remained attached. Dr. Zweng and Dr. Flock say the longer it remains attached, the greater the chances for full recovery, but they will not make a long-range forecast.

Dr. Scheuch says the treatment is simple and requires no anaesthetic as does the Zeiss machine used on comedian Bob Hope here last week. This machine requires about one to one and one-half second pulse, while laser pulse is less than one-half millisecond. Dr. Scheuch says you see only short, bright light. No discomfort is experienced.
increase attainable speeds of semiconductor integrated circuits by at least one order of magnitude—possibly to more than 100 Mc—says its developer, Signetics. The development eliminates the use of reverse biased p-n junctions that presently provide d-c isolation between components. A new approach to the fabrication of components in a monolithic block is substituted, the firm says. Result is a radical change in the circuit's physical structure that is expected to produce wider junction configuration variety and improve yields significantly, according to Signetics.

FAA Asks for Comments On Cockpit Recorders

FAA HAS PUT its stamp of approval on cockpit recorders and asked interested parties for their comments (p 53, Nov. 15). Little opposition is expected because the concept has already received the endorsement of plane manufacturers, airlines and pilots. Under the FAA proposal, commercial jetliners would be required to have the devices by July 1, 1965; four-engine prop airliners by Jan. 1, 1966, and two-engine planes by July 1, 1966. The recorder would retain 30 minutes of crew conversation to aid investigators in the event of a crash.

NASA Awards $60 Million Lunar Orbiter Pact

WASHINGTON — Boeing Co. has been awarded a $60-million incentive contract to build five lunar orbiter spacecraft, designed to take high-resolution photographs of the lunar surface. The photos will help find landing sites for LEM vehicles and for unmanned landings of Ranger and Surveyor spacecraft.

The first Lunar Orbiter, slated for launch in 1966, will also carry radiation measuring and micrometeoroid density sensors. Later orbiters will carry a larger variety of sensors. The craft will have an Eastman-Kodak camera system and RCA communications subsystem.

Punch-Card Shopping Bows at Swedish Market

FOOD SHOPPING by data cards is being tried in Sweden. Shelves in one Stockholm market hold samples of each commodity, with batches of punched cards beneath. The shopper takes one and gives it to the cashier for invoicing by a Bull data machine. The bill is sent to a basement stock room where clerks collect items by hand and bag them; the customer then picks up her goods at the door. The store, which opened in August, says personnel costs and shoplifting are reduced, sales areas kept smaller, stock control aided, and shopping made easier. Possible disadvantages? Fresh foods are virtually eliminated, the firm says, and the customer may feel rigidly mechanized or deprived of the “charm” of shopping. She must also line up twice—once to pay, again to collect purchases.

Gamma-Ray Exposure Retards Lasing Action

SPOKANE, WASH. — Gamma rays hinder lasing in uranium and neodymium-doped crystals, says GE. Twice as much energy was needed to induce laser action after the crystals were exposed to 1.5-million roentgens of gamma radiation—making the firm doubtful that gamma energy can be converted to laser output energy. The studies, conducted at GE's Hanford Labs, were stimulated by speculation that useful energy could be converted from nuclear reactors and fission products; now GE thinks this improbable due to the increase in energy required after gamma exposure. The phenomenon could bear also on the use of lasers in space probes, GE says, or in other space applications.
Computers Due for Another Good Year

WASHINGTON—The electronic computing and accounting machine industry continues to move ahead, with 1964 factory shipments, estimated at $1.99 billion, expected to show a 9.5-percent increase over 1963 shipments of $1.82 billion, the U. S. Department of Commerce, estimates.

Shipments of electronic computing and accounting machines rose 10.8 percent in 1963 over 1962; 1964 shipments are estimated to rise about 9.5 percent. Electronic data processing machines and associated equipment showed a greater percentage rise than the whole industry in 1963, 16 percent, and are expected to show a 13.6 percent increase in 1964. Conventional computing and related machines, including cash registers, rose 6.8 percent in 1963 and are estimated to continue at this rate in 1964.

Dollar volume of 1963 exports rose to $295 million, an increase of 9 percent over 1962 exports of $271 million. The estimate of 1964 exports is $340 million, a 15-percent increase over 1963.

Federal government use of computers has soared from one computer in 1949 to an estimated 1,248 computers in 1963. An additional 317 are planned for installation during fiscal year 1964. The government spent $188 million for computer leasing in 1963; the 1964 estimate is $243 million.

New Explorer

AIR DENSITY Explorer launched last week is expected to tell NASA whether there are enough gas molecules to cause resistance or drag to spacecraft moving through them. White painted dots control temperature for tracking beacon, solar cells and batteries mounted on skin

Closed-Cycle Plasma

Power Source Developed

NEW YORK—The Martin Company said last week it has produced electrical power with a closed-cycle magnetoplasmodynamic system. Mostafa E. Talaat, manager of Martin's Energy Conversion Laboratories, said the experiment proved the principle that with magnetically-induced, nonequilibrium ionization, electron temperatures twice the temperature of the host gas could be obtained (p 29, Sept. 1, 1961). Gas conductivity at 2,600 F was equivalent to that at 5,200 F in combustion gases.

Martin estimates that the new equipment would occupy about one-tenth the space of a comparative steam turbogenerator. Talaat thinks mpd plants will have efficiencies on the order of 50 percent, compared to 30 to 35 percent for conventional systems. With fewer moving parts, maintenance is also expected to be less costly.

Teaching-Machine Market

Getting Big, New Entrant?

IBM'S ANNOUNCEMENT last week that it plans to buy Science Research Associates, Inc., Chicago, a publisher of educational materials, stirred speculation that the giant manufacturer of computers might be getting ready to enter the teaching-machine market. An IBM spokesman said he had no comment on this but that his company had been conducting research on teaching machines for some time. Science Research Associates prints mostly programmed teaching material, similar to material used in teaching machines, a representative of that firm told ELECTRONICS.

IN BRIEF

TIROS 8 weather satellite, successfully launched last Saturday, will evaluate the first experimental Automatic Picture Transmission (APT) camera system (p 20, July 26).

POST OFFICE has given Farrington Manufacturing Co. a $1,176,277 contract to produce an automatic mail address reader. The machine, which will go into operation a year from now in Detroit, will sort 27,000 letters an hour for 50 states and 50 large cities.

FIRST industry-built Saturn initial stage, scheduled for launching from Cape Kennedy late next year, was turned over to NASA's Michoud Operation by Chrysler Corp. this week.

LOCKHEED says instrumentation aboard polar orbiting satellites indicates the auroral curtain is several hundred miles thick.

MODEL of Airborne Instruments Laboratories' microwave instrument landing system (p 24, Aug. 2) will be part of the science exhibit at the New York World's Fair. It will include a complete ground control pattern of an airport with an airplane that periodically lands and taxis up to unload.

SYLVANIA has tested an electronic device that protects bombers from air-to-air and ground-to-air, radar-guided weapons.

ORDERS for the Honeywell 200 (p 10, Dec. 13) total $50 million in sales value, firm says.

EITEL-MCCULLOUGH has licensed two British companies to manufacture its family of uhf, klystron tubes in England. The two firms are English Electric Valve Co. and Standard Telephones & Cables, Ltd., ITT's British subsidiary.

DOUGLAS has received an additional $48,064,658 contract for its part in the Saturn program.

UNIVERSITY of Michigan will study radar detection of moving ground vehicles from the air for the Air Force.

DEEP-SEA seismometers are being used in the Pacific to develop methods for detecting underground nuclear detonations. Tests, part of the Vela uniform program, will also help development of underwater devices.

SWEDISH newspapers report that three Swedish companies, Saab Asea and L. M. Eriksson — have combined forces to make a $50,000, six-month preliminary study for Europe's first satellite.
Red Tape Will Be Next Target of Pentagon Scissor

By Watching the Millions, Says Air Force, It Saved a Billion

NASA Wants Spanish Station

President May Ground Nuclear Rocket Program

A pilot study aimed at reducing Defense Department monitoring of contracts will begin soon. The objective is to cut back on the volume of reporting, auditing and other controls without losing the effectiveness of the monitoring. Northrop Corporation’s production of the T-38 jet trainer and F-5 fighter has been picked for the first test. An electronics firm will be selected early next year for a similar study.

The Pentagon believes that reducing the burden of paperwork on its contractors will let them lower costs, and in turn offer the government lower prices. This thinking stems from the new emphasis on fixed-price contracting. In the loosest type of contract—cost plus fixed fee—need for monitoring is highest. But it declines steadily with the tighter forms of contracting the government now favors.

Air Force is now detailing the results of its cost-cutting efforts in the past year. It claims savings of $1.2 billion against a programmed goal of $982 million. The goal for the current fiscal year is $1.5 billion. Here are some examples of methods being used to reduce costs:

- A contractor buying a high-reliability vacuum tube for the Minuteman from a single source was directed by Air Force's contract management branch at Philadelphia to a lower-price commercial tube. Total saving: $1 million.
- Flying suits for high-altitude use were being bought from a single company. Air Force divided the suit into its components. As a result, three firms divided the order, eliminating subcontracting. Davis Clark Co. supplied coveralls, gloves, boots and helmets; Pioneer Central got the controllers portion, and Firewel Co. the regulators portion. Saving: $3 million.
- A magnetic-tape rehabilitation facility—believed to be the first of its kind—was put into operation, with equipment supplied by General Kinetics, Inc. Some 18 million feet of used tape was cleaned up in a few months, at a saving of one-quarter of the $40 cost of a new reel. Total saving: $50,000.

A giant tracking station will be built in Spain by the National Aeronautics and Space Administration, providing agreement can be reached with the Spanish government. The station is needed for tracking the three-man Apollo spacecraft. The Spanish government wants complete assurance that the purpose is peaceful.

