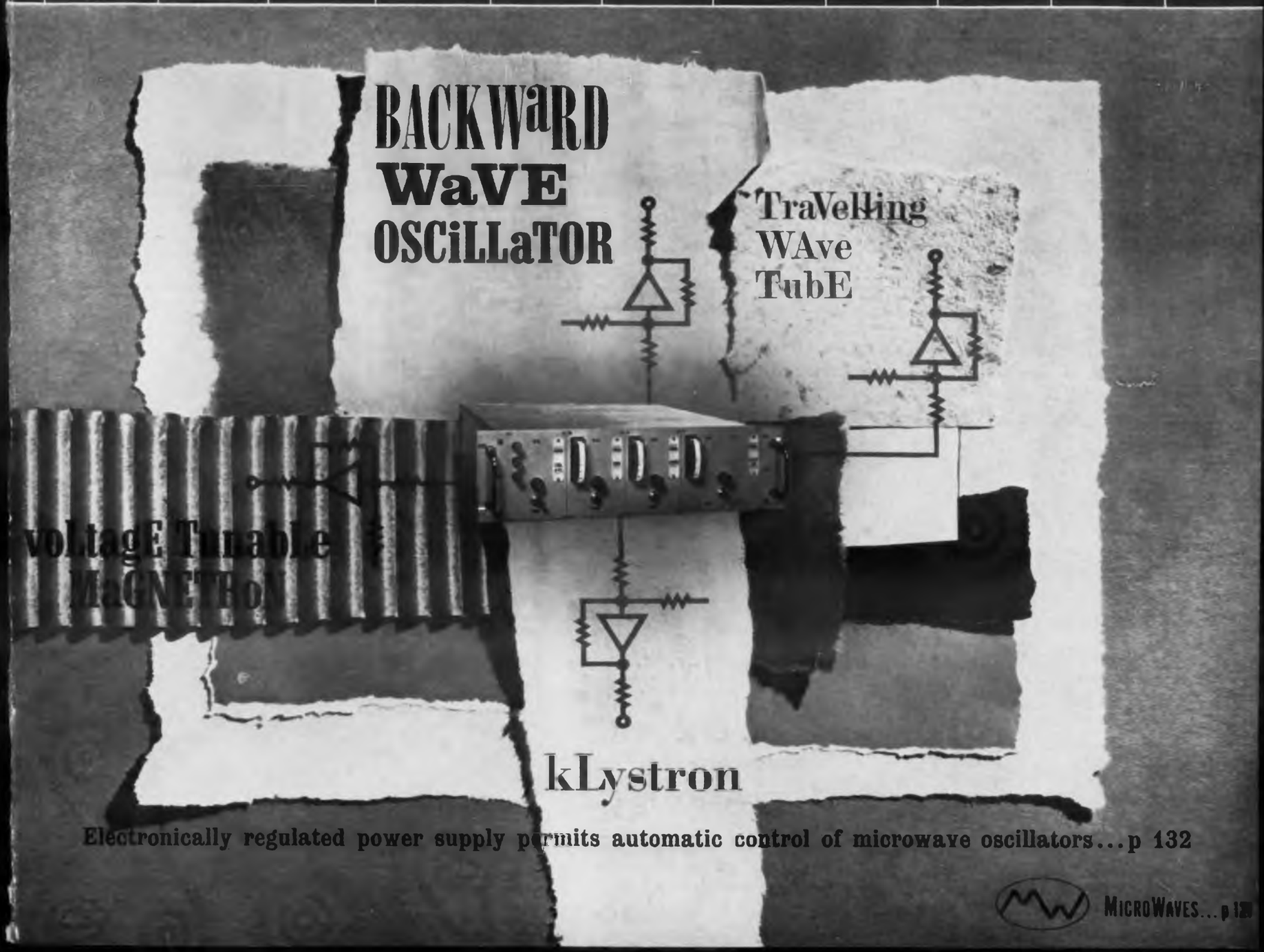
ELECTRONIC DESIGN



Electronically regulated power supply permits automatic control of microwave oscillators... p 132

MICROWAVES... p 121

COVER: A pebble from the beach . . . a rusty nail in a board . . . yesterday's newspaper. These are a few of the ingredients in the heady brew dished up by many modern artists. In their more recognizable forms, such assemblages are called collages. To some artists (and most art lovers) pasteups of scraps of printed matter, cloth and other materials suggest merely interesting texture and/or composition. To ELECTRONIC DESIGN's artist, the collage offered a graphic means of expressing a design concept. He used different-textured paper—Kraft, corrugated, chrome-coat, newsprint and wood-grained—to create a background in which four areas are dominant. These background areas and the typographical display (itself reminiscent of early collages that used random scraps of printed matter) represent the four types of equipment that can be controlled with the modular-type power supply.

Sidelights of This Issue

English as she is spoke and wrote by engineers must make lexicographers wince on occasion. It is perhaps inevitable that a precocious science like electronics should outgrow its mother tongue.

Consider, now, the formidable task of the foreigner trying to write for American engineers in their peculiar brand of English. Go a step further, and think of the added handicap for the Japanese translator, whose English often is many decades removed from space-age jargon.

It is in this vein of amused sympathy that we pass along a few thoughts culled from the report written in Japan on a new millimeter-wave klystron (see p 134):

"In the figure, we indicated the values of the factors calculated standing on the assumption."

"The value is pretty greater

than . . . "

"This leads us to the conclusion that the output was too greatly measured or the circuit efficiency was too smally obtained in our measurement circuit . . . "

"Accordingly the output of about 30 w will be possible, if so required, by improving the designing."

"We trust the above advantages will make this tube good as the oscillator in the mm-wave FM radar, FM communications etc."

". . . and then the oscillation is enabled."

An ELECTRONIC DESIGN editor tried for weeks to get details on the Japanese device from the American distributor. Each call brought the same response from the distributor's secretary: "Sorry, but he went to Japan."

Our editor had just about concluded that his man had "gone native", when the distributor returned. Japan's a nice place to visit, but . . .

Vistas Unlimited

Silicon-controlled rectifiers (see p 46) may not have the glamour of nanosecond-computer transistors, but their potential can, nevertheless, make the mind boggle.

A case in point is the frenetic competition between the two major manufacturers of automatic bowling-alley equipment for the first logic system for automatic scorekeeping. The secrecy involved in this scramble would do credit to the most advanced defense project.

The problem is, of course, attainment of a realistic reliability-to-cost ratio, and SCRs are expected to help solve it.

Beyond the automation of bowling scorekeeping lie such dreams as automated supermarkets, vending-machine systems, mail-order warehouses and traffic control.

In fact, now that inexpensive semiconductor devices with power-handling capability such as SCRs, are available, think of the many slow, unreliable and bulky electromechanical logic systems waiting to be updated and expanded. And think of the thousands of areas without the benefit of electromechanical logic.

CIRCLE 2 ON READER-SERVICE CARD ▶

CONTENTS

November 22, 1961
Vol. 9 Number 24

Electronic Design Hayden Publishing Company, Inc.
850 Third Ave., New York 22, N.Y.

Countdown on MicroWaves

The editorial offices of ELECTRONIC DESIGN soon will hum with the tension of a Cape Canaveral block house. In March, 1962, we will place a new magazine—MicroWaves—into orbit.

The launching preparations took an important step forward this week. Robert E. Ahrensdorf, publisher of MicroWaves, announced that Manfred Meisels will be managing editor of the new magazine. Manfred has been an ELECTRONIC DESIGN editor for two years, and has specialized as technical editor in charge of the MicroWaves section. He has a science degree from Purdue and is working toward his master's degree in physics at New York University. He is a member of the IRE and of the New York Business Paper Editors Association.

Manfred, together with a staff of engineer-editors now being recruited in a nation-wide search, will bring new depth and perspective to the reporting of microwave developments.

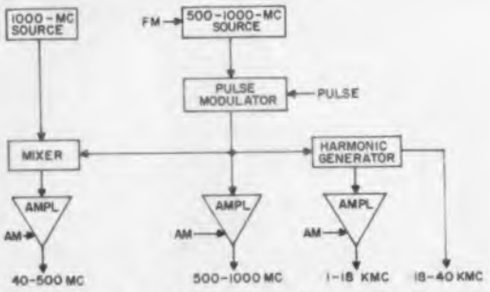
ELECTRONIC DESIGN is published biweekly by Hayden Publishing Company, Inc., 850 Third Avenue, New York 22, N. Y. T. Richard Gascoigne, Chairman of the Board; James S. Mulholland, Jr., President; Edmund C. Grainger, Jr., Secretary.

RFI Men Still Guessing On Pentagon Specs

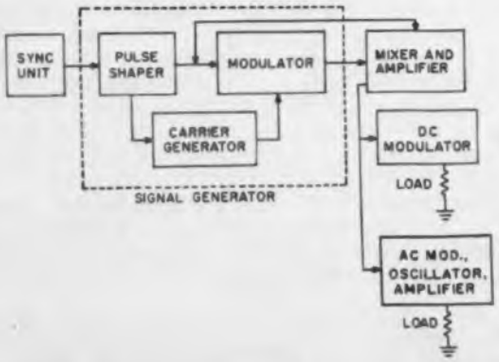
Turmoil Evident at Chicago Conference—Analysis Center Begins To Chart Data Base—Companies Rush to Develop Instruments

Alan Comeretto
News Editor

THE radio-frequency-interference community has been thrown into turmoil by the Defense Dept.'s new and much-needed plan to assure electromagnetic compatibility of electronic equipment. The plan is gathering momentum, equipment is being developed, measurements are being taken, yet design engineers are still wondering what it all will mean to them.



Signal source providing ultra-stable signals of as high as 40 Gc was developed for the Rome Air Development Center in connection with the three-service electromagnetic compatibility program. It is based on successive steps of harmonic generation and amplification.



Audio-transient generator consisting of a signal generator, ac modulator and dc modulator was developed to test transient susceptibility of weapon systems. It injects up to 400 w in varying pulse shapes into power lines of systems under test.

There is agreement that the DOD's new RFI approach, which has been described by industry engineers as a "clampdown," will upset many industry practices. But no specifics are discussed, despite the widespread activity triggered by military plans.

The activity was apparent at the Seventh Conference on Radio Interference Reduction and Electronic Compatibility, held Nov. 7 to 9 at the Illinois Institute of Technology, Chicago. Officials of the Electromagnetic Compatibility Analysis Center, Annapolis, Md., reported on plans and progress, but said later that it is too early to tell what influence the interference center will have on equipment and system design. Authors of technical papers described new techniques and devices but said they wished they knew more about future requirements in instrumentation for DOD's compatibility program.

Compiling a Data Base to be Main Activity Of Annapolis Interference Center

S. I. Cohn, technical operations director of the analysis center, reported that the facility is rapidly taking shape at the Naval Experimental Engineering Station. The center is housed temporarily in various buildings at the naval station and is still concerned mainly with hiring and training personnel. It expects to move into a new building next spring. But the center has started to direct several projects in the areas of collecting spectrum signatures and conducting research on models.

The four main activities of the center will be acquisition of a data base for all studies relating to controlling RFI, formulation and adoption of validation tests, establishment of permanent facilities and activities, and operational problem analysis.

Included in the data base will be: spectrum signatures of all military emitters and receivers; an environmental file of locations of all emitters and receivers detailing such information as hours of operation, frequency, bandwidth, and antenna height; technical literature and diagrams on all equipment; details on present and future R&D programs for equipment and test instruments; engineering standards; and interference reports.

There was much discussion at the meeting of the difficulty of taking spectrum signatures, and, indeed, of properly interpreting the published procedures for measurements. DOD experts made it clear that in cases of doubt the best procedure is to follow the intention of the collection plan. The plan is meant to provide complete characteristics of the significant outputs of emitters throughout the frequency spectrum and the response characteristics of receivers.

Signatures are being collected and the requirement to collect them is being written into some equipment contracts. Environmental data sheets, or maps, also are being produced. Two such maps, for the San Diego area and the Montgomery, Ala., air-defense sector, are being examined by analysts of the center. Future data will be collected on forms to be processed for the center by the Bureau of Census, which will use FOSDIC mark-sensing equipment. This is expected to make the collected data easy to analyze automatically with computers.

The maps will be updated continuously, so that designers and users of equipment intended for a particular site will be able to learn instantly what interference their equipment will be up against.

Microwave Source, Transient Generator Among Devices and Techniques Described

Among the devices described at the meeting was a high power, wide-frequency-range

Diagram of the role of the Dept. of Defense's interference center at Annapolis was developed to show how the center, the tasks it is to perform, and the complete compatibility program are dependent on each other for maximum effectiveness.

microwave-signal source. According to D. E. Farmer of American Electronic Laboratories, Inc., Philadelphia, the source is continuously tunable from 40 mc to 40 Gc. Rf power output is 100 w cw for 40 mc to 4 Gc and more than 1 w from 4 Gc to 18 Gc. Above 18 Gc, output falls to about 1 mw at 40 Gc.

Frequency stability of about one part in 10^{9} is achieved by locking the system to an ultrastable standard. The design was said to be an extension of the master oscillator-power amplifier technique. A tunable oscillator provides a 500 to 1,000-mc signal that is amplified in the same band. Frequency is raised by successive steps of harmonic generation and amplification. Desired signals are selected by filters, Mr. Farmer said.

To produce signals between 40 mc and 500 mc, the output of the 500-1,000-mc oscillator is heterodyned with the output of a second oscillator operating at a fixed frequency. Both fixed and variable oscillators are stabilized by referencing their output to a crystal-controlled oscillator.

The equipment, which occupies six large racks, was developed for the Rome, N. Y., Air Development Center, and can be extended in frequency coverage by addition of passive doublers or amplifiers, for which power and control circuits already are included. Mr. Farmer reported that power output could be raised in the C, X and K bands with suitable traveling-wave-tube amplifiers.

An audio transient generator designed to permit testing of interference susceptibility

NEWS

RFI Designers . . .

(continued from p 5)

of airborne weapon systems was described by R. C. Dyer, Boeing Co., Seattle. The two main design problems that had to be solved were generating, externally, audio transients of the same shape as those observed in the systems under test, and providing enough power to inject the transient into the power lines of the system.

The generator has an available transient power output of 400 w on a given line and was said to be capable of producing transient shapes adjustable over a wide range. It consists of three functional units; a signal generator, an ac modulator, and a dc modulator. The signal generator synthesizes the desired transient shapes by integration and differentiation of rectangular pulses, using circuits with variable time constants, Mr. Dyer said.

Injection of the transients directly into power lines was chosen because it permits checking of all maximum susceptibility points without analyzing the design to estimate the location of these points. ■ ■

Inexpensive Photo-Glass Circuits Stir Trade Talk

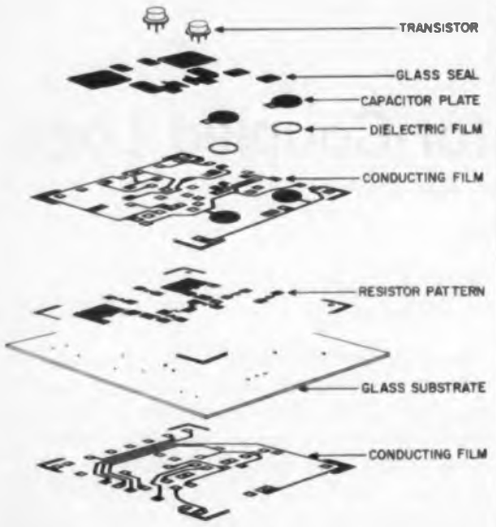
The passive portions of small computer-type circuits are being manufactured at unit prices as low as $1 by a small California company. The recent development has attracted considerable attention from defense contractors.

The manufacturing method consists of photographically developing resistors, capacitors and conductor patterns on glass substrates. The technique was developed by Intellux, Inc., Santa Barbara, Calif.

Among the companies reported to be investigating the photographic method are North American Aviation, Inc., Los Angeles; the Naval Ordnance Laboratory, Kearfott Div. of General Precision, Inc., Little Falls, N. J.; and Litton Industries, Beverly Hills, Calif.

Intellux says it can deliver units at the rate of thousands per week on short notice.

Intellux supplies the glass substrate with 14 passive elements. The 10 active elements



Exploded view of Intellux's photographic process shows the relative positions of the glass substrate, the top and bottom conducting layers, the resistive layer, the dielectric films and capacitor plates, and the final glass seals. Research is under way to include thin-film semiconductor devices in the process.

are added by the customer.

Intellux says the photographic approach will enable it to control the shapes of the thin-film circuits, and therefore the electrical parameters, very closely. The company also says that it can add more glass over the final substrate to achieve a true hermetic seal for the whole module.

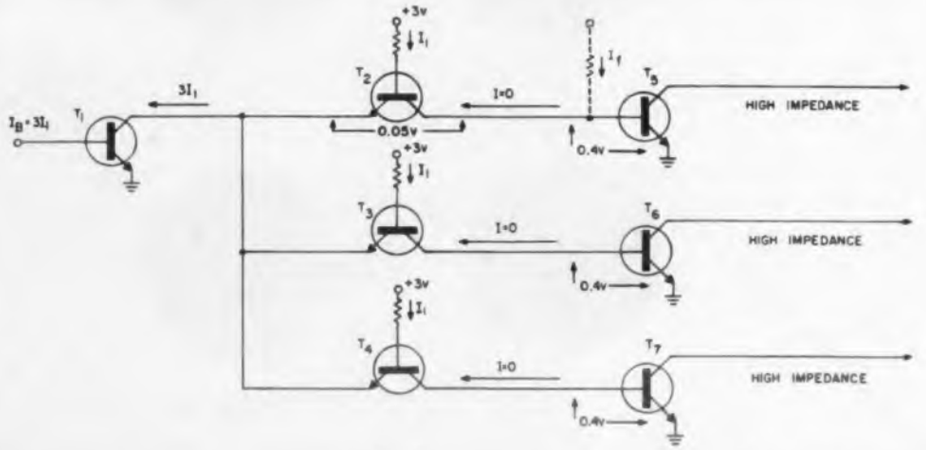
The next steps in the process now under investigation at Intellux are the inclusion of thin-film silicon diodes on the substrate and, after that, inclusion of transistors.

Substrate for this flip-flop can be produced for $1 in quantities of several thousand units. The substrate is glass and contains twelve resistors produced by a multi-layered photographic process. The four transistors, two capacitors and six diodes are added afterwards. It is possible to incorporate the capacitors on the substrate and the maker hopes soon to deposit silicon diodes on the substrate. The flip-flop was made for evaluation by North American Aviation.

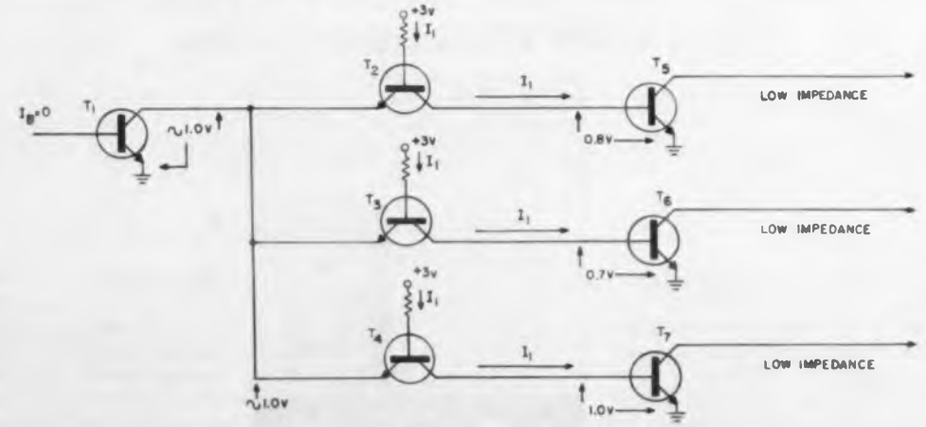
New in Integrated Circuits: Transistor-Coupled Logic

Experimental Design Replaces Diodes, Resistors as Couplers in Digital Fan-Outs; Technique Paves Way to High-Yield Modules, Yet Simplifies Production

Coupling Transistor Always Saturated in TCL Operation



Outputs are "off" when input driver is "on". No current flows in base of T_1, T_2, and T_3. Coupling transistors, T_2, T_3, T_4, are in the saturated state with about 0.05 v offset voltage. Resistance in coupling transistor base circuit is about 1 K, which results in I_1 of about 2 ma; a total of about 6 ma flows in T_1 collector to base path. Output transistors' V_{be} is called 0.4 v: this is the sum of the input V_{ce} and the coupling transistors' offset voltage. Fault currents (shown with dashed line) that may exist due to degradation of output transistor have little effect on circuit, will not turn output transistor on as with diode-coupled logic. I_f may be of magnitude comparable to I_1 before circuit degradation.



Outputs are "on" when input driver is "off". Varying loads, transistor characteristics are assumed for the output transistors, making V_{be}, the "turn-on" voltage, different in each branch. Coupling transistors are still saturated, having 0.05 V_{be}, but I_1 now flows from output base to emitter, and from collector to emitter. All driven stages turn on simultaneously. Since there is no charge-storage problem in "always-saturated" operation, propagation time is low—less than 7 nsec. V_{ce} of T_1 is determined by the highest voltage in the three branches: the sum of 1.0 V_{be} in T_1 and 0.05 V_{ce} in T_4.

T. E. Mount
West Coast Editor

TRANSISTOR-COUPLED logic circuits, (TCLs), now under development, are said to show promise for inexpensive, fast, integrated-circuit modules. The new technique uses transistors, instead of resistors or ultrafast diodes, to couple input-transistor switches to the output fan-outs in digital circuits.

James L. Buie, project engineer at Pacific Semiconductors, Inc., Culver City, Calif., pointed to the significance of his company's coupling-transistor development for integrated circuitry. Unlike direct-coupled (DCTL) or resistance-coupled logic, (RCTL), he said, transistor parameters need not be held to extreme tolerances. In DCTL or RCTL, V_{be} of the output transistors must be nearly identical to avoid "current hogging" by one of the transistors.

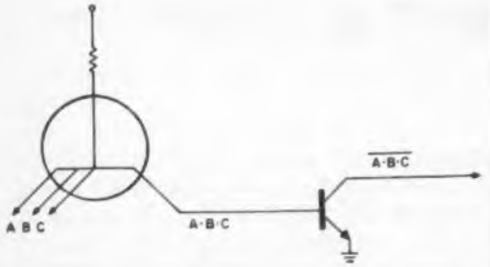
Diode-coupled logic avoids this problem, but to make an integrated circuit that contains both fast diodes and transistors requires certain production compromises.

Simple Process Expected To Improve Reliability

With coupling transistors, logic modules could be produced in high-yield batches since manufacture is simplified, Mr. Buie asserted. Super-close tolerances need not be held in diffusing sets of transistors, and there is no need for diffusing fast diodes on the same silicon slab with the transistors, which require different temperature sequencing.

Other advantages of coupling-transistor techniques include wider design and production latitude, level shifting so the integrated circuits can communicate with other types of logic schemes and fast coupling.

According to Mr. Buie, TCL circuits simulated in the lab, using conventional components, allow 1-K resistors to be connected indiscriminately from one terminal to another without causing the circuit function to fail. Fault currents due to degradation of the transistor would not cause the inte-



By adding emitters to a standard transistor in production a simple, high-yield integrated NAND circuit can be made.

grated circuit to be out of specification, Mr. Buie thinks.

In conventional diode-coupled logic, fault currents of much less than 1 ma will cause the output transistor switch to turn on.

Typical TCL logic levels are 0.2 and 0.8 v. The output of any module, however, could communicate directly with a system requiring logic levels of up to 5 v, and at the same time drive other integrated circuits connected to the same terminal.

Fast Coupling Claimed For TCL Circuitry

TCL is said to be a relatively fast method of coupling, equal to or better than propagation times observed with very fast diodes. The coupling transistor is in the "always-saturated" state. In switching, the only internal effect is a redistribution of excess carriers in the base region, Mr. Buie explained.

"The charge storage in the collector region—which is the real problem in saturated switching for the diffusion silicon transistor—is either not affected or only slightly so," he said. Propagation time is less than 1 nsec.

Development of TCL leads to more sophisticated kinds of coupling-transistor logic. By diffusing on one or more extra emitters during manufacture, logic circuits like that shown in the diagram are possible. In this NAND circuit only one resistor need be deposited or diffused for two transistors. "We end up with twice as many transistors as resistors," Mr. Buie said.

The coupling-transistor approach shows so much promise for integrated circuitry that Pacific Semiconductors is planning to market TCL modules, as well as take orders for conventional integrated circuit modules, when development is complete. ■ ■

CIRCLE 9 ON READER-SERVICE CARD ▶

NEWS

SIGNIFICANT BITS

Important news items for electronic designers written for fast scanning.

Efficiency of present digital-circuit approaches creates serious problems for microminiature circuits of the future because of expected heat-dissipation problems, Richard H. Baker of MIT's Lincoln Laboratory warned at the recent Electron Devices Meeting in Washington (see *ED*, Nov. 8, p 4). For example, he said, core memories with inputs in volts and amperes give outputs in mv and ma—efficiency: 10^{-6}. Thin film memories with inputs on the same order give outputs in mv and ma—efficiency: 10^{-9}. Low-gain devices are used for both amplifiers and detectors—particularly detectors where resistors are sometimes used. He suggested that in space, where computation speed is usually not critical, switching time could be traded for power dissipation in digital designs.

0001

Prices on basic standard systems for industrial process machinery are now being published by General Electric Co., Schenectady, N. Y. GE defines a system as an "assemblage of electrical equipment and other components and services which systems engineers have integrated to perform functions specified by the customer." Systems prices will be available in handbook sheets similar to those used for to GE's product-buying information.

0010

All parts of the horizon will be covered by an 85-ft-diam tracking antenna now rising in College, Alaska. The X-Y mounted antenna will be used by the National Aeronautics and Space Administration for Project Nimbus, a meteorological satellite experiment. The antenna, made by Blaw-Knox Co., Pittsburgh, is 110 ft. high, weighs 200 tons and has a 6,000-sq-ft parabolic aluminum reflecting surface. The surface of the antenna will allow

operation to about 10 Gc. The antenna is expected to be completed next spring.

0011

Sales of Hewlett-Packard Co. products in Canada will be handled by a new sales company, Hewlett-Packard (Canada) Ltd. Principal office, warehouse and service facilities will be in Montreal, with branches in Ottawa and Toronto. The operation will begin Jan. 1. The company has been using an independent sales representative in Canada.

Closed-Circuit TV Teaches 2,000 at Air University

A closed-circuit television system, capable of providing instruction simultaneously to 2,000 officers at 165 viewing locations has been placed in operation at the Air University, Maxwell Air Force Base, near Montgomery, Ala.

The system includes a new television tape recorder developed by Radio Corp. of America. Another feature is a talk-back facility, which allows students to relay questions to the TV lecturer while he is appearing before the studio cameras.

In addition to the monitors, the intercommunications unit and tape recorder, the closed-circuit layout includes four RCA TK-11 image-orthicon TV cameras, two audio consoles, two multiplexing film systems, switching and distribution equipment and "off-air" pickup facilities.

Control room of the Air University's closed-circuit television system, where questions from students are relayed to the TV lecturer while he is on the air.

NEWS

FAA Forms Systems-Design Team

Group to Implement Project Beacon Suggestions, Seek Better Weather Data and Airport Standards

Robert Haavind
Chief News Editor

RAPID expansion of support systems for national civilian air traffic is promised by the formation of a new Systems Design Team within the Federal Aviation Agency, and by proposals made in the recent Project Beacon report.

A significant proposal made by the Project Beacon task force, appointed by Najeeb E. Halaby, FAA administrator, was the integration of present SAGE air defense radars and communications links into the civilian air-traffic-control system. SAGE computers and displays, however, were called inadequate for handling traffic needs in high-density terminal areas.

The evolution to an integrated national air-traffic system will be administered by the new Systems Design Team. This group, presently being formed within the FAA's Aviation Research and Development Service, is headed by Albert Brown, formerly chief of plans for the R&D Service.

The team will consist of about 14 specialists—predominantly engineers. For example, Mr. Brown told ELECTRONIC DESIGN, men skilled in such diverse fields as management, meteorology, aeronautics, communications, navigation, flight rules and procedures and data acquisition will be in the systems group. Mr. Brown pointed out that studies of future air-traffic control have not been implemented.

Problems other than air-traffic control to be handled by the new Systems Design Team include improved operational standards for airports and a nationwide Weather Data System.

Steps will be taken to improve facilities at airports that do not meet the new standards.

Improved weather sensing, prediction and data dissemination are among the requirements

Plan Position Data Display (PPDD), center, now being evaluated by the FAA is designed to display data such as flight identification and altitude from a computer along with a radar blip. This computer data, now obtained from flight plans, would come from beacon transponders on the aircraft under the planned air traffic system. General Precision Laboratories, Inc., designed this display unit.

Project Beacon Plans

Several important policy shifts in air-traffic control were recommended by an eight-man Project Beacon task force in the recently released "Study of the State and Efficient Use of Airspace." Some of the recommendations important to electronic equipment designers are:

- **All aircraft should carry $500 short-range transponders for altitude data, flight identification and blip enhancement. These would work between airports as well as in terminal areas.**
- **Displays should show flight numbers and altitude beside blips.**
- **SAGE computers should not be used. Commercially available, rather than specially designed, computers are preferable.**

The report estimates that a system based on these recommendations could be operational in five years, at a cost of $500 million for equipment. R&D costs could be handled by present budgets, the planners said.

of the proposed Weather Data System. Mr. Brown noted that aviation requires weather information on a relatively short-term basis—that is the 0- to 2-hour periods—in contrast with the longer-term needs of the general public. Also, he said, localized, rather than area-wide, predictions are needed.

The FAA is now evaluating automatic weather stations that sense conditions and broadcast data at regular intervals, Mr. Brown said. Computers already are being used to some extent.

Dissemination of information to pilots in flight is another important step in this program, Mr. Brown explained. This data will be transmitted from airports and picked up by VOR sets aboard aircraft in the vicinity.

Target date for the complete weather network is 1964, Mr. Brown said, but portions will become operational as they emerge from development. ■ ■

NEWS

Crystal Grower Makes Production Flexible

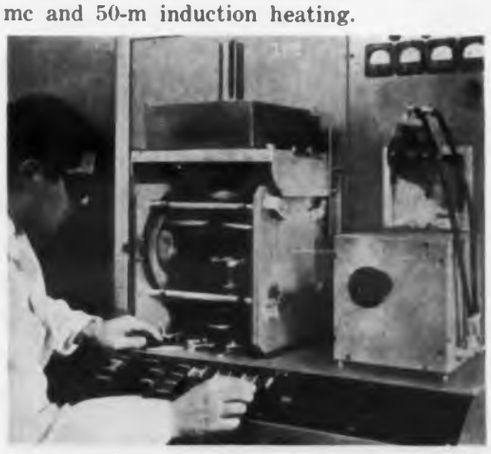
A multi-purpose crystal-growing machine developed for the Air Force by ITT Federal Laboratories is reported to be capable of producing a variety of quality single crystals, ranging from semiconductors, to alumina and other oxidic crystals.

With the new grower, germanium and silicon crystals can be made by the Czochralski, float-zone or horizontal zone-leveling technique. Alumina crystals—such as rubies and sapphires—and ferrites—such as garnets—can be made by the newly developed Bauer-Marino method. This process uses high-frequency (50 mc) induction heating instead of conventional flame fusion.

Designed for the Air Force Cambridge Research Laboratories by ITTs' Nutley, N. J., division, the crystal grower has provision for accurate rotation and pulling of a semiconductor cystal from a melt for use with the Czochralski method. The crystal ends also can be made to rotate at different rates for the float-zone technique. A container permits growth of larger crystals with the horizontal zone-leveling process, which is similar to float-zoning.

In the Bauer-Marino method no gas is used for heating, so there is less chance of impurities combining with the growing crystal, Fred A. Muller, director of the ITT Basic Sciences Laboratories, explained.

The grower has provision for 450-kc, 5-mc and 50-m induction heating.



Four crystal-growing techniques, including the newly developed Bauer-Marino method for growing rubies and sapphires, can be used with ITT's multi-purpose crystal grower. Sometimes called "flameless fusion," the Bauer-Marino method uses 50-mc induction heating. Semiconductors can be grown by Czochralski, float-zone or horizontal zone-leveling processes.

EIA Seeks Standardization Of Wirewound Resistors

A program to standardize wirewound resistors has been announced by the Electronics Industries Association. The EIA appealed to the industry to aid in the project.

The study also will emphasize implementation of high-reliability specifications in accordance with the Defense Dept. report, "Parts Specifications Management for Reliability," also known as the Darnell Report.

Companies can contact the EIA group by writing to J. Howard Schumacher, EIA Engineering Dept., 11 W. 42nd St., New York 36, N. Y.

Snap 10A Nuclear Unit To Generate 500 W

Snap-10A, the most advanced unit developed under the Snap-reactor concept, will have an output of 500 w and be suitable for use in communication satellites. This was reported by A. B. Martin, vice president of Atomics International Div. of North American Aviation, Inc., at the recent Atomic Forum in Chicago.

Snap-10A will be a completely static reactor-thermoelectric unit with a life expectancy of about one year. Like the other units in the Snap family, its performance characteristics will be extendable well beyond initial figures, Mr. Martin said. Its reactor core consists of a bundle of homogenous uranium-zirconium-hydride fuel moderator rods, the high hydrogen content of which is mainly responsible for the compactness and lightness of the core.

External Control System Simplifies Design

The reactor is controlled by drums in the beryllium reflector, rather than by conventional in-core control and safety elements.

In use, Snap-10A would ride on the top of a communications satellite. Thermoelectric converter units would ride between the reactor and the satellite body. The thermocouples would be connected in series-parallel to produce the required 500 w and to provide redundancy for reliability.

Temperature and power density of the reactor are sufficiently low so that the reflector-control drums are needed only for startup of the reactor. After equilibrium is reached, the system operates as a completely static system.

Pulse Counters, Air Samplers Unveiled at AtomFair

AtomFair '61, the exhibit of nuclear instruments and equipment held in conjunction with the winter meeting of the American Nuclear Society and the Atom Forum, Nov. 6-9, reinforced evidence that designers of nucleonic equipment need take a back seat to no one. Latest design features, transistorization, remote control, modular construction and fine styling were apparent in the equipment displayed at the Conrad Hilton Hotel, Chicago.

ELECTRONIC DESIGN photo

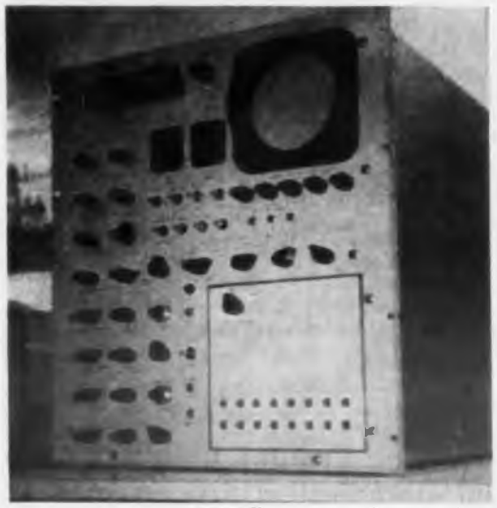
Remote handler (above) proposed for use under water has four arms: two for holding itself in place, two for working. A propeller for hovering and for up-and-down motion rotates within the circle of fuel tanks. Two TV cameras and arc lights are at center and at right of unit, which would be about 6 ft high. System is under study at Hughes Aircraft Co., Culver City, Calif.

Remote monitoring system (left) for atmosphere-borne radioactive particles draws in about 1 cu ft of air per min and counts pulses of radiation to indicate intensity in microcuries per cc of air. Two sets of scintillators and counting equipment are included for reliability of operation and accuracy of readings. Small indicator and alarm unit at top right is for monitor office. Range of the air monitor, made by Eberline Instrument Corp., Sante Fe, N. M., is from 0 to 2,000,000 counts per min.

ELECTRONIC DESIGN photo

Air sampler (right) for laboratory and reactor environments monitors alpha, beta and gamma radiation at count rates of 50 to 50,000 per min. New circuitry provides, for first time, a reading of the alpha-to-beta-and-gamma ratio. Transistorized unit is being produced by Nuclear Measurements Corp., Indianapolis, Ind.

ELECTRONIC DESIGN photo



ELECTRONIC DESIGN photo

First transistorized 800-channel pulse-height analyzer retains up to a million counts per channel in a ferrite-core memory. The ST800DM, made by Victoreen Instrument Co., Cleveland, Ohio, accepts up to 50,000 pulses per sec per input, and up to 8 detector inputs. Main feature is said to be fast and linear analog-to-digital conversion circuitry.

Modular counting system consists of, from left, power supply, amplifier and discriminator, 6-decade preset count scaler, and 5-decade timer. System was designed by Radiation Instruments Development Laboratory Inc., Melrose Park, Ill., so that interchangeable modules could be plugged in. Maximum continuous count rate of scaler is 1 mc with five-decade preset.

NEWS

Adaptive Control System Tested

Adaptive flight-control system, designed for flight test in the hypersonic X-15, gets final check by researcher at Minneapolis-Honeywell's Aeronautical Div. Constant-response performance to command inputs is attained by use of a "model," a network analog of ideal response performance. Vehicle response follows the model output. Basic damper system is dual redundant; outer loop modes are not redundant. Checkout console is at left.

Standard Ensures Uniformity In Shock-Testing Processes

After three years of research by the Air Force and industry, a standard has been issued specifying the design, construction and operation of a medium-impact shock-testing device.

According to the American Standards Association, which has approved and published the specification, the shock-testing process will provide industry and the government with uniform procedures for determining shock characteristics.

The device itself is of the drop-table type and can test loads ranging from 150 to 400 lb. The load is tested by dropping it from a height of up to 13 in. into a sandbox at the base of the machine.

The Acoustical Society of America and the American Society of Mechanical Engineers served as sponsors of the committee that developed the standard. C. E. Grede of the California Institute of Technology was committee chairman.

Copies of the standard (S2.1-1961) are available for $1.00 from the American Standards Association, 10 E. 40th St., New York 16, N. Y.

Micromin Digital Computer Uses Semiconductor Net

A microminiature digital computer, using semiconductor logic networks, rather than individual components, has been built by Texas Instruments Inc., Dallas, for the Air Force.

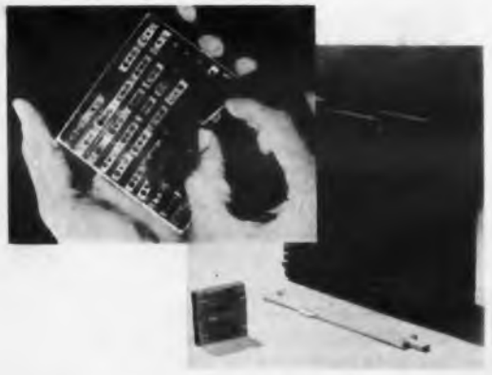
The experimental model, having a total volume of 6.3 cu in. and weighing 10 oz, uses 587 digital solid circuits, each formed within a small bar of silicon material. The binary computer is a serial, fixed-point machine with an operand word length of 10 bits, plus sign. The computer uses synchronous logic, being timed from an internal 100-kc clock.