President Johnson is now deciding the fate of Project Rover. His 1965 federal budget spending plans will include a basic decision on whether to hold back or go full steam ahead on the big-payload-capacity spacetruck (Electronics, p 20, Nov. 22, 1963; p 24, Dec. 28, 1962). Rover was one of Johnson's pet projects when he headed the National Space Council, but his science adviser, Jerome B. Wiesner, is suggesting that a cutback in the nuclear rocket effort offers a chance for big savings. Atomic Energy Commission and NASA, however, say their request for next year for $280 million has already been cut to $200 million for Rover by Wiesner and the Budget Bureau. This is about as deeply as the program can safely be cut, they argue. But Wiesner counters that by stressing reactor development work only, and slowing down space vehicle development, the total AEC-NASA expenditure could be held to $50 million.
Save Device Handling Time

add switching time measurements to your tact* system

The Switching Time Measuring Unit, added to your TACT system, can cut your device handling at least 50% because all tests are made in a single socket . . . you do not have to change units from one socket to another. You do not need additional scopes or pulse generators. Switching time measurements on semi-conductors can be intermixed in any order with other parameters. And with TACT, automatic data recording will increase your savings. Digital card programming eliminates set-up and operating errors, assures repeatability. Standard switching time parameters, \( t_{os}, t_{r1}, t_{am}, t_{os}, t_{f}, t_{off} \) may be measured within the range of 1 nanosecond to 10 microseconds. Performance circuits are precisely matched to your requirements . . . the desired circuit selectable by the program card. The switching time measuring unit is another planned advancement of the ever-expanding TACT system. Since its introduction in 1960 with d-c capability, the Transistor And Component Tester has continuously expanded with pulse, h-parameter, \( h_{YH} \), low-current measurements, and environmental tests. Now switching time can be added to every TACT system, new or old. Let a TI engineer show you how to save by using the TACT system.

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MIL SPEC DESIGNS

VIBRATION: MIL-T-4807A
HUMIDITY RESISTANCE
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ADVANCED ENGINEERING FEATURES

- All solid state
- Completely protected
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- Constant voltage/constant current
- Wide input frequency and voltage range
- Convection cooled
- Series/Parallel operation
- Remotely programmable
  — resistance and voltage

MASS PRODUCTION PRICES

LE SERIES CONDENSED DATA

<table>
<thead>
<tr>
<th>DC OUTPUT (VOLTAGE REGULATED FOR LINE AND LOAD)</th>
<th>Voltage Range</th>
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Current rating applies over entire voltage range.

 Prices are for nonmetered models. For models with a metered model add suffix “M” to model number and add $40 to the nonmetered price. For metered models and front panel control add suffix “FM” and add $50 to the nonmetered price.

REGULATED VOLTAGE:

Regulation
(line and load) . . . Less than .05 per cent or 8 millivolts (whichever is greater). For input variations from 105-135 VAC and for load variations from 0 to full load.
Remote Programming . . .50 ohms/volt constant over entire voltage range.
Ripple and Noise . . . Less than 0.5 millivolt rms.
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AC INPUT: . . . . . . . . . 105-135 VAC; 45-66 CPS and 320-480 CPS in two bands selected by switch.

PHYSICAL DATA:

Mounting . . . . . . . . . Standard 19” rack mounting.
Size . . . . . . . . . . . . . LE 101, LE 105, LE 109 3½” H x 19” W x 16” D
LE 102, LE 106, LE 110 5¼” H x 19” W x 16” D
LE 103, LE 107 . . . . 7” H x 19” W x 16½” D
LE 104 . . . . . . . . . . 10½” H x 19” W x 16½” D

SEND FOR COMPLETE LAMBDA CATALOG.
DESIGNING LASERS WITH PUMP-POWER CHARTS

Chart relates the three most easily measured, and most often specified laser parameters—pump power, wavelength and propagation direction—in easy-to-use graphical form, for rapid performance evaluation of lasers.

By ROBERT A. KAPLAN
Wheeler Laboratories
Great Neck, New York

THE DEVELOPMENT of the laser provides a source of highly coherent radiation at optical wavelengths. Numerous applications of this device have been proposed; however, the evaluation of a laser requires an understanding of the characteristics of the emitted radiation.

As is well known, a laser oscillator comprises two essential parts: an active material and a resonant circuit. The active material is capable of storing the pump energy and using this energy to amplify an electromagnetic wave. Energy is stored by pumping the active system into excited energy levels. Amplification is accomplished by stimulated emission of a photon and a corresponding quantum transition of the system between the laser energy levels.

The resonant circuit of the laser is usually a modified Fabry-Perot interferometer formed of high-reflectivity end walls and low-reflectivity side walls. Because of the large dimensions of the typical resonator, compared to the wavelength of the emitted radiation, the cavity can support a large number of modes, where each mode is described by a particular stable field configuration. The usual method of designating a particular mode is by three integers, which are related to the field variations along particular coordinates in the resonator. An alternate method is to specify the resonant wavelength and direction of propagation, relative to the resonator axis, of the nearly plane waves which comprise that mode. This latter description permits a simplified approach to the evaluation of laser performance.

The possible modes that can be supported by the resonant cavity of a laser depend on the resonator geometry and the wavelength. The modes that actually oscillate, however, depend not only on the geometry of the resonator, but also on the
properties of the active material and the pump power. These factors contribute to the loss and gain, which in turn determine the threshold condition. (The threshold condition is specified by the requirement that the gain exceed the loss.) The geometry and the wall reflectivity are the major factors determining the loss in each mode; this loss depends chiefly on the off-axis direction of propagation of the nearly plane waves comprising the mode. The characteristics of the material determine the gain in each mode as a function of pump power; this gain depends chiefly on the departure of the resonant wavelength from the central wavelength of the quantum transition. By specifying the modes of a laser in terms of a direction of propagation and resonant wavelength, the conditions for oscillation may be readily found by means of the pump-power chart.

As a first step, the modes of the resonator are plotted on a mode chart in terms of the direction of propagation and resonant wavelength of the plane waves comprising those modes. The relation between threshold pump power and these factors appears as contours on the chart, forming the pump-power chart. This chart permits the determination of the modes of oscillation of a laser at a given pump level in terms of wavelength and direction of propagation, and thereby permits the determination of the frequency and angular spectra of the emitted radiation. In particular, the total bandwidth and beamwidth of the laser output may be obtained directly. Although the chart does not provide exact values for the wavelength and direction of propagation of each mode of oscillation, the information provided is useful in practical situations.

Resonator Modes—The modes of most interest in a laser are those with directions of propagation near the resonator axis. If the resonator dimensions are large compared to the wavelength, an approximate relation between resonant wavelength and direction of propagation can be used to describe these modes. This relation, given in Eq. 1, forms the basis of a mode chart, similar to those used at microwave frequencies. The use of normalized variables, \( \theta \) and \( \lambda \), simplifies the extension of this chart to lasers of arbitrary configuration and material. The transverse character of a mode is described by \( \Delta \rho \); modes with the same value of \( \Delta \rho \) are said to lie along a "modal characteristic."

\[
2L \frac{\delta \lambda}{\lambda_0} \frac{\lambda}{\lambda_0} \Delta \rho = - \frac{\lambda}{L(\lambda_0)} \theta^2 \]  

(1)

A typical example of a chart is presented by the solid curves in Fig. 1A. Note that the \( \theta \) scale is quadratic, so that the modal characteristics are linear. In addition, since only certain discrete values of \( \theta \) are allowed, as determined by transverse considerations, the actual modes of oscillation are represented by discrete points on the chart. These points are determined by the intersections of the modal characteristics and horizontal lines representing the possible values of \( \theta \). The permissible values of \( \theta \) are represented by dotted lines in Fig. 1A. The spacing between these lines (\( \Delta \theta \)) is given in Eq. 2. This \( \Delta \theta \) is usually small so that \( \theta \) may often be considered almost as a continuous parameter; for clarity the spacing between horizontal lines has been exaggerated in Fig. 1A.

\[
\Delta \theta = 1 - \frac{\lambda}{2 \rho} \theta \]

(2)

Although the modal characteristics have been drawn for a specific laser configuration and material, the mode chart with a quadratic \( \theta \)-scale may be obtained by the following simple procedure for any other laser. Since the modal characteristics of Fig. 1A are linear, all that need be known is their slope and intercept. The slope \( (m) \), as determined from Eq. 1, is given in Eq. 3. The absolute value of the intercept of the central modal characteristic is arbitrary within the approximation made in Eq. 1; however, the spacing between intercepts for successive modal characteristics \( (\Delta \lambda) \) can be determined and is given in Eq. 4.

\[
m = \frac{2 \delta \lambda}{\lambda_0} \frac{\lambda}{\lambda_0} \]  

(3)

\[
\Delta \lambda = \frac{1}{2} \frac{\lambda^2}{L \delta \lambda} \]  

(4)
**Resonator Loss**—The loss experienced by a wave in a laser resonator is one of the two important factors determining the threshold condition. This loss depends on the geometry and wall reflectivity of the resonator and on the particular mode under consideration. The lack of perfect reflectivity of the resonator end plates is often the major factor determining the loss in the axial modes, since this loss is by design usually made equal to or greater than the total losses due to dissipation, diffraction and scattering to maximize the laser output. Loss can be specified in terms of a photon lifetime, which is the average time a photon in a given mode will remain in the resonator. This photon lifetime is directly proportional to the Q of the mode. In particular, the photon lifetime of the axial modes is given by

\[ t_a = \frac{L}{v (1 - R)} \]  

(5)

For off-axial modes the lifetime is limited by both the end-plate reflectivity and the finite number of reflections before a photon in a particular mode leaves the cavity at the side walls. The approximate lifetime may be derived directly from geometrical considerations by considering the average number of reflections a photon will experience.

\[ t = \frac{L}{v \cos \theta} \frac{1 - R^{|\theta|}}{(1 - R)} \]  

(6)

The lifetime of off-axial modes with nonreflecting side walls and highly reflecting end walls, normalized to that of the axial modes, is therefore

\[ \frac{t}{t_a} = \frac{1 - R^{|\theta|}}{\cos \theta} \approx \frac{(1 - R)}{\Theta} \]  

(7)

The normalized lifetime of a photon in a resonator is shown as a function of the normalized direction of propagation in Fig. 1B for three different values of end-wall reflectivity. This curve, therefore, graphically presents the relation between the loss and the off-axial direction of propagation, in terms of the photon lifetime.