Flip-Flops, NOR Gates, Logic Drivers Are Used

Three types of semiconductor networks are used in the tiny computer: flip-flops, NOR gates and logic drivers. The individual hermetically sealed semiconductor networks, measuring 0.250 x 0.125 x 0.030 in. are assembled by welding 8 to 16 of them together in a stack and then encapsulating the stack to form a rigid module.

The computer consists of 47 modules. Each module contains an average of 12 networks, occupies approximately 0.057 cu in. and weighs about 0.04 oz. Total power dissipation of the computer is 16 w, according to the company.

The experimental computer was developed as a part of a molecular electronic program under the technical guidance of the Electronic Technology Laboratory, Aeronautical Systems Div.



Module, containing a dozen solid circuit semiconductor networks, is plugged into tiny computer, insert. At right, the module stands next to a computer containing 8,500 components with conventional circuitry that performs the same functions.

WASHINGTON REPORT

Wilbur H. Baldinger
Washington Editor

NASA BEATS PENTAGON TO THE DRAW

The National Aeronautics and Space Administration has taken the New Frontier play away from the Defense Dept. in an R&D policy swing from private industry to government laboratories (See *ED*, Nov. 8, p 20). Glamorous—and aggressive—NASA is not waiting for the Pentagon to get things moving. The space agency is embarked on a nation-wide drive to upgrade its own force of scientists, designers and engineers—possibly at the expense of the Defense Dept. itself.

While Defense Secretary Robert S. McNamara and Dr. Harold Brown, the Pentagon research chief, mapped lobbying plans to ask Congress next year for higher pay for in-house personnel, NASA's administrator, James E. Webb, went to the White House. In the face of an administration order to all federal departments and agencies to cut down on hiring, Webb came away with President Kennedy's approval of a recruitment campaign to add 2,000 specialists to NASA payrolls at salaries running to $21,000.

"All of our organizations will participate in the recruiting drive," Webb announced—and they simultaneously posted specific personnel needs in Operation Upgrade. "Special teams composed of NASA scientists will visit virtually every area of the U. S. in coming weeks to interview candidates," Webb said.

NASA employment office doors swung wide open at Ames Research Center, Mountain View, Calif.; Flight Research Center, Edwards, Calif.; Goddard Space Flight Center, Greenbelt, Md.; Langley Research Center, Hampton, Va.; Lewis Research Center, Cleveland; Marshall Space Flight Center, Huntsville, Ala.; Wallops Station, Wallops Island, Va.; and Manned Spacecraft Center, Houston.

All electronic space-age fields—data systems, measurement and instrumentation systems, experimental facilities and equipment, flight systems, etc.—will be tapped by NASA. In want-ad style, Webb made this pitch: "Aerospace technology career opportunities with NASA offer interesting and important positions in research, development, design, operations, and administration."

Webb said "recent science graduates who are just beginning their careers" will be wooed in particular to take government, instead of private, jobs. McNamara and Brown were given no announced assurances that specialists in Defense Dept. establishments would be off limits to NASA recruiters. In fact, they are bracing themselves for NASA raids.

HUMPHREY PROMOTES MEDICAL ELECTRONICS

A "vast expansion" in federally financed work on applications of electronics to medical science has been called for by Sen. Hubert H. Humphrey (D, Minn.). Issuing a progress report by a government operation subcommittee, which he heads, the assistant Senate Democratic leader said there are "impressive vistas" in medical electronics, which are barely seen now. Humphrey urged more budget

money for research on artificial organs, patient-monitoring equipment and other electronic instrumentation.

R&D GOLIATHS FACE SMALL-FIRM COMBINE

The Small Business Administration has matched a David against the Goliaths in the field of prime government R&D contracts. In a precedent-making move to encourage small companies to take on big ones, the SBA has officially approved formation of the first small business combine specifically to compete for defense R&D work in electronics and related areas.

Going forth into battle for contracts with SBA blessing—and armed with exemptions from anti-trust and Federal Trade Commission laws prohibiting industrial pools in restraint of trade—is the New York Research & Development Team, Inc. Headquartered at 150 Broadway, New York, the combine starts out with 128 employes and joint R&D resources of four small companies—Aerolite Electronics Corp., Radiation Research Corp., Manhattan Physical Research Group, Inc., and New York Testing Laboratories, Inc.

GOVERNMENT GRANTS BYLINES, TOO

The Federal Council for Science and Technology, a White House office set up in 1959 to coordinate government-supported research projects, is adding some fringe benefits to new contracts. It has adopted a government-wide policy of paying "page charges" levied by nonprofit journals of learned societies for printing research reports, which otherwise might be filed and forgotten.

The council thus gave official recognition to a tradition in scientific circles—that a research project is not really entitled to notice until its results have been published under a proper imprimatur. Not all scientific journals charge authors for printing reports, but those that do collect an average of about $20 per page. This can run into money for young scientists who need space to tell what they have been doing.

Under the new policy, a token allowance for page charges will be written into research grants. The amount will be subject to adjustment after a final report is written and submitted to a journal —but there will be ground rules to make sure that the publisher assesses printing costs with an even hand.

Another innovation in communications between scientists has been proposed by a Massachusetts Institute of Technology research team. After two years of study for the Commerce Dept.'s Office of Technical Services, the team reported that what is needed is a "science information network" utilizing newspapers, radio and television. This would speed "the flow of information between originator and user," the MIT researchers said. Issuing their report, the OTS noted dryly that "actual construction" of such a network was left "in the realm of speculation."

CAPITAL CAPSULES:

New at the Bureau of Standards: an electronic differential analyzer to simulate melting in small-diameter tungsten rods; work on superconducting magnets with field strengths higher than any previously known; and a tabulation of intensity values for 70 chemical elements in a wavelength range of 2,000 to 9,000 A ■ ■ ■ Computers have been given the job of speeding the Pentagon's $93-million fallout-shelter survey. The computers will do the job of 2,000 to 3,000 architect-engineer companies, which the Pentagon first thought it would need.

NEWS

Standardized Testers Imminent—Air Force

Procurement Requirements for 45 ATE Modules Are Due Early in '62

PROCUREMENT requirements for 45 standard modules to be used as building blocks for automatic test equipment are scheduled to be announced by the Air Force early in 1962, ELECTRONIC DESIGN has learned.

Specifications for the modules are being drawn up at the Dayton Air Force Depot, according to Air Force officials. The next step will be the preparation of documentation for procurement offices, which will write requests for quotes. This should be completed in January or February, 1962, a spokesman said.

The 45 modules described in the specifications are said to satisfy up to 90 per cent of Dept. of Defense electronic-equipment test requirements. They will be designed to plug together in "tinkertoy" fashion to create automatic test equipment for missile and aircraft electronics.

When the missile design is changed or becomes obsolete, the test equipment could be dismantled and the modules returned to the shelves of a supply "library."

The first major effort at standardization in the ATE field, the Air Force program will call for black boxes with standard electrical input-output characteristics and physical configuration to be supplied in "service-test quantities" to Dayton Air Force Depot. The depot will serve as a pilot-shop to work out any bugs in the building-block concept.

From there, the program will be extended to the Air Force Logistics Command at the depot level. The third stage will be to supply field facilities on an Air Force-wide basis, it was learned.

Modules to Comprise Control, Measuring, Stimulus Functions

Functions provided by the standard modules will include programming, comparison, switching, measurement and stimulus functions, Air Force ATE officials said. Programmable signal generators, pulse generators, power supplies, impedance loads and conversion equipment will be included in the procurement list. Exact specifications for the

modules, and identification of their precise functions, have not been made public.

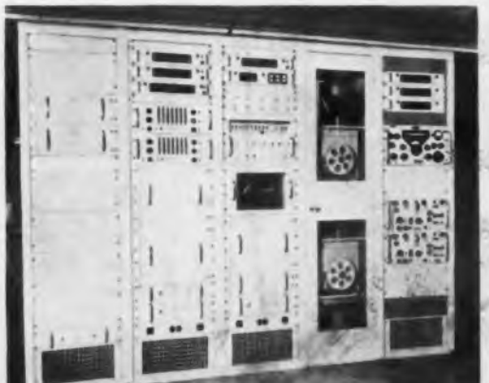
Since each module would have standard electrical and physical characteristics, modules could be procured from any of several competing manufacturers. Each manufacturer would be free to use whatever components or electronic circuits he wanted—within the specified black box. Module cost, with large quantities on order in a competitive situation, will come down, the Air Force thinks.

Additional modules, providing specialized functions required by any given prime equipment, also will be ordered, spokesmen said.

According to John R. Taylor, assistant secretary of defense for installations and logistics and director of maintenance policy for the Air Force, the Air Force is definitely not looking for "universal" test equipment, which may require complex and expensive adapters. Varying needs of different missiles result in much duplication of equipment in adapters.

Reaction to the standardized building-block concept by other military services is said to be favorable. At a tri-service seminar held in Dayton earlier this year the concept appeared to meet with immediate acceptance by all the services according to Air Force spokesmen. ■ ■

Tracker to Guide Moon Shot



This antenna angle-positioning system will be used in controlling the flight of the Surveyor space vehicles and their landing on the moon. The positioning system, developed by Datex Corp., Monrovia, Calif., will provide and record digitally the angular position of the axes of an equatorially mounted radio-tracking antenna. The system also will generate and record time, record Doppler frequency, data condition and parameter data.

DESIGNERS' DATEBOOK

DEC. 1961						
S	M	T	W	T	F	S
					1	2
3	4	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28	29	30
31						

JAN. 1962						
S	M	T	W	T	F	S
	1	2	3	4	5	6
7	8	9	10	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25	26	27
28	29	30	31			

NOVEMBER

22-27 Milan, Italy — 5th Conference on Automation and Instrumentation; Federezoine delle Societa Scientifiche e Techniche di Milano, via S. Tomaso 3, Milan.

26-Dec. 1 New York — Mechanical Engineers' Winter General Meeting; Statler-Hilton Hotel; ASME.

29-Dec. 1 Asbury Park, N. J. — Communication Wires and Cables Symposium; Berkeley-Carteret Hotel, Communications Dept. of U.S. Army, Fort Monmouth, N. J.

30-Dec. 1 Minneapolis — 12th National Conference on Vehicular Communications; Radisson Hotel; PGVC.

DECEMBER

4-6 Orlando, Fla. — Aerospace Support and Operations Conference; San Juan and Angebilt Hotels; IAS.

4-8 Bellevue, France — International Colloquim on Ionic Bombardment; Bellevue, France. (National Scientific Research Center, 15 Quai Anatole France, Paris 7e, France.

12-14 Washington, D. C. — Eastern Joint Computer Conference; Sheraton Park Hotel; IRE, AIEE, ACM.

26-31 Denver — Annual Meeting and Exposition of Science and Industry; Hilton Hotel; AAAS.

27-29 Los Angeles — American Physical Society Meeting; University of California; APS.

JANUARY

9-11 Washington, D. C. — 8th National Symposium on Reliability and Quality Control; Statler-Hilton Hotel, PGRQC, AIEE, ASQC, EIA.

29-Feb. 2 New York — AIEE Winter General Meeting and Exposition; New York Coliseum; AIEE.

new!

APPLICATION NOTES:

Power switching and RF Amplifier Transistor application notes are the result of exhaustive work employing the most advanced power switching and power amplifier transistors available today. They will be valuable additions to your reference files.

Fill out and mail TODAY!

Please send applications notes checked below:

- ☐ Power Switching Applications
- ☐ Converter Design
- ☐ Switching Applications — 2N1899 - 2N1901
- ☐ Pulse Driving with 2N1899 - 2N1901
- ☐ Transistorized Nixie Drivers
- ☐ Transistorized Relay Drivers
- ☐ High Speed Logic Laminar Transistors
- ☐ Citizens Band Transmitter
- ☐ RF Oscillators & Amplifiers
- ☐ Power Transistor Data Sheets
- ☐ RF Power Applications
- ☐ Transistor Catalog
- ☐ General Catalog

Split-Focus Grid Device Eliminates TV Image Lines

Television-picture lines are eliminated by a new split-focus grid device that is said to be readily adaptable to existing sets.

The tube eliminates the scanning lines by subjecting the electron beam to a small-amplitude, high-frequency deflection and enlarging it vertically to fill the black areas between information lines.

The output of an oscillator is used to deflect the scanning spot, instead of having it trace a straight path. If the frequency of the oscillator is high enough, the lines blend to give the impression of a thicker line, rather than just one that oscillates.

The new tube was developed by the Electronic Tube Div. of Westinghouse Electric Corp., Elmira, N. Y. In exchanging the new tube for an old one, a plug-in unit would be inserted between its base and the existing socket.

Except for the separate leads from each half of the split electrode, which are brought out at the base of the tube for connection to the plug-in oscillators, the gun structure is conventional.

System Tested at Sea

A new underwater navigation system, developed by the Martin Co. for use by submerged submarines, is being tested aboard an elaborately equipped floating electronic laboratory. James W. Fitzgerald, president of The Geraldines' Ltd., owner of the craft, examines some of the gear. Acoustical apparatus aboard includes: an audio-signal generator, one-half octave analyzer, narrow-band analyzer, level recorder, monitory hi-fi speaker system for monitoring, hydrophone, projector, four-channel tape recorder, and PQM sound-measuring set.

Illiac II Computer Shaping Up for Tests Next Spring

University of Illinois Expects Giant Asynchronous Machine With 2-Microsec Add Time to be Doing Useful Work by End of '62

Alan Corneretto
News Editor

ILLIAC II, the University of Illinois' scientific computer, is expected to be ready for its first system tests next spring.

At that time the arithmetic units, some of the control units, core storage and some tape units should be completed. At present, the repetitive parts of the arithmetic units have been run error-free, the first 4,000 words of core storage are being debugged, and the computer's special buffer memory—or flow gate—is nearing completion. Illinois project engineers expect the computer to be doing useful work by the end of 1962.

The Illiac II is said to be the most asynchronous computer so far devised. Latest performance specifications given for the machine are:

- Multiply time—6 to 8 μsec.
- Add time—1.5 to 2 μsec.
- Divide time—15 to 20 μsec.
- Core cycle time—1.8 to 2 μsec.
- Access time to fast buffer store—0.25 μsec.

These figures are for floating-point operations on 52-bit words, of which 7 bits form an exponent representing a power of 4 and 45 bits the fractional part.

Because the university will be the only user of Illiac II, the computer is being built with only 8,192 words of core storage, divided into two units. These will be backed up by 65,536 words of storage on magnetic drums having an access time of 7 μsec once in synchronism. Illiac's designers say that computing time will be slowed only 10 or 15 per cent by the lack of all-core storage, and that the saving in cost of hardware more than compensates for this.

One of the basic considerations affecting design of the computer was the inequality in speeds of arithmetic and storage operations. Because of the relative slowness of storage, Illiac II was organized so its programs require as few references to core memory as possible. Also, the core memories are designed to be fast in themselves and to be used in multiplex. To enhance the effects of these steps, fast controls were designed and the arithmetic unit and input-output devices were linked to the core memories. The design objective was to make the operating time for all devices roughly equal and to run them concurrently.

Illiac II, an asynchronous computer partly completed at the University of Illinois, is being built with module frames mounted in floor-to-ceiling racks rather than with conventional circuit boards and cabinets.

To minimize access to core storage, Illiac is provided with a compact order code, fast storage of short loops, storage of intermediate results through use of a fast buffer and an organization that permits concurrent operation of core and arithmetic units, initial decoding of addresses, decoding of instructions and transfers of memory blocks.

Word Length Increased, Number of Bits Reduced

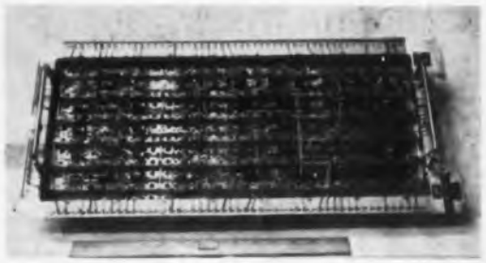
Also, to reduce the necessity for access to instructions, word length was increased and instructions were designed to be more powerful than usual for a given number of bits. The number of bits per instruction was reduced.

Another design feature allows a number of instructions held in fast transistor registers to be obeyed repeatedly without further reference to the core memory for instruction.

To reduce the number of bits per instruction, variable-length instructions are used in the Illinois computer. Long 26-bit instructions are used only where needed. The rest of the time, 13-bit instructions are used.

Because the computer is designed to be asynchronous to an unusual degree—which the designers call speed-independence—control is critical and is achieved in a novel fashion. In addition to interplay control and an arithmetic control that corresponds to the usual delayed control (DC), Illiac includes an advanced control. This circuitry processes every instruction; it is said to correspond to the memory bus, instruction unit and look-ahead of the Stretch scientific computer, made by International Business Machines Corp.

At Illinois, speed independence means the elimination of race conditions in control cir-



Transistorized arithmetic unit is one of the basic modules consisting of circuitry wired into frames for later mounting in racks. The module is about 4 in. high, permitting access to every connection.

cuitry during computer operation. In synchronous, clock-controlled computing systems, circuits operate according to timing instructions from the clock, and, in effect, race to complete their operations so that other operations may begin. In the speed-independent Illiac II, circuits are designed so that wherever possible the slow ones do not hinder the fast ones. Though a clock is not used, completion of each circuit operation is signalled by that circuit so that succeeding operations can begin.

The disadvantages of this relatively complicated organization are said to be compensated for by the gains in parallel operation and its resulting speed. The computer's arithmetic units are not speed-independent, however; the relatively small advantages that would be possible in the already fast units reportedly would not be worth the added complications.

Module-Frame Construction, Rather than Circuit Boards, Used

Circuit-board construction is not used for Illiac II. Instead, module frames measuring about 2 ft by 1 ft are used as the basic units. These are mounted in ceiling-to-floor racks in an air-conditioned room at the university's digital computing laboratory.

The basic transistors used were the fastest available when the computer was in early design three years ago. They are custom-made by Western Electric Co. and Texas Instruments Inc. and resemble the pnp germanium mesa 2N559, but have a power dissipation of 200 mw. They are used mainly in nonsaturated circuitry. More than 36,000 transistors ultimately will be used in the Illiac II. In the storage units, current-switching diodes are used in emitter-follower logic.

Design and construction of the computer are being supported by the Atomic Energy Commission, the Office of Naval Research, and the University of Illinois. ■ ■

Navy Static Inverter Uses Tunnel Diodes

Low-Voltage Device Provides Square Waves From TE Cells

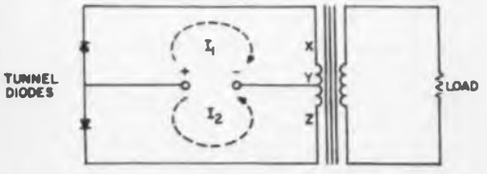
A STATIC inverter consisting of two tunnel diodes and a square-loop magnetic-core transformer has provided square waves from low-voltage, high-current dc inputs reliably over reasonably wide ambient conditions.

Developed at the U.S. Naval Research Laboratory, Washington, D. C., the inverter is intended for use with such power sources as thermoelectric, thermionic and fuel-cell generators. According to J. M. Marzolf of the naval laboratory, the normal practice of connecting such power sources in series to build their voltages—of around a quarter of a volt—to usable levels is less desirable than raising the voltage by transforming it.

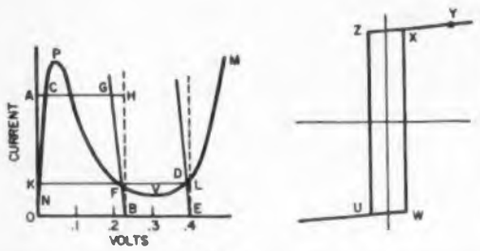
No static device, however, is capable of being used as a chopper in such a transforming circuit. This is so because the saturation resistance of the high-power transistors and silicon-controlled rectifiers used is not low enough for efficient operation.

The inverters built at the laboratory use two high-current tunnel diodes. The diodes operate as switches rather than as amplifiers, Mr. Marzolf reports. Some of the diodes are experimental units with peak currents ranging as high as 27 amp. Power-handling capability of the inverters has exceeded 2 w. Efficiency has gone as high as 50 per cent.

Though these figures are relatively low, they could be raised significantly if tunnel diodes became available with peak currents



Static-inverter circuit using two tunnel diodes as switches oscillates under proper operating conditions, permitting inversion of low-voltage inputs, as from thermoelectric generators. Transformer is square-loop magnetic core unit.



Characteristic curve, left, and idealized hysteresis loop of magnetic-core material, right, of tunnel-diode static inverter.

in the thousands-of-ampere range. Efficiency probably could be increased to 80 or 90 per cent, Mr. Marzolf thinks.

Some tunnel-diode inverters already have been used experimentally on thermoelectric generators at the laboratory, where they provided good square-wave outputs. Output voltage and frequency of the inverters were inversely proportional to the load for a fixed input voltage, and directly proportional to the input voltage for a given load. Mr. Marzolf reported on the device at the recent Fall General Meeting of the American Institute of Electrical Engineers, in Detroit.

How Navy's Tunnel-Diode Static Inverter Works

The operation of the inverter can be understood by referring to the adjoining diagrams from Mr. Marzolf's AIEE paper. It can be assumed that the input-terminal voltage is OB in the drawing of the curve, and the slope of the dc load line, BG, is such that the load line intersects the tunnel-diode characteristic curve at a single point, F, somewhere within the negative resistance region.

If an input voltage is applied to the terminals of the device, currents I_1 and I_2 will start to flow as shown in the schematic.

If both loops including the tunnel-diode characteristics were identical, the currents would be identical at all times and the circuit would not oscillate. However, in a practical circuit this condition cannot occur because the loop impedances and the diode characteristics will be slightly different.

Therefore, it can be assumed that I_1 is larger than I_2 and very quickly reaches its operating or dynamical equilibrium point, C, on the curve. The current OA consists of the load current, the magnetizing current for the core and the current in the other primary loop, I_2. When operating at this point, AC represents the voltage across the diode, CG represents the voltage induced

NEWS

Static Inverter . . .

(continued from p 29)

in the primary winding by the changing flux in the core and represents the induced component of the load voltage referred to the primary circuit, and GH represents the IR drop of the primary circuit. The sum of these three voltages equals the input voltage OB.

The changing flux in the core will induce a voltage in the lower half of the primary winding, also equal to CG. However, its polarity is such that it adds to the input voltage in determining the voltage impressed across the lower tunnel diode. Thus, if BE is made equal to CG and the load line DE is drawn parallel to BG the operating point for the lower loop will be established at point D.

In the lower loop KO will be the current, KD represents the voltage across the diode and DL represents the IR drop in the primary loop. The sum of KD and DL equals the sum of the input voltage OB and the induced voltage BE. Therefore, the parameters of the circuit constrain its operation so that while the core flux is changing from W to X, as shown in the drawing of the hysteresis loop, the induced voltage CG will

Computer Aids Eye Research

Using an analog computer (AD-1-64PB), Dr. V. E. Kinsey (standing) and Dr. D.V.N. Reddy of Kresge Eye Institute, Detroit, determine by what means and in what quantities various substances are exchanged between the blood vessels and ocular chambers. The computer's ability to solve partial differential equations has shed new light on the mechanics of several therapeutic agents used in the treatment of ocular diseases. The computer was designed and built by Applied Dynamics, Inc., Ann Arbor, Mich.

remain constant. Thus, both the magnetizing current and the load current will remain constant. Consequently the difference in the primary currents, AK, will also be constant.

When the core saturates at point X on the loop, the induced voltage CG and BE decrease rapidly. The only way this can happen with the operating points remaining on the diode characteristic curve is for the difference between I_1 and I_2 to increase rapidly, and this can only be accomplished by I_1 increasing and I_2 decreasing. Thus, C will move toward P and D will move toward V. Also the operating point for the transformer core will move from X to Y.

Tunnel-Diode Characteristics Cause Instabilities Leading to Oscillation

When the peak and valley points are reached, $(I_1\text{-}I_2)$ can no longer increase because of the tunnel-diode characteristics; an unstable condition occurs. Very rapid transient conditions cause the operating point for the upper loop to shift from P to M and the lower loop to shift from V to N. Operation at these points requires that the induced voltage in the respective windings be reversed, which can be accomplished by a rapid decrease in $(I_1\text{-}I_2)$. Thus I_1 must decrease and I_2 must increase very rapidly, causing the operating point of the upper loop to move from M to L and the lower loop to move from N to C. During this time, the transformer-core operating point moves from Y to Z in the loop. When point Z is reached, the flux decreases from Z to U establishing a stable condition similar to the period while traversing the distance WX except that the induced voltages in the windings are now reversed. This condition will continue with the operating point for the lower loop at C and the upper loop at D, until the core saturates in the negative direction. Then, the circuit will quickly switch back to the initial conditions and complete one cycle, which will be repeated. Because the switching transient occurs rapidly, the load voltage will have a good ac-square-waveform. ■ ■

Accuracy Is Our Policy

The work being done by several companies to develop hydraulic logic devices is being carried on under license from the individual patent-holders of the basic hydraulic logic element, rather than under license from the Diamond Ordnance Fuze Laboratories, as stated in the article on pp 4 and 5 of the May 24, 1961 issue of *ED*.

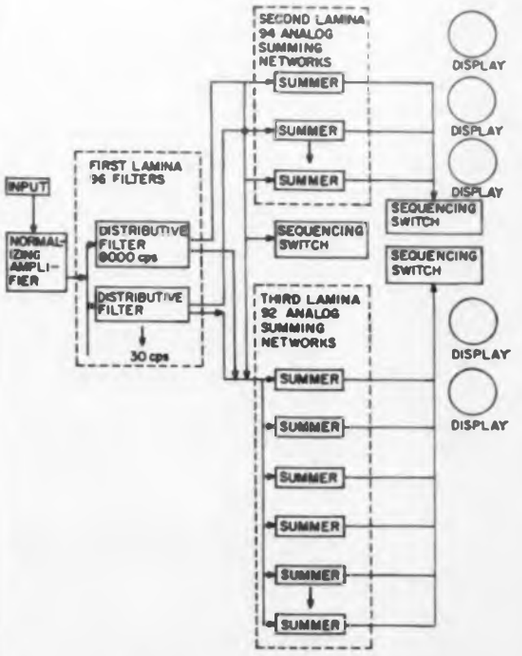
NEWS

Signal Analyzer To Simulate Ear

Analog Device Will Aid Study of Invariants in Speech

AN ANALOG dynamic-signal analyzer, nearing completion at the University of Illinois, is designed to permit study of speech waveforms by approximating the operation of the human ear. The device is said to be a multiple-tap transmission-line model of the ear.

Basically, the analyzer is a network of low-Q-tuned resonators coupled to provide oscilloscope displays of certain transients in speech-derived signals. The transients, it is hoped, would be those in the formants of speech that carry key information. The idea behind the device is that invariants of speech are characterized by the rate of change of formant parameters. This is why



Analyzer has been described as a multiple-tap transmission-line model of a portion of the ear. Its three main sections, or lamina, consist of filter or summer networks that reduce input signals into formants, take second and fourth derivatives, and display transient characteristics on scopes. Display from third lamina, it is hoped, would show speech invariants.

Printed-circuit board construction for analyzer is expected to simplify maintenance. Board at right is a high-speed gating circuit, board in foreground takes a derivative of an input signal.

the analyzer is designed to study signals in their transient, rather than their equilibrium, form.

The equipment, which occupies several large racks, functions by first normalizing incoming speech signals for amplitude. The normalized signals go to a bank of 96 distributed audio filters, which reduce them into formants. These filters, whose function resembles that of the lamina section of the ear, range in value from 30 to 8,000 cps.

Second and Fourth Derivatives Taken by Summing Networks

Each of the 96 filters is connected to three adjacent analog summers in a network of 94 units. The summing network takes a second derivative of the amplitude-vs-frequency curve of the incoming signals. Its effect is to sharpen the curves of the signals being passed by the filters. Each of the summers is connected to five other analog summers in another network designed to take the fourth derivative of its amplitude-vs-frequency input curves. The function of this network of 92 units is said to resemble that of the ear's basilar membrane, which, according to some theories, is believed to translate frequency information into nerve signals.

To study the signals processed by the analyzer, the university researchers have included sequencing switches at the outputs of all the individual filters and summers—one switch for each group, or lamina. The gates of these switches examine more than 90 inputs and 1 output at a rate of 1,200 per sec. The gates can examine half-millisec-

NEWS

Signal Analyzer . . .

(continued from p 33)

wide pulses in sequence going from a +6-v level to a −6-v level during the sampling time. Outputs from the sequencing switches are to be displayed on five oscilloscopes, which can be connected anywhere in the system.

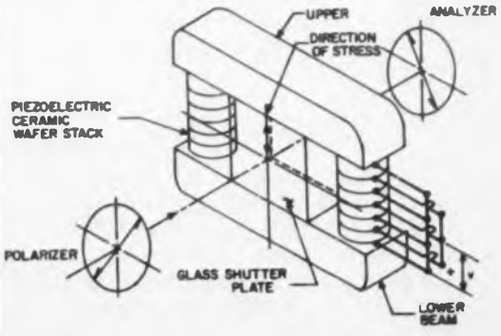
If the analyzer works as expected, it will provide invariants in speech that could be used to develop automatic speech-recognition systems, the researchers report. In such an application, the analyzer would function as a preprocessing input to an adaptive system. A similar but less complex analyzer under construction at the University of Arizona, and called a cochleagraph, is designed to process no further than the second derivative.

The Illinois device is expected to be completed in about two months and will cost about $15,000. ■ ■

Shutter Protects Eyes Against Nuclear Flash

A device to protect operators of optical equipment from nuclear flash blindness in the battlefield is under development.

The heart of the eye-protection device, designed at Electro-Optical, Inc., Pasadena, Calif., is a unit called a stressed-plate shutter. The shutter is placed in front of the objective end of a pair of binoculars or a



Strain from piezoelectric drivers is transmitted by rigid-beam assembly to the shutter plate. Strain in glass causes double refraction, which changes polarization of light beam passing through shutter plate.

Stressed-plate shutter, used in this experimental eye-protection device, can effectively close out the light from a nuclear flash in 0.0001 sec.

telescope. When a sensing device, developed by Edgarton, Germehausen & Grier, Inc. of Boston, detects a nuclear detonation, the shutter will close out the resultant flash in 0.0001 of a sec.

The stressed-plate shutter consists of an ordinary piece of glass plate mounted between a pair of rigid beams. Placed at either end of the beams are stacks of piezoelectric drivers. Voltage applied to these driver stacks causes them to expand or contract, depending upon the voltage polarity. This train is transmitted by the rigid-beam assembly to the shutter plate. Strain induced in the glass causes temporary double refraction, which changes the state of polarization of a light beam passing through the shutter plate.

If the shutter plate is mounted between a pair of crossed or parallel polarizers, and a modulation voltage is applied to the driver stacks, the light beam passing through the modulator will be modulated from a full-open to a full-close. The shutter is a mechanical analog of the Kerr cell.

The stressed-plate shutter is for use in the battlefield, since its relatively low operating requirement of 3,000 v can be supplied by batteries.

FRANCHISED SEMICONDUCTOR DISTRIBUTORS

EAST COAST

CONNECTICUT:
HARTFORD
SCELI ELECTRONICS, 78 Maple Avenue
JA 2-1144 Mr. Burton S. Prague

MARYLAND:
BALTIMORE
RADIO ELECTRIC SERVICE, 5 N. Howard St.
LExington 9-3835 Mr. John J. Bagliani

MASSACHUSETTS:
BOSTON
BENAMBRO RADIO SUP. CO., 1095 Commonwealth Ave.
ALgonquin 4-9000 Mr. Francis DeMambro
A. W. MAYER CO., 895 Boylston St.
COpley 7-5530 Mr. Henri Jappe

NEW YORK:
BUFFALO
GENESEE RADIO INC., 2550 Delaware Ave.
TR 3-9661 Mr. Frank Norwood
SUMMIT DISTRIBUTORS, INC., 916 Main St.
TT 4-3450 Mr. Geo. Saidman
METROPOLITAN NEW YORK
BOND ELECTRONICS, INC., 69-18 Roosevelt Ave.
Haymeyer 6-9718 Mr. Mel Fischer
FEDERATED PURCHASER, 1021 U.S. Rt. 22, Mountainside, N.J. ADams 2-8200 Mr. Wm. Kornhauser
H. L. DALIS, 35-35 24th St., Long Island City
EMpire 1-1100 Mr. Robert Ellenberger
MILO ELECTRONICS, 530 Canal St.
Beekman 3-2980 Mr. Robert Smith
TERMINAL HUDSON ELECTRONICS INC., 236 West 17th St.
CHelsea 3-5200 Mr. Manny Blumberg
ROCHESTER
MASLINE ELECTRONICS, 511 So. Clinton Ave.
HAmilton 6-0790 Mr. Edward Masline
VESTAL
FEDERAL ELECTRONICS INC., Vestal Highway
PI 8-8211 Mr. Frank Rinaldi

NEW JERSEY:
CAMDEN
RADIO ELECTRIC SERVICE CO., 513 Cooper St.
WOodlawn 4-2830 Mr. Tony Sofka

PENNSYLVANIA:
McKEESPORT
McKEESPORT ELECTRONICS INC., 1661 5th Ave.
ORchard 8-5111 Mr. Robert Alm
PHILADELPHIA
ALBERT STEINBERG & CO., 2520 N. Broad St.
BA 3-9400 Mr. Len Steinberg
RADIO ELECTRIC SERVICE, 701 Arch St.
WAlnut 5-5840 Mr. Ted Finestein, Contact Man
PITTSBURGH
RADIO PARTS CO., 6401 Pennsylvania Ave.
EM 1-4600 Mr. Jack J. Gerson
READING
THE GEORGE D. BARBEY CO., INC., 333 N. 4th St., P.O. Box 2
FRanklin 6-7451 Mr. Lee Wentzel
STATE COLLEGE
ALVO ELECTRONIC DISTR., 103 South Pugh
ADams 8-6277 Mr. T. Baker

WASHINGTON, D. C.:
CAPITOL RADIO WHOLESALERS, 2120 14th St. N.W.
HObart 2-0800 Mr. Clint Williams
ELECTRONIC WHOLESALERS, 2345 Sherman Ave., N.W.
HUdson 3-5200 Mr. J. B. Ford
KENYON ELECTRONICS, 1310 Apple Ave., Silver Springs, Maryland JUniper 8-6830
Mr. Joseph Walker

CENTRAL

ILLINOIS:
CHICAGO
ALLIED RADIO, 100 N. Western Ave.
TAylor 9-9100 Mr. B. Cramer
NEWARK ELECTRONICS CORP., 223 W. Madison
ST 2-2950 Mr. Francis McAllister
OAK PARK
MELVIN ELECTRONICS, 541 Madison St.
EUclid 3-5800 Mr. George Iden

INDIANA:
INDIANAPOLIS
GRAHAM ELECTRONICS SUPPLY CO., 122 S. Senate Ave.
ME 4-8486 Mr. Gordon Graham
RADIO DISTRIBUTING CO., 814 N. Senate Ave.
MElrose 7-5571 Mr. Lee Harrell

IOWA:
CEDAR RAPIDS
DEECO, INC., 618 First Street, N.W.
EMpire 5-7551 Mr. Arnie Jacobs

MICHIGAN:
ANN ARBOR
WEDEMEYER ELECTRONIC SUP. CO., 215 N. Fourth Ave.
NO 7-4457 Mr. Barrett Stimpson
DETROIT
GLENDALE ELECTRONIC SUP., 12350 Hamilton Ave.
TUlsa 3-1500 Mr. Lou Sterling
GRAND RAPIDS
INDUSTRIAL ELECTRONIC SUPPLY, 704 Jefferson Avenue, S.E.
CHerry 1-5695 Mr. William Little

MINNESOTA:
MINNEAPOLIS
NORTHWEST ELECTRONICS CORP., 52 So. 12th St.
FE 8-7551 Mr. E. G. Peterson
ST. PAUL
GOPHER ELECTRONICS, 370 Minnesota St.
CApitol 4-5666 Mr. Mac Bryan

MISSOURI:
KANSAS CITY
RADIO LAB INC., 1812 Grand Ave.
HA 1-0171 Mr. Ernie Krahenbuhl
ST. LOUIS
ELECTRONIC COMPONENTS FOR INDUSTRY, 2427 Brentwood Street
WOodland 2-9817 Mr. Boss Woosely
EDINGER INDUSTRIAL ELECTRONICS, 2507 So. Jefferson
PRospect 1-2900 Mr. John Devereaux

OHIO:
CINCINNATI
UNITED RADIO, 1314 Vine St.
CH 1-6530 Mr. John Cox
CLEVELAND
PIONEER ELECTRONIC SUP., 2115 Prospect Ave.
SUperior 1-9411 Mr. Wm. C. Pimenka
WINTERRADIO ELECTRONIC SUPPLY CORP., 1468 W. 25th Street
Maine 1-9383 Mr. Jack Langner
DAYTON
SREPCO, 314 Lee St.
BAldwin 4-3871 Mr. F. O. Arnold
TOLEDO
WARREN RADIO CO., Box 1004-1002 Adams St.
CH 8-3364 Mr. Ken Rosmeyer

WISCONSIN:
MILWAUKEE
RADIO PARTS CO., 1314 N. Seventh St.
BRoadway 6-4180 Mr. S. Jordan

WESTERN

COLORADO:
DENVER
L. B. WALKER CO., 300 Bryant St.
WEst 5-2401 Mr. J. H. Bevington

KANSAS:
WICHITA
INTERSTATE ELECTRONIC SUPPLY CORP., 230 Ida St.
HObart 4-6318 Mr. Lyle Darling, Contact Man

SOUTHERN

ALABAMA:
HUNTSVILLE
CURLE RADIO SUPPLY CO., 101 Winston Street
JEnnings 6-9689 Mr. W. W. Durham
BIRMINGHAM
FORBES ELECTRONICS DISTR., 2610 3rd Ave. South
ALpine 1-4104

FLORIDA:
ORLANDO
HAMMOND ELECTRONICS INC., 533 W. Central
GArden 5-0511 Mr. Raney Woods

GEORGIA:
ATLANTA
SPECIALTY DISTRIBUTING CO., 763 Juniper Street
TR 3-2521 Mr. Ted Cape

NORTH CAROLINA:
WINSTON-SALEM
DALTON-HEGE INC., 938 Burke St.
PArk 5-8711 Mr. Ivey Redman

SOUTH CAROLINA:
GREENVILLE
CAROLINA RADIO SUP. CO., 721 W. Washington St.
CEdar 2-6740 Mr. Russ Sutton

OKLAHOMA:
TULSA
RADIO INC., 1000 S. Main St.
LUther 7-9124 Mr. B. H. Keller

TENNESSEE:
KNOXVILLE
CHEMCITY RADIO & ELECTRIC CO., 2211 Dutch Valley Road
MU 7-3530 Mr. Harold Fee
NASHVILLE
RANDOLPH & BICE INC., 1213 McGavock Street
ALpine 5-5601 Mr. Earl W. Bice

TEXAS:
DALLAS
ALL STATE ELECTRONICS, INC., 2411 Ross Ave.
RI 1-3281 Mr. Homer Warlick
WHOLESALE ELECTRONICS INC., 2800 Ross Ave.
Riverside 8-5736 Mr. John Leadom
EL PASO
MIDLAND SPECIALTY CO., 509 W. Parsons Drive
KE 3-9555 Mr. Ed Loya
HOUSTON
LENERT COMPANY, 1420 Hutchins St.
CApitol 4-2663 Mr. Jack Roberts
SAN ANTONIO
SHERMAN ELECTRONIC SUPPLY INC., 722 San Pedro
CA 6-0247 Mr. W. H. Sherman

PACIFIC

ARIZONA:
PHOENIX
SOUTHWEST ELECTRONIC DEVICES, INC., 129 E. Jefferson St., P.O. Box 3751 Mr. Herman Middleton 252-7121

CALIFORNIA:
GLENDALE
R. V. WEATHERFORD, 6921 San Fernando Blvd.
Victoria 9-2471 Mr. Leo Porchia
INGLEWOOD
NEWARK ELECTRIC, 4747 W. Century Blvd.
ORchard 8-0441 Mr. Lee Goodman
NORTH HOLLYWOOD
RICHEY ELECTRONICS, 10818 Burbank Blvd.
Poplar 1-5133 Mr. Howard Richey
LOS ANGELES
FEDERATED PURCHASER, 11820 W. Olympic Blvd.
BRadshaw 2-8771 Mr. I. Krone
OAKLAND
DRILL SEMICONDUCTOR CORP., 810 E. 10th St.
TE 2-6100 Mr. Ralph Seitz
ELMAR ELECTRONICS INC., 140 11th St.
TE 4-3311 Mr. Peter Folini
PASADENA
ALLIED RADIO OF CALIF., 2085 E. Foothill Blvd.
SYcamore 5-5901 Mr. Don Dresser
SAN DIEGO
RADIO PARTS CO., 2060 India St.
BEimont 9-9361 Mrs. Georgette Young
SAN FRANCISCO
FORTUNE ELECTRONICS, 1321 Mission St.
UNderhill 1-2434 Mr. Roger Bates
SAN JOSE
PENINSULA ELECTRONICS, 456 So. 1st St.
CY 4-3594 Mr. William Lezchuck

UTAH:
SALT LAKE CITY
KIMBALL DISTRIBUTING CO., 350 Pierpont Ave.
EM 3-5813 Mr. Richard Roberts

WASHINGTON:
SEATTLE
W. S. CONNELLY CO., 1015 Republican St.
MA 4-4155 Mr. Danny Reirom

CIRCLE 37 ON READER-SERVICE CARD

EDITORIAL

Engineering Meetings: Room For Improvement

Are engineering-society-sponsored meetings really worthwhile? To this perennial question the answer usually is, "Yes, BUT . . ." The "but" often is supplemented by: "The papers could have been so much more worthwhile if . . ."

Some of the papers at the Electron Devices Meeting in Washington, D. C., Oct. 26-28, seemed to be clouded by the "company proprietary" issue.

We will be the first to grant that there are good reasons in some cases for a manufacturer to withhold information on an in-house process or device. One wonders, though, if this procedure is not being abused.

We have heard engineers speculate that a "new advanced process" will prove to be so simple—even nontechnical in nature—that it is kept secret merely to avoid the embarrassment of explanation.

There are other factors to consider. The solid-state industry, for example, has not yet attained the point in its life cycle equivalet to that of the tube industry. Thus we get a much more frank interchange of information in the latter field. "There are no secrets in the tube business" is an oft-repeated, if not entirely accurate, cliche.

In the end, one wonders whether withdrawal of a paper is not the best solution for both company and author when a large portion of the announcement must be couched in generalities. And what of the engineer attending the conference? Is it proper to entice him to a meeting, at an expense both in time and money, and expect him to listen to product "pitches" lacking technical explanations?

Finally, a note on the speaker's question-and-answer period. The speaker can greatly improve its value by:

- Making clear in his presentation which part of his work is theoretical and which has been reduced to practical experimentation. This avoids answers beginning, "I didn't mean to mislead you, but we haven't actually tried that yet . . ."
- Making clear, in the paper itself, that certain items are proprietary and cannot be discussed in more detail.
- Anticipating basic questions arising from his disclosure. In the case of a device, it is fairly obvious that even another device man will be interested in its ultimate applications. This might warrant a back-up talk by an associate who is oriented toward applications.

Generally speaking, we thought the Electron Devices Meeting was well-conducted, timely and interesting. Fortunately, engineers always seem to find room for improvement.

Donald Christiansen

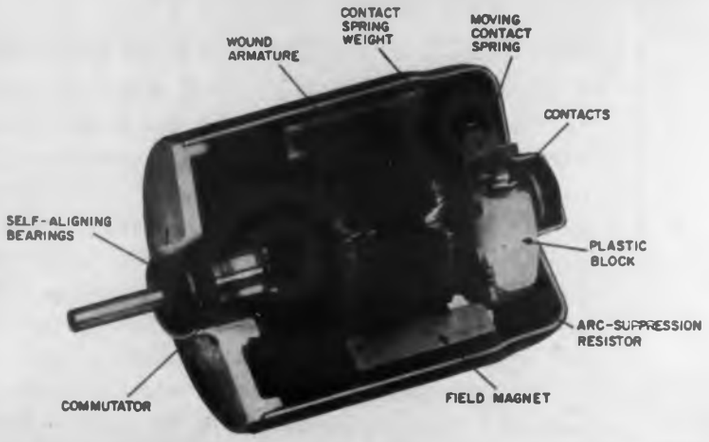


Fig. 1. Governor components in integral-governor motor are mounted on a plastic disk and rotate with the armature.

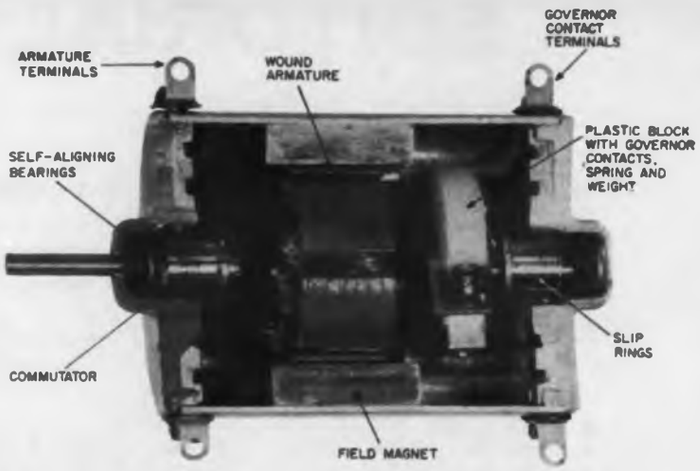


Fig. 3. Slip-rings are added in series-type governed motor through which governor contacts are brought out.

Guidelines for Selecting Battery-Operated Governed Motors

Millihorsepower, battery-operated motors, with few exceptions, require governed operating speeds. R. K. Warnimont presents information useful for the designer who has to select and apply these governed motors in his electronic equipment.

R. K. Warnimont
Chief Application Engineer
Barber-Coleman Co.
Rockford, Ill.

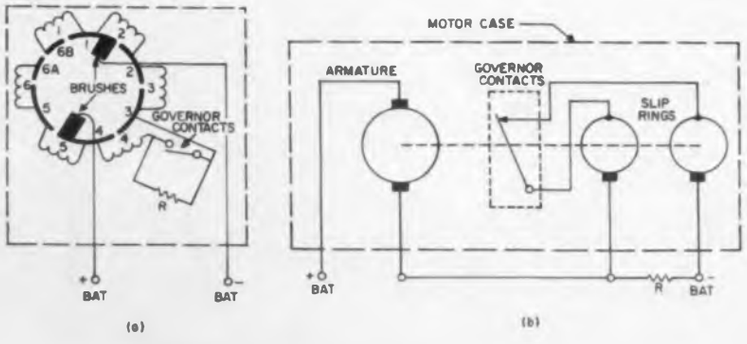


Fig. 2 (a). Integral-governor motor has governor contacts wired directly to the armature coils. **(b)** External, series-type governed motor has governor contacts brought out to separate terminals through slip rings.

SMALL, battery-operated governed motors may be classified according to whether the governor contacts are electrically integral with, or external to, the armature circuit.

In both cases the governor contacts are fastened to, and rotate with, the armature. Also, an arc-suppression resistor invariably is connected across the contacts to minimize contact wear and to reduce radio-frequency interference. The resistor is necessary because the high inductance of the armature may produce breakaway currents of hundreds of milliamps.

In the integral governor, Fig. 1, the contacts are connected directly in series with one of the armature circuits, as shown in Fig. 2a. The governor components, mounted on a plastic disk, rotate with the armature. These components include the contacts, a speed-calibration screw (not always supplied), and the arc-suppression resistor.

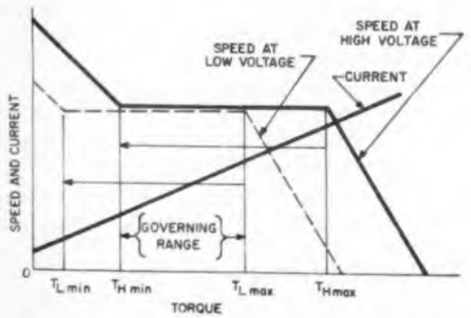


Fig. 4. Governing range shifts as applied voltage varies. Maximum governed range lies between minimum torque at highest voltage and maximum torque at lowest voltage.

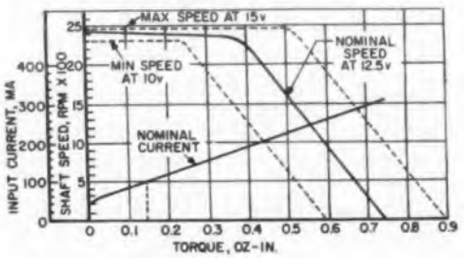


Fig. 5. Motor torque-speed curves show that applied voltage sharply affects torque range, as well as governed speed.

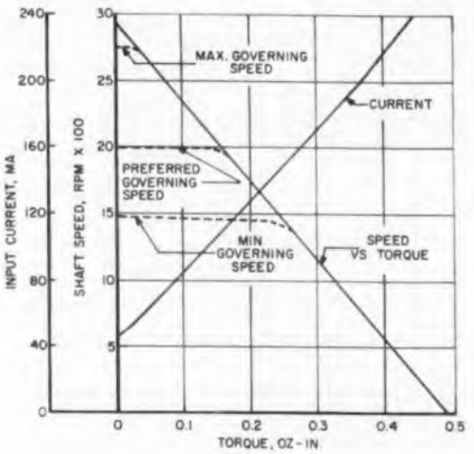


Fig. 6. Every motor has a "preferred" governing speed at which motor efficiency is highest. A higher speed reduces the governed load range.

Motors having integral governors generally consist of from three to six commutator segments, and the rotors are designed with a corresponding number of poles. The electrical connections are made directly on the armature; hence, only the two brush terminals are external. To operate these motors ungoverned in one direction requires a directional-sensitive switch to bypass the governor contacts.

The external governor, Fig. 3, has its contacts armature-mounted, but connections are made through a commutator, brushes and two external terminals, as shown in Fig. 2b. In this case, the resistor may be mounted outside the motor. Advantages claimed for the external, or series, governor are (1) improved utilization of rotor copper and (2) easier suppression of radio interference generated by brushes and governor contacts.

In some applications, such as tape recorders, the motor may be operated either governed or ungoverned, by bypassing the governor with a single-pole, single-throw switch.

Torque-Load Range Set by Motor Design

The governed torque range of these small battery-driven motors is a direct function of the applied voltage and the motor winding.

The maximum load that can be governed occurs at the point at which the contacts just remain closed; minimum governed load is at the point at which the contacts just remain open. For a motor operating at its highest voltage (as when the batteries are new), this governing range is indicated in Fig. 4 between the points of T_{Hmax} and T_{Hmin}. As the battery voltage decreases to its lowest permissible level, both maximum and minimum governed torques decrease and the speed-torque curve in Fig. 4 shifts to the left (dashed lines). Also, as the battery voltage decreases, the average governed speed usually drops slightly.

For these reasons, the use of the motor is limited by the minimum torque at the highest working voltage and the maximum required torque at the lowest (T_{Hmin} to T_{Lmax}). Usually, the motors are designed so that minimum operating torque is no-load torque, as shown in Fig. 5. There is no reason, however, why a specific governed range cannot begin with a minimum torque higher than no-load, such as shown in Fig. 4.

Optimum Governed Speed Depends on Motor Curves

From curves, such as shown in Fig. 5, the range of operating torque should fall between no-load at maximum voltage (T_{Hmin}) and maximum torque at minimum voltage (T_{Lmax}), in this case about 0.2 oz-in. The drop in governed speed with voltage also must be considered. If it is outside required limits, a new motor design may have to be considered.

The importance of matching the motor to the load cannot be overemphasized. The torque-speed curves of Fig. 6, for example, show that there is a preferred governing speed at which performance will be optimal. If adjusted to run faster than the preferred speed, the governing torque range is greatly reduced. At lower speeds, the governing range is extended somewhat, but governing characteristics and electrical efficiency may not be optimal. Reduced efficiency means higher battery drain and consequent reduced battery life. In general, motors can be designed to govern over a wide range of speeds.

On most inexpensive motors, governed speed cannot be changed because they include no means for adjustment. On more expensive motors, an access hole and an adjusting screw permit adjustment either of the contacts or of the tension on the governor spring.

If the initial adjustment falls in the middle of the specified operating range, governed speed can be adjusted about ±15 per cent of this value. Thus, for a 2,400-rpm motor, lowest recommended governed speed would be 2,000 rpm, while highest would be 2,800. If the desired speed is near the limit of the governor adjustment, another motor should be selected to provide the best efficiency. This involves a change in armature-wire size, governor springs or weights.

Sample Motor Tests Determine Required Torque

When specifying a governed motor, a common method of determining required torque seems to be an educated—but frequently incorrect—guess. The problem is that in typical applications of these millihorsepower

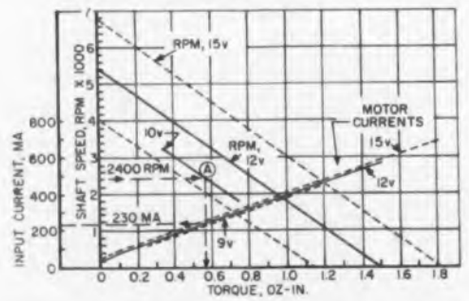


Fig. 7. Typical curves for a nongoverned motor can be used to determine torque for known values of speed, applied voltage and armature current.

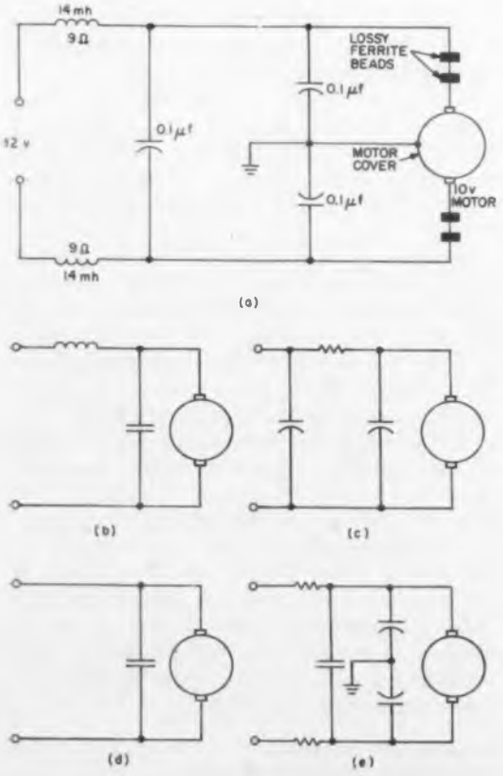


Fig. 8. Noise suppression circuits may use complete filtering arrangement of (a), or less complicated circuits of b-e.

motors, the torque loss due to driving-belt or pulley friction, or gears, frequently can be larger than that of the driven element. Consequently, calculations are seldom useful. Thus, if a precision dynamometer is not available, the following practical and reasonably accurate methods for determining torque are recommended.

The first method uses a sample motor having a relatively wide governed-torque range at the speed and voltage of interest.

Mount the motor in the prototype device and apply the nominal operating voltage at the motor terminals. Now, from the motor curves, read off the torque at the measured armature current. For example, from Fig. 5, with the motor operating at 12.5 v and drawing 100 ma, the vertical dropped from the intersection of 100 ma and the nominal current curve intersects the torque axis at approximately 0.15 oz-in. (Be sure to check that operation is at governed speed.)

The second, and somewhat more precise, method of torque determination, uses an ungoverned motor (or a governed motor with the contacts shorted), together with its typical curves.

Apply voltage to the motor and increase it until the motor reaches and stabilizes at the desired operating speed. Use a stroboscope or other speed-measuring instrument that will not impose any added load. As an example, in Fig. 7, let us assume that required speed is 2,400 rpm, voltage at the motor terminals is 10 v, and current drawn is somewhat over 200 ma. On the motor curves, interpolate the 10-v value, as shown. From the intersection of 2,400 rpm and 10 v (point A), drop a vertical to the torque axis. It intersects at approximately 0.56 oz-in. of torque. This is double-checked by reading the current (about 230 ma).

As torque on the driven element is varied between assumed maximum and minimum loading conditions, it will be reflected in a change of both the voltage and current required to drive the motor at 2,400 rpm. Torque thus can be determined for several pairs of these values. By providing the motor designer with a tabulation of these results, he is in a position to provide the most efficient motor for the job.

Standard Mounting and Coupling Reduce Motor Costs

Motor costs can be minimized by specifying the motor with standard terminals (no special leads) and without special markings, mounting flanges or brackets. Here, the user can save money by adapting his mounting to standard motor designs. Most motor manufacturers provide mounting holes on the housing. Another low-cost, frequently applied method is to use a large spring clip lined with sponge rubber. To mount, the motor simply is snapped into place. If required, the open ends of the clip can be secured with a simple fastener. Advantages of this mounting lie in freedom of motor movement, protection of motor against shock, and, most important, reduction of mechanical noise. Examples of these snap-in clip mountings are found in tape recorders and dictating machines.

Where a gear train is required, the motor must be mounted accurately to mesh the pinion with the driven gear. Precise means for locating the motor must be provided and, in some cases, the front end of the motor housing strengthened to withstand the load.

Methods for coupling the motor to the load vary with the application. To minimize mechanical noise and to dampen any wow, jitter or flutter, compliant belts or friction drives often are used. Belt pulleys should be spring-loaded to minimize vibration and armature-end play.

In applications requiring gears, nylon or its equivalent frequently are specified to reduce noise and to provide self-lubrication at low cost.

Motors are available with either ball or sleeve-type bearings. The sleeve type permits resilient mounting and is inherently quieter, but ball bearings can give more uniform performance throughout the motor life. Sleeve bearings can maintain closer alignments at tolerable prices. Ball bearings can provide equivalent precision, but they may frequently cost more than the entire motor.

Electrical Interference Must Be Reduced, Suppressed

Because of the sparking inherent in both commutator and governor contacts, interference becomes a problem in many applications having sensitive circuitry. While filtering is the first answer, sources of noise unique to these devices should be checked carefully.

For example, armature concentricity and balance play an important role. Out-of-roundness or imbalance cause brush bounce and excessive sparking at the commutator. Also, brush material should have a low resistance, as well as optimal frictional characteristics. Silver graphite or copper graphite are excellent for such use.

It has been found that electrical noise is generated when the armature slaps back and forth inside the housing. This may be due to excessive end play or to unbalanced forces on the motor shaft. For this reason, pulleys, belts and gears should be arranged so that the armature will seek a neutral position while running and maintain it. This, of course, is an important consideration for mounting and coupling.

The batteries driving the motor also may be a source of electrical noise. That one battery is "noisier" than another may be a function of internal impedance and structure. It is well for the designer to consider a variety of battery types to be sure he has specified the best.

Probably the most important noise-reducing factor is to place the motor away from high-gain circuits. Shielding the motor with a soft iron case is good design practice, but more frequently it is a matter of putting the motor in a shielded location. Usually, the shield need not be an integral housing, but simply a conducting barrier between the motor and the "hot" circuitry.

Adequate Leads, Suitable Ground Paths Important

In all cases, it is important to provide leads of adequate size and to insist on low-resistance and low-impedance ground paths. In addition, leads to and from the motor should be filtered and shielded, as indicated in Fig. 8. Do not use tubular capacitors for filters, but install wafer types. Best of all, use feed-through types, installing them in the barrier shield.

Motor leads should be shielded. However, they may be left open if they are kept as short as possible in unshielded areas, and if they are separated from amplifier circuits.

Grounding the motor case should be standard practice. But what is usually not realized is that the motor shaft extending outside the case frequently acts as a high-frequency radiator. Grounding the shaft with a cat whisker eliminates this antenna effect.

Another handy trick is the use of lossy ferrite beads, which are slipped over the motor leads close to the motor housing. These beads sharply attenuate the higher frequencies and substantially reduce this radiation.

In still other cases, a change in the value of governor shunt resistor or capacitor can have a marked effect on attentuation of sharp voltage pips on contact break. It is well to consult the motor manufacturer if unusual noise problems are encountered. ■ ■

Printed-Circuit Boards: A Guide to Fabricating Techniques

Lockheed Aircraft's Missiles and Space division, a heavy user of printed-circuit boards, undertook an evaluation of board-manufacturing methods. In this two-part series, author Prise presents, first, the step-by-step fabrication procedures and, in part 2, the survey's findings and recommendations.

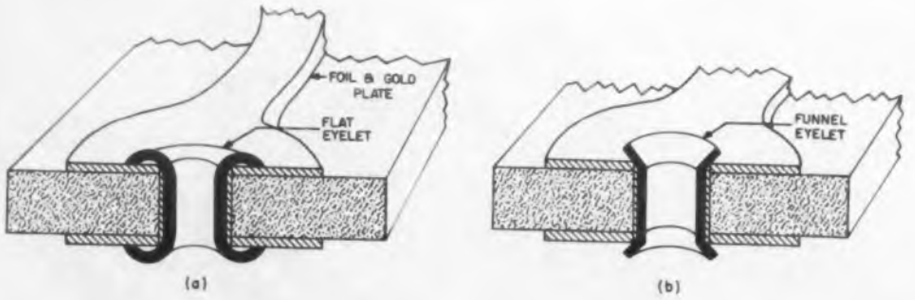


Fig. 1. Process A—Conductive pattern of photoetched board is solder-coated, with either (a) flat or (b) funnel eyelets placed in drilled holes.

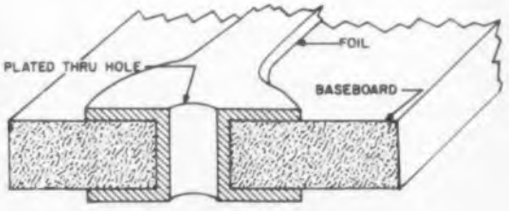


Fig. 2. Process B—Conductive pattern of photoetched board is gold-plated; plated-thru hole is used.

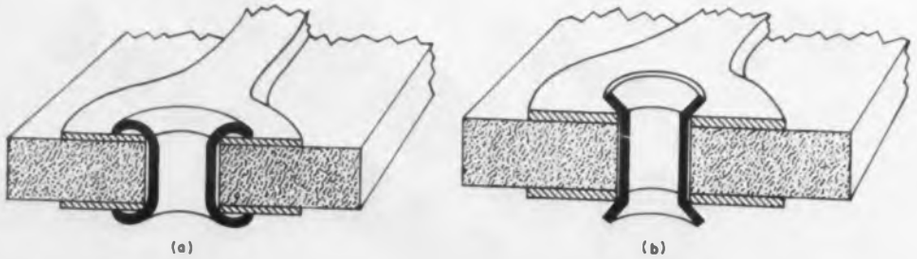


Fig. 3. Process C—Completed board of process B has either (a) flat or (b) funnel eyelets added to it.

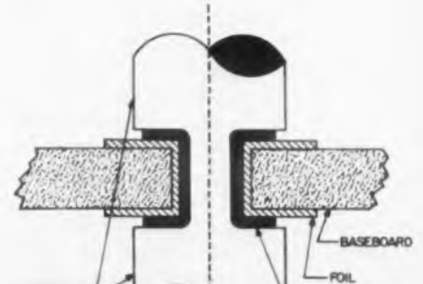


Fig. 4. Process D—Eyelets are resistance fused to the conductive pattern which has been prepared as in process A.

Part 1 of a
Two-Part Series

Walter J. Prise
Design Specialist
Missile & Space Div.
Lockheed Aircraft Corp.
Sunnyvale, Calif.

A PRINTED-CIRCUIT board basically consists of a conductive foil affixed to a dielectric baseboard. This conductive pattern may be deposited on either one or both sides of the board. Further, either or both sides of the board may have electronic components attached and, often, the opposite sides of the board are interconnected electrically.

There are certain characteristics a well-manufactured printed-circuit board should have. The baseboard should be:

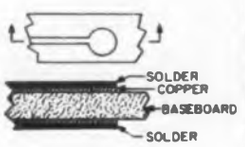
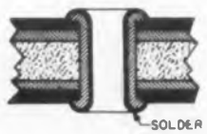
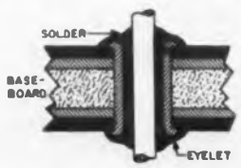
(1) high in insulation resistance
(2) machinable
(3) impervious to moisture, vibration, fungus, shock and temperature changes
(4) homogenously constructed
(5) light in weight

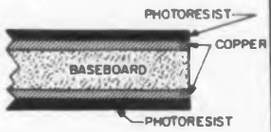
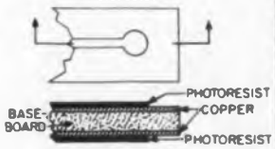
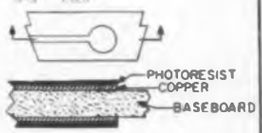
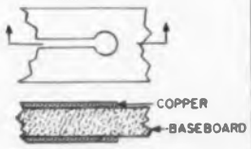
The conductive pattern should be:

(1) a good conductor
(2) easy to machine and drill
(3) easy to solder-coat or plate
(4) uniform in thickness, width and surface finish
(5) non-corrosive
(6) non-magnetic
(7) strongly bonded to the baseboard

Fabrication Procedures for Printed-Circuit Boards

Process A—Solder-Coated, Eyeletted

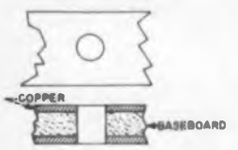
Process Step	Potential Problems
A-11 Dip Solder 	A-11 (a) Warping of board. (b) Insufficient coverage by solder. (c) Poor adhesion between solder and copper. (d) Blistering. (e) Wrong solder. (f) Impurities in solder. (g) Excess of solder. (h) Contamination of solder joint. (i) Solder in holes.
A-12 Drill Holes 	A-12 (a) Mechanical contamination of boards by dust. (b) Defects in drill pattern may affect registration between sides of boards. (c) Inadequate and improper drills, drilling techniques.
A-13 Remove Dust by Vacuum	
A-14 Install Eyelets & Terminals 	A-14 (a) Cracking of eyelets. (b) Denting of base board. (c) Pressure too high or too low. (d) Loose contacts. (e) Oxidation of eyelets. (f) Breaking of conductive foil. (g) Uneven setting of eyelet. (h) Dirty eyelets.
A-15 Flux & Dip Solder 	A-15 (a) Temperature too high or too low. (b) Remnants of solder in holes and boards. (c) Contamination of solder. (d) Lack of adhesion. (e) Dirty eyelets. (f) Incomplete solder penetration between eyelet and conductive foil.
A-16 Install Component Leads	A-16 (a) Improper mounting. (b) Lack of mechanical strength in joint. (c) Poor electrical contacts between components and solder. (d) Cracking of lead wire. (e) Poor soldering due to oxidation of leads. (f) Undesirable stressing of components.
A-17 Dip Solder Components 	A-17 (a) Dirty (or oxidized) component leads. (b) Poor tinning of leads. (c) Poor condition of solder—excessively low or high temperature. (d) Overheating of board. (e) Poor solder penetration around barrel of eyelet. (f) Warping of boards. (g) Breaking of conductive foil. (h) Wrong type of solder.
A-18 Install Components Opposite Side	
A-19 Hand Solder Components Opposite Side	

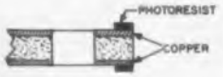
Process Step	Potential Problems
A-1 Apply Photoresist 	A-1 (a) Contamination of resist by impurities in air. (b) Uncoated spots on surface. (c) Poor adhesion between resist and board. (d) Uneven thickness of resist coating.
A-2 Develop & Remove Photoresist 	A-2 (a) Looseness between board & negatives. (b) Loss of vacuum. (c) Insufficient exposure time. (d) Residue of removal chemical remaining on board. (e) Incomplete removal of resist.
A-3 Apply Photoresist Dye	A-3 (a) Incomplete coverage of area by dye.
A-4 Retouch	A-4 (a) Omission of areas in retouching. (b) Incorrect use of brush, ink, etc.
A-5 Etch 	A-5 (a) Inadequate solution. (b) Overetching. (c) Underetching. (d) Impurities in solution. (e) Contamination of baseboard. (f) Undercutting.
A-6 Wash Boards	A-6 (a) Residue of etchant remaining. (b) Insufficient washing time.
A-7 Remove Photoresist with Thinner 	A-7 (a) Residue of resist remaining on copper. (b) Contamination of copper foil and base board. (c) Contamination causes lack of wetting for soldering. (d) Poor solderability due to contaminated surface.
A-8 Trim & Route	A-8 (a) Delamination of base board. (b) Split between copper foil and base board. (c) Impurities left from this process contaminate board.
A-9 Vacuum & Clean Board	A-9 (a) Impurities in cleaning solvent get into board. (b) Contamination of board by cleaning solvent.
A-10 Flux	A-10 (a) Uneven application. (b) Voids and cracks in flux coating.

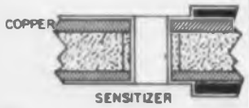
Process C—Gold-Plated, Through-Hole Plus Eyelet

Process B—Gold-Plated, Through-Hole

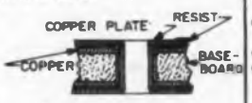
Process Step	Potential Problems
B-1 & C-1 Drill Holes	B-1 & C-1 (a) Poor registration of holes due to misalignment. (b) Rough edges in hole. (c) Delamination of baseboard. (d) Mechanical contamination. (e) Resist penetration into hole. (f) Splitting between foil and board. (g) Damage to leads and conductive foil. (h) Wrong drill and drilling technique.
B-2 & C-2 Remove Dust by Vacuum	B-2 & C-2 (a) Insufficient time in vacuuming operation. (b) Contamination by dust.
B-3 & C-3 Apply Photoresist	B-3 & C-3 (Same as A-1) (a) Contamination of resist by impurities in air. (b) Uncoated spots on surface. (c) Poor adhesion between resist and board. (d) Uneven thickness of resist coating.
B-4 & C-4 Develop & Remove Photoresist	B-4 & C-4 (Same as A-2) (a) Looseness between board & negatives. (b) Loss of vacuum. (c) Insufficient exposure time. (d) Residue of removal chemical remaining on the board. (e) Incomplete removal of resist.
B-5 & C-5 Apply Photoresist Dye	B-5 & C-5 (Same as A-3) (a) Incomplete coverage of area by dye.
B-6 & C-6 Retouch	B-6 & C-6 (Same as A-4) (a) Omission of areas in retouching. (b) Incorrect use of brush, ink, etc.
B-7 & C-7 Soak in Cleaning Tank	B-7 & C-7 (a) Polution of tank due to poor condition of solvent and boards.
B-8 & C-8 Insert into Sensitizing Solution	B-8 & C-8 (a) Contamination by impurities in air. (b) Uneven coating of sensitizer. (c) Lack of adhesion between sensitizer and base board. (d) Chemical reaction between resist and sensitizer. (e) Chemical reaction between copper and sensitizer. (f) Chemical reaction of sensitizer with base board.
B-9 & C-9 Rinse in Tap Water	B-9 & C-9 (a) Incomplete rinse. (b) Residue remaining on surface.
B-10 & C-10 Dip in Hot Water	

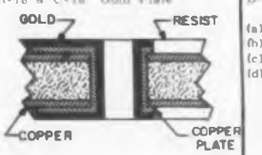


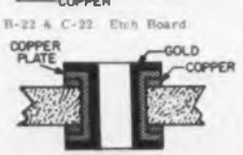




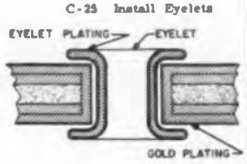
Process Step	Potential Problems
B-11 & C-11 Spray on Conductive Coating (Silver Solution) & Reducing Solution	B-11 & C-11 (a) Incomplete coverage (b) Improper solution (c) Poor adhesion (d) Contamination.
B-12 & C-12 Rinse	
B-13 & C-13 Rack Parts	B-13 & C-13 (a) Physical damage due to rough handling of boards.
B-14 & C-14 Copper Plate	B-14 & C-14 (a) Lack of adhesion of copper to base board. (b) Voids in coating. (c) Uneven coating of copper.
B-15 & C-15 Remove Plating Solution	
B-16 & C-16 Cyanide Dip	B-16 & C-16 (a) Contamination.
B-17 & C-17 Rack Board	
B-18 & C-18 Gold Plate	B-18 & C-18 (a) Insufficient thickness of gold. (b) Poor adhesion. (c) Voids on surface. (d) Contamination by chemical remaining on surface after insufficient cleaning, washing, etc.
B-19 & C-19 Remove Gold-Plating Solution	
B-20 & C-20 Rinse	B-20 & C-20 (a) Insufficient rinsing time may lead to contamination of boards. (b) Chemical reaction with parts of the board.
B-21 & C-21 Remove Photoresist	B-21 & C-21 (a) Incomplete removal will affect etching; leads to creation of "islands" of leftover copper metal.
B-22 & C-22 Etch Board	B-22 & C-22 (a) Undesirable etching due to void in gold coating. (b) Overetching. (c) Underetching. (d) Contamination, etc. (e) Undercutting.
B-23 & C-23 Wash	B-23 & C-23 (a) Incomplete washing will contaminate boards and components after installation.

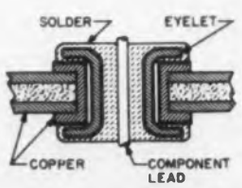




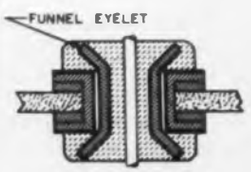


Process Step	Potential Problems
B-24 & C-24 Trim	B-24 & C-24 (a) Mechanical contamination. (b) Bad surface after cutting or trimming. (c) Improper handling of tools. (d) Poor tools. (e) Splitting of laminated baseboard.
C-25 Install Eyelets	C-25 (a) Loose eyelet. (b) Cracking of supporting metal. (c) Splitting of gold from copper foil. (d) Cracking of eyelet. (e) Hidden defects in the joint. (f) Poor contact between eyelet and conductive foil. (g) Oxidation of eyelets.
B-25 & C-26 Flux & Dip Solder	B-25 & C-26 (Same as A-14) This step is omitted if gold coating is necessary on finished board. (a) Cracking of eyelets. (b) Identing of base board. (c) Pressure too high or too low. (d) Loose contacts. (e) Oxidation of eyelets. (f) Breaking of conductive foil. (g) Uneven setting of eyelet. (h) Dirty eyelets.
B-26 & C-27 Install Components	B-26 & C-27 (Same as A-15) (a) Temperature too high or too low. (b) Remnants of solder in holes and boards. (c) Contamination of solder. (d) Lack of adhesion. (e) Dirty eyelets. (f) Incomplete solder penetration between eyelet and conductive foil.
B-27 & C-28 Flux & Dip Solder Component Leads	B-27 & C-28 (Same as A-16) May be omitted for the same reasons as B-26. (a) Improper mounting. (b) Lack of mechanical strength in joint. (c) Poor electrical contacts between components and solder. (d) Cracking of lead wire. (e) Poor soldering due to oxidation of leads. (f) Undesirable stressing of components.
C-29-1 Hand Solder Components	
B-28 & C-30 Install Components Opposite side	
B-29 & C-31 Hand Solder Components	





C-31-1



C-31-2

Part 2 of this series, "Printed-Circuit Boards: An Evaluation of Fabricating Techniques" will appear in the Dec. 6 issue.

Process D—Resistance-Fused Eyelet

Process Step	
D-1 to D-12 Titles & Description of Steps are Identical with A-1 to A-12	D-16 - Same as A-14.
	D-17 - Same as A-15
D-13 - Installation of eyelets (eyelet must be plated before installation)	D-18 - Same as A-16
	D-19 - Same as A-17
D-14 - Fusing of Eyelets	
	D-20 - Same as A-18
D-15 - Installation of Terminals Same as A-13 if other than resistance fusing process is used.	

Interconnections such as eyelets, which penetrate the board, must provide a strong mechanical and electrical bond with the conductive patterns. This penetrating connection also should not change the patterns' mechanical and electrical characteristics.

On an assembled board, components must be firmly attached. Good electrical connection must be made between component leads and conductive patterns. And, the whole assembly should be impervious to fungus growth, electrolytic corrosion, short circuit or mechanical damage and component dislacement.

Printed Boards Are Made By One of Four Methods

Four main processes exist for manufacturing printed-circuit boards. These can be described as:

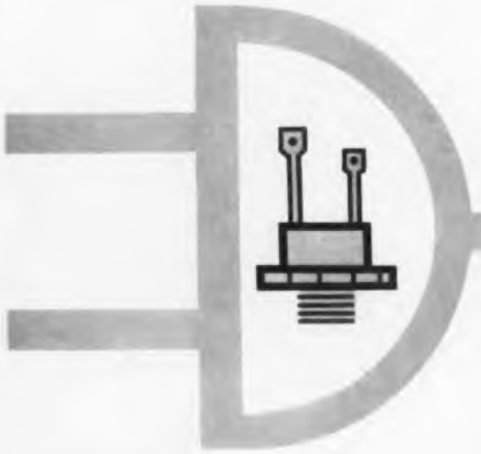
A—(Fig. 1) Boards are photo-etched, conductive pattern is solder-coated and eyelets are placed in holes drilled through the solder-coated foil. (Process 1A uses flat eyelets; process A, funnel eyelets.)

B—(Fig. 2) Board is photo-etched using gold plating as an etching resist. Conductive pattern of the board is gold-plated and gold-plated through-holes are used.

C—(Fig. 3) Board is photo-etched in the same manner as in process B. Conductive pattern is gold-plated with gold-plated through-holes. Eyelets are installed after gold-plating. (Process 1C uses flat eyelets; process 2C funnel eyelets.)