**Gain**—The other important factor, which determines the threshold condition, is the gain in the laser material. An electromagnetic wave propagating through a laser material may experience gain due to stimulated emission if enough systems (active atoms or ions of the material) are in an excited state. The conditions required for gain were originally presented in Ref. 7.

The gain of the laser is a function of the wavelength because of the finite linewidth of the laser material. For most materials the spectral distribution assumes a Lorentzian shape, maximum gain occurring at the central wavelength of the quantum transition. The gain as a function of wavelength, normalized to that at the central wavelength of the quantum transition, is

\[ g = \frac{g_0}{(\lambda - \lambda_0)^2 + (\delta \lambda)^2} = \frac{1}{A^2 + 1} \]  

(8)

This function is shown graphically in Fig. 1C. It presents the relative gain of a laser material as a function of wavelength.

The gain \( g \) of the laser is directly proportional to the popula-
tion inversion ($\Delta N$). Since this population inversion is a function of pump power, the gain is also a function of the pump power. For a four-level system, the population inversion and gain are directly proportional to pump power. This assumes that the population of the metastable state equals the population inversion. For a three-level system the population inversion and gain are less sensitive functions of the pump power; they are proportional to the pump power plus a large constant. This is because a large fraction of the power is required to maintain the population of the metastable level equal to that of the terminal level without providing the population inversion necessary for gain.

**Pump-power Chart**—The dependence of gain on pump power and wavelength, developed above, can be combined with the dependence of the losses on the direction of propagation to determine the conditions for oscillation of the individual modes of the laser. The relation between these three parameters (pump power, wavelength and direction) is not simple, however, and the relation may vary from a simple mathematical form. This graph has been termed the pump-power chart. The significance of this chart is that it relates the three most easily measured and most often specified parameters of a laser, and thereby permits the rapid evaluation of performance.

The pump-power chart is based on the threshold condition of a laser oscillator. The power required for stimulated emission, for any particular values of wavelength and direction of propagation, depends on the photon lifetime (Fig. 1B) and relative gain (Fig. 1C) of the material. The pump power must be sufficient to provide a gain equal to or greater than the losses represented by the shortness of the photon lifetime. The particular value of power required for stimulated emission in the central wavelength, axial mode (highest-Q mode) is termed the threshold power ($P_\text{th}$). For a four-level laser material, this power is inversely proportional to the product of the photon lifetime and the relative gain of the quantum system. Therefore, the pump power required for stimulated emission in any other mode relative to the threshold pump power, is given by

$$P = \frac{1}{(t/t_0)} \frac{1}{(g/g_0)}$$

(This assumes that the modes of the resonator are weakly coupled, which is a good assumption for many lasers.)

For a three-level laser material, the required pump power is a different function of the gain, as mentioned. The pump power required for stimulated emission in any mode, relative to the threshold pump power, is

$$\frac{P}{P_\text{th}} = \frac{(t/t_0)}{(g/g_0)} + \alpha$$

However, it should be noted that at wavelengths far from the center of the quantum transition, the power is again inversely proportional to the gain.

The curves of Fig. 1B and 1C combined with Eq. 9 or 10 may be used to plot contours of constant $P_\text{th}/P$ on the mode chart shown in Fig. 1A. For each value of normalized direction of propagation ($\theta$) and wavelength ($\lambda$), the normalized values of lifetime and gain may be determined from Fig. 1B and 1C respectively. These values may then be substituted in either Eq. 9 or 10 to determine a value of $P_\text{th}/P$ for those particular values of $\lambda$ and $\theta$. Contours of constant $P_\text{th}/P$, plotted in the $\lambda-\theta$ plane, are shown in Fig. 2. Since this plane is also the plane of the mode chart, shown in Fig. 1B, the individual modes are represented by points and Fig. 2 can be used to determine the relative pump power required for oscillation in each mode. For this reason, this figure is termed the pump-power chart.

A typical pump-power chart for a four-level laser is shown in Fig. 3. The end-plate reflectivity has been chosen as 0.95; the side walls are assumed completely non-reflecting. The modal characteristics have not been plotted directly on the chart but are obtained by using the circular reference scale. For a specified resonator geometry and material, the proper line is obtained by computing the slope ($m$) of the modal characteristic. A family of parallel lines is then obtained with a separation along the $\lambda$-axis given by $\Delta \lambda$. (The exact location of this family of lines is indefinite by an amount $\Delta \lambda$, since a cavity resonance has arbitrarily been assumed to occur at $\lambda_\text{th}$.) The points on the lines, representing the off-axial modes, are separated by $\lambda (\Delta_\lambda/D^2)$ along the $\theta$-axis. These rules may be used to graphically determine the point representing any particular mode.

To illustrate the use of the chart, it is noted that at any relative value of pump power, oscillation can occur only in those modes within the proper power contour as shown in Fig. 4A. The total bandwidth of all the modes of the laser output is proportional to the maximum spread of normalized wavelength determined by the intersection of the modal characteristic curves and the power contour; the actual bandwidth is

$$\Delta f = \frac{\pi \delta \lambda}{\lambda^2} (\text{max } \lambda - \text{min } \lambda)$$

The wavelength spectrum of the output, as derived from the pump-power chart, is shown in Fig. 4B. Each point on the pump-power chart, representing a single mode, gives rise to a single frequency in the laser output, as shown by the vertical lines in Fig. 4B. Each group of modes on the same modal characteristic, having the same value of $\Delta \lambda$, gives rise to a broad spectrum represented by the envelope of the vertical lines, also shown in Fig. 4B. The amplitude of each mode is not shown exactly since this level is a complicated function of pumping conditions. Part of the information required to determine this level is available from the pump-power chart; however a consideration of the competition between modes for the available excited systems is also required. For short pulses, competition between modes may be neglected and, since the gain in each mode is proportional to the intensity of that mode, the relative output of the modes is expected to be a function of $\exp (P/P_\text{th}-1)$.

Also, since the wavelength separation of off-axial modes is very small, the spacing of these modes is only shown symbolically.

The radiation beamwidth of the laser output is proportional to the maximum direction of propagation of the modes of the resonator, which is again determined by the intersection of the modal characteristic curves and the power contour; the beamwidth is
This relation describes the beamwidth as determined by geometric optics. It is not valid in the special case when only one mode is excited since the beamwidth will then be determined by diffraction. An angular spectrum, similar to the wavelength spectrum shown in Fig. 4B, could also be obtained directly from the pump-power chart.

The above discussion has indicated the use of the chart for a given set of input conditions and laser parameters. The variation of the laser oscillator bandwidth and beamwidth as a function of the input conditions (pump power) and laser parameters (dimensions, linewidth, end-plate reflectivity, etc.) may also be determined directly from the pump-power chart. The effects of pump power are indicated by the power contours; the effects of laser parameters are determined by drawing new modal characteristics. Be-
cause of the particular choice of
normalization used, the relative
power contours do not depend on
the parameters of the laser.

Application Example—The application
of the pump-power chart will
be investigated by computation of
the performance of a specific four-
level solid state laser oscillator. The
pertinent data for this oscillator are
listed in Table II.

First, the slope of the modal char-
acteristic \( (m) \) is computed to be
0.003 (Eq. 3); this line \( (O-A) \) is
drawn on the power chart, using the
circular reference scale as shown in
Fig. 4A. The family of modal char-
acteristics are spaced along the
\( \lambda \)-axis by a computed value of
0.3 (Eq. 4) and are drawn parallel to
\( O-A \). As discussed previously, the
actual \( \lambda \)-intercepts of these lines
may not be known exactly, since the
central wavelength of the quantum
transition may not exactly corre-
spond to resonance in an axial mode
of the cavity. Since, in general, there
are a large number of modes, the
character of the output is essentially
independent of the exact location of
the modal characteristics on the
pump-power chart. The modes in
which oscillation may occur are
represented by points within the
power contour as shown.

It is noted that the minimum nor-
malized wavelength of oscillation is
-0.97 as indicated on the chart. The
maximum normalized wave-
length is 0.90. The oscillation band-
width, as computed by Eq. 11 from
the parameters obtained from the
chart is 26 GHz. The entire spectrum
is shown in Fig. 4B. As can be seen,
there are a large number of over-
lapping modes so that the resultant
spectrum will appear essentially con-
tinuous. The results are in qualita-
tive agreement with reported meas-
urements of the bandwidth of laser
oscillators.9

The maximum normalized angle
of propagation is 0.73 as indicated
on the chart. The radiation beam-
width, as computed from Eq. 12, is
therefore 48 milliradians.

This illustrates a typical operation
on the pump-power chart. The chart
is being used at Wheeler Labora-
tories to evaluate more complex
laser parameters such as power
density, spectral brightness and
beamwidth and bandwidth as a
function of power input. In all these
cases, approximate results are easily
obtained by this graphical tech-
nique.

In addition, the variation of the
bandwidth and beamwidth with the
parameters of the laser, (length,
diameter, wavelength and linewidth)
are obtained by considering the
changes in the modal characteris-
tics with the respective parameter.
Therefore, the pump-power chart
may be used as a tool to picture the
effects of variations in the param-
eters of a laser oscillator on the
character of the output signal.

The study described in this article
was performed for Hazeltine Elec-
tronics Division, Little Neck, New
York. The author wishes to ac-
knowledge the assistance of H. W.
Redlien and E. R. Schineller and
the advice of H. A. Wheeler.

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NEAR-FIELD PLOTTER:

Design Tool for Millimeter-Wave Antennas

Initial design based on ray optics or first-order calculations is refined in consecutive steps using field recordings.

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FIELD RECORDING used as a design tool is a modification of the spinning dipole technique described by Cullen and Parr. A small scattering probe is introduced into the antenna near field and the associated reflected wave in the antenna feed line measured as a function of probe location. The field perturbation method at millimeter wave lengths is actually superior to direct measurement of the local field. The probe is suspended by a nylon cord and rotated to modulate the reflected signal. It is thus readily distinguished from spurious reflections from stationary objects. The probe must be small to prevent disturbance but large enough so the reflected signal is above the receiver noise level.