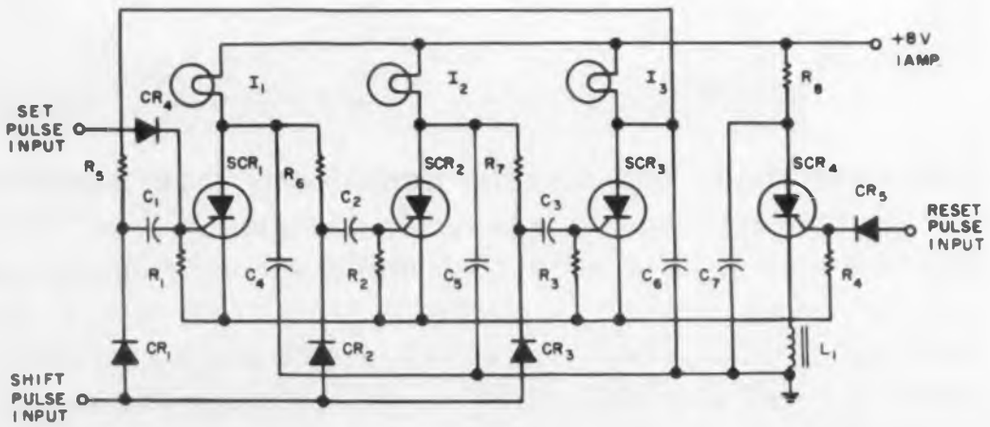
D—(Fig. 4) Similar to process A except in the method of installing the eyelets. In this process, eyelets are resistance-fused to the conductive pattern of the board.

The tables detail the step-by-step procedures involved in each of these processes. At each step, potential problem areas are pointed out. ■ ■



"Power-Logic" with SCRs

Industrial and consumer-equipment manufacturers are taking a second look at silicon-controlled rectifiers. Price cuts are enhancing the utility of SCRs as a means of handling power and logic simultaneously and efficiently. Here is a preview of new "power-logic" circuits, which will be described in the new edition of General Electric's SCR application manual.



$R_1 - R_3 - 220\Omega$, 1/2 WATT
$R_5 - R_7 - 4.7K$, 1/2 WATT
$R_8 - 47\Omega$, 2 WATT
$C_1 - C_3 - 0.1\mu fd$, 50V PAPER
$C_4 - C_7 - 4\mu fd$, 50 V PAPER
$SCR_1 - SCR_4$ – G-E C9U OR C12U
$CR_1 - CR_5$ – G-E IN1692
$I_1 - I_3$ – G-E 1855 LAMP, 6.3V, 0.8A
$L_1 - 200\mu h$, 0.2Ω
PULSE – 3–8 VOLT, 10–20 μsec, 15–20 Ω

Fig. 1. SCR counting circuit and shift register: three stages are shown but the circuit can be extended to many more. (A possible consumer-type use for this circuit would be computing displays for bowling-alley score-keeping.

T. Peter Sylvan
General Electric Co.
Syracuse, N. Y.

THE silicon-controlled rectifier (SCR) is one of the few semiconductor devices capable of both bistable action and efficient control of large blocks of power. Therefore, it has many applications where a moderate amount of logic must be applied during the control of power. Three classes of circuits, binary computing, time-delay, and fault switching, will be described to show how the SCR's "power-logic" abilities may be put to work.

1 Ring Counter and Shift Register

A ring counter may be considered as a circuit that sequentially applies voltage to two or more loads, one at a time. These may be either power loads or signal loads. An SCR flip-flop (Fig. 1) is thus a two-stage ring counter and most SCR ring counters are

simply an extension of the basic flip-flop circuit with minor modifications in the pulse-gating circuitry and the commutating circuitry. Several configurations of the SCR ring counter are possible, differing mainly in the commutating principle used, but the circuit of Fig. 1 is presented as being one of the most versatile and as offering a good example of the principles involved.

In this circuit, SCR_1, SCR_2 and SCR_3 form a three-stage ring counter. SCR_4 is a reset pulse generator which is not required for all applications. When power is first applied to the circuit none of the SCRs will turn on. To "set" the circuit a positive pulse is applied to the "set pulse input," which turns on SCR_1 and applies voltage to the lamp load I_1. The diodes CR_1 and CR_3 will be reverse biased by 8 v while CR_2 will be reverse biased by less than 1 v as determined by the voltages on the anodes of the various SCRs.

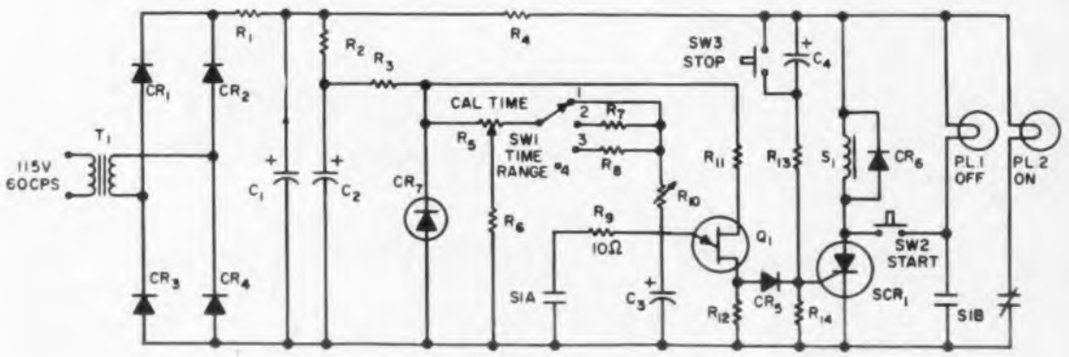
If a positive pulse with a peak amplitude of less than 8 v and greater than 3 v is applied to the "shift pulse input," CR_1 and CR_3 will block the pulse from the gate of SCR_1 and SCR_3 while the pulse will be transmitted to the gate of SCR_2 through CR_2 and C_2 causing SCR_2 to turn on. When SRC_2 turns on, the discharge current of C_5 through SCR_2 causes a large voltage pulse to appear across inductor L_1 thus reverse biasing SCR_1 and causing it to turn off.

Note that C_4 serves to hold the anode voltage of SCR_1 down during the commutating interval. When the next shift pulse occurs SCR_3 turns on and SCR_2 turns off in a similar manner, SCR_1 turns on and SCR_2 turns off, etc.

If a pulse occurs at the "reset pulse input" at any time, SCR_4 will fire and turn off any of the other SCRs that happen to be on at the time. SCR_4 then will remain on until one of the other SCRs turns on which in turn will cause SCR_4 to turn off. Additional stages can be added to the circuit as desired. A 10-stage circuit using 10 SCRs can be used to perform the function of a decade counter with direct lamp readout.

The circuit as shown can function as a shift register in which any combination of SCRs can be on at one time and the entire pattern will move one stage to the right each time a pulse occurs at the trigger pulse input. The circuit also has the advantage that the commutation pulses do not appear across the loads that are not being switched.

An alternate version of the circuit in which the commutating capacitors C_1, C_2, and C_3 are connected between the anodes of the adjacent SCRs can be used if only simple ring-counter operation is required and if the appearance of the commutating pulses across all the loads is not objectionable. This version permits both the commutating capacitors and the commutating inductor to be reduced by a factor of 2 for a given lead over that for the circuit of Fig. 1.



R_1 — 2Ω, 1 WATT	R_{10} — 100K, 10 TURN HELIPOT	C_4 — 10μFD, 50V
R_2, R_3 — 330Ω, 1/2 WATT	R_{11} — 150Ω, 1/2 WATT	SCR_1 — G-E 2N1930
R_4 — 35Ω, 5 WATT	R_{12} — 18Ω, 1/2 WATT	CR_1 — CR_6 — G-E 1N1692
R_5 — 2.5K, LINEAR POT	R_{13} — 1.2K, 2 WATT	CR_7 — 18V, 10%, 1WATT ZENER
R_6 — 25K, 1/2WATT	R_{14} — 100Ω, 1/2 WATT	Q_1 — G-E 2N1671B
R_7 — 100K, 1/2%, 1/2 WATT	C_1 — 500μFD, 50V	S_1 — G-E CR2791G122A4 4PDT RELAY
R_8 — 200K, 1/2%, 1/2WATT	C_2 — 100μFD, 50V	PL_1, PL_2 — G-E 1477, 24V LAMP
R_9 — 10Ω, 1/2WATT	C_3 — 100μFD, 20V TANTALUM	T_1 — 115V/25V 1A TRANSFORMER

Fig. 2. Time-delay circuit using SCRs: multiple units of this circuit, in cascaded or other arrangements, could be used for automatically sequencing machine tool-control actions.

2 Time Delay Circuits

Time-delay circuits are used frequently in industrial controls and aircraft and missile systems to apply or remove power from a load a predetermined time after an initiating signal is applied. Cascaded time-delay circuits can be used to sequentially perform a series of timed operations.

Fig. 2 illustrates a time-delay circuit using

a relay output with a push-button initiation of the timing sequence. In the quiescent state, SCR_1 is on and relay S_1 is energized. Contact S_{1A} is closed, shorting out the timing capacitor C_3.

To initiate the timing cycle push-button switch SW_2 is momentarily closed which shorts SCR_1 through contact S_{1B} causing SCR_1 to turn off. When SW_2 is released S_1 is de-energized and the timing sequence begins. Resistance R_{10} determines duration.

The particular configuration of SW_2 and S_{1B} is used to prevent improper operation in case SW_2 is closed again during the timing cycle. Capacitor C_3 is charged through R_8, R_{10} until the voltage across C_3 reaches the peak-point voltage of Q_1, causing Q_1 to fire. The positive pulse generated across R_{12} fires SCR_1 which pulls in the relay and ends the timing cycle. The timing cycle can be terminated at any time by push-button switch SW_3 which causes current to flow in R_{13}, thus firing SCR_1. Capacitor C_4 supplies current through R_{13} during the instant after the supply is turned on, thus firing SCR_1 and setting the circuit in the proper initial state.

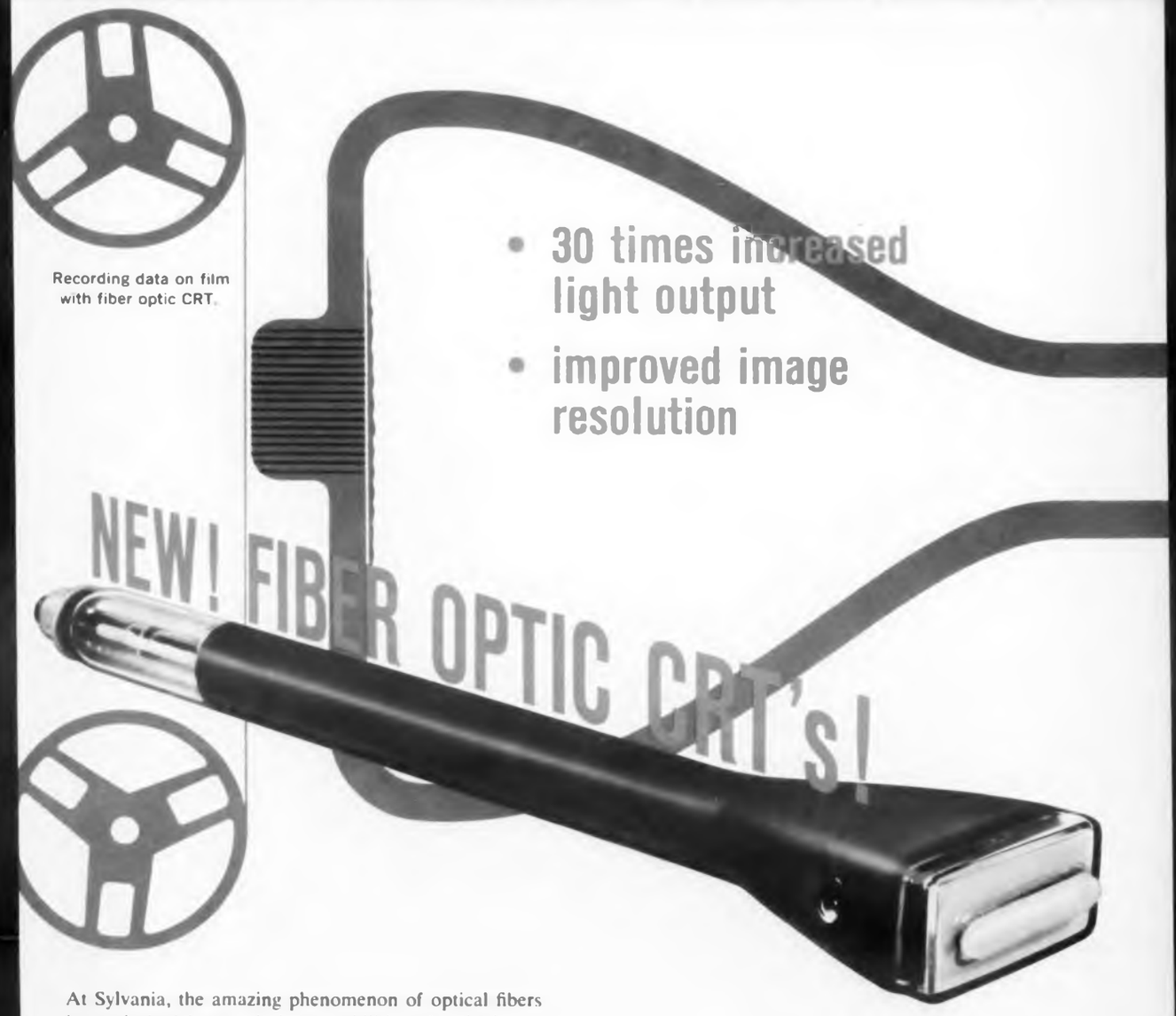
The timing interval is determined by the setting of a precision 10-turn helipot R_{10}, which may be set from 0.25 to 10.25 sec in increments of 0.01 sec. The initial setting of 0.25 sec takes into account the added series resistance of the time-calibration potentiometer R_8. Additional series resistance of 100 K and 200 K may be added by SW_1 to extend the time range by 10 sec and 20 sec. A fourth position of SW_1 is added to open circuit the timing resistors and thus permits unrestricted on-off control of the circuit.

Tests of the circuit have shown an absolute accuracy of 0.5 per cent after initial calibration and a repeatability of 0.05 per cent or better.

3 High-Speed Switch

A form of "electronic crowbar," shown in Fig. 3, has proved very useful for protecting dc circuits against input-line voltage transients and short-circuit load conditions. If the dc supply exceeds the desired maximum value as determined by the setting of potentiometer R_1, the voltage at the emitter of UJT_1 exceeds the peak-point voltage, causing UJT_1 to fire; this in turn fires the SCR. The full supply voltage is then ap-

ELECTRON TUBE NEWS from SYLVANIA



Recording data on film with fiber optic CRT.

- 30 times increased light output
- improved image resolution

NEW! FIBER OPTIC CRT's!

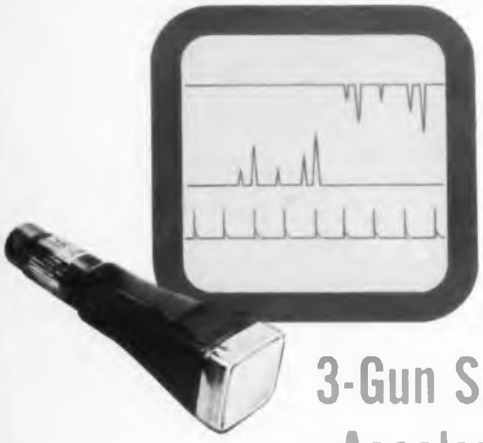
At Sylvania, the amazing phenomenon of optical fibers is revolutionizing resolution capabilities of cathode ray tubes. These tiny light pipes, transparent dielectric cylinders only 10 microns in diameter, conduct light from the phosphor screen to the outside surface of the CRT face. This dramatic new technique completely eliminates parallax. Used in photo-recording applications, it eliminates lens requirements, enables direct photoprinting.

Now available for sampling are: 5" diameter CRT's with faceplates composed entirely of optical fibers or with a .250" x 4.125" array of optical fibers for linear scanning; a rectangular 3" x 1½" CRT featuring a .250" x 2.750" array of fiber optics. These remarkable tubes can be supplied with either electrostatic or magnetic deflection and focus and with aluminized or nonaluminized P11 or P16 screens.

Currently under development are fiber optic CRT's capable of magnifying images and of coding signals by "scrambling" light transmission.

If your project calls for exceptionally high resolution in photo recording, flying spot scanning, mapping or reconnaissance systems, these extraordinary developments deserve your careful examination. Ask your Sylvania Sales Engineer for complete information.

NEW from SYLVANIA!



3-Gun Spiral Accelerator

for multiple tracking radar

Sylvania SC-3090 is a high-precision instrument with a 5½" square face. Its tri-gun structure is so accurately designed and aligned it provides a tracking error of less than .055" at any point on the tube face. Electrostatically deflected and focused, it offers high deflection sensitivity, high resolution and writing speed, minimal pattern distortion. SC-3090 is available with aluminized screen and P19 phosphor.

Single-gun Spiral Accelerators, 5BGP/T51, 5BHP/T54, are available with a new brighter phosphor and "Bonded Shield" safety cap for increased image readability. Assembled on Sylvania-developed mounting jigs to exceptionally close tolerances, they provide superlative precision performance.

Absolute Max. Ratings	SC-3090	5BGP—	5BHP—	Units
Anode #3 Voltage	10,500	13,200	13,200	Vdc
Isolation Shield Voltage	3,500	2,300	2,300	Vdc
Deflection Plate Shield Voltage			2,300	Vdc
Anode #2 Voltage	3,500	2,200	2,200	Vdc
Anode #1 Voltage	1,750	880	880	Vdc

Low drain heater-cathode design for battery-powered applications . . .

Now in 3 CRT families!

Typical of continuing Sylvania advancements in the "state of the art" is the remarkably efficient heater-cathode assembly employed in Sylvania-3BGP–, 3BMP–, SC-3016. With a rating of 1.5V @ 140mA, it consumes only 0.2 watts and enables battery life of 400 hours from a #6 dry cell operating up to 2 hours daily. Further, it possesses extremely low mass (0.05" dia., 0.011" thick), thereby enhancing resistance to shock and vibration, so vital for reliable, portable operation. Significantly, this unusual development is adaptable to virtually any existing CRT design.

Key Characteristics	3BGP—	3BMP—	SC-3016	Units
Anode #3 Voltage		6600*		Vdc
Anode #2 Voltage	2750*	2200*	2750*	Vdc
Anode #1 Voltage	1100*	1500*	1100*	Vdc
Face Dimension	1½x3	3	1⅛	Inches
Over-All Length	9¼	10	6	Inches

*Absolute maximum ratings

Low grid drive! Low current heater!

Sylvania-10ANP for radar display

Sylvania-10ANP is ideally suited to compact radar equipment. Here's why: small yoke for increased sensitivity, low grid voltage requirements and 300mA heater enable excellent performance from transistorized power supplies; further, it features small, 0.840" diameter neck, short over-all length of only 16" and 9-pin miniature base.

Sylvania-10ANP offers magnetic deflection and focus, aluminized screen and a wide range of phosphors. Currently under development at Sylvania are 5", 7" and 12" versions of the 10ANP.

If your design demands specialized cathode ray tubes, call on the high quality-quantity capabilities of Sylvania. For technical data on specific types, write Electronic Tubes Division, Sylvania Electric Products Inc., 1100 Main Street, Buffalo 9, New York.

NEEDED NOW:

Radiation-Resistant Components!

Few reliability studies hold such great import for national security as those investigating radiation effects on electronic components. Will, for example, electronic components withstand continuous radiation from the reactor of a nuclear-powered craft?

Intense radiation is known to have disastrous effects on solid-state performance. How, then, do you design for reliable, compact circuitry without imposing prohibitive weight penalties of massive shielding?

One good way: design around radiation-resistant Sylvania Gold Brand Subminiature Vacuum Tubes. All Gold Brand Subminiature types are rated for steady state radiation resistance. Extensive testing prove them capable of withstanding 10^{12} neutrons/sq. cm./sec. dose rate for a total dosage of 10^{16} neutrons/sq. cm. Further, Gold Brand Subminiature Tubes tolerate pulses of pure gamma radiation of approximately 10^{8} R./sec. Compare this with the gamma dose rate of 0.1 R./sec. absorbed ¾ mile from a 20KT bomb—it's well within the operating capability of Gold Brand Subminiature Tubes.

Vacuum tubes are compatible not only with nuclear environments but extreme shock and excessive temperatures. Extended periods of storage, too, have little or no effect on vacuum tubes. Ask your Sylvania Sales Engineer for complete information on the many remarkable capabilities of electronic tubes. He can supply you with detailed documentation of Sylvania Gold Brand Subminiature Tube reliability.

bright performance lights up sales
when you design around . . .

SYLVANIA CdS Photoconductors

Sylvania-8100 is the first of a new family of Cadmium Sulfide photoconductive devices for industrial-commercial light-actuated control applications. Proven in self-adjusting TV brightness and contrast controls, Sylvania-8100 features two foot-candle resistance of 5000 Ohms and a minimum dark resistance of 200,000 Ohms.

Sealed-in-glass techniques provide a moisture-resistant device, protect wafer, assure long, reliable life.

Blue Dot Protection on light-sensitive wafer indicates device is vacuum-tight. If the unusual occurs and a leak develops, blue dot turns to pink . . . a special confidence feature on all Sylvania photoconductors.

Hydrogen-Filled after thorough evacuation, improves dissipation characteristics, enhances stability and uniformity.

Automated Techniques provide excellent control of physical characteristics such as the configuration of electrodes on the CdS wafer, assure superior characteristics of uniformity.

If your design area includes lighting, sorting, door controls, headlight dimmers, data processing, fire or smoke detection or similar work, contact your Sylvania Sales Engineer. He will give you complete information on this and other photoconductors under development at Sylvania. For technical data on Sylvania-8100, write Electronic Tubes Division, Sylvania Electric Products Inc., 1100 Main St., Buffalo 9, N. Y.

SYLVANIA

SUBSIDIARY OF

GENERAL TELEPHONE & ELECTRONICS

GENERAL SYSTEM

P-1289-3

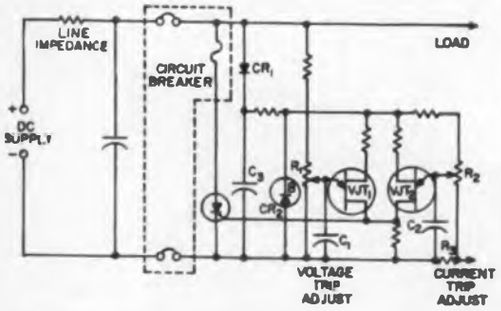


Fig. 3. Fast-acting circuit breaker: it will trip on either excessive voltage or current.

plied to the circuit-breaker trip coil, causing the circuit breaker to open the main dc supply bus.

Besides increasing the speed of the circuit-breaker action, this circuit instantly loads down the dc bus, preventing the voltage on the load from rising until the circuit breaker has time to operate.

The circuit also protects the load and the supply against short-circuit conditions by monitoring the current through resistor R_3. When the voltage across R_3 exceeds the desired maximum value as determined by the setting of potentiometer R_2 the voltage at the emitter of UJT_2 exceeds the peak-point voltage, causing UJT_2 and the SCR to fire as before. Due to the stable firing voltage of the UJT, the trip voltage across R_3 can be very low, a value in the range from 100 to 500 mv being entirely suitable for most applications.

If only overvoltage protection is desired the circuit of Fig. 3 can be simplified by eliminating UJT_2 and its associated circuitry. Similarly, if only overcurrent protection is desired UJT_1 and its associated circuitry can be eliminated.

In the circuit of Fig. 4 rectifier CR_1 and capacitor C_3 are used to provide filtering against negative-voltage transients, which would otherwise result in false tripping of the circuit. The values of potentiometer R_1 and R_2 are chosen to have appropriate time constants with C_1 and C_2 so as to give the desired voltage-time response in the tripping action.

The SCR is ideal for this type of circuit because of its ability to switch on within a few microseconds after being triggered. Its high surge rating permits it to carry momentary currents as high as 2,000 amp for 2 msec without damage, in the case of the 2N1909 SCR series. ■ ■

PRODUCT FEATURE

12 Different Displays from One Indicator Switch

A NEW indicator switch sharply reduces panel-space requirements and switch costs. A single "Cue" display switch can replace as many as 12 conventional labeled switches, in about 1/12 the space.

The compact switch, manufactured by Industrial Electronic Engineers, Inc., 5528 Vineland Ave., North Hollywood, Calif., contains a built-in miniature read-out unit with a 12-display capacity. If required, a different display for each circuit may be contained in a single "Cue" indicator switch, to replace up to 12 conventional display switches.

The "Cue" switch weighs only 5 oz and extends just 3-7/8 in. behind the panel. A positive-action, quick-disconnect feature makes lamp re-

The viewing screen of the "Cue" indicator switch is mounted as a push button. When the button is depressed, displays are selected in sequence with each subsequent depression.

placement possible in a few seconds. For the model using a dpdt switch, the operating force is 2.5 lb with an electrical rating of 5 amp at 250 v ac.

The switch combines a standard switching device with a series 120,000 miniature 12-position rear-projection readout. The viewing screen is mounted as a push button. When the button is depressed, displays are selected in sequence with each subsequent depression. Used in conjunction with stepping switches and relays, the unit can provide a high degree of selectivity of display.

By depressing the front portion of the unit, the viewing surface moves approximately 1/8 in. and this movement is transmitted to a standard miniature-switch mechanism that actuates a spst or a dpdt switching contact. The actual type and number of switching contacts are not restricted by the basic design of the unit and a large variety of special configurations can be provided. Voltage rating and current-carrying capacity of the switch contacts are available over a large range.

There are two basic modes of operation possible with the switch-display. In the first mode of operation, the control equipment determines that some action is to be taken or observed by the operator, and the appropriate circuits are opened or closed to change the message or instructions projected onto the viewing screen of the unit. The second mode of operation is to some extent the reverse of the first in that the operator initiates the operation by actuating the switch-display unit. The control equipment then will perform a given pre-determined function and when completed, will report the present status by displaying a new message on the face of the switch.

Available with 3- to 4-week delivery, these units are priced at $55 each with quantity-discount prices available. For more information on these indicator switches, turn to the Reader-Service Card and Circle 250.

NEW PRODUCTS

Covering all new products generally specified by engineers designing electronic original equipment. Use the Reader-Service Card for more information on any product. Merely circle number corresponding to that appearing at the top of each description.

Digital Resistance Bridge Has Broad Test Range 256

Using a self-balancing wheatstone bridge, this unit measures the per cent deviation of resistors from their rated value, and then displays this deviation via a four-window, in-line read-out. Model EM 1291A, which measures from 10 ohms to 15.9 meg, permits the operator to preset the allowable deviation limits from ±0.1% to ±9.9% in 0.1% steps. Featuring an accuracy of 0.1%, the equipment is readily adapted to accommodate an external digital display unit or printer.

Solartron, Inc., Dept. ED, 1743 S. Zeyn St., Anaheim, Calif.

P&A: *$2,495.00 fob Anaheim; stock to 30 days.*

Pulsed Laser Has Zoom Lens 255

The sighting telescope is equipped with a 2.5 to 8 power "zoom" lens and transmit mounting and has a range to several hundred yards. Low-cost model 100, which accommodates materials to 4-1/2 in. in length and 1/2 in. in diam, features a peak power of 1 kw nominally and a pulse width of 0.5 msec nominally with ruby laser materials. Available with a choice of two power supplies, the instrument has built-in Fabry-Perot 3/4-in. multi-layer end reflectors at ruby wavelength of 6,943 A which permit use as both a coherent light source and laser materials tester.

Optics Technology, Inc., Dept. ED, 248 Harbor Blvd., Belmont, Calif.

P&A: *$2,810 to $2,965 with power supply; 4 weeks.*

Dual Gun Oscilloscope Uses Only Two Tube Types 257

Two identical vertical amplifiers, each with a bandpass of dc to 5 mc and a sensitivity of 100 mv to 100 v continuously adjustable, are featured in model 5 Mc-2P/R. Sensitivity of the lower amplifier is increased to 1 mv per cm with a built-in preamplifier. A Schmitt Trigger with both internal and external capabilities provides the sweep, which has 1% linearity from a constant current RC network. The compact unit, which uses only two types of vacuum tubes, weighs 22 lb.

Packard Bell Electronics, Dept. ED, 12333 W. Olympic Blvd., Los Angeles 64, Calif.

P&A: *$570.00; stock.*

Meter Measures Voltages on 14 Ranges 258

The measurement of ac and dc voltages from 1 mv to 1,000 v full scale in 14 ranges, and midscale resistances from 10 ohms to 10 meg in 7 decade ranges, is possible with model R-21. The unit incorporates a feature which allows the upper 10% or 1% of any dc voltage range to be expanded to cover the full meter scale. The circuitry ensures that all dc readings are up-scale, with indicator lights showing polarity of the measured voltage.

Hathaway Denver, Dept. ED, 5800 E. Jewell Ave., Denver 22, Colo.

***P&A:** $675.00 fob Denver; stock.*

Rapid Response Switch For Steady-State Acceleration 259

Insensitive to low frequency vibration, series AS31 accelerometer switches cover ranges of ±1 g up to ±50 g, and may be specially ordered for higher ranges. The instruments, which are hermetically sealed to meet MIL-S-8484, grade A, are said to withstand severe environments, including temperatures from −54 to +120 C, shock of 30 g and severe vibration. The 4-oz. units measure 1.7 in. long by 1.03 in. in diam.

Humphrey, Inc., Dept. ED, 2805 Canon St., San Diego 6, Calif.

P&A: $85.00 to $100.00; 5-6 weeks.

CIRCLE 46 ON READER-SERVICE CARD ➤

New Products Directory

A complete index of all new products contained in this issue of ELECTRONIC DESIGN, *including page and reader-service numbers.*

Category	p	rsn
MW Antennas		
common carrier	138	712
S-band	144	703
MW Devices		
actuator, solenoid	146	721
attenuator, variable	148	682
attenuators, variable	143	698
circulator, Y-junction	148	678
detector, crystal	136	728
filters, bandpass	149	696
isolators, miniature	144	715
lines, slotted	147	718
multipliers, varactor	146	702
plotter, impedance	142	714
semiconductor switch, C-band	147	701
switch, double-throw	137	727
switch, waveguide	146	717
tuner, waveguide	140	707
varactors, gallium arsenide	137	726
waveguide feed, circular	144	720
MW Equipment		
altimeter system, radar	140	706
booster, crystal	136	729
compressors, miniature	149	695
oscillator, backward wave	143	693
oscillators, C-band	140	711
parametric amplifier, X-band	150	709
power supplies, microwave tube	132	724
pressurizing system	138	713
radar beacon, C-band	150	708
system, microwave	150	686
MW Hardware		
adapters, waveguide-coaxial	152	722
coating, dielectric	143	683
connector, coaxial	151	705
covers, flange	142	692
junctions, hybrid	147	677
radomes, microwave	151	704
MW Test Equipment		
card kit, resistance	152	716
oscillator, klystron	149	685
probe, rf	152	690
probe, tunable rf	142	710
pulse generator	148	700
MW Tubes		
klystron, amplifier	138	689
klystron, mm-wave	134	725
radar display	151	719

CIRCLE 47 ON READER-SERVICE CARD ➤

NEW PRODUCTS

Wire Cleaning Compound 452

Removes borate coating and copper oxides formed by the fusing of Dumet wire to glass. Cleaner No. 206 may be used at room temperature or at 110 to 125 F. The manufacturer claims that the cleaner will not cause under-cutting or attack on the copper even after long immersion period.

Fidelity Chemical Products Corp., Dept. ED, 470 Frelinghuysen Ave., Newark 14, N. J.
P&A: *$40.80 per 12-gal container; stock.*

Digital Recorder 403

Automates microscope readings. This system converts translational motions along three orthogonally related axes, x, y, and z, of a film scanning microscope into coded digital data on punched paper tape. Three encoder assemblies provide 1,000 counts per input shaft revolution and have a total count capacity of 100,000 counts.

Datex Corp., Dept. ED, Monrovia, Calif.

Planar Epitaxial Diode 451

FD 600 features a reverse recovery time which is typically 2 nsec and a minimum forward current of 200 ma at 1 v. Other guaranteed electrical characteristics include: breakdown voltage, 75 v (min) at 5 μa; capacitance, 2 pf (max) at 0 v; reverse current, 50 na (max) at 50 v and power dsisipation of 500 mw at 25 C.

Fairchild Semiconductor, Dept. ED, 545 Whisman Road, Mountain View, Calif.
P&A: *$5.00 (100-999); stock from distributors.*

◀ CIRCLE 48 ON READER-SERVICE CARD

Pressure Transducer 404

Senses gas pressure from below 1 micron to 25 lb. The Barocel consists of a thin metal diaphragm (0.0003 to 0.002 in. thick, depending on full-scale range) stressed with approximately 60,000 lb and supported between two capacitor plates. When used as a null detector, the output voltage can be read with an ac servo ratio-meter, direct ac voltmeter, hand operated bridge balance control or analog to digital converter or ratiometer.

Datametrics Inc., Dept. ED, 87 Beaver St., Waltham, Mass.

Beryllium Analyzer 409

Laboratory model BAL 35 detects 0.005% of BeO per 100 g sample. Radioactive source is Sb-124 which meets ICC specifications for radiation safety. The unit, which handles 80 and 190 g samples, weighs 450 lb including scaler and timer. Accessories include a model 20 survey meter, dosimeters, chargers, and standard samples.

Kleber Laboratories, Inc., Dept. ED, 2530 N. Ontario St., Burbank, Calif.

***Price:** $6,750.00 fob Burbank.*

Teflon Wire Coding 358

Wire from AWG 26 to 2 is custom coded. This cured coding can be any distance from the center of the wire. The wire may be furnished by customer and can be in continuous coils or cut to length.

Manager Electric Co., Dept. ED, N. State St., Stamford, Conn.

CIRCLE 49 ON READER-SERVICE CARD ➤

NEW PRODUCTS

Multiplier Phototube 474

Two-in. diam head-on type has venetian blind dynode structure and has S-11 response. Type 8053 is designed specifically for scintillation counter applications. Features include a semi-transparent photocathode having a minimum useful diameter of 1.68 in., a first dynode having large area, a flat window to facilitate mounting flat phosphor crystals, and 10 dynode (secondary emitter) stages.

Electron Tube Div., Radio Corp. of America, Dept. ED, Harrison, N. J.

Teflon Cable 431

CR Teflon cables are rated up to 15,000 v ac and 50,000 v dc, with higher ratings available on special order. The insulation contains an agent that reacts under corona bombardment to form a liquid. The liquid covers the wall of the corona cavity with a protective film which absorbs the impact of corona ions, preventing them from penetrating the solid dielectric.

W. L. Gore & Associates, Inc., Dept. ED, 487 Paper Mill Road, Newark, Del.

Feedthru Connector 476

Contact point is cone-shaped, with a sharp apex for minimum contact resistance on low-current control circuits. Model FT-SM-706 measures 0.125 in. max diam by 0.218 in. overall length. The Teflon-insulated unit is designed for high-density assemblies.

Sealectro Corp., Dept. ED, 139 Hoyt St., Mamaroneck, N. Y.

***Availability:** stock, to 2 weeks.*

New, improved EDC contains 8,700 New Product items arranged by product category.

Synchronous Motor 430

Angular rotation is constant within ±0.1 deg, no load to full load. Type GS has power output up to 1/100 hp and 1:1 speed ratio depending on driving frequency. The motor current is approximately 75 ma per phase. It can be operated single phase in the plate circuit of a single ended amplifier or as a two-phase motor when driven by a push-pull amplifier.

Westrex Communications Systems Div., Litton Systems, Inc., Dept. ED, 540 W. 58th St., New York 19, N. Y.

***P&A:** $200.00; 30 days.*

Zener Reference Diodes 443

Consisting of 26 voltages ranging from 18.5 to 200 v, the units feature temperature coefficients of 0.005% per deg C max with a ±5% max tolerance on nominal zener voltage. Units have temperature ranges of 0 to +75 C and −55 to +100 C. They were designed to meet the mechanical and environmental requirements of MIL-S-19500B.

Dickson Electronics Corp., Dept. ED, 248 Wells Fargo Ave., Scottsdale, Ariz.

***Price:** from $11.05 (1-24).*

Variable Speed Drives 429

SCRs in conjunction with magnetic trigger and other solid-state circuitry are used in this drive to control dc shunt motors in the range of 3/4 to 5 hp. Units feature NEMA enclosures, modular construction and circuit design, optional tachometric feedback and reversing. Models are available for operation from 115 v, single phase and 230 v, single and 3-phase.

Magnetic Amplifiers Div., The Siegler Corp., Dept. ED, 632 Tinton Ave., Bronx 55, N. Y.

***P&A:** $470.00 to $600.00; 3 to 4 weeks.*

Accuracy Is Our Policy

Specifications for the Glennite CT 10 capacitor, manufactured by Gulton Industries, Inc. of New Jersey, should have read: Length is 0.255 ±0.010 in., and diameter is 0.095 ± 0.003 in. The item appeared on p 159 of the Oct. 25 issue of ELECTRONIC DESIGN.

NEW PRODUCTS

Epoxy Resins 372

Eccoseal 1207, an impregnant, is a high-temperature epoxide of low viscosity. Stycast 1209, an encapsulant, is a casting resin which also has high thermal stability. Together, these two materials may be used for transformer and coil embedments.

Emerson & Cuming, Inc., Dept. ED, Canton, Mass.

P&A: *$2.50 fob Canton; stock.*

Sweep-Signal Generator 448

Model SP-135 features eight adjustable outputs. Each of the 8 plug-in type oscillators may be selected at any fixed frequency to 124 mc and can be equipped with up to six crystal-controlled pulse markers. A single output on the front panel provides a horizontal sawtooth voltage of approximately 15 v peak to peak into 1,000 ohms.

Telonic Industries, Inc., Dept. ED, Beech Grove, Ind.

Enclosure Tubes 436

Metallized units withstand down-shock from 275 C to ice water. Standard metallizing consists of fired-on silver, copper plated, and electro-tin plated. The glass has a coefficient of expansion of 3.3 x 10^{-6} in. per in. per C; density at 25 C is 2.25; and the dielectric constant is 4.0 at 100 mc.

Electronic Components, Corning Glass Works, Dept. ED, Bradford, Pa.

Phase Sensitive Voltmeter 483

Measures in-phase, quadrature, and fundamental rms voltages and phase angle lead of any 400-cps voltage from 0-300 v with respect to a line reference. Voltage accuracy is within ±5% and phase accuracy is within ±2%. The unit requires 115 v ac, 400 cps at 60 va.

Kearfott Div., General Precision, Inc., Dept. ED, Little Falls, N. J.

8,700 New Product items arranged by category —EDC 1961-62.

Thermistor Probes 455

Maximum temperature in standard units is 150 C, with higher temperature units available on special request. Probes are produced in a resistance range of 50 ohms to 100 K, using grade 1 through 4 materials. Standard diameters are 1/4-in. with a 1/8-in. pipe thread mounting.

Magnetic Materials Section, General Electric Co., Dept. ED, Edmore, Mich.

Folded Circuit Board 461

Angletron features metallic strips that "go around corners." Units are built with walls or edges which may be set at any desired angle. The metallic strips on the "floor" of the board continue without interruption up the "walls." Supporting strips are applied to increase the structural strength of the corners.

R. G. Circuits Co., Dept. ED, 15216 Mansel Ave., Lawndale, Calif.

P&A: $64.00 to $86.00; 21 days.

Tantalum Capacitors 360

Type W wet slugs are designed for use over the temperature range −55 to +85 C. Units are available in working voltages from 6 to 125 v dc in a range from 1.7 to 560 μf. Case size is from 29/64-in. length x 3/16-in. diam.

Tansitor Electronics, Inc., Dept. ED, West Road, Bennington, Vt.

P&A: $0.74 to $8.80; stock.

Power Resistors 512

Miniature precision power resistors Code C-2 have temperature coefficients of ±2 ppm per C. Tolerances to ±0.05%, ratings from 1/2 to 10 w, resistance from 25 to 275-K ohms and inductive or non-inductive windings are available. Similar to the Code C-2, Codes C-5 and C-10 have coefficients of ±5 and ±10 ppm per C.

Omtronics Manufacturing, Inc., Dept. ED, P. O. Box 1419, Peony Park Station, Omaha 14, Neb.

P&A: $0.70 to $4.50; 7 days to 3 weeks.

CIRCLE 802, 803, ON READER-SERVICE CARD ➤

NEW PRODUCTS

Varistor Disks 460

Disks of 0.75- and 1.12-in. diam are rated at 0.75 and 1.5 w max continuous dc power rating respectively. "Thyrite" units are available in sizes to cover a voltage range of 15 to 15 v dc for the 0.75-in. disks, and from 30 to 300 v dc for the 1.12-in. disks. Standard voltage tolerances for both families of devices are ±20%.

Magnetic Materials Section, General Electric Co., Dept. ED, Edmore, Mich.

Military Synchros 465

Size 11 synchros meet the latest requirements of MIL-S-20708A. Each of these units operates in an ambient temperature range of −55 to +85 C and weighs 4.7 oz. Synchros feature a rotor moment of inertia of 2 gm cm², friction of 0.05 oz-in. max at 25 C, and friction of 0.07 oz-in. max at −55 C.

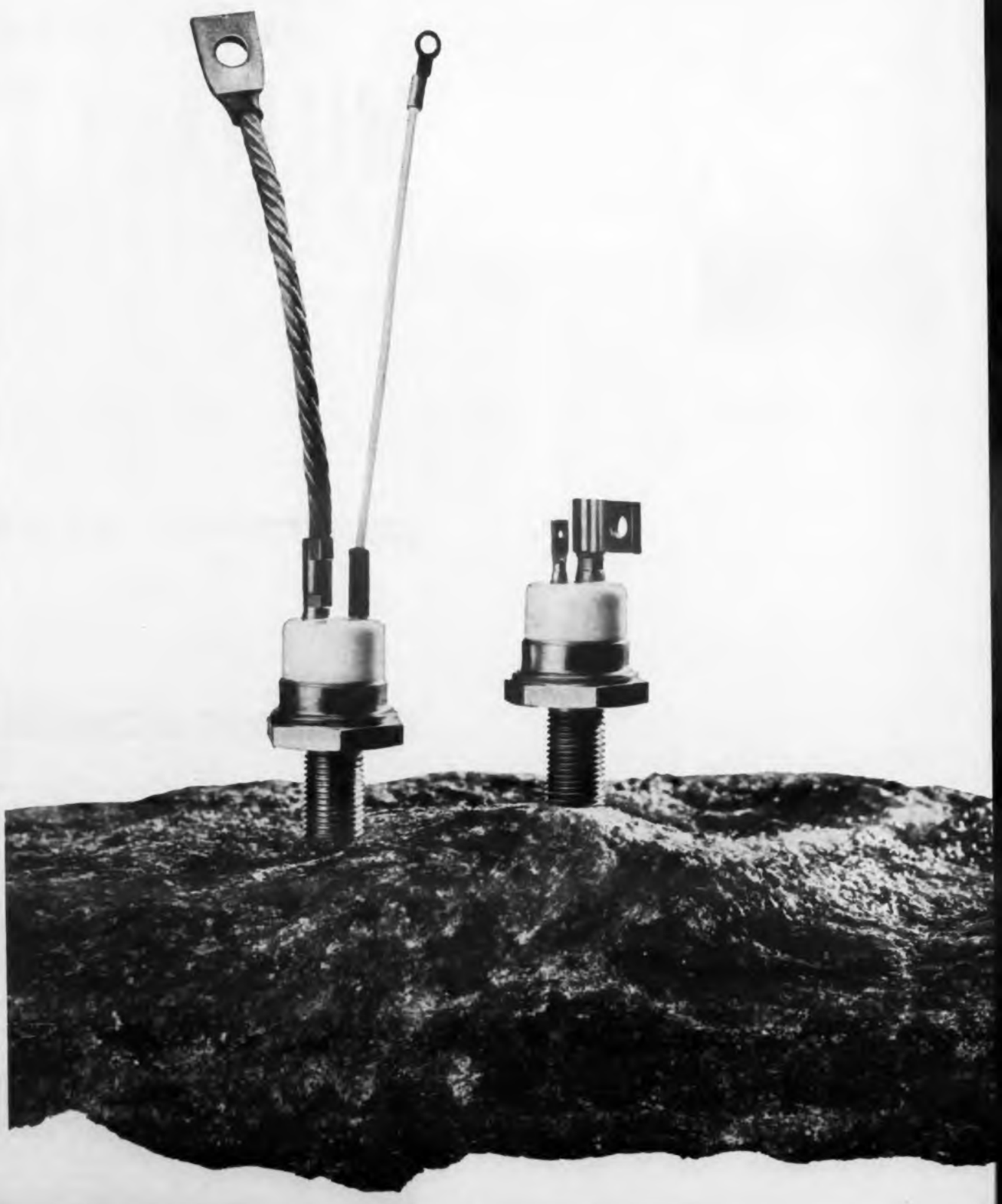
Kearfott Div., General Precision, Inc., Dept. ED, 1150 McBride Ave., Little Falls, N. J.

Sonic Delay Line 449

Delays from 20 to 1,500 μsec with ±2 μsec adjustment. Rise and fall times are to 0.1 μsec. Input pulse width is 0.4 μsec; amplitude is 16 v at 50 ma; and pulse repetition frequency, 1 mc return to zero. Output amplitude is 20 mv into 3.9 K and pulse width is a double dipulse of 1.0 μsec ±0.15 μsec peak-to-peak. Series S66, which has an insertion loss of 55 db, features a temperature coefficient of ±0.1 μsec from 0 to 50 C.

Computer Control Co., Inc., Dept. ED, 983 Concord St., Framingham, Mass.

Trying to find manufacturers' sales offices? Phone numbers? See EDC 1961-62.



Sleeving Cutter 462

Maintains length tolerances of ±2%. Automatic cutter adjusts to any cutting length from 1/32 in. up to 6 in. and operates at the rate of up to 7,200 cuts per hr. The unit handles tubing of up to 3/16-in. OD, wire of up to No. 20 gage, solder, and several diameters of fiber glass and Teflon tubing.

Compton Industries, Inc., Dept. ED, Vestal, N. Y.
***Price:** $495.00.*

DC Microvoltmeter 363

Accuracy is ±0.1%. Model 1101 has resolution of 1 μv on the 1 mv full-scale range. Ranges are: ±1,000 μv, ±10, ±50, and ±100 mv. This unit, which weighs 35 lb, operates from 110-115-v, 60-cps ac source. The equipment is useful in measuring outputs from bonded or unbonded strain gages, thermocouples, etc.

Physical Sciences Corp., Dept. ED, 389 N. Fair Oaks Ave., Pasadena, Calif.

Silicon Transistor Oscillator 400

Epoxy-encapsulated units have a temperature range of −20 to +85 C. Two models are designed to create a sine-wave signal source. Current drain for each oscillator is 28 v at 2 ma. Distortion is less than 5% total. Model S-100 operates from 400 to 50,000 cps; Model S-200, from 25 to 50,000 cps.

Solid State Electronics Co., Dept. ED, 15321 Rayen St., Sepulveda, Calif.
***P&A:** $186.00-$275.00; 4 weeks.*

◄ CIRCLE 55 ON READER-SERVICE CARD

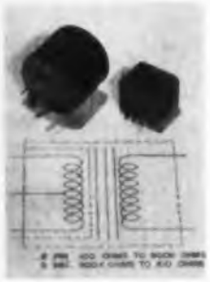
NEW PRODUCTS

Compression Amplifier 432

Features automatic stepped gain control. Model OR-LA/1 has a wide band response of from 30 to 20,000 cps and low distortion. Input signals of up to 100 db dynamic range can be compressed to 20 db. Variable gain is provided in 10 db increments. Output gain is continuously adjustable from 0 to 50 db, for a maximum output voltage range of 1 to 10 v.

Gulton Industries, Inc., Dept. ED, 212 Durham Ave., Metuchen, N. J.
***P&A:** $1,600.00; 3 months.*

Chopper Input Transformers 471



High impedance units feature balanced windings and magnetic and electrostatic shielding. They are available in step-up and step-down configurations for use in transistor, Nuvistor and tube circuitry. Sizes are miniature (1-1/4-in. seated height) and microminiature (3/4-in. seated height). Units are designed to meet MIL-T-27A.

James Electronics, Inc., Dept. ED, 4050 N. Rockwell St., Chicago 18, Ill.
***P&A:** $8.75 to $18.00 each; samples from stock.*

Test Block Connector 482

Printed circuit five-point connector has 5-amp current rating and contact to contact voltage breakdown of 3,000 v rms at sea level and 675 v rms at 70,000 ft. Molded of glass filled diallyl phthalate MIL-M-19833, type GDI-30, the device meets applicable paragraphs of MIL-C-8384 and MIL-C-5015.

Lionel Electronic Laboratories, Dept. ED, 1226 Flushing Ave., Brooklyn 37, N. Y.
***Availability:** 4 to 6 weeks.*

Accuracy Is Our Policy

The New Product item appearing on p 69 of the Oct. 11 issue of ELECTRONIC DESIGN was in error. The double-acting quick release pin, manufactured by the Hartwell Corp., of Los Angeles, Calif., was described as single acting.

Predetermining Counter 473

Push button reset is featured on panel mounting adding predetermining electrical counter. Presetting is by means of a parallel set of wheels underneath the hinged cover. Upon reaching the preset count, an spdt knockoff switch is thrown. Switch is reset to normal only with push button. Count rate is 25 per sec, panel dimensions are 2-1/2 x 3-3/8 in.

Presin Co., Inc., Dept. ED, 2014 Broadway, Santa Monica, Calif.

P&A: $56.50; stock.

Paper-Tape Reeler 466

Unidirectional equipment is capable of supplying tape at any speed up to 40 in. per sec and rewinding at speeds from 45 to 60 in. per sec. Model RS-200 is said to prevent tape breakage under all conditions. Standard 10-1/2-in. reels are accommodated.

Omnitronics, Inc., Dept. ED, 511 N. Broad St., Philadelphia 23, Pa.

Sensitive Relay 479

Two-coil relay allows switching up to 3pdt at 5 amp, 120 v ac, 60 cps. Snap-action switching of 1,000 w of tungsten lamload is possible. Typical coil power required is 0.1 w for pick-up and 0.025 for drop-out. Type 100 relays can be produced to meet UL requirements. They can be hermetically sealed or dust covered.

Telex/Aemco, Dept. ED, 10 State St., Mankato, Minn.

NEW PRODUCTS

Epitaxial Transistor 510

For computer switching applications. This germanium pnp mesa type, 2N828, meets the mechanical and environmental requirements of MIL-S-19500B and features a storage time of 50 nsec max. This type features a high minimum gain-bandwidth product of 300 mc min at $V_{CE} = -1$ v and $I_C = -10$ ma; and low saturation voltages.

Radio Corp. of America, Semiconductor and Materials Div., Dept. ED, Somerville, N. J.

Availability: *stock.*

Synchronous Motor 463

Output speeds are 300, 600, or 1,200 rpm. Type 5001 ac three-speed hysteresis motor operates from 115 v ac to 60 cps, and can drive tapes at speeds of 3-3/4 in. per sec through 30 in. per sec. The unit is insensitive to voltage changes of 40 v in either direction, according to the manufacturer. Minimum synchronous rotor torque is 7 oz-in. and temperature range is −65 to +165 F.

Beau Electronics, Inc., Dept. ED, 1060 Wolcott Road, Waterbury, Conn.

P&A: *$145.00; 30 days.*

Grade 4 Thermistors 453

Resistivity is 10 times that of grade 1 material, according to the manufacturer. Resistances range from 1-K to 1 meg. Units are available in a range of sizes from 0.05 to 0.17-in. diam rods, and from 0.05 to 1.0-in. diam disks or washers. Temperature sensitivity is said to be approximately 10% higher than grade 1 material.

Magnetic Materials Section, General Electric Co., Dept. ED, Edmore, Mich.

Interested in New Products? EDC 1961-62 contains over 8,700 New Products.

◀ CIRCLE 59 ON READER-SERVICE CARD

FOR IMMEDIATE DELIVERY CONTACT THESE STC DISTRIBUTORS

in Alabama:
MG Electronics & Equipment Co.
Birmingham — FA 2-0449

in Arizona:
Southwest Electronic Devices, Inc.
Phoenix — AL 2-1741

in California:
Finn Electronics Corp.
San Carlos—LY 1-4423
Hollywood Radio & Electronics, Inc.
Hollywood—HO 4-8321
Kierulff Electronics, Inc.
Los Angeles—RI 8-2444
San Diego — BR 6-3334
Shanks & Wright, Inc.
San Diego — BE 9-0176

in Connecticut:
N.E.E.D., Inc.
Danbury—PI 3-9844
Sun Radio & Electronics Co., Inc.
Stamford — WH 9-7715

in Florida:
Gulf Semiconductors, Inc.
Miami — MO 5-3574
Hammond Electronics, Inc.
Orlando — GA 5-0511

in Indiana:
Graham Electronics Supply, Inc.
Indianapolis — ME 4-8486

in Maryland:
Valley Electronics, Inc.
Towson — VA 5-7820

in Massachusetts:
Durrell Electronics, Inc.
Waltham — TW 3-7020
N.E.E.D., Inc.
Watertown—WA 6-1130

in New Jersey:
Sun Radio & Electronics Co., Inc.
Princeton — WA 1-2150

in New York:
Arrow Electronics, Inc.
Mineola, L.I. — PI 6-8686
Progress Electronics
New York — CA 6-5611
Standard Electronics, Inc.
Buffalo — TT 3-5000
Sun Radio & Electronics Co., Inc.
New York — OR 5-8600

in Pennsylvania:
Herbach & Rademan, Inc.
LO 7-4309
Philadelphia Electronics, Inc.
Philadelphia — LO 8-7444

in Tennessee:
Electra Distributing Co.
Nashville — AL 5-8444

in Texas:
All State Electronics, Inc.
Dallas — RI 1-1295
Lenert Company
Houston—CA 4-2663

CIRCLE 60 ON READER-SERVICE CARD

THIS

2N2034

(actual size)

REPLACES

THIS

(actual size)

From STC . . . A Significant Technological Breakthrough . . . Miniaturized High Power Silicon Transistors That Don't Require Heat Sinks.

STC's 2N2034 with saturation resistance under 0.3 ohms at 1.0 amps in the TO-5 package improves power switching circuit efficiency by 97% as compared with the 10 ohm 2N424 mounted in a heat sink as illustrated above. Specs: H_{FE} 20 to 60 at 1 amp; BV_{CES} 80 volts min; I_C = 3 amps.

(actual size)

The 2N2035 in the TO-8 package and the 2N2036 in the TO-37 package with higher power dissipation are also available.

SILICON TRANSISTOR CORPORATION

CARLE PLACE, L. I., NEW YORK, Pioneer 2-4100

CIRCLE 61 ON READER-SERVICE CARD

NEW PRODUCTS

Selector Switch 480

Up to 24 positions are available with the remotely controlled unit. Use of a second unit can give the user individual command of 216 different circuits. Design combinations permit great variety of applications for stepping, counting, adding, subtracting, programming and sequencing. Hermetically sealed models are also available.

Ledex Inc., Dept. ED, 123 Webster St., Dayton 2, Ohio.

Electromagnetic Pulse Counter 470

Type ZM-53 has 10 armatures operating sequentially on application of a pulse series. Nominal minimum pulse duration for operation of the device is 20 msec and minimum interval between pulses is nominally 20 msec. Actuating winding is available in 24- and 60-v designs with ratings of 650 and 324 ma, respectively.

Components Div., International Telephone and Telegraph Corp., Dept. ED, Clifton, N. J.
P&A: *$14.75 each (1-99); stock.*

Melamine-Glass Cloth Laminate 484

For applications involving high moisture. Laminate exceeds requirements of MIL-P-15037C, type GME; and MIL-P-15037B, type GMG. Typical absorption value for 1/16-in. thicknesses of Lamicoid 6038E is 0.68%. Material is available in thicknesses from 2 to 0.008 in.

Mica Insulator Div., Minnesota Mining & Manufacturing Co., Dept. ED, Schenectady, N. Y.
P&A: *36 x 42 x 1/16-in. sheet, $2.50 per lb for 300 lb or over; stock to 4 weeks.*

Accuracy Is Our Policy

Model T-X/NF-105 tuning unit extends the range of noise and field intensity meter NF-105; its tuning range is 14 to 150 kc. An incorrect description of the unit, manufactured by Empire Devices of Amsterdam, N. Y., appeared on p 89 of the Sept. 27 issue of ELECTRONIC DESIGN.

Printed Circuit Connector 439

White lettering on black body prominently identifies each contact. Lettering is permanently heat stamped into the connector body. Both sides of the connector top are lettered plus a single row at the bottom. Maximum fatigue resistance is achieved by the beryllium copper contacts which have a gold over silver finish. Flash-over voltage is 2,500 v dc at sea level and 1,000 v dc at 60,000 ft.

Arcon Electronics, Dept. ED, Box 31, Los Alamitos, Calif.

Availability: *1 week.*

Tantalum Capacitor 469

Ratings are from 0.0047 to 330 μf and 6 to 35 v dc. Environmental characteristics meet MIL-C-26655A. Type 901 solid, polarized unit is available in four subminiature case sizes and has a temperature range of −55 to +125 C. Dissipation factor is 6%. Tolerances are ±20% or ±10% (±5% available on request).

Ed M. Hunter & Co., Dept. ED, Suite 430, 818 17th St., Denver 2, Colo.

Availability: *stock, from distributors.*

Feedthru Terminal 477

Combines hole-thru and slotted terminals. Type FT-SM-1SL-1 is a sub-miniature size, measuring 0.312 in. overall, with Teflon body 0.106 in. minor diam. Terminal lug above chassis is round, slotted; while the lug under the chassis is round, hole-thru. The slot is 0.101 in. and the hole is 0.017 in.

Sealectro Corp., Dept. ED, 139 Hoyt St., Mamaroneck, N. Y.

Availability: *stock, to 2 weeks.*

NEW PRODUCTS

Power Relay 478

Type 136 is a heavy current switching or multi-pole relay with up to 24 contact points for either ac or dc circuit switching. The unit is said to be capable of exceeding 5 million mechanical operations with 4pdt 15-amp contacts. Protective covered, hermetically sealed or plug-in units are available.

Telex/Aemco, Dept. ED, 10 State St., Mankato, Minn.

AFC Systems 446

Three distinct types of automatic frequency control units, series C, are available: miniature tubes, subminiature tubes or transistors. High temperature components, such as silicon transistors and tantalytic capacitors are employed to insure high temperature operation of 125 C.

Orion Electronic Corp., Dept. ED, 108 Columbus Ave., Tuckahoe, N. Y.
Availability: *4 to 6 weeks.*

Plug-In Connectors 475

Gold-plated heavy brass terminals for low resistance are provided for use with standard printed circuit connectors. Because switches use fine silver contacts and brushes, the assembly is suitable for dry circuits where low contact resistances of less than 1.5 milliohms are desired.

Langevin Div., Sonotec Inc., Dept. ED, 503 S. Grand Ave., Santa Ana, Calif.

TYPICAL SPECIFICATIONS (60 CPS resistive loading)

	Type FW 600	Type CT 600 R/L	Type CT 600 C	Type VB 600
Maximum allowable PRV	600	600	600	600V
Maximum allowable RMS voltage	420	420	210	210V
Maximum allowable continuous reverse DC voltage	600	600	600	600V
Maximum allowable DC output current (at 100°C ambient) (at 50°C ambient)	1.0 1.5	.5 .75		.5 amp .75 amp
Maximum allowable one-cycle surge current	15	15		15 amp
Maximum peak recurrent forward current	5	5		5 amp
Maximum surge current (4ms)	35	35		35 amp
Maximum full-load forward voltage drop (peak @ 100°C) res. load	3	.5		.5V
Maximum leakage current (full cycle average @ 100°C)		.25		.25 ma

Now you can get a complete full-wave bridge or voltage doubler circuit—in a single compact package ready to mount in a chassis or printed circuit—at a cost lower than that of the individual rectifiers. Mallory rectifier packages simplify assembly, reduce your purchasing, handling and inventory requirements. And, while bringing important savings in your plant, these packaged circuits deliver top-flight performance in your products, in commercial-industrial equipment and appliance applications.

All Mallory rectifier packages are of cold-case design, encapsulated in moisture-impervious resin. Their unique new cell construction results in exceptional reliability: low forward voltage drop, low leakage current, high temperature stability. Our engineers are ready to help you make profitable use of Mallory packaged silicon rectifier circuits. Write today for data or a consultation.

costs of stocking, wiring, assembly

Mallory Semiconductor Company, Du Quoin, Illinois
a division of

P.R. MALLORY & CO. Inc.
MALLORY

New Mallory Type D silicon rectifiers pack performance that belies their low cost. They are the first silicon rectifiers capable of operation at 125°C, at a cost substantially less than that of "top hat" rectifiers. Measuring only 0.240" in diameter and 0.405" in length, they are ideal for high density packaging. Hermetically sealed, and available with an insulating sleeve. Supplied in peak reverse voltage ratings from 50 to 600 volts. Write for data.

CIRCLE 64 ON READER-SERVICE CARD

Encapsulating Material 481

"Thermofit" sleeves are dropped over the component and heat is applied in excess of 275 F for 3 to 8 sec causing the sleeve to shrink and tightly grip the resistor or capacitor in a moisture-tight casing. All variations have a dielectric strength up to 1,000 v per mil. Continuous temperatures from −67 to 275 F and up to 500 F for short periods will not damage the material.

Rayclad Tubes, Inc., Dept. ED, Redwood, Calif.

High-Accuracy Resolvers 467

Size 11, CR4 0987 00 — resolvers feature 0.1% function error, ±3 min inter-axis error, and 0.1% transformation ratio unbalance. Each of these units weighs 4.0 oz and has the following mechanical characteristics: 2 gm-cm² rotor moment of inertia; 4 gm-cm friction at 25 C; 16 gm-cm friction at −55 C; and an operating temperature range of −55 to +125 C.

Kearfott Div., General Precision, Inc., Dept. ED, 1150 McBride Ave., Little Falls, N. J.
Availability: *30 to 60 days.*

Fused Eyelet Processer 428

Automatic eyelet attaching machine model NR-ESSM feeds, sets and fuses eyelets as small as 0.033 in. ID to printed wiring boards as thin as 1/32 in. The process meets requirements of MIL-STD-275A. Model TW has a 15-in. throat depth and can fuse eyelets to 0.020-in. ID in boards as thin as 1/64 in.

Edward Segal, Dept. ED, 132 Lafayette St., New York 13, N. Y.
P&A: *$705.00 to $5,400.00; 4 to 6 weeks.*

Multiple Turn Potentiometers 433

Three series are available including 10-, 5- and 3-turn units. Eighty standard units range from 100 to 300,000 ohms. Maximum dc voltages across terminals are: series A, 773 v; series R, 1,000 v; and series D, 446 v. Operating temperature range for all series is −55 to +110 C.

Arcon Electronics, Dept. ED, Box 31, Los Alamitos, Calif.

NEW PRODUCTS

DC to DC Voltage Regulator 472

Efficiency is better than 50% with 24 v input at full load. A pair of alloy junction power transistors perform the switching function. The unit is designed for use in computer installations, telephone and telegraph terminals, and other military and industrial systems which require a regulated decrease in dc voltage for their transistorized circuits.

Moore Associates, Inc., Dept. ED, 893 American St., San Carlos, Calif.

Polyurethane Coating 426

Coating is designed for printed-circuit boards, wave guides, etc. Pro-Seal 768 is said to have favorable electrical and physical properties. The material exhibits 600% elongation, has a tensile strength of 7,000 psi, and an operating range of from −80 F with permissible intermittent exposures at 275 F.

Coast Pro-Seal & Manufacturing Co., Dept. ED, 2235 Beverly Blvd., Los Angeles 57, Calif.

Telemetering Switch 468

Provides up to 90 channels per pole on each of five poles in a 5-1/2-cu in. volume and 7 oz weight for airborne and ground telemetering applications. Sampling rate of "Micro-Com" is up to 30 rps. Contact resistance is less than 1 ohm with a 100-ohm switching load.

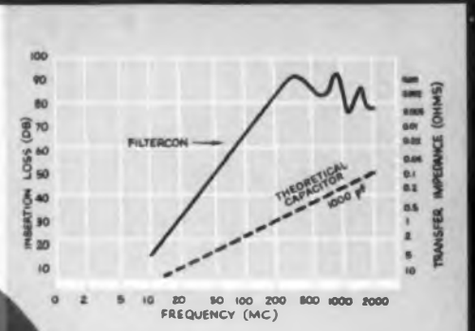
General Telemetry, Inc., Dept. ED, 475 Watchung Ave., Watchung, N. J.

Accuracy Is Our Policy

The 7/8-in. sine-cosine potentiometer, manufactured by Fairchild Controls Corp., Hicksville, N.Y., was incorrectly described in a New Product release as a 1/8-in. unit. The item appeared on p 149 of the Oct. 11 issue of ELECTRONIC DESIGN.

CIRCLE 831 THRU 835 ON READER-SERVICE CARD ▶

NEW...FILTERCONS BY ERIE for highest attenuation in the 100MC to 2000MC range



As shown in the graph (right), FILTERCONS provide optimum performance in the UHF range of 100MC to 2000MC, far exceeding the performance of a theoretical 1000pf capacitor. Measurement is made in accordance with MIL-STD-220A.

FILTERCONS are available in single-section small and large bushing and eyelet mounts plus six and twelve section units. Minimum attenuation is 45 db from 200MC to 2000MC or 50 db from 100MC to 2000MC. Low frequency capacitance is 1000pf for small mount FILTERCONS at 200 VDCW, 2000pf for large mount at 500 VDCW, and 5000pf for six and twelve section units at 350 VDCW. All styles have operating temperature ranges of −55°C to either +85°C or +125°C.

Circle 831 on Reader Service Card

new

ERIE

ELECTRONIC COMPONENTS

New Development—
THE TANTACON
an hermetically sealed, solid electrolyte tantalum capacitor

Makes possible high capacitance per unit volume while maintaining stable temperature-capacitance characteristics and low dissipation factor over an operating temperature range of −80°C to +85°C. Solid electrolyte eliminates leakage problems. Supplied in metal MIL cases, sizes A, B, C, D (insulated and non-insulated).

Capacitance Range: 0.47mf to 330mf
Capacitance Tolerances: ±5% (on request), ±10%, ±20%
Voltage Ratings: 6, 10, 15, 20 and 35 VDCW

Circle 833 on Reader Service Card

Sturdy and reliable—
NEW ERIE PRECISION GLASS TRIMMERS
operate at 1000 VDCW from −55°C to +125°C

Erie glass-dielectric trimmers feature linear, nonreversing capacitance change with rotation, uniform torque, and positive stop at maximum and minimum settings to prevent accidental disengagement of the piston. Less mounting space is required because drive screw and piston never extend beyond the trimmer body.

Available for panel or printed circuit mounting.

Capacitance Ranges: 1.0pf to any of the following: 4.5pf, 8.5pf, 12.0pf, 18.0pf, 30.0pf
Temperature Coefficient: 400 ± 100ppm/°C or 0 ± 100ppm/°C

Circle 832 on Reader Service Card

	PART NUMBER		
	5855	5815	5815
Nominal Capacitance	0.05mf	0.1mf	0.2mf
Maximum Diameter	.437"	.593"	.593"
Maximum Thickness	.156"	.156"	.200"
Lead Spacing	.250"	.375"	.375"

ERIE TRANSCAPS®
The smallest 0.2mf, 25 VDCW ceramic capacitor on the market

Exclusive Erie developed techniques of producing thin-film dielectrics make possible the TRANSCAP with capacitance values from 0.05mf to 0.2mf, capacitance tolerance of +80%, −20%, 25 VDCW, and operating temperature range of −30°C to +85°C (EIA: Y5U).

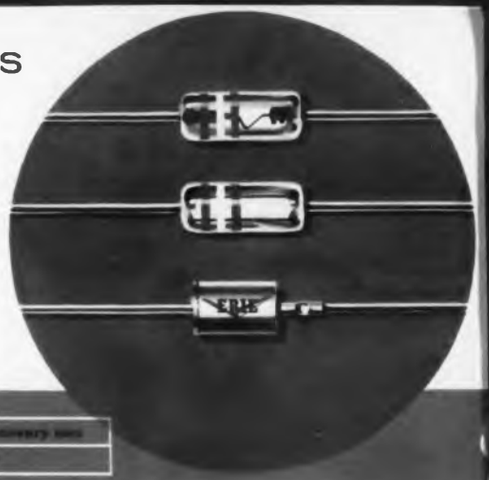
Ideally suited to transistor circuits, TRANSCAPS are supplied with conventional, kinked, or Wil-Lok® leads.

Circle 834 on Reader Service Card

NEW SEMICONDUCTOR COMPONENTS

Electron Research, Inc., a division of Erie Resistor Corporation, is a specialist in the manufacture of germanium and silicon diodes and rectifiers. Production capabilities are available for Point Contact, Gold Bond, Alloy Junction and Epitaxial Germanium Diodes and Rectifiers, and for Diffused Junction, Alloy-Diffused Junction, Planar, Mesa and Epitaxial Silicon Diodes and Rectifiers. Many diodes can be fabricated by several different methods but Erie diodes and rectifiers are fabricated by the One Best Method for each individual application.

Among the latest products from Electron Research are:



NEW ULTRA-FAST RECOVERY GERMANIUM COMPUTER DIODE

Type #	PIV	I_F @ V	Max. Reverse Current I_R @ V	Reverse Recovery nsec
ERI 2007*	15	5ma @ .6V	10 μa @ 5V	5*

*Measured in ERI #5 Recovery Circuit from 20 ma to 0.1 ma.

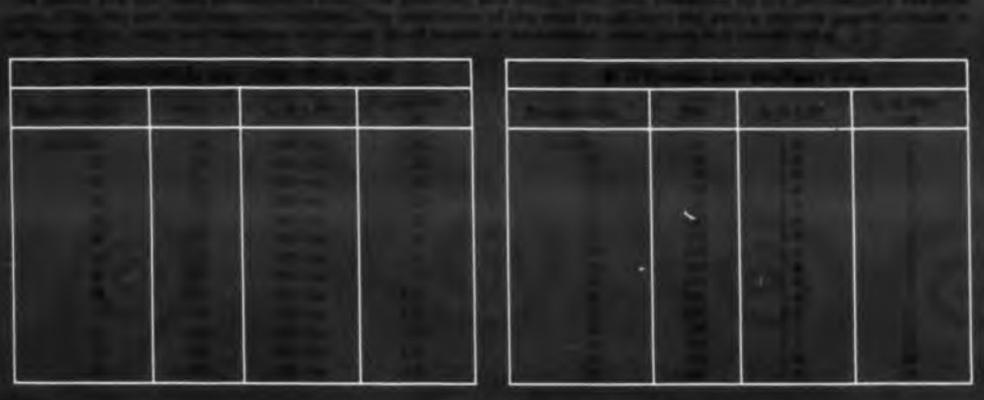
NEW CONTROLLED LOW FORWARD VOLTAGE DROP GERMANIUM DIODE

Type #	Fwd. Volt Drop @ 10 ma		Max. Inverse Operating Voltage	Max. Reverse D. C. Current	Max. D. C. Fwd. Current ma
	Min.	Max.			
IN909	.34V	.37V	50	10 μa @ 10V	100
IN910	.34V	.37V	30	10 μa @ 10V	100
IN911	.34V	.37V	20	10 μa @ 10V	100

NEW CONTROLLED LOW FORWARD VOLTAGE DROP SILICON DIODE

Type #	Fwd. Voltage Drop @ 1.0 ma		Max. Inverse Operating Voltage	Max. Average Rectified Current ma
	Min.	Max.		
IN929	.50V	.78V	200V	250
IN930	.50V	.78V	300V	250
IN931	.50V	.78V	100V	250
IN932	.50V	.78V	200V	250

NEW CO-AXIAL PACKAGE, HERMETICALLY SEALED SILICON RECTIFIER



Erie Electronic Components are available in quantities under 1,000 pieces from leading electronics distributors.

ERIE

ERIE ELECTRONICS DIVISION

Erie Pennsylvania

Erie Resistor Corporation
644 West 12th Street
Sales Offices in principal cities of U.S.A., Canada, Europe

Pressure Switch 370

Series 70-2940 switches handle up to 5 amp. Designed to MIL-E-5272 and MIL-F-8615, these spdt-NO or NC units have setting from 0.5 psig to 3,000 psig. The 2-11/16 x 1-1/4 in. sq switch comes in aluminum and stainless steel, with a burst pressure as high as 7,500 psig. Operating temperature is −65 to +250 F.

International Resistance Co., Dept. ED, 401 N. Broad St., Philadelphia 8, Pa.

DC Amplifier 588

Model 993 is entirely self contained and features ±2% linearity. Clear lucite is used to encase the mechanism, which is mounted on a bakelite base. Ten to one amplification of photovoltaic cell outputs is achieved with this unit. Amplifier is powered by 1.34-v mercury cell.

Weston Instrument Div., Daystrom Inc., Dept. ED, 614 Frelinghuysen Ave., Newark 14, N. J.
Price: *$25.00.*

Tube Tester 368

All the newest tubes, as well as standard foreign and domestic tubes, can be checked. Model 107A can run a mutual conductance test on a prewired chassis, or up to 11 positive checks for leakage, shorts and grid emission. Unit comes in a carrying case with a flip chart of setup data.

Seco Electronics Inc., Dept. ED, 5015 Penn Avenue South, Minneapolis 19, Minn.
Price: *$149.50.*

◀ CIRCLE 831 THRU 835 ON READER-SERVICE CARD

NEW PRODUCTS

Production Tester 580

Electronic assemblies and components can be production tested with model 8522 test set. High voltage breakdown to 2.5 kv, with automatic readout of leakage current and insulation breakdown are featured. Resistance reading up to 500 ohms with signal lights for above or below tolerance ratings, can be used to actuate external equipment for fully automatic installations.

Associated Research, Inc., Dept. ED, 3777 W. Belmont Ave., Chicago 18, Ill.

Power Supplies 413

Provide 40 v dc at 5, 10 or 30 amp from an input of 115 v, single-phase. Model TCV-40-10 power supplies can be adjusted for voltage or current regulation by means of a switch. Current regulation is 0.02% for ±10% line change; voltage regulation is 0.01 for ±10% line change.

Spectromagnetic Industries, Dept. ED, P. O. Box 3306, Hayward, Calif.

Circuit Patterns 427

Automatic step and repeat photographic machines facilitate rapid, accurate production of microminiaturized electronic circuit patterns. In copying area sizes of 25 x 26 in. and 29 x 43 in., accommodating originals up to 9 x 12 in. Larger model, available in sizes from 40 x 56 to 56 x 80 in., will accommodate originals up to 24 x 24 in.

Royal Zenith Corp., Dept. ED, 180 Varick St., New York 14, N. Y.

Transistor Test Rack 511

Modular basis design allows life test rack to accommodate any number of modules. Each module holds 20 transistors, with dissipation of 50 to 100 w. Heat exchanger design maintains transistor case temperature within ±5 C of nominal test temperature from 70 to 150 C.

Bay State Electronics Corp., Dept. ED, 43 Leon St., Boston 15, Mass.

***P&A:** $9,800.00; 10 to 12 weeks.*

Slip Ring Assemblies 564

For −200 to +200 C use, these Teflon-clad slip ring assemblies handle high voltages without arcing damage, even under conditions of extreme humidity. They maintain high resistance between circuits.

Electro-Tec Corp., Dept. ED, 10 Romanelli Ave., S. Hackensack, N. J.

Acrylic Sleeving 528

Class B (130 C) insulating material, Hygrade AC-761, is compatible with epoxy, acrylic, polyester, phenolic, formvar, and is non-corrosive to conductor wire. Excellent electrical characteristics, oil resistance and cut-through resistance are claimed by the manufacturer.

L. Frank Markel & Sons, Dept. ED, Norristown, Pa.

Silicon Rectifiers 514

Ten 5-amp diffused-junction silicon rectifiers have stud mounting. Rectifiers meet military, environmental and mechanical needs. Zirconium-copper alloy mounting stud withstands 25 in.-lbs torque. Dynamic leakage current is 1 ma max at 150 C case temperature, for the 1N1612 through 1N1616. Reverse polarity models are also made. Radio Corp. of America, Semiconductor Div., Dept. ED, Somerville, N. J.

***P&A:** 100 to 999, $1.85 for 50 v and $8.30 for 600 v; immediately.*

CIRCLE 769 ON READER-SERVICE CARD ▶

NEW PRODUCTS

Translator and Display 600

Portable transistor translator and decimal display translates binary, 8-4-2-1, code to decimal equivalent. The TADD-4-BCD unit has no relays and is completely transistorized. The case is for standard relay rack mounting and most parts are mounted on the cover for easy access.

Norden, Div. of United Aircraft Corp., Dept. ED, Norwalk, Conn.

Readout Oscilloscope 367

Digital presentation on automatic computing programmer is simultaneous with analog display on 5 in. crt. Indicators light to designate the readout zone, while the actual measurement is given in a 4-digit decimal display, on model 567. Delay, rise, storage and fall times can be read directly in such applications as transistor switching measurements.

Tektronix, Inc., Dept. ED, P. O. Box 500, Beaverton, Ore.

P&A: $700.00; late 1961.

Thermocouple Signal Conditioner 374

Up to eight channels may be accommodated. Model TSC-1 has one to four different ranges, plus or minus calibration, and 1- or 2-point calibration and zero. Mercury cells are used in bias and calibration circuits. The unit features controls for loop-impedance monitor and adjust.

Astra Technical Instrument Corp., Dept. ED, 9905 W. Jefferson Blvd., Culver City, Calif.

Plated Copper Wire 507

Single-end copper conductors electroplated with a continuous nonporous coating of pure nickel are available in five standard plating thicknesses. Designed for use where continuous temperature of between 250 and 750 C are encountered, the wires are normally employed under high temperature insulations such as Teflon TFE and ceramic coatings.

Hudson Wire Co., Dept. ED, Ossining, N. Y.

AVAILABLE FROM STOCK!

C. I. C.
PRECISION FILM POTS

You can have any of these precision film pots on their way to you within hours. No need to wait for "custom" pots.