Oval Mirror—A flat, elliptically shaped metallic reflector is best.

The probe is rotated about its minor axis, with the rotation axis oriented approximately parallel to the H vector of the antenna field. The reflected signal comprises a series of pulses, of a period twice the probe rotation frequency. A pulse occurs each time the probe faces are parallel to the local wavefront of the field.

The test setup is shown in Fig. 1. A c-w microwave signal is applied through a hybrid junction and a phase shifter to the antenna. A servo system scans the probe through the antenna field. The wave
SPINNING probe technique in which reflected energy is returned to the antenna from probe. Vector diagram shows relationships—Fig. 1

FEED and lens system (A) radiation intensity from the cylindrical horn (B) and beam deflected horizontally (C)—Fig. 2

SERVO system used to position the probe scan apparatus relative to the antenna—Fig. 3

LENSS design is possible using a single-scan record—Fig. 4

reflected by the probe passes through the phase shifter and the hybrid to be detected at port 2. Port 3 is terminated in a load with a tunable mismatch, which causes a part of the microwave signal to bypass the antenna and go directly to port 2. The crystal detector at port 2 receives two signals, the small reflected signal and a fixed phase reference from the termination at port 3. A time vector presentation of the resultant signal is shown for a particular phase between the reference and reflected signals. The signal is detected and the a-c components are amplified and displayed on an oscilloscope or recorded with a galvanometer.

Wavefronts—To measure the wavefronts of the field, it is practical to scan the probe at a constant velocity and to record the changing modulation as a function of the scanning coordinate. Modulation records are made with a compressed time scale so only the envelope of the modulation pulses is shown. A change of the envelope amplitude from a maximum to a null corresponds to a rotation of the reflected signal vector through 90 degrees from in-phase to out-of-phase with the reference signal vector. The 90-degree rotation is related to a phase difference of 45 degrees, or \( \pi/4 \), between the E-fields at the two probe locations at which the envelope maximum and null are recorded as shown in the photograph.

Probe Scan—The design of the apparatus must be adapted to the field configuration of the antenna system under measurement. In particular, the scanning coordinates must be chosen such that the probe rotation axis is maintained approximately parallel to the H field throughout probe scan. However, this condition is not critical during tests of the crude antenna design. As the desired field configuration is approached through design refinements, errors caused by incorrect orientation of the probe's rotation axis decrease.

The layout of the millimeter wave antenna system to which the experimental design technique was applied is shown in Fig. 2A. The system has rotational symmetry about the vertical system axis and consists of a conical horn, a reflector
and a ring-shaped lens. The mode in the feed waveguide is the circular TE\textsubscript{01}, which propagates into the conical horn (Fig. 2B) and is deflected at the reflector to form a flat pancake-like radiation pattern shown at Fig. 2C. The intensity maximum is directed horizontally and the wavefronts radiated by the horn-reflector combination are approximately spherical. Considering the TE\textsubscript{01}-mode pattern (Fig. 2A), it is evident that the E-field lines form circles about the system axis. The H-field lines are orthogonal to the E field and parallel to the wavefronts.

**Phase Front**—The field configuration of concern, which determines the far-field characteristics of the antenna system, is the amplitude and phase pattern at the aperture of the ring-shaped lens. A cylindrical phase front (flat, as seen in an elevation plane) is required, with an appropriate illumination taper to obtain optimum gain and sidelobe level ratios.

The probe scanning apparatus was designed to provide vertical probe scanning parallel to the wavefront of the desired field, with the probe's rotation axis parallel to the H field. For vertical scanning, the probe can be set at different radial distances from the system axis. A photograph shows the apparatus and a horn-reflector combination under test. Rigid mounting makes possible exact alignment of the antenna system elements.

Scattering from structural elements in the region of high field intensity is reduced by using Eccosorb covers. The three-pole mounting unit supporting the antenna elements during near-field tests (at the left in the photograph) can be detached and used as a mount for far-field testing. The rotary joint in the feed line and the bearings needed to rotate the antenna system during tests for cylindrical symmetry are an integral part of the mounting unit.

The servo system used to rotate and scan the probe through the antenna near-field is illustrated in Fig. 3. Accurate probe setting and a constant scan velocity with no noticeable backlash were achieved using precision-ground drillrod rails to guide the motor assemblies during the scanning operations. At 70 Ge, a tolerance of 0.010 inch normal to the wavefront corresponds to a phase error of approximately 21 degrees. The horizontal and vertical scan velocity is 0.84 cm per sec. Probe rotation is 943 rpm.

**Antenna Design**—The design of the antenna system was begun with the layout of the horn-reflector combination. The horn flare angle and the desired illumination function at the lens aperture were assumed and the reflector profile was constructed using ray tracing. The lens was designed last, using the measured wavefront of the finalized horn-reflector field.

For the field tests, the horn and the reflector were set in the mounting unit in precise axial alignment. Circular symmetry of the near-field was tested first. Noncircular modes in the circular feed waveguide were eliminated by mode filtering. The experimental design of the reflector was then carried out. The design procedure consists of axially positioning and contour shaping the reflector under observation of the field wavefront and illumination at the lens aperture.

A typical vertical scan record taken at the approximate lens distance is shown in the photograph first referred to. Distances between two consecutive nulls of a scan record correspond to phase differences of $\pi/2$. The wavefronts of the field were obtained from a set of such records taken in an elevation plane approximately $\lambda/4$ apart. A scaled mapping of the envelope nulls of all the records of the set was made. Identification of equal phase points was easily made and the wavefronts were drawn $\lambda/4$ apart. The illumination (field intensity), was then plotted by evaluating the magnitudes of envelope maxima, which are proportional to $E$.²

**Final Result**—In conducting the experimental reflector design, it was found that necessary incremental changes of the position and the shape of the reflector needed to approach the desired field were easily derived. Increasing or decreasing the separation between the horn and the reflector shifts the direction of the intensity maximum up or down without appreciably influencing the shape of the wavefronts. By increasing reflector convexity, the illumination is broadened.

A lens was designed and built to collimate the wavefronts of the final horn-reflector combination. A cross section of a lens designed from a single probe scan record is shown in Fig. 4.

The aperture field of the complete antenna system was tested for phase errors. Deviations in the order of 10 degrees were measured by vertically scanning the probe close to the lens face and observing the modulation waveforms on the oscilloscope. Lens corrections were made accordingly.

**REFERENCE**

Operating X-Band Tunnel Diodes

Impedance transformation technique allows a tunnel diode to operate at up to four times rated frequency. And an X-band diode may cost only 1/12th as much as a Q-band diode (Q band = 33 to 50 Gc).

TUNNEL DIODE oscillation above theoretical limits has recently been achieved. Using a specially designed tunnel diode waveguide transformer and mount, a 1N3219A S-band tunnel diode has produced fundamental X-band oscillations. To obtain this X-band oscillation, the microwave circuit was "designed so that the microwave impedance of the circuit matches the negative impedance of the tunnel diode at a desired operating frequency." This was accomplished by impedance transformation, with the lumped junction and package capacitance of the packaged tunnel diode transformed into the distributed parameter capacitance of the waveguide. This technique does not eliminate these parameters, but it does reduce their effect on the maximum frequency of oscillation. Also, the technique allows a redefinition of the terminals in the tunnel-diode equivalent circuit.

Employing the same principle of impedance transformation, a millimeter wave circuit has now generated Q-band (33 to 50 Gc) fundamental oscillations with an X-band (8.2 to 12.4 Gc) tunnel diode. The tunnel diode employed is a D4168D, Serial Number 1381-63, A89-3, X-band diode. Pertinent parameters for this particular diode are: $I_v = 2.00$ ma, $C_j = 0.6$ pf, $R_s = 2.1$ ohms, $R_n = 69$ ohms, $f_{osc} = 11.3$ Gc, and $f_{ero} = 21.74$ Gc.

Tunnel diodes for Q-band are commercially available but most of them are permanently mounted in a waveguide and are not interchangeable. Also, such a tunnel diode-waveguide system is 12 times more expensive than the X-band tunnel diode utilized in this investigation. The size, weight and power consumption advantages of the tunnel diode as compared to the klystron at millimeter frequencies are self-evident.

Diode Mount—The tunnel diode waveguide mount is shown in Fig. 1 and a cross-section is shown in Fig. 2. The mount uses the impedance transformation technique of a tapered waveguide section and was designed specifically for a packaged, commercially available tunnel diode. The diode is mounted in the center of the waveguide with a spring-loaded pressure contact. Retaining disk and the waveguide are fastened together with nonconducting bolts. When necessary, these sections are also insulated from one another with an acrylic insulating material.

Resistive films are specially designed to bias the tunnel diode, to display volt-ampere characteristics, and most important, to suppress low-frequency parasitic oscillation. As shown in Fig. 3, the resistive films are separated by a brass disk. The d-c power

OUTSMARTING TUNNEL DIODES

In the June 1, 1962 issue of Electronics, Professor Ishii and C. C. Hoffins presented results of their work on extending the frequency of oscillation of an S-band tunnel diode up to X-band. Now the same basic principles with some new refinements are used to push an X-band diode up to Q-band frequencies. Much cheaper diode cost is the reason for using the lower frequency unit to get the higher frequency output.
supply, whose output is placed across $R_1$, has an output impedance of one ohm. Consequently, $R_1$ must be approximately one ohm to insure that disturbances within the power supply are not propagated to the tunnel diode circuit. This tends to isolate the power supply from the tunnel diode circuit. The volt-ampere characteristic is monitored on an oscilloscope, placing the voltage across the diode on the horizontal, and the voltage across $R_2$, which is proportional to the current through the diode, on the vertical. Total resistance of $R_1$ in series with $R_2$ is 11.6 ohms.

**Film Resistors**—The film bias resistors must be so constructed that current paths are through the films rather than around them. Current flow must be straight through conduction current as opposed to radial current. Also, the conductivity per unit area per film resistor must be extremely uniform to eliminate current bunching within the film. Satisfactory resistors tend to maintain uniform field distribution within the waveguide circuit.