LINEAR SINGLE TURN FILM POTENTIOMETERS

Diameter	Resistance	Linearity
1/2"	1K	± .5%
	10K	± .5%
	50K	± .5%
7/8"	1K	± .5%
	10K	± .5%
	50K	± .5%
	1K	± .25%
	10K	± .25%
	50K	± .25%
1-3/32"	1K	± .5%
	10K	± .5%
	50K	± .5%
	1K	± .25%
	10K	± .25%
	50K	± .25%
2"	5K	± .25%
	20K	± .25%
	50K	± .25%
	5K	± .1%
	20K	± .1%
	50K	± .1%
3"	5K	± .1%
	20K	± .1%
	50K	± .1%
	5K	± .05%
	20K	± .05%
	50K	± .05%

SINE-COSINE SINGLE TURN FILM POTENTIOMETERS

Diameter	Resistance	Conformity
1-3/32"	10K	± .75%
	20K	± .75%
2"	10K	± .25%
	20K	± .25%
3"	10K	± .15%
	20K	± .15%

LINEAR MOTION FILM POTENTIOMETERS

Size	Resistance	Stroke	Linearity
1" Sq.	10K	1" Stroke	± .5%
	20K	1" Stroke	± .5%
	10K	2" Stroke	± .25%
	20K	2" Stroke	± .25%
	10K	3" Stroke	± .1%
	20K	3" Stroke	± .1%

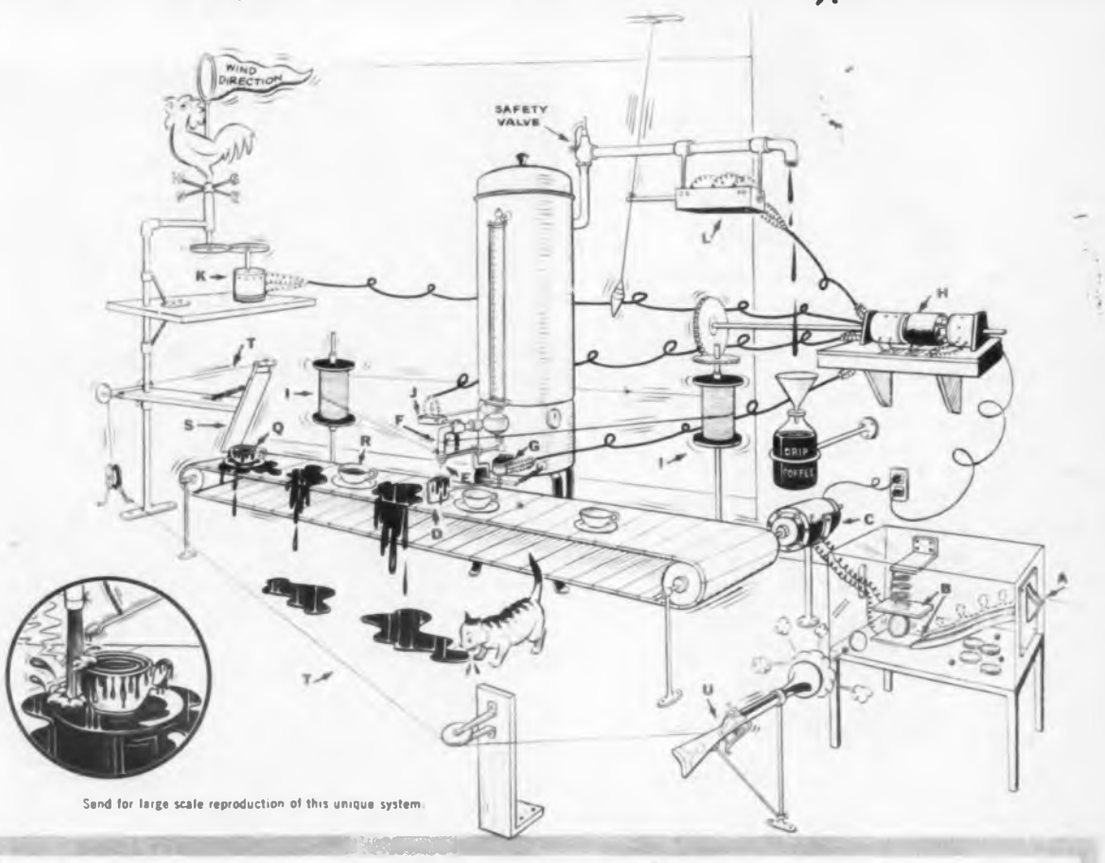
WRITE OR CALL IN YOUR ORDER! POTENTIOMETERS WILL BE IN YOUR PLANT WITHIN 24 HOURS!

C. I. C.

COMPUTER INSTRUMENTS CORPORATION
92 MADISON AVE., HEMPSTEAD, L. I., N. Y.

CIRCLE 72 ON READER-SERVICE CARD

Here's One Way to Automate Coffee-Pots With Some Servo Pots...



Send for large scale reproduction of this unique system.

Place dime into coin slot (A). Coin rolls down ramp into position between spring-loaded metal contacts (B). Contact starts motor (C) and coffee-conveyor-belt proceeds to carry cup into position below spout. As coffee cup pushes actuator blade (D), plug (E) is lowered from spout (F) and coffee starts flowing. Wire-wound pot (G), indicating cup position, sends signal to high gain servo-amplifier (H) and precision drive system (I), causing spout to move toward cup. Wire-wound spout-indicator-pot (J) feeds signal back to amplifier in effort to follow movement of cup. In order to compensate for wind direction and angle of building, wire-wound windage-pot (K) and vertical-sensor-pot (L) send additional aiming signals to servo-motor amplifier. Due to **poor linearity, high noise, poor resolution and high starting torque** — **typical of wire-wound pots** — servo-system is unstable and inaccurate. Coffee misses cup, spills over belt onto floor, where coffee-loving pussy cat (Cafe au lait colored, of course) attempts to keep floor clean. Note that cup (Q) is overflowing, while cup (R) is only half-full. As cup (Q) reaches end of belt, paddle (S) is pushed forward causing string (T) to pull trigger of early 18th century solid-propellant missile launcher (U). Missile dislodges coin, thereby stopping entire system. (Which isn't a bad idea, considering the price of coffee!)

Men who know coffee and servo-systems best* all agree that the above system works perfectly, everytime, **by replacing wire-wound with C. I. C. film potentiometers.**

*Every major aircraft and missile manufacturer uses C. I. C. precision film potentiometers.

BUT THE BEST WAY YET...

Whether aiming missiles or coffee, use C. I. C. Precision Film Potentiometers . . . only C. I. C. film pots have infinite resolution, linearity to .01%, low starting torque and microvolt operational noise.

C I C *first in film pots*

COMPUTER INSTRUMENTS CORPORATION
92 MADISON AVENUE • HEMPSTEAD, L. I., NEW YORK

CIRCLE 73 ON READER-SERVICE CARD

NEW PRODUCTS

Telephone Lever Switch 447

Locking telephone lever switch guards against accidental switching from shock, operator fatigue, vibration, or unintentional operation. Called the Lever-Lock switch, the device has 3-amp, 300-w contacts. Two or three position actuators are available. Switches are built to customer specifications.

Switchcraft, Inc., Dept. ED, 5555 N. Elston Ave., Chicago 3, Ill.

Indicator Light 543

All plastic, two-terminal neon panel light, model 858, does not expose bare wires. Using the NE-2-H bulb, it mounts in a 5/16-in. diam hole and is held in place behind the panel with a speed nut.

Color-Lite Div., The Sloan Co., Dept. ED, 7704 San Fernando Road, Sun Valley, Calif.

Data Processor 548

Solid-state modular digital data processor, model DDP-19, has 19 to 25 bit range. Unit utilizes 5μsec, 4- or 8-thousand word core memory, with 2.5 μsec access. Input is a 500 to 1,000 character per sec paper tape; output is Flexowriter.

Computer Control Co., Inc., Dept. ED, 2251 Barry Ave., Los Angeles 64, Calif.

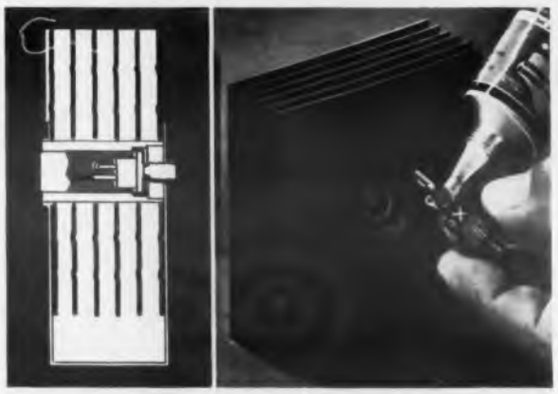
***Price:** $120,000 to $400,000.*

– specify these silicones

Solder melts — laminate unaffected

Specified for their excellent resistance to space age environments, silicone-glass laminates are easy to work with, too. Soldering heat doesn't loosen terminals even where complex wiring requires repeated soldering in a small, confined area. Made with Dow Corning silicone resins, glass laminates retain their excellent dielectric properties despite heat, moisture, storage, environmental aging, rapidly changing ambients and vibratory shock. Light in weight, strong at elevated temperatures, they resist ozone, arcing, corona and fungus attack. In addition, they are easy to fabricate and assemble, have good physical properties . . . resist creep under pressure.

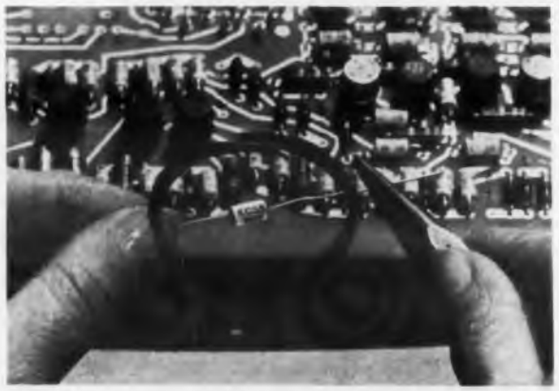
CIRCLE 771 ON READER-SERVICE CARD



Silicone compound for heat sink seal

Heat sinks built by Fairfield Controls, Inc., Stamford, Conn., combine pure copper fins with Dow Corning 3 Compound to assure full load operation of silicon control rectifiers within the maximum allowable junction temperature of 125 C. Dow Corning compound with its petroleum jelly-like consistency, provides excellent heat transfer between the 25.5 amps diode shown here and the metallic parts of the heat sink assembly. The operating portion of the rectifier is inside the heat sink, with silicone compound to facilitate heat transfer from the entire diode body to the heat sink proper. At the same time, moisture and contaminates are sealed from the diode lead connections.

CIRCLE 772 ON READER-SERVICE CARD



Key to stability — silicone fluid

Dow Corning silicone fluid is used in a new line of hermetically sealed precision film resistors developed by Key Resistor Corporation of Gardena, California, to "provide the ultimate in long term life and stability." According to Key engineers, "the unique silicone fluid filled construction results in excellent heat dissipation characteristics — minimizes effects of severe overloads." Dow Corning silicone fluids are used as filling and cooling media in numerous electronic and electro-mechanical applications because they maintain initial viscosity over a wide temperature range, are stable at high temperature, are excellent dielectrics . . . offer numerous other advantages.

CIRCLE 773 ON READER-SERVICE CARD

Free 12-page manual, "Silicones for the Electronic Engineer". Write Dept. 4035, Dow Corning Corporation, Midland, Michigan.

CIRCLE 770, 771, 772, 773 ON READER-SERVICE CARD

Oscillograph 573

Seven in. of rack height is needed for this 24-channel, direct-recording oscillograph. Model 1508 visicorder records on 8-in. wide paper at frequencies of dc to 5,000 cps, at any of 12 speeds. The push-button unit records deflections of 8 in. peak to peak, in excess of 50,000 in. per sec writing speed.

Minnepolis-Honeywell Regulator Co., Heiland Div., Dept. ED, 5200 E. Evans Ave., Denver 22, Colo.

P&A: $3,000 to $3,500; stock.

Toroidal Inductors 571

Hf and vhf toroidal inductors have volume of 0.004 cu in., are vacuum encapsulated in epoxy and meet MIL-C-15305B, grade 1, class B. Series 91 has a frequency range of 25 to 150 mc and ranges in inductance from 0.01 to 1.0 μh; series 92 has inductances of 0.1 to 33 μh and ranges from 1 to 50 mc.

Vanguard Electronics Co., Dept. ED, 3384 Motor Ave., Los Angeles 34, Calif.

Thermal Resistance Tester 562

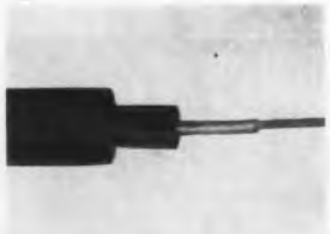
Junction temperature of semiconductor diodes and rectifiers is measured by model 222 test set. Switching circuits allow heating currents up to 10 amps, forward drops to 5 v and temperature to 150 C. Unit measures 13 x 19 x 15 in. Adapter for transistors will be available in the future.

Wallson Associates, Inc., Dept. ED, 912 Westfield Ave., Elizabeth, N. J.

P&A: $1,620; stock.

NEW PRODUCTS

Buoyant Cable 546



Single-conductor cable features an extruded natural polyethylene inner jacket over the center conductor and two additional jackets of black foamed polyethylene to give the cable a max of 0.76 specific gravity. Specification requirements include water testing at 600 psi.

Times Wire and Cable Co., Inc., Dept. ED, Wallingford, Conn.

Availability: 3 to 4 weeks.

Infrared Detectors 541

Heat seekers are capable of detecting a wide variety of items. The detectors, covering the band from 1 to 30 microns, are available in a variety of packages, using combinations of sensing materials and cooling techniques.

Raytheon Co., Microwave & Power Tube Div., Dept. ED, Foundry Ave., Waltham, Mass.

Two Gang Switch 583

Two snap-action switches mounted on a single panel form this miniature unit. It can be used in linear, rotary or rotary cam operations. Overtravel of 0.125 min eliminates close tolerance cam designs. Switches are rated: 10 amp, 125 v; 5 amp, 250 v; 1/3 hp 125 or 250 v ac.

Cherry Electrical Products Corp., Dept. ED, P. O. Box 66, Highland Park, Ill.

Polarized Relays 527

One or two coil units on 8-pin octal base, and three or four coil units on 12-pin plug-in base are available in side-stable, spring-biased and center-off configurations. Selection of contact materials includes: silver, silver-platinum, tungsten, tungsten carbide and special gold alloy.

Magnetic Devices, Inc., Dept. ED, 712 East St., Frederick, Md.

Timer-Counter 513

Portable console has high-speed time interval and expandable cycle-counting capability. TC-1 uses transistorized plug-in digital modules and crystal controlled oscillator for time base interval. Unit is 10 x 13 x 15 in., weighs 30 lb, operates on 115 v ±10 v, 60 cps at 35 w. Time interval is 0 to 999.999 sec, in 1 msec steps.

Astro-Space Laboratories, Inc., Dept. ED, 2104 Memorial Parkway, Huntsville, Ala.

P&A: $4,000 ea; 60 days.

Electronic Welder 356

Solid-state capacitor-discharge welder has two ranges. Versatility of the unit is obtained through its two ranges of 0.04 to 9 w-sec low, and 0.2 to 45 w-sec high. Output is ±1% for 100 to 130 v ac input, regulated. Model 1059 has a discharge time of 0.001 sec. The unit measures 6-3/8 x 12 x 12-7/8 and weighs 41 lbs.

Weldmatic Div., Unitek Corp., Dept. ED, 950 Royal Oaks Drive, Monrovia, Calif.

P&A: $440.00; stock.

CIRCLE 78 ON READER-SERVICE CARD ▶

NEW PRODUCTS

Insulated Tape 522

Mica coated, type MGS is designed for use at 300 C and has an electrical strength of 2,000-1,300 v per mil. At 1 mc, power factor is 0.12 and dielectric constant is 1.43. Types MGA and MMS are also stocked. Standard 25-yd rolls in various widths up to 3 in., as well as 250-yd rolls of 36-in. wide cloth, are available.

Mica-Coated Products Div., McMillan Laboratory, Inc., Dept. ED, Brownville Ave., Ipswich, Mass.

Silicon Rectifier Assemblies 544

Features 50,000 peak reverse voltage. SDI series double-diffused silicon high-voltage potted rectifier assemblies are designed in single phase and three phase types. They feature miniaturization (up to 6,000 v in 3/4 x 3/4 x 1 in.), high surge ratings, and operating and storage temperature range of 165 to +150 C.

Solitron Devices, Inc., Dept. ED, 500 Livingston St., Norwood, N. J.

Microminiature Plugs 376

Made to hold 32 diodes, these microminiature plugs, called Microplugs, are 0.395 in. deep, excluding terminations. Pin contacts are twisted wire; they are self-aligning and individually shrouded in the insulator. Pins are set at 0.05 in. centers. A surface measuring 2-3/4 x 3-1/4 in. can hold 32 plugs.

Cannon Electric Co., Dept. ED, 3208 Humboldt St., Los Angeles 31, Calif.

Angle Counters 619

Continuous display from 0 to 359.9 deg is provided. Equipped with Geneva drives, the Mark II counters can be supplied with torque levels as low as 0.1 oz-in. and slew speeds up to 2,500 rpm. Parts are stainless steel. Military requirements for shock, vibration and case size are met.

General Precision, Inc., Dept. ED, 1150 McBride Ave., Little Falls, N. J.

Receiver Preamplifiers 502

RPA series feature low-noise ceramic tubes and a weatherproof housing for mounting directly at antenna. Models RPA-1 to RPA-7 have bandwidths ranging from 2 to 5 mc and are designed to operate in a 50-ohm system. The units, which have type N connectors, require 117 v ac, 60 cps.

Defense Electronics Inc., Dept. ED, 5455 Randolph Road, Rockville, Md.
Price: *$975.00 to $1,025.00*

Frequency Standard 540

The Raloc system provides a means to acquire the vlf transmissions of primary frequency standards and to compare and/or lock the output frequencies of the local standard oscillator to the broadcast transmission. It becomes a true frequency standard which maintains continuously and automatically an accuracy of better than ±5 parts per 10^9.

Pickard & Burns, Inc., Dept. ED, 240 Highland Ave., Needham 94, Mass.

Colored Laminates 437

Used for color coding, these copper-clad and unclad laminates are available in red, blue, grey and jet black. All colors exhibit the same dielectric strength as the natural green which conforms to the requirements of MIL-P-18177B and MIL-P-13949B. Type G-10 fireproof and type G-11 laminates are available in jet black. Sheet size is 24 x 42 in.

Fortin Plastics, Inc., Dept. ED, 14811 Keswick St., Van Nuys, Calif.

Operations Recorder 602

Transistorized, high-speed operation recorder, Panastat THOR VII, prints out events in exact sequence, with only 1 msec between occurances. Printout cannot be scrambled due to simultaneous alarms and momentary alarms can never be lost, even with filled memory circuit. Operator can view off-normality of all alarms.

Informations Systems, Inc., Dept. ED, 10131 National Blvd., Los Angeles 34, Calif.

NEW PRODUCTS

Beam Power Tubes 524

Delivers plate current of 390 ma with zero bias and 60 v on plate. These 9-pin tubes, 6GT5, 12GT5 and 17GT5, have a "dark heater" which functions efficiently at operating temperatures 350 K below the 1,500 to 1,700 K of conventional heaters. These novar tubes feature all glass integral base design.

Radio Corp. of America, Electron Tube Div., Dept. ED, Harrison, N. J.

Availability: *stock.*

Pre-Amplifier 594

Unit consists of three stages of transistor amplifier with degeneration. A self powered device, it is suitable for increasing the sensitivity of laboratory instruments or transducers. Size is 1-1/4 x 1-1/2 x 2-1/2 in. including battery. Frequency response is from 1 mc down to 1 cps, 3 db bandwidth. Output impedance is less than 100 ohms and current consumption is 1.2 ma, with a max output as high as 8 v peak-to-peak clipping.

AD-YU Electronic Laboratories, Inc., Dept. ED, 249-259 Terhune Ave., Passaic, N. J.

P&A: *$98.00; 2 weeks.*

Rate-Gyro Subsystem 531

Three-axis telemetry subsystem is for measuring spin-stabilized missile speeds of up to 5,000 deg per sec. Input to the system is ±100 deg per sec on the yaw and pitch axes, and ±5,000 deg per sec on the roll acxis. Sensitivity threshold is 0.05% of full scale. It withstands high shock and vibration.

Fairchild Controls Corp., Dept. ED, 225 Park Ave., Hicksville, L. I., N. Y.

Printed-Circuit Plugs 377

MIL C-21097 specifications are met by the PBA-series printed-circuit plugs. Grids from 0.054 to 0.071 are accommodated. Contacts, gold-plated, are bellows bifurcated; terminals accommodate three AWG-No. 20 wires. Current rating is 5 amp. Flashover rating is 2,500 v, 60 cps.

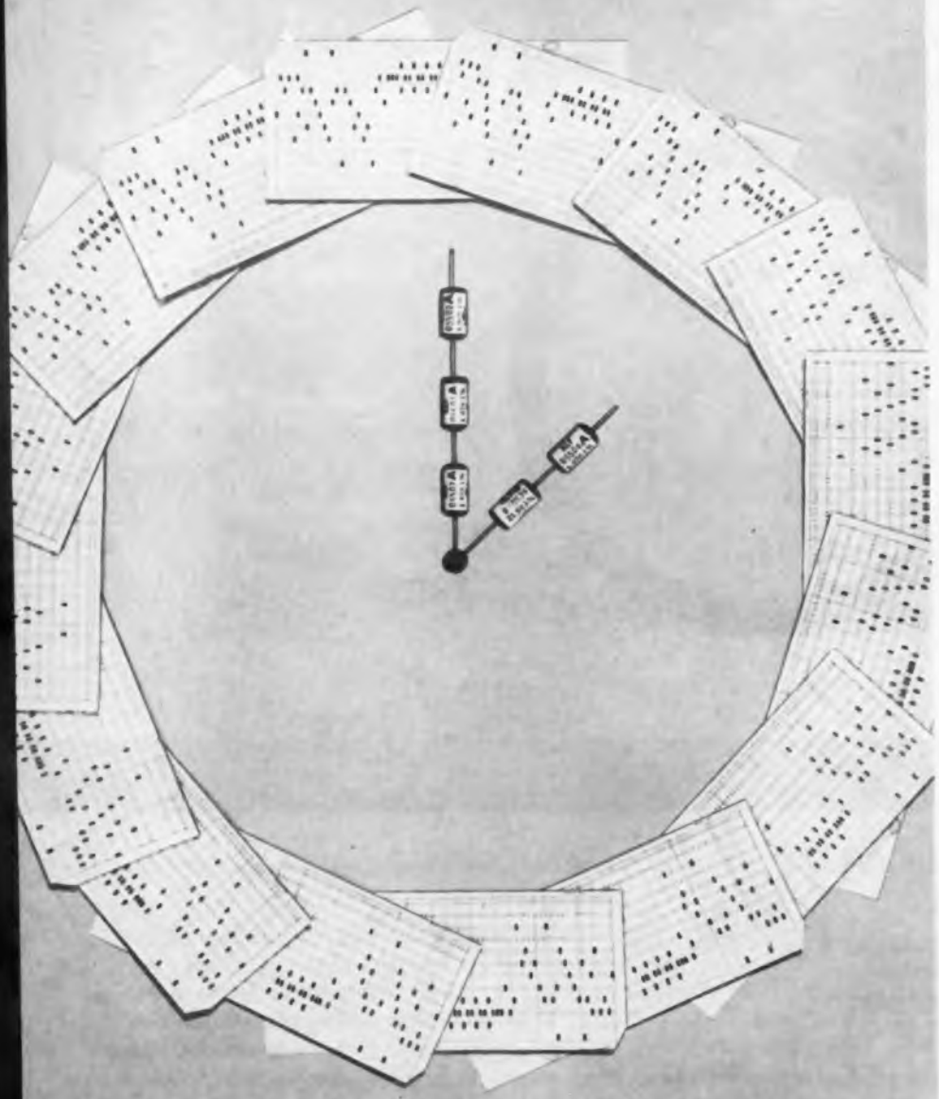
Cannon Electric Co., Dept. ED, 3208 Humboldt St., Los Angeles 31, Calif.

CIRCLE 81 ON READER-SERVICE CARD ➤

in COMPONENT RELIABILITY: if it's news, expect it first from IRC

Never before resistors with this

DOCUMENTED RELIABILITY



250,000,000 hours mean-time-to-failure rate. IRC's new Type XLT resistors have a failure rate of less than 0.0004%/1000 hours. This extreme reliability will be proven to a 60% confidence level, by testing 65,000 units for 4,000 hours. XLT failure is defined, not as a catastrophic "open" or "short", but as any resistance change greater than 0.5%.

To document this new high concept of reliability, the production history of each XLT is shown on a punched data card supplied with the unit. XLT's not allocated for MINUTEMAN are available now for other applications requiring ultra-reliable resistors.

Write for "Resistors with Documented Reliability." International Resistance Company, Documented Reliability Dept., 401 North Broad Street, Philadelphia 8, Pa.

CAPSULE SPECIFICATIONS

Power Rating	⅛ W at 125° C, derating to zero at 165° C
Tolerance	±1%
Resistance range	10 ohms to 100K ohms
Temperature coefficient	±25 PPM/°C ±50 PPM/°C } −55° to +145° C ±100 PPM/°C
Type	Evaporated metal film
Construction	Hermetically sealed glass, helium atmosphere
Leads	Weldable (gold-plated Dumet)
Body Length	.281±.030"
Body Diameter	.155±.015"

XLT Resistor developed

When Reliability Counts Most IRC

NEW PRODUCTS

Variable DC Power Supply 553

Output of model 723A can be programmed by external resistance for fast repetitive testing. Unit is variable at a 50 ohms per v rate from 0 to 40 v, with a full load output of 500 ma. Ripple and noise are less than 150 μv rms. A current limit control protects test circuits.

Hewlett Packard Co., Dept. ED, 1501 Page Mill Road, Palo Alto, Calif.

***P&A:** $225.00; 7 weeks.*

Matrix Board 549

Fotoceram glass-ceramic board requires no etching. Board has universal ring-and-dot pattern of metalized runs, pads and through-plated holes. The 4-1/2 x 5-1/2 x 1/16 in. board is for use in ambient temperatures as high as 250 C.

Corning Glass Works, Dept. ED, Bradford, Pa.

***P&A:** $9.95; 1 week to 10 days.*

Transient Voltage Detector 586

Solid-state, portable unit has three ranges: 100 v, 1 kv and 10 kv. Direct reading dial and built-in self-calibration features eliminate the need of charts. Accuracy is to $\pm 1\%$, for transients to 1 msec risetime, down to dc.

Halmar Electronic Products Co., Ltd., Dept. ED, 1550 R W. Mound St., Columbus 23, Ohio.

Stepping Motor 591

Add and subtract pulses turn stepping motor 9 deg each time a step signal is applied. Non-cumulative no-load position error is ±0.5 deg in the model 611. Frequency range is 0 to 6,000 cps, with 20 axial slots forming 10 pole sets. Applications include operating mechanical counters and positioning code disks.

U. S. Science Corp., Dept. ED, 5521 W. 102nd St., Los Angeles 45, Calif.

Remote Indication-Control 587

For process-control equipment remote indication and control is accomplished by the MT-61 Metertrol. The device has an optional explosion-proof enclosure. Input requirement is 15 kv 2 w, or 10 kv 3 w. Units can be adapted to specifications.

Jordan Controls, Inc., Dept. ED, 3235 W. Hampton Ave., Milwaukee 9, Wis.

Price: $96 to $270.

Solid-State Multiplexer 590

All solid-state unit has sampling rates between 20 and 200 frames per sec. Differential inputs range between 0 to 5 mv and 0 to 10 v full scale, with an output of 0 to 10 v. Accuracy is ±20 μv for the mv ranges and ±0.05% for the high level ranges; input impedance, 5 meg min for low level, and 0.5 meg for high level.

Apparatus Div., Texas Instruments Inc., Dept. ED, P. O. Box 6015, Dallas 22, Tex.

NEW PRODUCTS

Serial Word Generator 434

Selectable word lengths of up to 80 bits are offered by the model 5500 serial word generator. Clock rate selection provides bit rates from 100 cps to 1 mc in four decade ranges. Pushbutton data coding is provided. Both pulse and non-return to zero outputs are available. Circuitry is modular solid-state.

Servo Corp. of America, Dept. ED, 111 New South Road, Hicksville, L. I., N. Y.

Ultra-Miniature Resistors 545

Encapsulated wire-wound resistors are available with axial or radial No. 30 tinned-copper wire leads in resistances to 25-K. Series 203 resistors have a temperature range of −35 to +400 F and any temperature coefficient up to 4,500 parts per million.

Spicer Electronics, Inc., Dept. ED, 2088 E. Villa St., Pasadena, Calif.

P&A: from $0.50; 2 to 14 days.

Power Supply Module 601

Transistor power module is designated TP. Included with an overload protection circuit, is regulation of 0.01%. The unit can be mounted in any position on any face. The housing is designed to eliminate the need of heat sinks or forced air for heat dissipation. Ranges are from 5 to 41 v, to 3.5 amp.

ACDC Electronics, Dept. ED, 2979 N. Ontario St., Burbank, Calif.

Teflon-Coated Glass Fabric 435

Low permeability low heat-sealing and laminating temperatures are offered by this addition to the firm's Armalon line of Teflon-coated fabrics. The material also has high dielectric strength and low moisture absorption. The material is made for aircraft, missile, cable, and printed-circuit applications.

Du Pont Co., Dept. ED, Room WT-902, Wilmington 98, Del.

Availability: in limited quantities.

Vernier Potentiometer 351

High-resolution vernier potentiometer gives resolution of 10-turn models, with just 1-1/2 turns. Model 20A has a main resistance element mounted in an outer case and a concentric smaller vernier potentiometer. Uses include strain gages and analog computers. Units come in various resistance values, power ratings and resettable dials.

John Fluke Manufacturing Co., Inc., Dept. ED, Box 7428, Seattle 33, Wash.

Delay Line 568

Magnetostrictive delay line model 20Mol provides a time delay of 60 μsec. Adjustment range is ±3 μsec; input imedance is 550 ohms; output impedance is 2,000 ohms, attenuation is 50 db; signal ratio is 12:1. Uses are in computers, data processing and airborne instruments.

ESC Electronics Corp., Dept. ED 534 Bergen Blvd., Palisades Park, N. J.

Availability: *6 weeks.*

Epoxy Adhesive 352

Flurobond Kit bonds Teflon and Kel-F to glass, plastic, aluminum and other metals. The kit consists of a tube of surface treatment solution, adhesive catalyst and general purpose epoxy adhesive, J-60. Each kit will treat 1,000 sq in. Strengths as high as 55 lbs per in. peel strength are claimed.

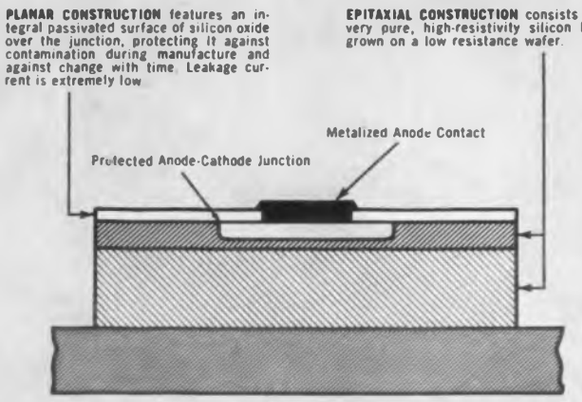
Joclin Manufacturing Co., Dept. ED, Lufbery Ave., Wallingford, Conn.

Price: *$8.50.*

CIRCLE 86 ON READER-SERVICE CARD ▶

ANNOUNCING THE FAIRCHILD FD600

FAIRCHILD PLANAR EPITAXIAL DIODE STRUCTURE



PLANAR

for surface protection and reliability

EPITAXIAL

for superior performance; high speed, high conductance

DIODES

EPITAXIAL CONSTRUCTION

A thin pure silicon epitaxial layer provides high breakdown voltage, low capacitance and fast reverse recovery. Added mechanical strength, low resistance path to the collector connection are made possible by thicker, low resistivity supporting wafer.

SILICON PLANAR RELIABILITY

An integral silicon oxide surface permanently protects the junction against contamination from the start of manufacture.

ADVANTAGES

Increases current handling capabilities of diode matrices without reducing speed. Decreases number of gate amplifiers between diode gates in series diode logic circuitry.

APPLICATIONS

High-speed, high conductance applications such as avalanche circuitry; core drivers; logarithmic amplifiers for pulse applications; critical circuitry requiring high conductance and low internal power dissipation, without sacrificing speed.

FD600 GUARANTEED CHARACTERISTICS

Forward Current	:	200 mA (min.) @ 1 Volt
Breakdown Voltage	:	75 Volts (min.) @ 5 μA
Capacitance	:	2 $\mu\mu$f (max.) @ 0 Volts
Reverse Current	:	50 mμA (max.) @ 50 Volts
Power Dissipation	:	500 mW @ 25°C

REVERSE RECOVERY TIME SPECIFIED FOR YOUR USE

● For magnetic memory applications

Fast recovery with no turn-off current required

t_{rr} = 20 mμsec (I_F = 200 mA, I_R = 0 mA)

● For current mode switching in driver applications

Fast recovery with high forward conductance

t_{rr} = 2 mμsec (I_F = I_R = 10 to 400 mA)

● For diode logic applications

Fast recovery with low reverse current

t_{rr} = 4 mμsec (I_F = 10 mA, I_R = 1 mA, recovery to 0.1 mA)

FAIRCHILD

SEMICONDUCTOR

545 WHISMAN ROAD, MOUNTAIN VIEW, CALIF. · YORKSHIRE 8-8161 · TWX: MN VW CAL 853

A DIVISION OF FAIRCHILD CAMERA AND INSTRUMENT CORPORATION

CIRCLE 87 ON READER-SERVICE CARD

NEW PRODUCTS

Digital Set Point 552

Type 510 digital set point unit, for use with HP-30 series Pyrometer, is accurate to ±0.25% total span. The unit will convert the HP-30 Pyrometer to a null-indicator, detecting a change of 0.25 F. Ambient operating range is 0 to 140 F.

General Electric Co., Dept. ED, Schenectady 5, N. Y.

Availability: November, 1961.

Power Controller 520

Operates with any standard universal testing machine. Model TM-9 controls high and rapid rising temperatures on test specimens within 10 deg in a range from room temperature to 6,000 F. The unit has two controlled output voltages, a low voltage for self resistance heating and a high (220 or 440 v ac) for control of ovens, etc.

The Marquadt Corp., Dept. ED, Van Nuys, Calif.

Field-Effect Transistors 518

Silicon field-effect transistors have low noise figures. Six types, C620 through C625, come in standard TO-5 cases. Maximum noise figures of 0.5 db on some of the series, is believed by the manufacturer to be below any amplifying device previously made.

Crystalonics, Inc., Dept. ED, 249 Fifth St., Cambridge 42, Mass.

Lamp Signals For Replacement 598

Twin filament miniature lamp is designed for use as a signal indicator lamp. It signals need for replacement. It is made with two filaments; one supplies the major portion of the light output, the other being designed for long life.

Chicago Miniature Lamp Works, Dept. ED, 1500 N. Ogden Ave., Chicago 10, Ill.

LOOK TO SOLA

the pioneer in a-c and d-c regulated power!

Constant-voltage transformers and d-c power supplies conveniently available nation-wide.

ALABAMA
Birmingham —
James W. Clary Co.
M-G Electronics & Equipment Co.
ARIZONA
Phoenix —
Midland Specialty Co.
CALIFORNIA
Glendale —
R. V. Weatherford Co.
Los Angeles —
Federated Purchaser, Inc.
Oakland —
Brill Electronics
Elmar Electronics
Palo Alto —
R. V. Weatherford Co.
Pasadena —
Electronics Supply Corp.
San Francisco —
Pacific Wholesale Co.
COLORADO
Denver —
Denver Electronic Supply Co.
Inter-State Radio & Supply Co.
Radio & Electronics Supply Co.
L. B. Walker Radio Co.
CONNECTICUT
Bridgeport —
Sprague Electrical Supplies
Hartford —
Electrical Supplies, Inc.
Waterbury —
Bond Radio Supply

DELAWARE
Wilmington —
Radio Elec. Service Co. of Delaware
DISTRICT OF COLUMBIA
Washington —
Capitol Radio Wholesalers
Electronic Wholesaler, Inc.
FLORIDA
Melbourne —
Electronic Wholesalers, Inc.
Miami —
Electronic Wholesalers, Inc.
Orlando —
Hammond Electronics
Pensacola —
Grice Electronics
Tampa —
Thurow Electronics
GEORGIA
Atlanta —
Electro Tech Inc.
Specialty Distributing Co., Inc.
ILLINOIS
Chicago —
Allied Radio Corp.
Lukko Electronics
Newark Electronics Corp.
E. H. Sargent & Co.
The Welch Scientific Co.
Oak Park —
Melvin Electronics
Peoria —
Klaus Radio & Electric Co.
INDIANA
Evansville —
Ohio Valley Sound

Indianapolis —
Graham Electronics Supply
Radio Distributing Co.
South Bend —
Radio Distributing Co., Inc.
IOWA
Davenport —
TCR Distributors
Des Moines —
Gifford Brown, Inc.
KANSAS
Wichita —
Interstate Electronic Supply Corp.
KENTUCKY
Lexington —
Radio Electronic Equipment Co., Inc.
Louisville —
P. I. Burks Co., Inc.
LOUISIANA
New Orleans —
Southern Radio Supply Co.
MARYLAND
Baltimore —
Wholesale Radio Parts Co., Inc.
Bethesda —
Empire Electronic Supply Co.
Silver Springs —
Kenyon Electronics Corp., Inc.
MASSACHUSETTS
Boston —
DeMambro Radio Supply Co.
A. W. Mayer Co.
Radio Shack Corp.
Cambridge —
Electrical Supply Corp.
MacAlaster Bicknell Co.
Newton —
Cramer Electronics, Inc.
Springfield —
T. F. Cushing, Inc.
Soundco Electronic Supply Co., Inc.
MICHIGAN
Ann Arbor —
Wedemeyer Electronic Supply Co.
Battle Creek —
Electronic Supply Corp.
Detroit —
Radio Specialties Co., Inc.
Jackson —
Fulton Radio Supply Company
Muskegon —
Western Electronic Supply Co.
MINNESOTA
Minneapolis —
Lew Bonn Co.
Northwest Electronics Corporation
Stark Electronics Supply Co.
St. Paul —
Gopher Electronics Co.
MISSOURI
Joplin —
Four State Radio Supply Co.
Kansas City —
Burstein-Applebee Co.
St. Louis —
Walter Ashe Radio Co.
NEBRASKA
Omaha —
Radio Equipment Co.
NEW JERSEY
Mountainside —
Federated Purchaser, Inc.
NEW MEXICO
Albuquerque —
Radio Specialties Co., Inc.
NEW YORK
Albany —
Ft. Orange Radio Dist. Co., Inc.