Film resistor $R_1$ consists of an extremely porous paper base coated with a homogeneous mixture of number ten motor graphite and silver conducting paint. Resistor $R_2$ is painted directly on the waveguide retaining disk, thereby reducing contact resistance at this point, and consists of a homogeneous mixture of Q-dope polystyrene and number ten motor graphite. Both resistors were baked at 125 C for 45 minutes, then placed in the waveguide circuit; the waveguide retaining disk was then bolted to the waveguide. The resistors were cured this way for two weeks. At the end of this aging period, the films appear uniform and constant in conductivity.

Oscillation of the D4168D tunnel diode in the circuit was detected by a large kink, Fig. 4, in the negative resistance region. Shape and magnitude of this kink is a function of how tightly the retaining disc and the waveguide are bolted together. Correspondingly, since the amount of pressure applied varied the value of the bias resistors, the magnitude of the film bias resistors affects circuit operation. As the pressure is varied oscillation can be completely suppressed.

**Frequency**—With the pressure set to obtain the large kink, oscillation was detected with a RWT receiver having a range from 2 to 75 Gc. Fundamental oscillation was detected and verified with both the receiver and a calibrated shorting plunger at 42.29 Gc for a bias of 155 mv. Oscillation frequency is essentially a linear function of bias voltage, ranging from 42.39 Gc at 130 mv to 42.14 Gc at 200 mv, giving a 250 Mc tuning range with bias voltage. The oscillation is easily reproducible and is stable with time and variations in load. Output power is a function of load, bias voltage and the magnitude of the film bias resistors. Maximum power output was —70 dbm at 42.34 Gc and bias of 160 mv. Oscilloscope display of the RWT receiver output due to the tunnel diode oscillating at 42.29 Gc is shown in Fig. 4.

Exhaustive experiments were conducted to verify that the observed oscillation was a fundamental and not a harmonic.

Unpackaged, laboratory made tunnel diodes, mounted in waveguide structures, have been operated at 100 Gc. Such diodes are not commercially available but packaged tunnel diodes, designed for operation up to 30 Gc, are commercially available upon special request.

The authors thank J. E. Billo, J. A. Stefancin, S. Krupnik, Jr. and C. C. Hoffins for their assistance in this investigation. This research is supported in part by a University Committee on Research grant.

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HOW TO DESIGN **Arbitrary-Length**

**BINARY COUNTERS**

Simple set of design rules for building binary counters for any length sequence saves time and eliminates trial-and-error procedures


**INSIDE THE COUNTER**

The variable-modulus counter, shown in the photo, is made up of integrated circuits, fabricated within monolithic silicon substrates by planar techniques. The circuits are designed for applications in high-speed low-power computer systems.

**IN NEARLY EVERY** system designed, the need arises over and over again for counters to count to some arbitrary length sequence. By trial and error, one can eventually find a logic design that will do the job, but trial and error seldom produces a minimum package count. Here is a set of rules that will consistently produce a design for a counter of any length sequence with a minimum number of packages, and in which the required fan-in and fan-out of the gates used are minimized. Also, in applications where the

**TABLE 1**

<table>
<thead>
<tr>
<th>D</th>
<th>C</th>
<th>B</th>
<th>A</th>
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VARIABLE MODULUS counter, designed for and using integrated circuit modules, shown packaged in modified TO-5 cans.
counter designed according to these rules must merely count repetitively rather than start at a predetermined state, no "clear" signal is necessary. After a short count through some of the out-of-sequence states, the counter will automatically go into the desired sequence.

**Operation**—Consider first a simple binary ripple counter as shown in Fig. 1A.

The flip-flops trigger on the negative-going edge of the clock input signal if one logic input is down. If the first flip-flop of the counting chain above is in the ZERO state, the ONE output is low, and therefore, the set input is low. When the input line goes down, the flip-flop goes to the ONE state, with its ONE output high, and the ZERO output (and, therefore, reset input) low. On the falling edge of the next clock pulse the flip-flop returns to the ONE state; thus, the first flip-flop changes state on the falling edge of every input pulse. In similar fashion the second flip-flop changes state every time the ONE output of the first flip-flop falls, and similarly for succeeding stages. Thus it can be seen that the network counts the input pulses in binary. If a continuous train of pulses is applied to the input, the counter will cycle through all of its possible states, return to its initial state and cycle through the same states repetitively. Since the number of possible states is a power of two, the length of the counting sequence is also a power of two. Specifically, if the number of flip-flops is \( n \), the length of the sequence is \( 2^n \), which, for the counter shown, is 16. Now consider how to get sequences of other lengths.

**Modifications**—To understand the design procedure, consider the count sequence in the table for a simple four-stage binary counter. There are a total of 16 possible states in the table, and therefore, the counter will count a sequence of length 16. If means are provided to prevent the counter from reaching some of the possible states, then the length of the sequence can be limited to any desired number \( (L) \) less than 16. A commonly accepted practice is to force the counter to go from the state representing \( L-1 \) back to the beginning of its normal sequence (all zeros) on the \( L \)th clock pulse. This is usually accomplished with a configuration of gates that causes the counter to reset automatically on the \( L \)th pulse. This technique, however, may frequently require an uneconomical number of gates. In the following example, it will be shown that with a minimum number of gates, one can force a counter from \( L-1 \) through its normal final count (all ones) and back to all zeros, in the duration of the \( L \)th clock period.

Assume the 16-counter shown above is to count a sequence of length 9. Note from the table that on the eighth count \((L-1)\) flip-flops \( A, B \) and \( C \) are zeros, and \( D \) is ONE. The objective is to return the counter to all zeros by the end of the ninth clock pulse. If one connects, as inputs to a NAND gate, the clock pulse and the ONE side of flip-flop \( D \), the output of this gate will go down only when both of these inputs are high. Connect the output of this gate to the set inputs of flip-flops \( A, B \) and \( C \) as shown in Fig. 1B. Now consider the timing diagram for this counter, Fig. 1C. On the falling edge of the eighth clock pulse, the counter goes to \( 1000 \) with flip-flop \( D \) up. On the rising edge of the ninth clock pulse, the gate output goes down, and the counter goes to all zeros. Thus, the cycle from state 8 through 15 and back to zero is completed during one clock time, and the counter has made nine counts.

It should be noted that, in the practical implementation of this
technique, the propagation delay through the feedback gate should be compensated for to assure reliable operation. This is readily done by inserting an identical gate in the clock line. Since the gate will invert its input signal, the input to this gate and to the feedback gate must be complementary. Relative timing of In and In′ is not critical, the only requirement being that In′ go down no later than In goes up.

Note also, in the example given, that it is not necessary to use the entire configuration for state 8 as a feedback or reset signal, as is commonly the case. Fan-in and fan-out requirements for the feedback gate are minimized, because only those flip-flops that are ones for the L-1 state are connected to gate inputs, and the gate fans out only to those flip-flops that are zeros for state L-1.

**Design Rules**—The example and observations above can be generalized into the following set of design rules:

1. Determine desired length of sequence. Call this \( L \).
2. If \( L \) is a power of 2—as 4, 8, 16, etc.—merely construct a binary ripple counter according to instruction 4, with \( L = N \).
3. If \( L \) is not a power of 2, find the next higher power of 2. Call this \( N \).
4. Find \( \log_2 N \). This is the number of flip-flops required in the ripple counting chain. Construct this counter.
5. Determine the binary equivalent of \( L-1 \).
6. Connect, as an input to a NAND gate, the one side of all flip-flops that will be ones when the counter reaches \( L-1 \). Include as an additional input the inverse of the counter input.
7. Connect the gate output to the d-c set input of all flip-flops which are zeros at \( L-1 \).

**Example**—Construct counter to count a sequence of length 19.

1. \( L = 19 \).
2. \( L \neq 2 \), a power of \( 2 \).
3. Next larger power of \( 2, N = 32 \).
4. \( \log_2 32 = 5 \ldots 5 \) flip-flops required.
5. \( L - 1 = (18)_2 = 10010 \).

Construct the counter as shown in Fig. 1D. The added gate, previously discussed, compensates for the delay of the feedback gate. Actually, for those counter configurations that do not require feedback to the first stage, the delay problem does not exist, and this added gate may be eliminated.

**Limitations**—As with counters of other designs, consideration must always be given to limitations on counting rate. The maximum rate at which the counters described here can count is a function of the length of the sequence. In the worst case, a signal must propagate through the length of the counter, back through the feedback gate and through the first flip-flop again before the next input pulse arrives. In cases where this propagation time must be decreased, consideration should be given to breaking the counter into a number of smaller counters running in parallel with their outputs gated together. The sequence length is then the product of the sequence lengths of the individual counters, and the maximum propagation time is that of the largest individual sequence length plus the delay associated with the required gating at the output. In designing such counters, care should be taken to avoid the occurrence of common factors in the sequence lengths of any of the individual counters used. Where common factors occur, the sequence length will be the product of the individual sequence lengths divided by the common factor. Thus, an 18 and a 6 counter operated in parallel and gated together will count 18 and not 108.

It should be apparent from the discussion that counters designed in accordance with the rules specified will automatically come into the desired sequence no matter what their state when power is first applied. If it is necessary to have the counter start at all zeros when power is applied, an initial clear signal should be applied to all the d-c reset inputs. Provided that this signal is longer than the maximum possible carry propagation, the counter will be forced to the clear state.

The rules and observations presented here were checked empirically on an experimental variable-modulus counter in which the sequence length can be changed conveniently on a patch panel (Fig. 2). This counter can be made to count up to any number from 2 to 32, by connecting the feedback gate inputs and outputs in accordance with the table in Fig. 2, which conforms to the rules previously discussed.
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Synchronized sweep ....................................................7 v min.
Synchronized pulse ...................................................3 v pos; 9 v neg
Carrier acceptance ........50-10,000 cps (ext); 1 watt, 26 v/115 v terminals provided
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Ultra-Mate gets its go/no-go reliability from the female half's hard faced, closed entry receptacle. Ultra-Mate is the only truly environmental, space age connector that combines a hard dielectric with front servicing. Any stubby-fingered technician can assemble or disassemble an Ultra-Mate connector in mere seconds.

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Take a close look at the female Ultra-Mate. You'll see 55 funnel-shaped openings, one for each contact. These hard-dielectric entryways guide contact-pins smoothly into their sockets. Like Figure 1 at the right. If pins are bent out of line, the connector halves just won't mate.

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For the first time, an environmental connector combines tamper-proof safety and service features with MIL-C-26500 performance. Ultra-Mate also meets the requirements of MIL-C-38300, a recently issued Air Force specification that retains the rigid environmental and temperature standards of MIL-C-26500, but specifies either a hard closed-entry or soft dielectric. It also employs, as does MIL-C-26500, front removal of contacts and incorporates new reliability requirements never included in connector specifications to date.

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6. Insulation resistance exceeds 5,000 megohms.
7. Unaffected by exposure to hydraulic fluid, lubricating oil, ozone, and moisture.

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You can specify Ultra-Mate connectors now in all basic sizes referenced in MIL-C-26500. Bayonet or threaded couplings. Any Amphenol Sales Engineer can give you the complete specs and engineering data. Or, write to: Dick Hall, Vice-President, Marketing, Amphenol, 1830 S. 54th Avenue, Chicago 50, Illinois.

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"Electronic" Hospital Opens

Experimental hospital's twin will be used at New York World's Fair

MONTGOMERY, ALA.—Business and medical men here are backing a new concept in hospital design, one aimed at lowering the cost of medical care. Hospital bedrooms are built around a core containing electronic patient-monitoring and data-handling consoles.

The first Atomedic Research Center was opened here last month with an assist from electronics firms who loaned or donated much of the equipment.

Atomedic's director, Dr. Hugh C. MacGuire, hopes the experimental hospital will step up world-wide use of modern medical technology. A twin of the 22-bed hospital in the round is scheduled to serve the New York World's Fair in March.

Monitoring—For electrocardiogram monitoring, miniature transducers and an 87-Mc f-m transmitter are taped to the patient. Signals are picked up by a monopole antenna in the bedroom ceiling and go by coaxial cable to one of 22 receivers at the central console. The ekg waveform is displayed on a Tektronix 565 oscilloscope. An abnormal heartbeat triggers an alarm lamp and buzzer. Aero Geo Astro, which designed the equipment, says the system can be expanded to handle other physiological parameters, such as temperature and respiration, by adding modules and multiplexing the transducer signals.

Computer—A Control Data 160 computer scans data inputs and activates the alarms when readings exceed preset limits or change from past readings. It can scan 80 analog and 36 closure inputs at rates of 100 and 1,000 points a second. Data is converted to digital form and displayed or recorded on demand. This system, when expanded, will also record ambient hospital conditions and handle clerical data and information retrieval.

Closed-Circuit Tv—This system lets nurses watch four beds at once from the central console. Low-light-level, automatic cameras made by Packard Bell are installed in each room. Miratel supplied the monitors.

Southern Bell's communications system provides for outside phone calls and also acts as an intercom system. Data-Phone transmission units can be plugged in to transmit medical data to a larger parent facility in the future.

CUTAWAY VIEW shows arrangement of rooms around monitoring consoles
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ADDRESS DEPT. E-12

WEATHER STATION that automatically translates and prints out radiosonde data as it is received has been demonstrated by NASA's Marshall Space Flight Center at Huntsville, Ala.

The radiosonde automatic data-processing system was designed by Friez division of Bendix to work with the Rawin set AN/GMD-2 (or upgraded AN/GMD-1) and modified radiosonde AN/AMO-9 or AN/DMQ-9. Every five seconds, it will print out a card giving temperature, humidity, slant range, azimuth and elevation angles of the weather balloon, and the time the card is prepared.

Data Handling—Angle and range data are converted from the synchro signal outputs of the GMD-2 to bcd (binary coded decimal) form with servo-driven shaft-to-digital encoders. Data are then put into 10-line decimal form and stored by transistor-controlled relay matrices for simultaneous, automatic readout on commands from the timer.

The AMQ-9 transmits meteorological signals at 1,680 Mc to the GMD-2 receiver. The GMD-2's a-f signals go to the converter-detector chassis and are converted to d-c voltages for level detection and fur-
Is Automated

Data is read out of system on IBM cards at rates of 6 or 12 cards a minute. A 1620 computer then processes data.

Equipment Modifications—In the Huntsville system, a control recorder and an AN/TMQ-5 radiosonde recorder normally provide manual backup. The control recorder also provides antenna slewing, receiver tuning and power distribution by remote control.

Two AN/GMD-Ib Rawin sets were modified to slant-range measuring capability in meters. AN/AMO-9 radiosondes with new commutators provided short duration reference identifiers preceding humidity and temperature segments to facilitate decommutation. The equipment cost $72,000 to build using commercially available parts.

Bendix Friez recently developed a distance indicator to correct for ambiguous slant-range measurements resulting from signal loss. The company expects to use this feature in future versions of the system.

Lacing tape might represent as little as 1/100,000th part of the total cost for producing a standard electronic unit. The labor cost for tying the harness with this tape could be as much as 500 times greater than the material cost. Where then, can the economy of saving a few cents on wire lacing be profitable? Of much more worth is the confident knowledge that in specifying Gudebrod Flat Braided Lacing Tapes you are providing the very best for your wire harness lacing work.

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For samples, for further information, for the Technical Data Book, get in touch with your local Gudebrod representative, or write to the Electronics Division.

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Lensless Optical System Uses Laser

Opaque 3-D objects may be imaged without lenses using reflected light

By LEON H. DULBERGER
Associate Editor
CHARLES WIXOM
McGraw-Hill World News

CLEAR PHOTOGRAPHS are being produced without use of lenses in a new optical technique developed at the University of Michigan. The new system may have extensive effects on photographic technology. Though it has not been demonstrated at x-ray wavelengths, the lensless technique may afford sharp images, rather than the shadowgraph images now available for x-ray systems.

The work was carried out at the University's Institute of Science and Technology, by Emmett N. Leith and Juris Upatnieks. The research engineers use a two-step process, requiring spatially coherent and monochromatic light. The experiments are readily carried out with a helium-neon gas laser. A mercury arc lamp and an interferometer may also be used, with longer exposure.

Using a transparency as the object to be reproduced, light from the laser is passed through the transparency onto a film contained in a camera-like device (see photo). At the same time, a portion of the laser light is passed through a prism, set at an angle to direct it onto the film, superimposing it on the Fresnel diffraction pattern produced by the light passing through the transparency. The second beam, termed a reference beam, provides phase information by producing a fringe pattern superimposed on the diffraction pattern. Thus a hologram recording is produced with phase information for later reconstruction. The fringe pattern is both amplitude and phase modulated by the Fresnel diffraction pattern; the film acts as a square-law modulating device.

In the second step of the process, collimated monochromatic light from the laser is directed through the hologram, using a projector-like device. The hologram acts as a diffraction grating, which produces a real image at a displaced position, a distance from the hologram. A photograph of this reconstructed image produces a high-quality picture of the original transparency, without the use of lenses. The reconstructed image has the same contrast as the original, and is positive if the transparency is positive.

Laser Application—Gas lasers rated at 1 to 5 mw were used. Operating wavelength is 6328 A. Pulsed lasers should also work, and might have advantages when short exposure times are desired. The type of spatial coherence required of the light source is such that the phase at one point in space be time-invariant with respect to the phase at another point in space. However, the point-by-point variation of this phase can be a completely random function. Thus the laser light may be passed through a frosted glass to diffuse the light, and the two-step process can still be carried out. Monochromaticity must be provided.

According to Emmett Leith, commercial uses may be hastened as the process is extended to shorter wavelengths—regions of the spectrum where good lenses are not available, as u-v, ir and x-ray. Leith points out that it is possible to record opaque three-dimensional objects using reflected light, and that this has been done. The image reconstructed from the hologram can be photographed, completing the second step. In addition it is possible to view the reconstructed image directly by placing the eye so as to intercept the light emerging from the hologram. A three-dimensional projection is formed, having the effect of stereo projection, though only one hologram is used.

An important beginning to this work was made by D. Gabor, who published a paper on a two-step imaging process in 1949. It did not, however, permit reproduction of continuous-tone transparencies.
Kepco voltage/current regulated power supplies in the KS series now come equipped with voltage/current mode indicators called "VIX". Time saving and added utility are provided by these indicators which show at a glance whether the power supply is in its voltage regulating mode or its current regulating mode. This indication is especially useful in the Kepco KS Models since they have extremely sharp cross-over characteristics.

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OPPORTUNITIES IN MELPAR'S RAPIDLY EXPANDING ELECTRONICS DIVISION

Melpar's Electronics Division has an immediate need for Engineers to fill these important positions:

MICROWAVE RECEIVER DESIGN
Specific problems include parametric amplifiers, varactor techniques, microwave filters, ultra-stable programmable oscillators, and dual and triple channel balanced receivers for monopulse and guard antenna gating.

DATA PROCESSING SYSTEMS DESIGN
Perform the logic design of digital equipment to process real time flight data. Problems include specifying necessary digital/analog interface equipment and the design of computer systems for a variety of applications.

COMPUTER PROGRAMMING
Generate programs for fixed point real time computers to be used with special purpose digital and analog equipment.

COMMUNICATIONS
Perform design studies of terminal equipment for time frequency dodging, matched filters, adaptive highly reliable communications throughout the electromagnetic spectrum. Techniques of interest include spread spectrum circuitry, error detection and correction coding, and privacy and security circuitry.

For Further Details, write in confidence to:
John A. Haverfield
Manager - Professional Placement

MELPAR INC.
(A Subsidiary of Westinghouse Air Brake Co.)
3436 ARLINGTON BLVD.
FALLS CHURCH, VA.
(A Suburb of Washington, D.C.)

COMPONENTS AND MATERIALS

Miniature Closed-Cycle Cooler Produces 25°K Reliably

Valveless unit cascaded for lower temperatures for space systems

By C. R. WHETSTONE
Assistant Editor

HIGH BRIDGE, N. J.—Cryogenic temperatures on the order of 25°K are produced by a miniature in-line cooler no larger than a football. Working on a modified Stirling cycle, the closed-cycle system has a cooling capacity of 12 watts at 77°K—the temperature of liquid nitrogen—with a rotary input of 100-watts.