Binghampton —
Federal Electronics, Inc.
Buffalo —
Radio Equipment Corp.
Summit Distributors, Inc.
Elmira —
Brady Supply Corp.
Long Island City —
H. L. Dalis, Inc.
Lynbrook L. I. —
Peerless Radio Distributors, Inc.
Mineola L. I. —
Arrow Electronics, Inc.
New York —
Harvey Radio Co., Inc.
Milo Electronics Corp.
Terminal Hudson Electronics, Inc.
Poughkeepsie —
Chief Electronics, Inc.
Rochester —
Regua Electrical Supply Co., Inc.
Rochester Radio Supply
Rome —
Rome Electronics, Inc.
Schenectady —
Electric City Radio Supply
NORTH CAROLINA
Asheville —
Frech Radio Supply Co.
Raleigh —
Southeastern Radio Supply Co., Inc.
Winston-Salem —
Dalton-Hege Radio Supply Co.
NORTH DAKOTA
Fargo —
Bristol Distributing Co.
OHIO
Akron —
Akron Electronic Supply, Inc.
The Sun Radio Co.
Cincinnati —
Herrlinger Distributing Co.
United Radio Incorporated
Cleveland —
Pioneer Electronic Supply Co.
Radio & Electronic Parts Corp.
Columbus —
Hughes-Peters, Inc.
Dayton —
The John A. Becker Co.
Srepco, Inc.
Lima —
Lima Radio Parts Company
Toledo —
Warren Radio Company
Youngstown —
Ross Radio Co.
OKLAHOMA
Tulsa —
Engineering Supply Company
Radio Inc.
S. & S. Radio Supply
OREGON
Medford —
Verl G. Walker Co.
Portland —
Central Distributors
Lou Johnson Co., Inc.
Stubbs Electric Co.
United Radio Supply, Inc.
PENNSYLVANIA
Erie —
Erie Industrial Electric Supply
Warren Radio, Inc.
Indiana —
Fischer Scientific Co.
(Instrument Div.)
Philadelphia —
Herbach & Rademan, Inc.

Pittsburgh —
Cameradio Co.
Fisher Scientific Co.
Radio Parts Co., Inc.
State College —
Alvo Electronics Distributors, Inc.
RHODE ISLAND
Providence —
Wm. Dandreta & Co.
SOUTH CAROLINA
Charleston —
Wholesale Radio Supply Co.
TENNESSEE
Kingsport —
Radio Electric Supply Co.
Knoxville —
Roden Electrical Supply Co.
Memphis —
Bluff City Distributing Co.
Nashville —
Electra Distributing Co.
TEXAS
Dallas —
Engineering Supply Co.
Wholesale Electronic Supply of Dallas
El Paso —
Midland Specialty Co.
Houston —
Busacher Electronic Equip. Co., Inc.
Harrison Equipment Co., Inc.
Sterling Electronics, Inc.
UTAH
Salt Lake City —
Standard Supply Co.
VIRGINIA
Charlottesville —
Virginia Radio Supply Company, Inc.

WASHINGTON
Everett —
Pringle Radio Wholesale Co.
Seattle —
Pacific Electronic Sales Co.
Seattle Radio Supply, Inc.
Western Electronics Co.
Spokane —
Northwest Electronics, Inc.
Tacoma —
C & C Electronics Co.
Wible Radio Supply, Inc.
Walla Walla —
Kar Radio & Electric Co.
WEST VIRGINIA
Beckley —
ChemCity Electronic Distributors
Huntington —
West Virginia Electric Supply Co.
WISCONSIN
Madison —
Satterfield Electronics, Inc.
Milwaukee —
Radio Parts Co., Inc.

S-52-61

SOLA

BPC

DIVISION OF BASIC PRODUCTS CORPORATION

SOLA ELECTRIC CO., 1717 Busse Road, Elk Grove Village, Ill., HEmpstead 9-2800

IN CANADA, Sola Basic Products Ltd., 377 Evans Ave., Toronto 18, Ontario

CIRCLE 89 ON READER-SERVICE CARD

NEW PRODUCTS

Direct-Writing Recorders 542

Model 322 dc coupling recorder with medium gain amplifier has sensitivity ranges of 10, 20, 50, 100, 200, 500 mv per division and 1, 2, 5, and 10 v per division. Model 321 two-channel carrier recorder provides a 2,400 cps carrier frequency and 4.5 v excitation voltage. Maximum sensitivity is 10 μv (from transducer) per mm.

Sanborn Co., Industrial Div., Dept. ED, 175 Wyman St., Waltham 54, Mass.

Proportional Controller 525

Requires only two adjustments. The controller is used in conjunction with a suitable primary instrument equipped with a 250 ohm transmitting slidewire. Model 80410 operates on 115 v ac, 60 cps. The instrument measures 15-5/8 x 7-7/8 x 9 in. and weighs 30 lb.

Thermo Electric Co., Inc., Dept. ED, Saddle Brook, N. J.

Field Effect Adapter 517

Unit can adapt Tektronix 575 Transistor Tracer for field effect transistor use. The adaptor is used externally and does not interfere with the tester being used for conventional transistors.

Crystalonics, Inc., Dept. ED, 249 Fifth St., Cambridge 42, Mass.
***P&A:** $15.00: stock.*

Zener Diodes 366

10-w silicon Zener diodes have 2, 5, and 10% tolerances. This line of diodes is claimed to exceed MIL S-19500, through a range of 5.9 to 200 v, at −65 to +150 C.

American Semiconductor Corp., Dept. ED, 3940 N. Kilpatrick Ave., Chicago 41, Ill.

Carbon Potentiometer 581

Temperature and moisture stability is offered by carbon element in model 3251, square shaped trimmer potentiometer. Resistance range is 20 K to 1 meg, 0.50 w at 50 C. Rotation is 25 turns, temperature range is —65 C to +150 C, size is 1/2 x 1/2 x 3/16 in. and weight is approximately 0.1 oz. Unit meets MIL-STD-202B.

Bourns, Inc., Dept. ED, 6135 Magnolia Ave., Riverside, Calif.
***Price:** $5.50 in quantities.*

Molding Compound 503

Flame resistant diallyl phthalate compound is manufactured to comply with MIL-M-19833. Type 3-2-530 is also specifically designed to meet the requirements for new barrier type terminal boards as outlined in MIL-T-16784. The material is formulated with long glass fibers and heat resistant polymers.

Acme Resin Corp., Dept. ED, 1401 Circle Ave., Forest Park, Ill.

Vertical-Dipole Antenna 521

J-150 is a unity gain half wave end fed antenna designed for operation between 144 and 180 mc to a power level up to 250 w. At any specific frequency and cut length, the antenna has a vswr of less than 1.1 to 1. Across a bandwidth of 5 mc, vswr is 1.5 to 1, making two frequency operation feasible with one antenna.

Mark Products Co., Dept. ED, 5439-41 Fargo Ave., Skokie, Ill.

Sealed Relay 369

Less than 1-pf capacitance in this 1/4-oz. relay. Nominal coil power is 0.06 w and contacts are rated at 4 w. With a 6-v, 10-ma coil this relay has a speed of 0.8 msec. Unit is hermetically sealed in inert gas.

New Products, Inc., Dept. ED, Box 10763, Cameron Village Station, Raleigh, N. C.
***P&A:** $4.85 each small quantities; 30 days.*

NEW PRODUCTS

Radiation Measuring Device 365

The Sensor provides radiation level information for immediate area of fallout shelter. The unit establishes the amount of exposure permitted in a 24-hr period. Operation is push-button, for preservation of its D-cell battery supply. A 50-ft cable is used to mount the probe outside the shelter.

Radiation Equipment & Accessories Corp., Dept. ED, 665 Merrick Road, Lynbrook, N. Y. *P&A: $99.95; 4 to 6 weeks.*

Solder Applicator 364

Twin automatic paste solder applicator makes two deposits at the same time. Double the amount of material can be applied or double the speed can be obtained by this method. Units can cycle together or independently.

Fusion Engineering, Dept. ED, 17921 Roseland Ave., Cleveland 12, Ohio.

Ultrasonic Cleaner 579

Self tuned cleaner needs no operator attention. Model MSS 90 series has a peak power of 360 w average power of 90 w, and operates on 117 v ac 60 cps. A complete line of accessories for this generator are readily available.

Sonic Systems, Inc., Dept. ED, 1250 Shames Drive, Westbury, N. Y.

Price: $319.50.

CIRCLE 92 ON READER-SERVICE CARD ➤

this is
the Brush
Mark II...
anyone
can
plug
it in

put it
in writing
anywhere

There is no direct writing recorder on the market that approaches the compact Mark II in sheer usefulness. It is a completely integrated engineering tool that can be operated by anyone . . . in the shop or in the field . . . for countless research or design requirements. Every function necessary for uniform, crisp, easily reproduced readouts is "built-in". The Mark II gives you two analog channels plus two event markers; 4 chart speeds; DC to 100 cps response with 40 mm amplitude; 10 mv/mm sensitivity; high input impedance. Ink or electric writing models. Immediate shipment from stock.

brush INSTRUMENTS
DIVISION OF
37TH AND PERKINS CLEVITE CORPORATION CLEVELAND 14, OHIO

A LIBRARY ON TRANSISTORS FOR THE ENGINEER AND THE ENGINEER'S TECHNICIAN

DESIGN OF TRANSISTORIZED CIRCUITS FOR DIGITAL COMPUTERS

by Abraham I. Pressman, M.S. (Digital Circuits Consultant for Radio Corporation of America.)

"...by far the most comprehensive coverage on the subject to date... It should prove quite useful to circuit designers in the computer field."

—Reviewed for the PROCEEDINGS OF THE I.R.E. by William B. Cagle, Bell Telephone Labs., Whippany, N. J.

A book that makes digital computor circuit design easy. To be of the greatest general utility, the author employs "worst-case" design techniques. "Worst-case" design is absolutely essential for digital type circuits, as these are of the nature of all or none-circuits, and single errors even over long periods of time cannot be tolerated. Pressman's design considerations permit circuits to work when all supply voltages, resistors, passive components and all transistor as well as diode parameters are simultaneously off their nominal values by the maximum expected tolerances. #215, cloth-bound, **$9.95.**

FUNDAMENTALS OF TRANSISTORS

(2nd Ed. revised & enlarged) *by Leonard M. Krugman, P.E.* ***"...will be extremely useful to the budding engineer...many qualified engineers will find it very helpful. Few who are interested in transistors can afford to be without it."***—WIRELESS ENGINEER.

Attacks the study of transistors from the viewpoint of transistors and transistor circuit parameters. The book emphasizes theory. It makes theory understandable through mathematical derivations and many numerical examples and solutions. Theoretical operation of various transistor circuits is made clear by step-by-step mathematical analysis. Problems are given at the end of each chapter. A highlight of this book is a very extensive bibliography. #160, **$3.50.**

FUNDAMENTALS OF TRANSISTOR PHYSICS

by Irving Gottlieb, P.E. A thorough analysis of the action of semiconductors from the physics viewpoint. Semiconductor physics is presented beginning with the theoretical aspects and culminating in the practical transistor and its fundamental circuit. Transistor circuit operations are dealt with only as they amplify the theory. Having reached the fundamental transistor, the author presents analogies to similar fundamental vacuum tube circuits. Related semiconductor devices such as the double base or tetrode transistor, the double-base diode, the unipolar field control transistor, and the silicon control rectifier are covered. Recent developments in transistor physics are discussed including the new tunnel diode. #267, **$3.90.**

PRINCIPLES OF TRANSISTOR CIRCUITS

by S. W. Amos, B.Sc. Penetrates deeply into the 'why' and 'how' of transistor operation and explains the three basic circuits configurations which form the foundation for all transistor circuits. #241, **$3.90.**

SEMICONDUCTORS & TRANSISTORS

by Alexander Schure, Ph.D. (25th in Electronic Technology Series). This book is a design oriented text on transistors. It provides the mathematical approach to semiconductors and transistors in the design of circuitry. It discusses and evaluates from the mathematical viewpoint, the theory and characteristics of these materials and devices including fabrication. The mathematical treatment is sufficiently extensive to make absolutely clear the pertinent ideas relating to circuit design. The reader, through presentation and practical situations and problems, is given an opportunity to apply the principles he has learned. Questions and problems are given at the end of each chapter. #166-25, **$2.90.**

BASIC TRANSISTORS

("Pictured-Text" Course), *by Alex Schure, Ph.D.* An ideal introduction to the entire field of semiconductors and transistors for the person approaching the transistor for the first time. In order that the reader get full appreciation of the operation and potentialities of transistor circuits, a thorough coverage is made of the characteristics of semiconductor materials, including what they are, how they operate and how they are made. Fundamental operation of a wide variety of transistor circuits in radio and general electronic equipment are analyzed and their actions described. The methods of biasing and coupling in transistor circuits are described. Coverage includes conventional voltage amplifier transistors, the power type, and tetrode units. Specially conceived illustrations make every phase of the subject of transistors completely understandable. #262, soft cover, **$3.95;** #262-H, hard cover, **$5.50.**

INTERNATIONAL TRANSISTOR SUBSTITUTION GUIDEBOOK

(4500 direct substitutions) *by Keats A. Pullen, Jr., Eng., D.* ***"Possible substitutions deemed 'doubtful', that is, they work in some cases, were omitted . . . thus, substitution guide is a 'safe' guide."*** — INDUSTRIAL ELECTRONIC ENGINEERING & MAINTENANCE.

An indispensable 'tool' for everyone who works with transistorized equipment—designing, repairing or maintaining. Only the painstaking, critical examination of the electrical specifications and the holding to close tolerances of each substitution could assure reliable circuit operation. Direct substitutions subject to qualifications bear the qualifying information. These are your assurances of reliability. Lists more than 4500 direct substitutions comprised of American, Japanese, British, French, German, Dutch and Italian transistor types. Includes triodes and tetrodes. Not only are the direct electrical substitutions shown, but case styles, dimensions and dasing diagrams for the original substitute also are given for maximum substitution flexiblity. #276, **$1.50.**

FREE!

DESCRIBES MORE THAN 250 TITLES

Design, research and production 'tools' that every engineer must have! Write for free catalog.

For these books and more than 250 Rider titles visit electronics distributor, book store or department store, or order direct.

JOHN F. RIDER PUBLISHER INC., 116 West 14th Street, New York 11, N. Y. a division of Hayden Publishing Company, Inc.

Canada: Chas. W. Pointon, Ltd., 66 Racine Rd., Rexdale, Ont.

Export: Acme Code Company, Inc., 630 9th Ave., N. Y. C. India: Asia Publishing House, Bombay and other cities

CIRCLE 240 ON READER-SERVICE CARD

Twin Power Supply 486

Featuring automatic overload resetting, type AS 1164 comprises twin 0-30 v, 1 amp floating supplies. Can be used separately as positive and negative supplies, or switched into parallel to give 2-amp capacity. Each supply has separate overload limit selectors and current monitoring meters.

Solartron Laboratory Instruments Ltd., Dept. ED, Cox Lane, Chessington, Surrey, England.

DC Power Modules 381

Temperature rating is −40 to +100 C. More than 90 models are available ranging from 2.8 to 52 v at powers of 1.0 to 20 w. Input voltage range is 105—125 v, 50—400 cps. Models are produced with both 0.05% and 0.5% regulation.

Technipower, Inc., Dept. ED, 18 Marshall St., South Norwalk, Conn.

Zener Diodes 556

Silicon junction Zener diodes range from 250 mw to 50 w power dissipation. All series of the Syntron diodes have 10% tolerance. Standard decade values are available with other values on special order. Diodes of 1/4 and 1/2 w dissipation are glass bead encapsulated, 3/4 and 1 w units are top hat cases and all others are stud mounted.

Semiconductor Div., Syntron Co., Dept. ED, Homer City, Pa.

NEW PRODUCTS

Composite Transistor 385

Current gain (beta, H_{FE}) exceeds 5,000. Type SST 610 contains a matched pair of hermetically sealed npn diffused mesa silicon transistors. Current range from 1 to 500 ma: dissipation is 1 w at 25 C case temperature. The unit, which has a temperature range from −55 to +150 C, is designed to meet MIL-S-19500B.

Solid State Electronics Co., Dept. ED, 15321 Rayen St., Sepulveda, Calif.

P&A: $68.00: stock.

Nonflash Getter 395

CerAlloy 400 is available in the form of vacuum sintered coatings on molybdenum, kovar and inconel as strips measuring 1 x 0.005 x 9.0 in. coated on one or both sides. It is said to be effective over a wider temperature range than other getters.

Cerium Metals and Alloys Div., Ronson Metals Corp., Dept. ED, 45-65 Manufacturer's Place, Newark 5, N. J.

Cooling Pump 394

Electric-motor-driven spur gear pump operates in dielectric coolant fluids. The RG17400 has an integral relief valve for flows from 1.5 to 2.5 gallons per min, at pressures to 225 psi. With "Coolanol" 45 fluid, the pump is rated 1.75 gallons per min at 175 F, against 50 psi back pressure, operating from 115 or 200 v, 400 cps ac.

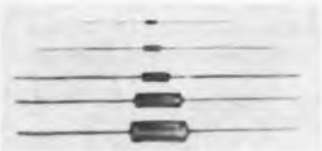
Lear-Romec Div., Lear Inc., Dept. ED, 241 S. Abbe Road, Elyria, Ohio.

Space Camera 415

Four-hundred-ft capacity DBM 10 camera will operate at 16 or 24 fps with register pin for high definition, resolving in excess of 200 lines per mm. Manufactured to sustain an 80 g load, the unit is hermetically sealed for submerged or explosive environments. It emits an operating output pulse for telemetering and complies with radio interference specifications of MIL-I-6181D.

D. B. Milliken Co., Dept. ED, 131 N. 5th Ave., Arcadia, Calif.

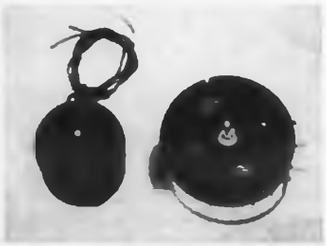
Carbon Film Resistors 386



Resistors feature tolerances of ±1.0%, voltage coefficient of less than 0.0002% per v, and temperature coefficient of −0.02 to −0.05% per deg C. PT-D series range from miniature to subminiature. PT40 measures 0.090-in. body diam x 0.281-in. body length, and is rated at 1/10 w with a resistance range of 10 ohms to 500 K.

Pyrofilm Resistor Co., Inc., Dept. ED, U. S. Highway 46, Parsippany, N. J.

Limited Rotation Motors 387



Series 90 current to torque transducers have no wiping contacts. Angular rotation limits can be varied ±5 to ±25 deg from a central position. Units are available in flange or front face type mounting for clamps or screws. Present units range from 0.1 oz-in. for the size 15 motor to 2 oz-in. for the size 23 motor.

Power-Tronic Systems, Inc., Dept. ED, Pine Court, New Rochelle, N. Y.

***P&A:** $225.00-450.00; 8 weeks.*

NEW PRODUCTS

DC Meter Linearity Tester 388

Model 113 checks 10 cardinal points on each meter, with an accuracy of ±0.2% or better. Meters may have full-scale sensitivities from 50 μa to 1 ma. Undamped meters may be tested by switching a variable shunt across the meter terminals.

IB Instruments, Dept. ED, Box 2460, Cleveland 12, Ohio.
Price: *$99.50.*

Multiple Key Switch 383

Available in 6 or 12 stations, the "MLK" requires only 2-3/32-in. depth behind the mounting panel. Contacts may be of fine silver rated at 3 amp, 120 v ac noninductive load (300 v max) or of palladium which is available on special order.

Switchcraft, Inc., Dept. ED, 5555 N. Elston Ave., Chicago 30, Ill.

Regulated Power Supply 418

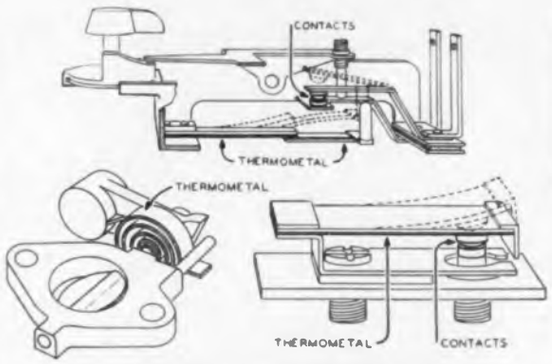
Chal-Pak is designed for systems involving relays, dc motors, transistorized circuitry and other electronic devices requiring adjustable output voltages of 20 to 30 v and up to 30 amp. Completely contained in a transformer-type, chassis-mounting case, 6 x 7 x 13 in., the unit can be used in computers, test equipment, laboratories, instrumentation systems and inverters.

Chalco Engineering Corp., Dept. ED, 15126 S. Broadway, Gardena, Calif.

FOR LOW COST PURIFICATION AND DRYING OF HYDROGEN AND OTHER GASES

The Deoxo Catalytic Purifier removes oxygen to less than one part per million from hydrogen gas. It can also be used with other gases such as Nitrogen, Nitrogen-Hydrogen Mixture, Argon, Helium, and Carbon Dioxide. • A combination unit, the Deoxo Dual Puridryer, contains the Deoxo Catalytic Purifier plus an extremely efficient automatically operated drying unit. Removes oxygen to less than 1 PPM from hydrogen and dries the purified gas to a low point of minus 100°F. It will also purify and dry other gases in a similar manner.

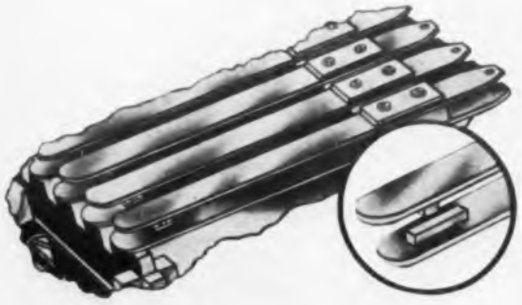
INDUSTRIAL EQUIPMENT DIVISION
GAS EQUIPMENT SECTION
113 ASTOR STREET • NEWARK, N. J.
CIRCLE 815 ON READER-SERVICE CARD



CONTROL TEMPERATURE, CURRENT AND VOLTAGE WITH THERMOMETAL®

Leading manufacturers rely on the dependable performance of Wilco Thermometal in electrical appliances, thermal cutouts, heating controls and many other applications involving the indication and accurate control of temperatures, electrical currents, voltages, etc. Thermometal is supplied in strip form, rolled and slit to close tolerances and tempered to specification. Thermometal elements and sub-assemblies are also supplied to specifications, with or without contacts attached. Send for literature.

H. A. WILSON DIVISION
U.S. HIGHWAY 22 • UNION, N. J.
CIRCLE 816 ON READER-SERVICE CARD



ECONOTAPE CONTACTS ARE MOST EFFICIENT FOR ELECTRICAL RELAYS

High reliability welded contacts and contact assemblies available for your relays. Weld strength guaranteed. • Overall contact height held within ±.00025. Assemblies are available in gold, platinum, palladium, silver and their various alloys—both solid and laminated. Single contact usable for various contact ratings, for wet and dry circuitry—assemblies protected for shelf life and handling. Designs for attachment to header by welding or brazing. Complete electrical and mechanical design services available.

D. E. MAKEPEACE DIVISION
PINE & DUNHAM STREET • ATTLEBORO, MASS.
CIRCLE 817 ON READER-SERVICE CARD

ENGELHARD
INDUSTRIES, INC.
EXECUTIVE OFFICES:
113 ASTOR STREET • NEWARK 2, NEW JERSEY

SALES OFFICES: CHICAGO • DALLAS • DETROIT • HOUSTON • LOS ANGELES • NEW YORK • ORLANDO • PROVIDENCE • SAN FRANCISCO • WASHINGTON, D. C.

Please send literature as indicated below, addressed to my attention:

☐ Minoxo Indicator ☐ Thermometal
☐ Econotape ☐ Deoxo Purifier—Puridryer
☐ Fused Quartz ☐ Platinum Spirals
☐ Nitroneal Generator

NAME .....
TITLE .....
FIRM .....
STREET .....
CITY ..... ZONE ..... STATE .....

RFI Gasketing 417

Monel knitted wire makes up Teckmat gasket. This shielding can be used between complex mating surfaces and is easily installed and positioned for positive case and interstage shielding. Custom formed to order, this gasketing is usually produced in sizes of less than 40 in.

Technical Wire Products, Inc., Dept. ED, 129 Dermody St., Cranford, N. J.
Price: $30 to $40, 1 to 5 prototype units.

Electronic Pilot Relay 416

Cold cathode tube (Type TT-1) permits the unit to control large values of current and power with a current flow of 2 millionths of an ampere. The relay, which operates over any input resistance from a dead short to 10 megohms, requires 115 v, 60 cps, and consumes 2 w.

Haledy Electronics Co., Dept. ED, 99 Wall St., New York, N. Y.
P&A: $47.50; stock.

Standard Frequency Comparator 420

Cabinet enclosure permits conversion from cabinet model to rack mount. Model WWVC has a sensitivity of 1 μv and crystal controlled frequencies of 2.5, 5.0, 15 and 20 mc. Visual measurements may be checked on the built-in 2-in. oscilloscope tube, and a 3-in. loudspeaker is provided for aural measurement.

Specific Products, Dept. ED, 21051 Costanso, Woodland Hills, Calif.
Price: $750.00.

NEW PRODUCTS

Altimeter-Barometer 398

Measures altitude up to 18,000 ft above sea level. Model 3D21d works on the barometric principle—through the measurement of air pressure. The unit weighs 3 oz and measures 2-1/2 x 2-1/2 x 3/4 in. It is easily read with the help of a pointer and recording disk.

AGA Corp. of America, Dept. ED, Box 447, South Plainfield, N. J.

Conformable Coatings 407

Two grades are available. Epocast H-1780 is a dark-colored low-viscosity grade capable of penetrating between fine electrical wires or into porous metal castings to develop a smooth uniform coating on metal surfaces. Epocast H-1724 shrouds the components in an all enveloping protective blanket.

Furane Plastics, Inc., Dept. ED, 4516 Brazil St., Los Angeles 39, Calif.

Nongeared AC Motor 405

Series YAA sizes offer ratings to 0.005 hp, no-load speed of 3,000-3,300 rpm, starting torques to 0.19 lb-in. and alignable sleeve bearings. Approximate dimensions are 2.5 x 2.25 in. Various mounting arrangements are available.

Barber-Colman Co., Motors & Components Div., Dept. ED, Rockford, Ill.

◀ CIRCLE 96 ON READER-SERVICE CARD

Portable Ohmmeters 406

Accuracy to 1/2 of 1%. Model 244-A has four ranges, allowing measurements from 0.05 to 50,000 ohms, with center-scale value of 1.2 ohms on low range. Model 246-A provides measurement from 0.1 to 100,000 ohms. Indicating meters on both models have mirrored scales 4-1/2 in. long.

Associated Research, Inc., Dept. ED, 3777 W. Belmont Ave., Chicago 18, Ill.

Miniature Relay 408

Features high resistance to shock and vibration. Typical operating time is 600 μsec for 28-v dc unit at nominal voltage. Contact to coil capacitance is 5 pf open and 10 pf closed at 1 kc. Units feature 1,000-v rms, 60-cps breakdown voltage (contacts to coil) for 1 min, and operating temperature of −54 to +75 C continuous. Natural contact frequency is 2,700 to 3,200 cps.

Hathaway Denver, Dept. ED, 5800 E. Jewell Ave., Denver 22, Colo.

Transfer Device 357

Parts up to one pound can be handled and placed by Transfe-Robot 200. Items can be placed in dies, jaws or nests with a tolerance of ±0.002 in. Horizontal stroke is continuously adjustable from 3 to 10 in. and the vertical stroke from 5/8 to 2 in. The entire unit is 24 x 6 x 10 in., weighs 36 lbs, and operates on 110 to 115 v, 60 cps ac.

U. S. Industries, Inc., Dept. ED, 250 Park Ave., New York 17, N. Y. ***P&A:** $2,500.00; stock.*

CIRCLE 97 ON READER-SERVICE CARD ➤

NEW PRODUCTS

Planar Epitaxial Transistors 402

Passivated silicon transistors operate at frequencies from 50 to 120 mc. P.E.P. series includes types 2N2193-2N2195 and 2N2193A-2N-2195A. These devices are capable of dissipating 2.8 w with a case temperature of 25 C. Housed in a TO-5 case, the units are rated for operation from −65 to +200 C, and for storage from −65 to +300 C.

General Electric Co., Semiconductor Products Div., Dept. ED, Kelley Building, Liverpool, N. Y. *P&A: $3.50 to $13.75 each (100-999); stock.*

Differential Transformers 401

Three linear variable models (E100D, E200D, and E300D) have linear range from ±0.100 to ±0.300 in. Signal output has a ±1% linearity over the specified range. Full-scale output voltage into a 500-K load is from ±0.3 v to ±1.26 v dependent upon model. Operating temperature range is −65 to 180 F. The device uses a standard 60 cps input at a 6-v level.

Schaevitz Engineering, Dept. ED, Route 130 and Schaevitz Blvd., Pennsauken, N. J. *P&A: $9.00-$13.00; stock.*

◀ CIRCLE 98 ON READER-SERVICE CARD

Liquid Level Detectors 412

Permits remote indication and monitoring of levels. Model 369 transducer makes it possible to indicate level, temperature and pressure on the same instruments. An adjustment is provided to calibrate the resistance level transducer for liquid specific gravity variations of from 0.7 to 1.1.

Instrument Div., Thomas A. Edison Industries, McGraw-Edison Co., Dept. ED, West Orange, N. J.

Magnetic Material 361

Type 4000 iron oxide combines high permeability with high resistivity. The combination of high initial permeability with low density makes the material suitable as a magnetic ink component. Its low chemical reactivity makes it suitable as a magnetic trace material.

Wright Industries, Inc., Dept. ED, 412 55th St., Brooklyn 20, N. Y.

Pressure Indicators 410

Deltadyne indicators are available for system working pressures up to 10,000 psi, operating temperatures from −65 to +275 F and actuation from 1.5 to 100 psi differential. Extended ranges can be supplied on special order. The units are designed for corrosive service, with housings of aluminum or stainless steel.

Pall Corp., Dept. ED, 30 Sea Cliff Ave., Glen Cove, N. Y.

CIRCLE 99 ON READER-SERVICE CARD ➤

NEW PRODUCTS

Microminiature Resistor 423

Diameter is 1/8 + 1/64 in. and maximum length is 5/16 in. Series 2005 operates at twice full rated power for extended periods and withstands ambient temperatures to 500 F. Resistances range from 10 ohms to 100 K. Maximum voltage is 100 v, and wattage rating is 0.1 w at 125 C, derated to zero at 145 C.

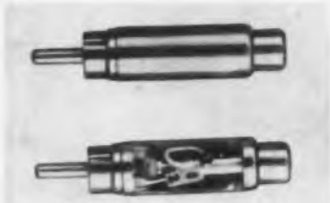
Robinson Electronic Components, Inc., Dept. ED, 409 McGroarty St., San Gabriel, Calif. ***Availability:*** *1 week.*

Multi-Output Power Supply 391

Computer grade unit offers one to five individually regulated outputs. Chal-Multi-Pak has ranges from 0 to 50 v and from 0 to 10 amp with a total output power capacity of 1 kw. The unit also features self-contained cooling and modular construction.

Chalco Engineering Corp., Dept. ED, 15126 S. Broadway, Gardena, Calif.

Audio Equalizer 382



Plug-in type is used with ceramic phonograph cartridges. Model 328A enables a ceramic cartridge to be plugged directly into the magnetic input of any amplifier without any modification. One is needed for monaural, two for stereo.

Switchcraft, Inc., Dept. ED, 5555 N. Elston Ave., Chicago 30, Ill.

Electronic Relay 421

Equipped with a cold-cathode thyratron, contact amplifier type CV 2 is designed for actuation by very light contacts varying between 10 and 60 mw or by high-output impedance apparatus. The unit is an electromagnetic pendent armature relay with electronic gain amplification consisting of the thyratron which is fed direct, without rectifier or transformer, from the 220-v alternating grid.

N. V. Instrumentenfabriek H. M. Smitt, Dept. ED, Middellaan 3-5, Bilthoven, The Netherlands.

Availability: *2 weeks.*

Silicon Rectifiers 384

Three series are available: medium and high voltage, 1,200 v piv to 1,100 ma average rectified current; 1,000 piv at 1,100 ma average; and 800 v piv to 1,100 ma average. The units are designed to exceed MIL-STD E-1084 and MIL-STD 202 method 103A humidity test.

Solitron Devices, Inc., Dept. ED, 500 Livingston St., Norwood, N. J.

P&A: *from $0.85; stock.*

Subminiature Thermostat 456

Snap-acting thermal switch is hermetically sealed and resistant to severe environmental conditions. Model 3001-2 meets or exceeds all applicable MIL specifications. The unit is designed for electronic communications equipment and missile and aircraft controls. Instantaneous "make and break" action eliminates creeping and false cycling.

Thermel, Inc., Dept. ED, 669 Elmwood Ave., Providence, R. I.

NEW PRODUCTS

Lamp Assembly 380

Series RLA replaceable assembly makes possible continuous mounting of replaceable indicators on horizontal and vertical centers as close as 3/8 in. Unlimited lengths and widths of displays on 3/8-, 1/2-, 3/4- and 1-in. centers can be achieved with series RLA indicator lights, according to the manufacturer. Twelve lens colors, transparent and translucent, in flat top and optional watertight design are available.

Tec-Lite Div., Transistor Electronics Corp., Dept. ED, 3357 Republic Ave., Minneapolis 26, Minn.

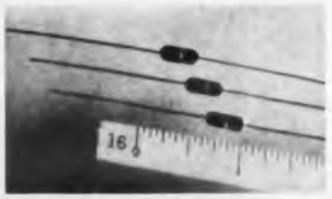
Transistor Sockets 393

Featuring gold-plated contacts. The socket mounts in a single round hole by compression fit of its Teflon body. Connections are made within 5/16 in. of the transistor case. Units withstand continuous use at 200 C.

Barnes Development Co., Dept. ED, 213 W. Baltimore Ave., Lansdowne, Pa.

P&A: $0.65 to $1.75; stock.

Ceramic Capacitors 419



Ratings for both 50 wvdc and 200 wvdc capacitors are at 85 C, and derated by 50% at 125 C. Temperature coefficient from −55 to +125 C is +10% to −30% at 0 v, and +10% to −40% at rated voltage. Series resistance is 0.20 ohms max at 8 to 10 mc and power factor is 2% max. Cerol capacitors are designed for general applications in by-pass coupling, filtering and blocking circuits.

Hi-Q Div., Aerovox Corp., Dept. ED, Olean, N. Y.

Availability: 3 to 4 weeks.

Circuit Card 389

Series DC10C 10-mc systems cards measure 2.75 x 5.5 in. and mount from two to four standard modules together with filter and bias components. The cards are fabricated from 0.062-in. black epoxy glass. The modules are 0.8 x 1.7 x 0.5 in. and occupy a volume of 0.625 cu in.

Control Logic, Inc., Dept. ED, 11 Mercer Road, Natick, Mass.

Delay Lines 373

Pulse information is stored for periods from 5 μsec to 1.5 msec. Lines consist of a nickel tube with transducers in the form of encapsulated ferrite cored coils threaded thereon. The delay lines can be supplied mounted in metal containers.

Cossor Radar & Electronics Ltd., Dept. ED, The Pinnacles, Harlow, Essex, England.

Computer Drive Motor 371

High-temperature, 40-frame dc motor. Model 4026-4 operates on an input voltage of 50 v. Output is rated at 500 oz-in. torque at 0 rpm, and a no-load speed of 1,500 rpm. Length is 8 in. and diameter is 4 in. The unit is equipped with a special shaft, brake, and flange mounting to meet exacting computer specifications.

Eicor Div., Indiana General Corp., Dept. ED, 517 W. Walnut St., Oglesby, Ill.

Terminal Systems 392

Panel-mounting systems are made in capacities of 100, 256, 400, 625 and 900; rack-mounting systems in 1250, 2500, 3750, and 5000. Single conductor color-coded leads have lengths from 3 to 35 in.

Automation Connector Div., Caine Electronic Sales Co., Dept. ED, 4120 W Lawrence Ave., Chicago 30, Ill.

NEW PRODUCTS

Delay Lines 379

Designed for space vehicles. Units are packaged in half an epoxy ring with 1.625-in. OD, 0.375-in. ID, and 0.5-in. thickness. Leads are No. 22 AWG nickel. Type DL 397 has a total delay of 0.2 μsec, rise time of 0.033 μsec and impedance of 500 ohms. Type DL 809 has a total delay of 0.03 μsec, rise time of 0.005 μsec and impedance of 200 ohms.

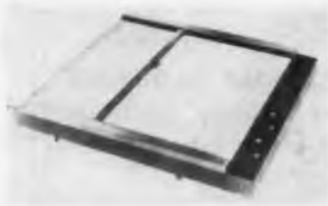
Valor Instruments, Inc., Dept. ED, 13214 Crenshaw Blvd., Gardena, Calif.
Availability: *2 weeks.*

Humidity Reader-Controller 396

Reading and controlling accuracy is ±0.25% relative humidity. Model PCRC Hygrocon-1 has four 25% expanded scales and a complete 0-100% scale. Differential control has independently adjustable high and low limits. The unit is fully transistorized and is available for 115- or 230- v, 50- or 60-cps operation for foreign use.

Phys-Chemical Research Corp., Dept. ED, 40 E. 12th St., New York 3, N. Y.
P&A: *$750.00; 4 weeks.*

Graphic Recorder 424



Features a 30-in. sq recording area. Model 7 has an accuracy of ±0.1% of full-scale and pen speed of 20 in. per sec max for each axis. Selector switches provide 13 voltage ranges in 1-2-5 sequence from 1 mv per in. to 10 v per in. or 30 mv to 300 v full scale on each axis. This instrument uses either individual sheets of graph paper or 50-yd roll charts.

F. L. Moseley Co., Dept. ED, 409 N. Fair Oaks Ave., Pasadena, Calif.
P&A: *$6,500.00; stock.*

Impact Noise Analyzer 585

Push button resets signal storage circuit of type 1556-B. Peak value of a single pulse of short duration can be measured by the storage feature of this unit. Noises of any type can be measured with this battery operated analyzer. One meter can measure peak, quasi peak and time average on one impact.

General Radio Co., Dept. ED, West Concord, Mass.

Price: *$220.00.*

Epoxy Cement 425

Two-component 1/10-oz Pa-Kit mixer packages are available for use in production lines, service kits and laboratories. Catalyst and resin are sealed in a vacuum-formed polyethylene container. Contents are mixed on-the-job just prior to use. Both components are of contrasting colors to furnish a visual indication of an even mixture.

Plastic Associates, Dept. ED, P. O. Box 36, Laguna Beach, Calif.

Digital Voltmeter 441

Model 412 measures ac and ±dc between 0.001 and 999.9 v. The militarized equipment consists of two units: a 466 ac-dc measurement unit containing all metering circuits, and a 474 control unit and readout containing all switches for voltmeter operation. Dc measurements are accurate to within 0.01% ±1 digit; ac accuracy is within 0.1% of full scale. Unit meets MIL-E-4158A.

Cohu Electronics, Inc., Kin-Tel Div., Dept. ED, 5725 Kearny Villa Road, San Diego 12, Calif.

P&A: *$10,000 (5 to 10) fob San Diego; 12 weeks.*

NEW PRODUCTS

Radar Detector 375

For motorists. Available with a dual-band circuit, "Radar Sentry" is said to be able to detect all commonly used police radar speed meters and traffic control units. The device measures 3-5/8 x 2-1/4 x 3-1/4 in. and weighs 13 oz. Three colors are available: beige, sapphire blue, and emerald green.

Radatron, Inc., Dept. ED, 232 Zimmerman St., North Tonawanda, N. Y.

Price: $39.95.