Some of the applications for the Cryomite—developed by Malaker Laboratories—include continuous cooling of infrared devices, temperature-sensitive semiconductor devices antennas and parametric amplifiers; reliquefaction and refrigeration of gases; cooling of densely packed electronic units for space applications; and spot cryogenic cooling of airborne or satellite components.

The Cryomite can mount infrared sensors or other devices directly on the cold head. It has also been designed into systems that previously used liquid nitrogen from a supply dewar.

Cooling Methods—There are five basic methods for cryogenic cooling: 1) cascaded evaporation systems; 2) systems based on Joule-Thompson cooling; 3) isentropic expansion systems, such as the Claude system, using reciprocating expansion engines or turbo expanders; 4) the Taconis system, using displacement expanders; and 5) modified Stirling cycle systems.

Careful evaluation of the various methods disclosed problems that would be encountered in miniaturization. For example, lack of reliable, miniature, block-free expansion valves make it difficult to utilize cascaded evaporation, Joule-Thompson, or Claude systems. The major drawback of the Taconis system is that a source of pressurized gas or an external compressor is required for operation.

Stirling Cycle—the modified Stirling-cycle engine picked by Malaker Laboratories, has a simple construction, partly because no valves are used. Since it is a closed-cycle system, there is no problem of contamination. The system is self-contained, and requires no external gas.
supply. No constrictive passages for gas flow exist, so blockage problems are avoided. The refrigeration temperature can be adjusted to the desired value by control of the motor speed. The engine can readily be made in a variety of sizes, based on a single design.

The fundamental requirements for a Stirling-cycle refrigerating engine are: to have a compression volume, $V_c$, at the higher temperature, $T_c$; an expansion volume $V_e$, at the lower temperature, $T_e$; and to allow a fixed quantity of gas to pass alternately from one volume to the other via a regenerator—thus no valves are used (see fig.). In order to maintain a refrigerating effect, the movements of the pistons in the two volumes must be out of phase, such that the expansion volume leads with respect to the compression volume. The necessary steps in the functioning of a refrigerating engine operating on an idealized Stirling cycle are shown in the figure.

| A | ISOTHERMAL COMPRESSION
HEAT EJECTED
| REGENERATOR
| COMpressor | Expander |
|-----|-----------------|-----|

| B | CONSTANT VOLUME GAS TRANSFER
HOT COLD
| HOT COLD |

| C | ISOTHERMAL EXPANSION
HOT COLD
| HEAT ABSORBED |

| D | CONSTANT VOLUME GAS TRANSFER
HOT COLD

MODIFIED STIRLING cycle—basic system used in unit to obtain cryogenic temperatures efficiently

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electronics December 27, 1963
PRODUCTION TECHNIQUES

Programmed Machine Cuts Cost of Plastic Parts

WORKPIECE is drilled by machine controlled with punched paper tape. Self-contained tape puncher is programmed by the operator.

Cost is less in short runs than molding or conventional drilling.

By BEN E. SHERESHAW
Chief Engineer
Dun-Rite Manufacturing, Inc.
East Rutherford, N. J.

INCREASED use of plastics in electronic equipment in small quantities is posing a tough production problem for the electronics industry: how to hold down production costs and lead time on short-run, high-precision plastic parts. A practical answer is a low-cost numerically controlled milling machine.

Example—A small order from ITT Federal Laboratories, Nutley, N. J. is an example of the savings in both lead time and money with low-cost numerically controlled systems.

This order called for 30 Rexalite 1422 discs (Rexalite 1422 is a translucent, thermosetting, styrene-based copolymer with a low dielectric constant). These discs were to have a diameter of 4.76 in. and be 0.291 in. thick, and have 267 holes drilled at intervals of 5.45 deg in concentric circles positioned to an accuracy of 1 mil.

Alternate Methods—Injection molding, the most common production technique for high-volume, low-precision plastic parts, was quickly rejected because shrinkage of the material inside the mold during cooling moves the closely spaced holes out of tolerance. The mold costs $2,500 with six to eight weeks required for fabrication.

Rotary indexing devices essential for conventional drilling introduce large margins and many drilling er-
rors. An automatic indexing device would help but costs $2,500.

The most practical solution to precision short runs such as this is obviously numerical control. With this technique a Bridgeport milling machine is driven by a numerical control console made by Hydra-Point division of Moog Servo Controls, Inc., Depew, N. Y. It is equipped with a self-contained Hydra-Point automatic tape punch.

Coordinate locations for the holes are punched into the tape that moves the drilling spindle of the milling machine. To maintain a high degree of accuracy, drill chucks are changed manually on signal from the programmed tape. To avoid error, an indicator points out the specific chuck required. Once the first work piece is checked out against the program sheet there is no longer any possibility of error.

Six hours was devoted to programming followed by tape punching at the numerically controlled machine. The first part, made during the punching of the tape, was checked: four errors were found. It took a total of two hours to find and correct the errors (all four were human errors made during programming).

The 30 pieces were run off one at a time under tape control taking 130 minutes each. No further inspection was needed.

The complete job, from receipt of the customer’s order, including procurement of materials, took 30 days and was accomplished during regular working hours.

Discover new reliability in molded variable coils. Eliminate the “weak link” in your system. Most variable coils (and transformers) are designed and built today exactly as they were 10 years ago. With the Delevan Molded “Variable,” the state-of-the-art for variables is advanced to equality with all other reliable components. Available with either powdered iron or ferrite cores, each coil is designed for minimum capacity and optimum Q. Delevan is proud of this achievement in high-reliability programming.

**SPECIFICATIONS:**

**SERIES 4000 MOLDED VARIABLE COILS**

- Size: 0.40” Diameter; 0.93” Molded Length
- Mounting: Chassis or Printed Circuit
- Inductance: .18 uh to 70,000 uh
- Environment: Grade 1, Class B, MIL-C-15305

Delevan Electronics Corporation
A SUBSIDIARY OF AMERICAN PRECISION INDUSTRIES INC.
270 QUAKER ROAD
EAST AURORA NEW YORK 14052

HERE ARE 2 NEW COIL ENGINEERING KITS THAT EQUIP YOU WITH THE RIGHT COIL FOR ANY DESIGN APPLICATION.

KIT No. 1 supplies 15 Series 4000 molded variable coils.
KIT No. 2 provides components to design your own variable coils.

Write for further information on these engineering kits today.
**NEW PRODUCTS**

**Instrument Displays Q Digitally**

Device eliminates constant oscillator retuning

**TYPE 71A** digital Q meter displays measurement information in digital form in the Q range between 0 and 999. Complete measurements can be performed in a fraction of a second, even by unskilled personnel. The instrument’s inherent digital design eliminates the necessity for retuning the Q meter for each inductor being tested.

Unit can also be used for go/no-go testing. Preset switches permit Q-limit selection throughout the full range of the instrument. Panel lamps indicate the over- or under-limit status of each measurement.

Type 71A is intended for testing the characteristics of components such as toroids, filters and i-f transformers. It is readily adapted to automated production setups and digital or analog recording of measurements.

**Frequency range of the device is 10 kc to 1 Mc. Test voltages are selectable in ten steps from 10 mv to 10 v. Inductance range is 10 µh to 1 h. Accuracy is 2% or 1 digit of Q, depending upon which is greater. Type 71A is priced at $2,190. J- Omega Co., 2278 Mora Way, Mountain View, Calif. CIRCLE 301, READER SERVICE CARD**

**Tiny Zener Diodes Have Low Impedance**

**Micro Zener** diodes are 750 mw units featuring sharp zener breakdowns, low impedance and leakage and low zener noise voltage. Voltage ranges from 6.8 v to 47 v. Units will meet specifications for MIL-S-19500 and can be supplied with specific burn-in, environmental and device specification reliability test data for individual units or lots.

Size is 0.150 inch × 0.060 inch with 0.5-inch minimum gold-plated silver leads that are 0.046-inch × 0.006-inch thick. Price ranges between $4.32 and $5.63 per unit in quantities of 100. MicroSemiconductor Corp., 11250 Playa Court, Culver City, Calif. (302)

**F-M Transmitter for Telemetry Band**

A NEW f-m telemetry transmitter for operation in the 216 to 260-Mc telemetry band and featuring all solid-state construction has been developed. Model 3116 also features completely separate power supply ground, case ground and modulation input return. Missile instrumentation system using the 3116 will not have the ground loop prob-
lems of other off-the-shelf transmitters not having separate grounds. Designed with built-in protection against transients and short circuits, the transmitter's circuitry provides a 4-w minimum power output at high efficiency for a wide input voltage range and extremes of temperature. Unit accommodates any signal having components between 30 cps and 200 kc, and differential input allows complete freedom in system input circuitry design and shielding arrangement. Radiation Inc., Melbourne, Fla. (303)

Shrinkable Tube Is Flame Resistant

SHRINKABLE tubing of modified Teflon FEP that shrinks instantly at 300 F and lower to permit inserted objects to have a surface of Teflon with a continuous service temperature of 400 F is now available. The shrinking process does not affect the electrical, mechanical and chemical properties of the modified Teflon FEP: good dielectric strength (500 to 1,000 v/mil); low dielectric constant (2.0) and dissipation factor (0.002); no change of electrical properties with temperature (−25 C to +250 C) or frequency (60 cps to 100 Mc); zero moisture absorption; unaffected by any commercial chemical. Penntube II-SMT is available in natural color and lightweight wall thickness. Pennsylvania Fluorocarbon Co., Inc., Clifton Heights, Pa. (304)

Push-Pull Tetrode Heats Instantly

INSTANT-HEATING, push-pull tetrode—the 8118—is intended for use as an r-f amplifier, driver or frequency multiplier at frequencies up to 500 Mc. In typical Class C operation as an r-f amplifier, it can deliver over 21 w of useful power to the load at 470 Mc with as little as 3 w drive power. Plate dissipation rating is 2 × 10 w under CCS conditions. Input capacitance is 4.5 pf, while output capacitance is 1.8 pf. Tube
GLOW DISCHARGE INDICATOR TUBE FOR SMALL SIGNALS (TYPE TG121A)

"Brand: Digitube"

The DIGITUBE TG121A is a display indicator specifically designed for transistorized equipment, with important advantages over neon indicators and miniature incandescent lamps. It can be switched on and off by an input signal of a few volts, and thus operated directly by transistor output voltage without amplification. Since it is a cold cathode device there is no heating problem, even when many are used. This, coupled with small size (length 18mm, diameter 8mm), makes it ideal for miniaturized equipment. Characteristics are stable and life is practically limitless. Studies have shown that it does not in any way affect the transient characteristics of a logic circuit and no circuit compensation is required. (See IRE Transactions, PGED, Vol. ED-9 No. 3, May 1962.) For details contact our nearest representative.
LITERATURE OF THE WEEK

COMPUTER SYSTEMS Radio Corp. of America, Camden 2, N.J., offers a brochure containing 11 technical papers on computer systems. (360)

DYNAMIC ANALYZER TUNER Spectral Dynamics Corp. of San Diego, P. O. Box 671, San Diego, Calif., 92112. Description and specifications of a new dynamic analyzer tuner are presented in a four-page bulletin. (361)

PRECISION POTentiometers Markite Corp., 155 Waverly Place, New York 10014, Six standard sizes of thinner, lower-cost Slimline infinite resolution conductive plastic precision pots are described in bulletin SL. (362)

INDUSTRIAL INSTRUMENTS Texas Instruments Inc., P. O. Box 66027, Houston, Texas 77017. Short form catalog covers a line of recording, testing, digitizing and sensing instruments. (363)

MAGNET MATERIAL Indiana General Corp., Valparaiso, Ind. Data bulletin 350A discusses a new improved Alnico V-7 magnet material. (364)

CONDUCTIVE EPOXY Adhesives Chomerics, Inc., 380 South St., Plainville, Mass. Booklet describes the nature of electrically conductive epoxy adhesives, cements and solders—and factors of primary importance in their selection and application. (365)


CONNECTORS The Pyle-National Co., 1334 N. Kostner Ave., Chicago 51, Ill. Bulletin 674 is a 12-page reference-guide to a line of environmental-resistant plugs and receptacles used primarily in electronic and aerospace industries. (367)

TOGGLE SWITCH Micro Switch, a division of Honeywell, Freeport, Ill. Data sheet 211 describes the 7ET-T, a 3-position magnetic hold-in toggle switch. (368)

VIBRATION MEASURING INSTRUMENTS MB Electronics, P. O. Box 1825, New Haven, Conn. 06508. An 8-page booklet describes a full line of vibration measuring instruments. (369)


B-W OSCILLATOR Stewart Engineering Co., 467 Beach Creek Road, Santa Cruz, Calif. Technical bulletin describes the SE-303 miniature X-band backward-wave oscillator. (372)

NEW! HIGH SENSITIVITY

GENERAL PURPOSE 247A

The type 247-A oscilloscope fully qualifies as a universal instrument because its performances and the size (13 cm (5") dia) of its C.R. Tube authorize accurate measurements and tests in all fields of low-frequency instrumentation. Also, because of its simplicity of operation, the 247-A is ideally suited for practical laboratory work of an educational nature.

TECHNICAL SPECIFICATIONS

Vertical amplifier
I channel: Frequency range: DC to 1 Mkc/s (3 dB)
Sensitivity: 50 mV/cm

AC: 10 c/s sine wave or 50 c/s square wave to 100 Kc/s (3 dB)
Sensitivity: 5 V/cm
Calibrated attenuator: step-adjustable from 5 mV to 20 V/cm

Sequence: 1 - 2 - 5 - 10 etc...
Attenuator vernier ratio 1/3
Constant input impedance: 1 M ohm 47 pF

Sweep
Free-running - triggered: single sweep
Duration: 1 cm to 0.5 µsec/cm in 20 calibrated positions

Vernier: 1: 5 ratio - x 5 magnification expanding sweep durations from 3 sec to 0.1 µsec/cm

Sync
Sweep: single sweep, HF, LF, TV-line, TV-frame
Polarity: - or - internal or external selection of triggering level

Horizontal Amplifier
Frequency range: 0 to 500 Kc/s (3 dB)

Oscilloscopes
204 A - High speed and fast rise oscilloscope
255 B - Portable oscilloscope
245 A - High performance portable oscilloscope
246 A - High sensitivity low-frequency oscilloscope
248 A - Maintenance oscilloscope.

Sweep frequency Generators
411 A - Laboratory sweep frequency generator
410 B - TV - FM sweep frequency generator
476 A - Radio sweep frequency generator

Signal Generators
405 A - Low frequency RC signal gen. (30 c/s-300 Kc/s)
428 A - HF constant amplitude signal generator (100 Kc/s-30 Mc/s)
456 - Pulse generator (5 c/s - 50 Kc/s)

TV pattern generators
485 C - Portable electronic pattern generator
494 A - Test - pattern generator

Regulated power supplies
117 A - Transistorized regulated power supply
114 A - Regulated power supply

Cameras
1000 A - oscilloscope camera with Polaroid
1001 B - oscilloscope recorder

OTHER INSTRUMENTS

RIBET-DESJARDINS

MEASURE & CONTROL DEPARTMENT, 13-17, rue Périn MONTROUGE PARIS 10 - ALESSIA 24-40
CANADIAN BRANCH : RIBET-DESJARDINS (CANADA) Room 11, 5737 Deelles Avenue - MONTREAL.
GT&E Elevates Two Executives

HERBERT F. LELLO has been named executive vice president-manufacturing of General Telephone & Electronics Corp., New York City, effective January 2. He is now president of GT&E's subsidiary, Automatic Electric Co., Northlake, Ill., where he has been active in telecommunications equipment manufacturing since 1923.

Darwin H. Deaver, executive vice president of Automatic Electric, succeeds Lello as president. He joined the firm in 1945 and was elected executive vice president last year.

Automatic Electric produces communications equipment for the independent telephone industry and also manufactures automatic control systems and devices. In addition to Automatic Electric, the domestic manufacturing subsidiaries of GT&E include Sylvania Electric Products Inc., and Lenkurt Electric Co., Inc.

Keonjian Accepts Grumman Post

EDWARD KEONJIAN has been appointed a full-time staff consultant by the Grumman Aircraft Engineering Corporation, Bethpage, N.Y. He will lead the efforts to apply microelectronics concepts to advanced systems, integrate Grumman-funded microelectronic advanced development programs and prescribe areas for incorporation of microelectronics into current weapon system programs.

Formerly, Keonjian was a staff scientist at Arma's Garden City, N.Y., Division. He continues in his posts as chairman of the EIA Advisory Committee on Microsystem Electronics and as a member of the Avionics Panel of the NATO Advisory Group for Aeronautical Research and Development.

Antenna Systems Elects Williams

ANTENNA SYSTEMS, INC., Manchester, N.H., announces that A.G. Williams has been elected to the position of vice president by the board of directors. He will continue to act as manager of ASI's Electronic Systems division in Maitland, Fla.
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Advertisements in the ELECTRONICS BUYERS' GUIDE are grouped together according to the kind of product advertised. All Power Supply advertisements, for example, will be found in the same section of the book. Thus it is made convenient for you to "shop" through the specifications presented to you by advertisers, without having to flip pages back and forth constantly. Keep your ELECTRONICS BUYERS' GUIDE close to your work area at all times.

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(Classified Advertising)

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TELEPHONES

As in previous years, the purpose of this section is to help those who have occasion to shop for such items in the Boston area. All items are for sale. No rentals or sales on consignment. For complete list write: Antique Telephone Engineering Co. Dept. 1264, Springfield, Pa.

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CIRCUIT/SYSTEMS/LOGIC

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Participate in system design of integrated automatic document handling and character recognition system.

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Information Processing System Design
Electromechanical Design

Working knowledge of optics, photoelectronics, principles of information theory and system design theory.

Salary open.

Processor and Display Devices:

For high speed analog signal processors and cathode ray display devices.

Timing circuits, oscillators and digital logic circuits as part of high speed analog and digital signal processing equipment.

To select digital modules for economical instrumentation of logic. Assist in design of wide band-width signal processing circuits.

BS-MSEE

3 or more years experience in circuitry design. Logical design and use of digital modules in complex mixed analog-digital system.

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The individual with whom we are interested in discussing the present opportunity will have a BSEE or MSEE and 3 to 5 years' experience in digital techniques with EDP hardware systems orientation.

You are invited to investigate the many advantages of being associated with a major computer manufacturer whose stability is enhanced by previously established compatible products.

Please address inquiries to: Mr. T. F. Wade, Technical Placement, The National Cash Register Company, Main & K Streets, Dayton 9, Ohio

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**SEISMOMETERS**

New transducers for communicating by seismic waves.

**SEMI CONDUCTORS**

Subasynchronous parametric amplifier for acoustic noise reduction.

**SERVICING**

Developing true stable state alternators.

**SQUELCH CIRCUITS**

Fail-safe squelch circuit adapts to changing noise levels.

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Combination of high fidelity with low cost.

**SPECTRUM ANALYZERS**

Contest produces novel circuit designs.

**SUPERCONDUCTIVITY**

Novel test techniques measure Q in organic resonant circuits.

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Chart gives RLC values for critical damping.

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Aiming a 30-ton telescope hanging from a balloon.

**TELESCOPES**

Fastening of an equatorial mount.

**TELEMETRY ALTIMETER**

Combining direct detection and dual-beam tracking.

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Home telephone made more reliable.

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For High Power Output:
- Fixed-tuned
- Gap-tuned
- Trim-tuned
- Dielectric-tuned

For Extreme Mechanical Stability:
- Fixed-tuned
- Gap-tuned
- Trim-tuned
- Dielectric-tuned

For Low Voltage Operation:
- Gap-tuned
- Trim-tuned
- Dielectric-tuned

For Wide Tuning Range:
- Gap-tuned
- Dielectric-tuned

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