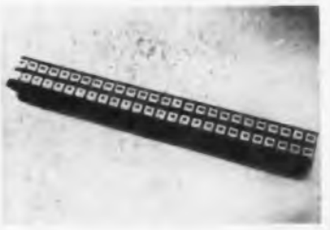
Asbestos-Polyester Insulation 444

Quinterrabord No. 880 is designed for applications to 50 kv at temperatures in the 155 to 180 C range. Produced in 35 x 72-in. sheets, the material is available in standard thicknesses ranging from 1/32 to 1/2-in. It has a density of 110 lb per sq ft, a perpendicular dielectric strength of 350 v per mil (1/16-in.), and a tensile strength of 30,000 psi (1/16-in.).

Johns-Manville, Dept. ED, 22 E. 40th St., New York 16, N. Y.

P&A: $2.00 per lb; 6 to 8 weeks in large quantities.

Switch Assemblies 539



Circuits with up to 6pst or 3pdt are available in various combinations of normally open and normally closed contacts. Assemblies employ standard pushbutton switchlights mounted on either 3/4 or 1-in. centers. Available types include: independent, momentary interlocking, independent locking and interlocking, locking with master release, etc.

Pendar, Inc., Dept. ED, 14744 Arminta St., Van Nuys, Calif.

Availability: *2 to 3 weeks.*

RF Parameter Tester 457

Instruments provide direct meter readings of the various rf parameters of mesa, drift, and surface barrier transistors. Units can provide measurements of the 20-mc current gain, the collector capacitance and the extrinsic base resistance-collector capacitance product. They are available as individual rack mounted units or as plug-in units tht mount in a bias supply cabinet.

Dynatran Electronics Corp., Dept. ED, 178 Herricks Road, Mineola, N. Y.

P&A: *model 1827PA, $725.00; 6 weeks.*

NEW PRODUCTS

Switching Diode 354

Gallium arsenide diode has nsec recovery time. The 3 types, DGS-51, -52, and -54 can be operated at temperatures up to 300 C. The units can be used in logic design or other low-current switching applications. Maximum inverse current rating is 1.0 and 10 μa at 25 and 300 C. Power dissipation of the device is 200 mw.

Diotron Inc., Dept. ED, 3650 Richmond St., Philadelphia 34, Pa.

***P&A:** $14.30 to $15.65, 1 to 99; stock.*

Cleaning Unit 359

Ultrasonic generator model UG 1000 has average power of 1,000 w. Unit has a drift free oscillator and a power amplifier circuit that permits full output with 1 v input. Model UG 110 is a compatible tank, holding 11 gallons of solution.

Ultrasonic Systems, Inc., Dept. ED, 2255 S. Carmelina Ave., Los Angeles 64, Calif.

Low-Level Multiplexer 355

Transistorized unit is capable of commutating input signals from 0 to ±15 v, with resolution to 1 μv. Offset voltage does not exceed 50 μv, with variations in source impedance of 0 to 10 K and −20 to +85 C. The system, with 15 channels, weighs less than 9 oz and volume is about 9 cu in. Units can be stacked to increase channels.

Alpha-Tronics Corp., Dept. ED, 1033 Engracia, Torrance, Calif.

◀ CIRCLE 113 ON READER-SERVICE CARD

Sintered Copper 353

Electrical conductivity of sintered copper is 93% that of wrought copper. Tensile is 39,000 psi, as opposed to 45,000 and 33,000 for hard and soft wrought copper respectively. This process can be used for many shapes or forms.

Electrical Contacts Div., Fansteel Metallurgical Corp., Dept. ED, North Chicago, Ill.

Ferrite Cores 362

For use in magnetic-memory systems, etc. At a full driving current of 480 ma, the 232M1 has a switching time of about 1 μsec. In "impulse switching" operation, the 401M1 at a "read" driving current of 570 ma can switch in 0.20 μsec. The 501M1 has a switching time of approximately 2.3 μsec at a setting current of 360 ma and a full driving current of 160 ma.

Radio Corp. of America, Semiconductor and Materials Div., Dept. ED, Somerville, N. J.

Balance and Control Unit 411

For check weighing, sorting, statistical evaluation, and accurate production control. Seven different models are available with rated capacities from 1 to 1,000 g. Sensitivity is 0.05%; weighing speed is up to 10,000 per hr. The system consists of a spring balance with rapid response, and an electronic control unit containing relays for control of further operations.

Mettler Instrument Corp., Dept. ED, P. O. Box 100, Princeton, N. J.

CIRCLE 114 ON READER-SERVICE CARD ➤

NEW PRODUCTS

Printed-Circuit Connector 378

Seventeen-in., double-row connector has 210 terminals. Three types of contacts are available; pierced, straight-dip solder, or right-angle-dip solder. Standard insulator material is diallyl phthalate per MIL-M-18794 that withstands 450 F. Current rating is 10 amp max and voltage breakdown at sea level is 3,200 v dc.

Viking Industries, Inc., Dept. ED, 21343 Roscoe Blvd., Canoga Park, Calif.
Availability: *stock.*

Rotary-Bar Printing System 397

Model RBP-72-20 buffer and control unit incorporates all input-output control, storage, conversion, and decoding functions for a 72-character per line, rotary-bar printer in a single 7-in. rack panel structure. Input rate is 100 kc. RBP systems are available in five standard capacities, with a wide range of standard and optional control and command facilities.

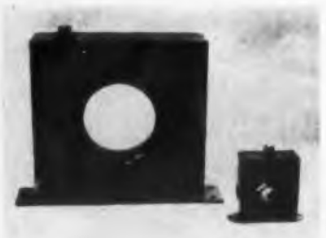
Di-An Controls, Inc., Dept. ED, 944 Dorchester Ave., Boston 25, Mass.

Proportional Controller 422

Operates on the principle of a light beam being interrupted when a pre-set point is reached. Proportional action of the controller is based on the system of switching-time modulation. Bandwidth of the proportionality area is adjustable between 0 and 10% of the full-scale length.

N. V. Nederlandsche Instrumenten- en Electrische Apparaten Fabriek, Dept. ED, Jutfaseweg 205, Utrecht, The Netherlands.
Availability: *2 weeks.*

Pulse Current Transformers 530



Rise times are less than 20 nsec, and ouput voltages are 0.25 v per amp. Model EDA-PCTD-3001 is capable of monitoring pulse currents of 100 amp peak and has a center hole large enough to accommodate a stripped RG-17U cable. Model EDA-PCTD-3002 monitors pulse currents of 2,000 amp peak at 300 kv dc in oil.

Electronic Design Associates, Dept. ED, 514 High St., Palo Alto, Calif.

P&A: *$75.00 to $297.50; stock to 2 weeks.*

Vertical Sensing Element 565

Snap-action, subminiature type 228571-1 vertical sensing element has a tilt angle of 0.75 deg. Differential output is 18 v; maximum current through either contact is 18 ma; range is 75 to 135 min of arc. Design is single-axis.

General Precision, Inc., Kearfott Div., Dept. ED, 1150 McBride Ave., Little Falls, N. J.

Wideband DC Amplifier 529

An open loop amplifier with very high gain, model 3102 has less than 1 μv per C drift, 0.01 gain stability, 50 meg-ohm input impedance and 0.06-ohm output impedance. The unit is capable of $\pm$15 v output at 100 ma. Bandwidth is 35 kc.

PM Electronics, Inc., Dept. ED, 5221 University Ave., San Diego 5, Calif.

P&A: *$390.00; 1 week.*

CIRCLE 117 ON READER-SERVICE CARD ➤

NEW PRODUCTS

Digital Readout 440

Binary input decimal readout, model RO-2, features positive imprinted digits for readability in any ambient light. Driving power is as low as 35 mw. All readouts in a line are driven by a single ac motor. The readout device incorporates two position snap action switches.

Calibration Standards Corp., Dept. ED, 1025 Westminster Ave., Alhambra, Calif.

***P&A:** model RO-2, $65.00; accompanying motor package, $55.00; stock.*

Transparent Scales 458

Four new reticles are available for use with the firm's magnifying comparator. No. 141 measures circles from 0.005 to 0.125 in. in diam. No. 142 measures widths from 0.1 to 2.0 mm by increments of 0.1 mm. No. 143 shows correct point angle and lip clearance for drilling various materials, and No. 144 measures circles from 0.1 to 2.0 mm in diam.

Finescale Co., Dept. ED, 218 S. Western Ave., Los Angeles 4, Calif.

***P&A:** comparator, $15.50; reticles, $1.00 per pair; stock.*

Ferrite Bead Choke 445

Designed for use in high frequency and vhf ranges. At frequencies above 10 mc, these units are said to exhibit a constant ac resistance and impedance.

National Radio Co., Inc., Dept. ED, Melrose, Mass.

Multiple Assembly Socket 438

DL 100 is a printed circuit dial light socket designed for data computers, processing equipment, switchboards and automation applications. The common side is pre-wired, leaving only one lead per socket for hand wiring.

Allegri-Tech, Inc., Sockets Div., Dept. ED, 141 River Road, Nutley 10, N. J.

Fluid Quality Meter 459

For two-phase cryogenic flow systems. The instrument provides a continuous indication of per cent vapor, by volume, over the range 0 to 100% vapor with an accuracy of 1% full scale, and to within 1 db to 400 cps.

Allied Research Associates, Inc., Dept. ED, 43 Leon St., Boston 15, Mass.

it's easy to use Electronic Design's 27th issue:

THE NEW, IMPROVED PRODUCT LOCATOR

ELECTRONIC DESIGNERS CATALOG **EDC**

8700 recent electronic products are listed and described

For example . . . are you looking for an *amplifier*? 361 of them are listed from audio to wideband, many of the write-ups describing entire series of amplifiers. Here's a typical entry:

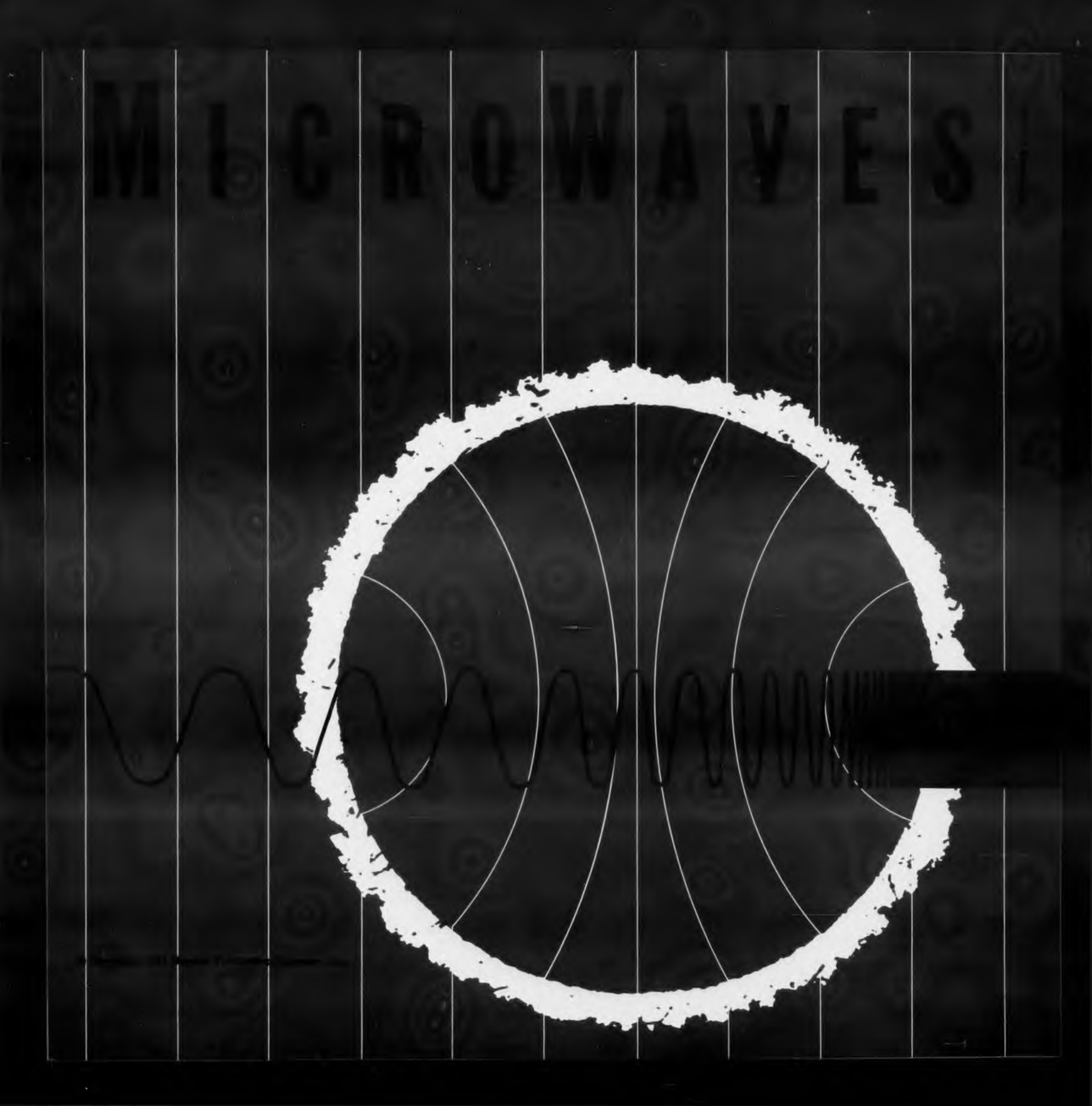
> MINIATURE (Model 207G): Germanium-transistor unit for servo, audio, pulse applications. Temp range -50 to 50 C. Measures 1-1/4 x 3/4 x 3/8 in. Open-loop gain is over 40 db; closed-loop 10 to 26 db.
> Taber Instrument Corp. 2/17/60 Pg 81 *2764

An asterisk * precedes the reader service inquiry number. For more information, write in this number on EDC's postpaid reader service cards (in this case the number is *2764).

Note that each listing gives page number and issue date the new product write-up originally appeared in *Electronic Design* magazine.

Remember, if you are looking for new products, EDC offers the most accurate new product information source available in the industry. It's unique!

MICROWAVES



MICROWAVES

Coming Soon— A New MicroWaves

With this issue, the MicroWaves section celebrates its first anniversary. The loyalty and support of our readers have encouraged us to begin, early next year, publication of MicroWaves as a separate magazine, devoted entirely to the professional needs and interests of microwave engineers and technical management.

A full range of research and development news, industry trends, practical design articles, new product information and other features for the microwave specialist will be provided in the new MicroWaves—planned to be your main and most useful source of microwave information.

At the same time, ELECTRONIC DESIGN will continue to serve its own total audience with continued publication of its own MicroWaves section. The MicroWaves section will continue through 1962.

These expanded editorial requirements create new opportunities for the publication of articles by our readers. As ever, the submittal of manuscripts and outlines is cordially invited.

New Microwave TWT Combines High Power and Bandwidth

Internal structure of meanderline twt. Tube is shown in two halves, normally joined at the midpoint where the carbon-impregnated lossy vanes and ceramic rods are situated. Note unusual slow-wave structure consisting of two serpentine lines separated by row of rings. Ceramic rods stop short near output end where the serpentine is loaded with pins. Over-all tube length is about 27 in.

AN EXPERIMENTAL megawatt peak-power traveling-wave tube with a 3-db bandwidth of 27 per cent at 3.4 Gc has been developed by the Sperry Electronic Tube Division, Great Neck, N. Y. The tube's performance is due to a novel, ring-loaded meanderline slow-wave structure.

The meanderline tube, developed under a Bureau of Ships contract, combines the high power levels of klystrons and the broad bandwidths heretofore available only in low-power twts. As such, the tube would be a natural choice for use in frequency-shift radars designed to outwit jamming.

Small-signal gain of the new tube is 47 db at the center of the band, tapering to 25 db at the edges. Efficiency is 28 per cent.

Sperry engineers note that these performance figures are for an experimental, uncooled tube. More refined versions, employing liquid-cooled slow-wave structures should deliver from 3 to 5 megawatts of peak power or 10 kw average power—again at S Band. In addition, the principle could be extended to twts for C or X Bands, though power output would be considerably reduced.

The meanderline slow-wave structure (see illustration), consists of two serpentine conductors separated by a row of parallel rings. The wave propagates along one "U" of the serpentine, meanders around one-half the circumference of a ring to the opposite serpentine, then along the opposite serpentine to the next ring, and so on down the tube. The electron beam, generated by a conventional klystron microperveance gun, travels down the center of the rings.

Upper frequency cutoff occurs when the slot length of the structure (one-half the ring circumference plus the periphery of a "U") is one-half the free-space wavelength of the propagating signal. There is no discrete low-frequency cutoff; rather, gain diminishes gradually as the frequency is reduced.

The serpentine is supported by ceramic rods along most of its length. The rods stop short of the output end, however, in order to minimize arcing. The unsupported section of the line includes loading pins that approximate the dielectric constant of the ceramic rod, thus avoiding electrical discontinuities that might induce spurious modes.

Carl Burklund, Sperry engineer, associated with the tube project, notes that the low-dispersion, high-impedance characteristics of the meanderline are primarily responsible for the performance of the tube. Also, the line has no fundamental backward wave modes, thus eliminating a major source of spurious oscillation, he explained.

The megawatt output of the meanderline tube was achieved with a 78.5-kw electron beam. Stronger beams, not currently available for testing should raise power output and improve the small signal gain at the edges of the band, Mr. Burklund told ELECTRONIC DESIGN.

The meanderline structure was originated by Dr. E. L. Chu of Stanford University as an evolution of his earlier work on cross-wandering helices and connecting-ring structures. Dr. Chu noted that in addition to the absence of backward modes, enabled by the inherent symmetry of the line, the meander structure embodies an unusually high heat dissipation factor. To date no companies other than Sperry appear interested in Dr. Chu's line. When asked why, Dr. Chu remarked: "It probably looks too simple." ■ ■

MICROWAVES

Design of a Broadband UHF Diode Switch

To date, little has been reported on high speed switching of semiconductors in the vhf-uhf range. Author James Hendershot here describes a high speed spst coaxial switch operating from 100 to 1,000 Mc. Design of a multiport 6-throw switch is also discussed.

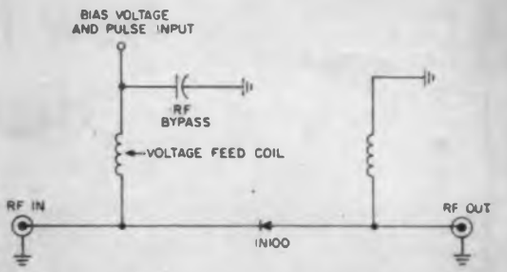


Fig. 1. Circuit diagram of spst diode switch.

James H. Hendershot
Electronic Communications, Inc.
Research Division
Timonium, Md.

THE SWITCH described in this article consists of a diode in series with the center conductor of a 50-ohm coaxial line. A schematic diagram of the switch is illustrated in Fig. 1.

When the diode is biased "on" with a positive voltage, it presents a low impedance to the incident rf power. For a negative applied voltage, diode impedance is very large and nearly all incident rf power is reflected.

The equivalent circuit for a diode enclosed in a cartridge is shown in Fig. 2 where

L is the whisker inductance,
R_s is the spreading resistance,
R is barrier resistance of the point contact, and
C is barrier capacitance of the semiconductor.

The resistance R is nonlinear and varies as a function of the applied bias voltage. Barrier capacitance C must not be overlooked in design of the switch. Capacitive susceptance can become greater than the conductance $1/R$ and consequently bypass or shunt out the effect of the barrier resistance when the diode is in the high impedance state.

Diode selection was based on forward and reverse resistance characteristics as a function of positive and negative bias voltages. For example, a 1N23E silicon crystal diode, tested for its forward and reverse resistance characteristics, had a forward resistance of approximately 13.7 ohms with a 2 v bias, and a reverse resistance of approximately 8,000 ohms with a −2 v bias. Other diodes of similar configuration such as the 1N21C, 1N23C, 1N25A and 1N263, exhibited approximately the same resistance characteristics as the 1N23E.

A second important parameter is barrier capacity. The barrier capacity specified by the manufacturer for the above diodes was 0.3 pf. Two other diodes, the Hughes 1N100 and 1N118 showed forward resistances of approximately 15 ohms and reverse resistances of approximately 2.5 megohms when biased at +0.7 and −10 v respectively. Barrier capacity of each diode was 0.5 pf.

1N100 Preferred for Size, Cost, And Lower Barrier Resistance

After comparing the characteristics of all these diodes for the switching application, the 1N100 was selected because of its high ratio of reverse-to-forward resistance, small physical size, low cost and reasonably low barrier capacitance. Although dc characteristics of the 1N118 are very similar to the 1N100, its rf characteristics are not. The insertion loss of the 1N118 diode switch is slightly higher within the entire frequency range of 100 to 1,000 mc.

The voltage-input feed arrangement for biasing the diode "on" or "off" must be designed so that the coil is not self-resonant within the operating frequency range of the switch. The two coils feeding into the main rf line must provide sufficient inductance to prevent rf leakage. Most commercially wound fixed coils are self-resonant within 100 to 1,000 mc, and cannot be used in the switch.

A 3-turn coil of No. 40 wire with turns spaced 0.100 in. apart, wound around 0.300 in. OD Teflon and enclosed within the coaxial line, concentric with the center conductor was arrived at empirically to solve the problem. The measured inductance of the coil was 0.35 μh.

Insertion loss vs frequency for the two coils in shunt with the main rf line (housed in the diode holder without the diode) is shown in Fig. 3. The 3-turn coil sacrifices insertion loss at the low end of the frequency range for band-width. Any increase in number of turns per coil results in self-resonance near the upper limit of the frequency band. Switch performance is illustrated in Fig. 4. Switching power for the "on" condition is approximately 30 mw; bias voltage for the "off" condition is −2.0 v.

The complete switch shown in Figs. 5 and 6, consists of two UG-23 D/U connectors, a

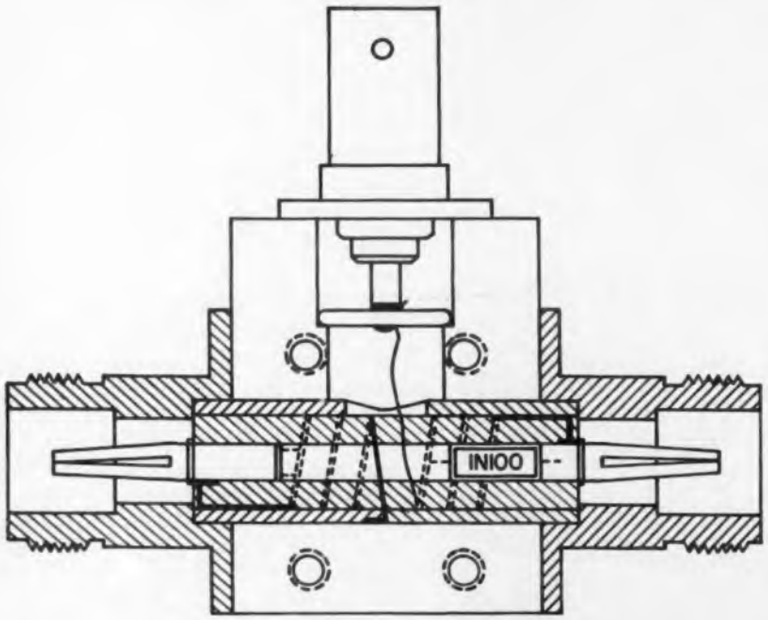


Fig. 6. Cross-section of packaged diode switch.

Fig. 5. Packaged diode switch. Entire assembly is housed in 1-in x 1-1/4-in aluminum block, exclusive of connectors.

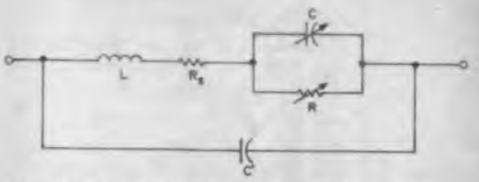


Fig. 2. Equivalent circuit of spst diode switch.

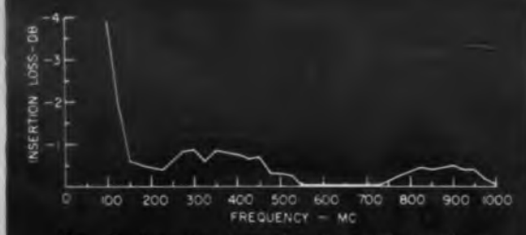


Fig. 3. Insertion loss of switch coils in shunt with the main rf line. Coils were housed in the diode holder (without diode).

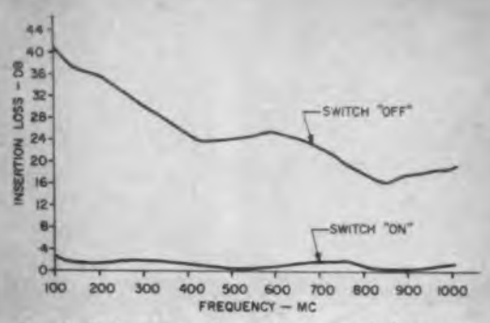


Fig. 4. Performance of spst diode switch from 100 to 1,000 mc.

MICROWAVES

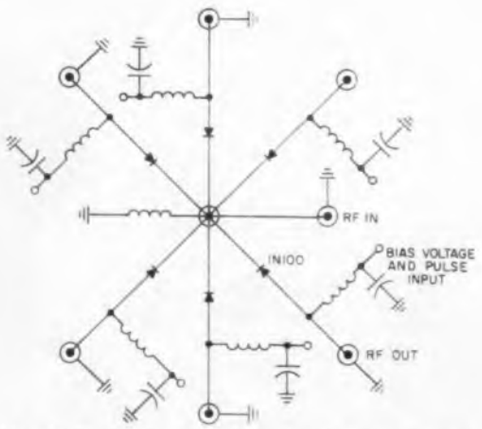


Fig. 7. Circuit diagram of single-pole 6-throw switch employing basic spst switch configuration.

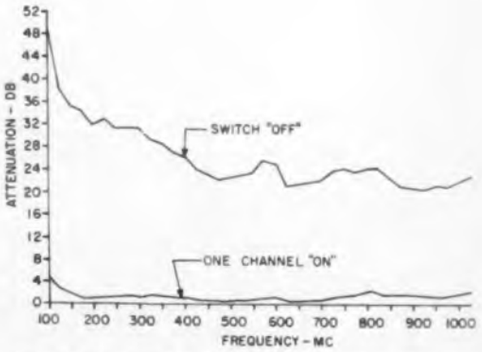
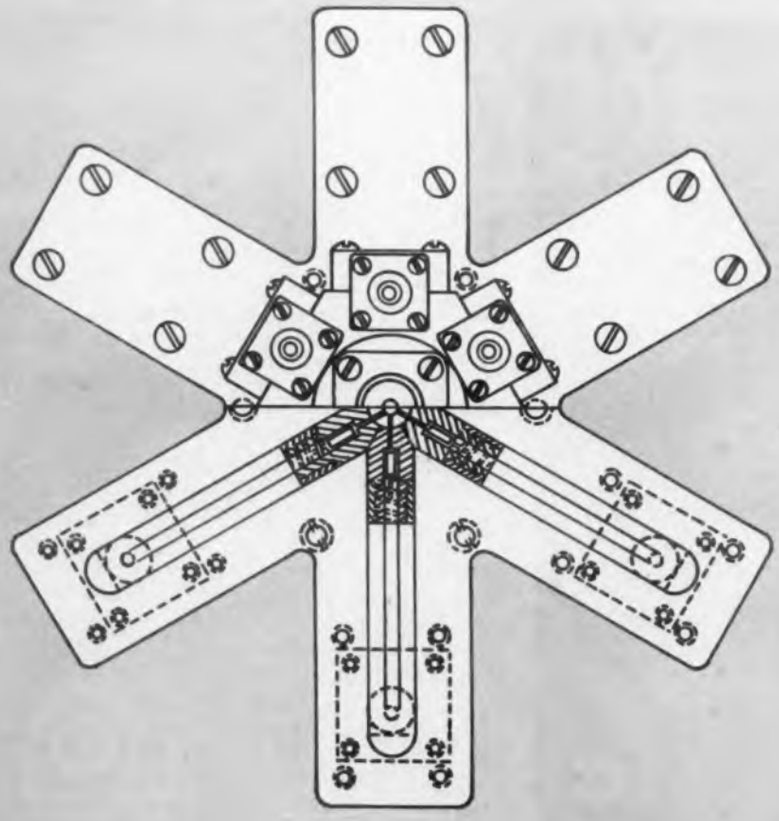


Fig. 9. Performance of typical port of single-pole 6-throw switch from 100 to 1,000 mc.



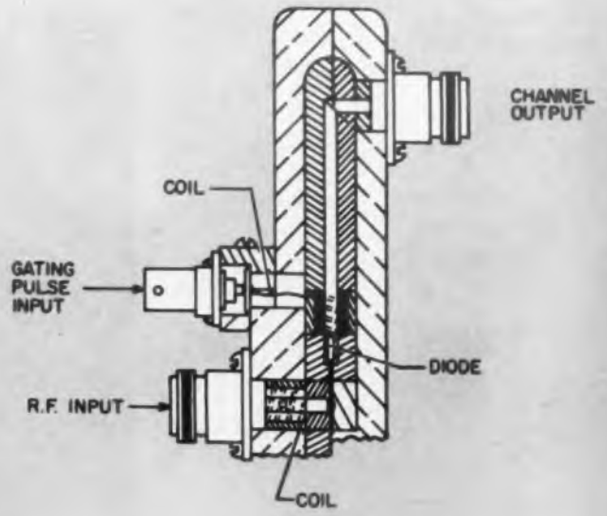


Fig. 8. Construction of single-pole 6-throw switch.

BNC connector, a Hughes 1N100 diode, two shunt voltage input coils, and a 250 pf button feedthrough capacitor.

Modification of Voltage-Feed Coil Improves Switching Ratios

At lower frequencies, better switching ratios can be achieved through modification of the voltage-feed coil arrangement. Increasing the number of turns per coil to increase the inductance, gives greater isolation from the main rf line. The self-resonance will again occur but can be positioned well out of the frequency band of concern.

A single-pole six-throw switch, shown in Figs. 7 and 8, was designed around the same basic spst switch configuration. Line length between the common junction and the diodes was kept very short to minimize the effect of line length when some of the diodes are in the high impedance state. The high impedances could otherwise appear as short circuits to the incident rf power when transferred back to the common junction.

A plot of insertion loss vs frequency for one typical port is shown in Fig. 9. The minimum crosstalk for any two ports is 23 db below the rf power level. Attenuation for this switch ranges from 50 db to 23 db in the "off" condition, and from 5.5 db to 0.9 db in the "on" condition. The higher attenuation for the "on" condition at the low-frequency end of the band can be attributed to insufficient inductance of the voltage-feed coils.

The gradual degradation of insertion loss with increasing frequency in the "off" condition is due to the barrier capacity of the diodes.

Minimum switching time for the 6-port device is 40 nsec.

These switches are useful for switching low-power signals in such receiver application as frequency channel selection or antenna switching. They have alternate uses as modulators, choppers, and attenuators. ■ ■

References

(1) Robert V. Garver, High-Speed Microwave Switching of Semiconductors—II. IRE Trans on Microwave Theory and Tech.; Vol. MTT-7, pp 272-276, April, 1959.

(2) M. R. Millet, "Microwave Switching by Crystal Diodes," Vol. MTT-6, pp 284-290; July, 1958.

MICROWAVES

Versatile Waveguide Nomogram Speeds S-Band Design

All aspects of the waveguide equation, including the effects of various dielectrics, are united in this nomogram. Author Burrell Hatcher developed the nomogram to aid him in design of dielectric-loaded waveguides for phasing of antenna arrays at S Band. Now he describes how it can be used to solve quickly a variety of common waveguide calculations. For added convenience, he has keyed the nomogram to the cutoff wavelengths of several standard RG guides.

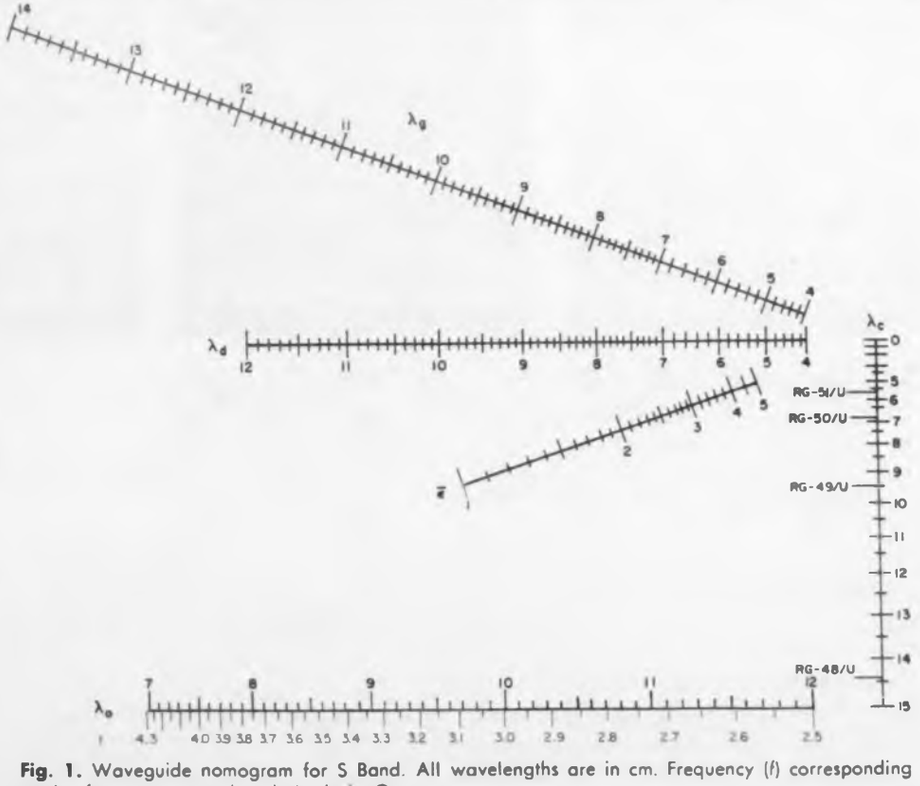


Fig. 1. Waveguide nomogram for S Band. All wavelengths are in cm. Frequency (f) corresponding to the free-space wavelength λ_0 is in Gc.

Burrell R. Hatcher
Chu Associates
Littleton, Mass.

THE nomogram (Fig. 1) combines the equations

$$\frac{1}{\lambda^2_g} = \frac{1}{\lambda^2_d} - \frac{1}{\lambda^2_c} \qquad (1)$$

and

$$\lambda_d = \frac{\lambda_0}{\sqrt{\bar{\epsilon}}} \qquad (2)$$

where

λ_0 = free space wavelength,
λ_c = cutoff wavelength in the guide,
λ_g = guide wavelength,

$\bar{\epsilon} = \frac{\epsilon}{\epsilon_0}$ = relative permittivity of the dielectric in the guide,

and

$\lambda_d = \frac{\lambda_0}{\sqrt{\bar{\epsilon}}}$ = wavelength in an unbounded isotropic medium of relative permittivity $\bar{\epsilon}$ (for air, $\bar{\epsilon} = 1$).

Since the quantity λ_d is common to both equations, a combined nomogram is possible and calculations for dielectrics other than air can be solved graphically with ease.

In the nomogram, all wavelengths are ex-

pressed in centimeters. The f scale represents the frequency in Gc corresponding to λ_0. Cutoff wavelengths for each of four standard RG—XX/U guides excited in the TE_{10} mode also are indicated.

Typical applications of the nomogram will be described.

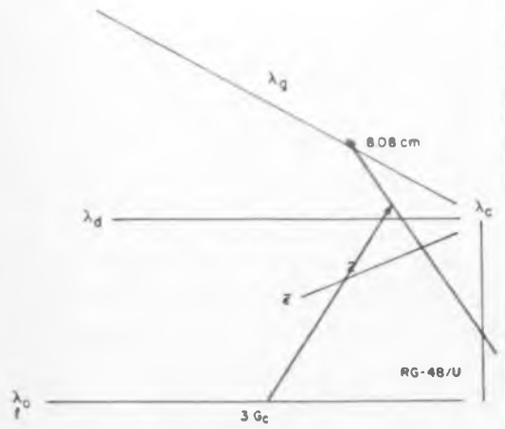


Fig. 2. Solution for example 1.

Example 1:

Determine the TE_{10} guide wavelength at 3 Gc in RG-48/U guide filled with a dielectric of relative permittivity 2.

As illustrated in Fig. 2, connect the points $f = 3$ and $\varepsilon = 2$ by a straight line extended to the λ_d scale. The point of intersection on the λ_d scale then is connected to the cutoff frequency of the RG-48/U guide and extended to intersect the λ_g scale. This intersection gives $\lambda_g = 8.08$ cm as the guide wavelength.

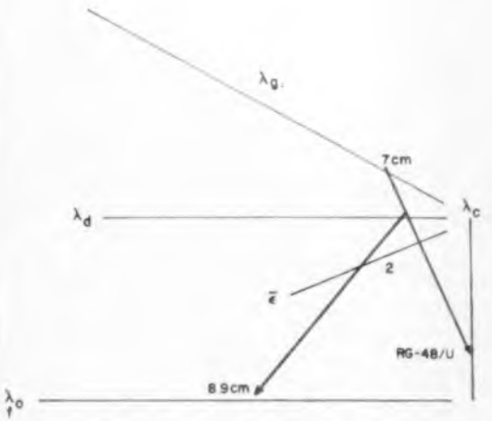


Fig. 3. Solution for example 2.

Example 2:

Determine the free space wavelength if the guide length in a section of RG-48/U guide, filled with dielectric material ($\bar{\varepsilon} = 2$), is 7 cm.

Connect $\lambda_g = 7$ and the RG-48/U cutoff frequency by a straight line, as shown in Fig. 3. From the intersection of this line at the λ_d scale, extend a line through $\bar{\varepsilon} = 2$ to the λ_0 scale. The intersection of this line on the λ_0 scale is 8.9 cm, the free space wavelength.

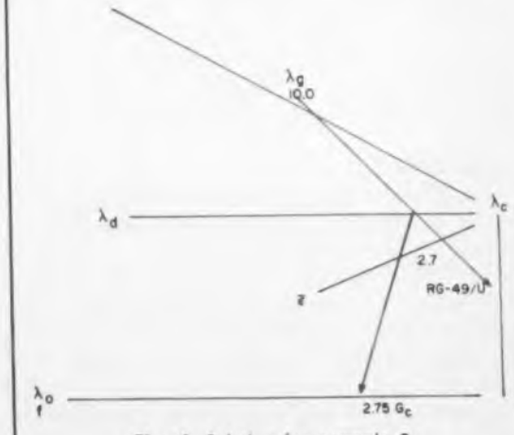


Fig. 4. Solution for example 3.

Example 3:

RG-49/U guide is filled with a dielectric. The guide wavelength in the dielectric is 10 cm at 2.75 Gc. Find $\bar{\varepsilon}$.

Connect $\lambda_g = 10$ cm and the cutoff frequency for the RG-49/U guide by a straight line, as shown in Fig. 4. From the intersection of this line with the λ_d scale, draw a line to f = 2.75 Gc. The intersection of this line with the $\bar{\varepsilon}$ scale gives the solution 2.7.

The same procedure can be used to determine the dielectric constant in coaxial lines.

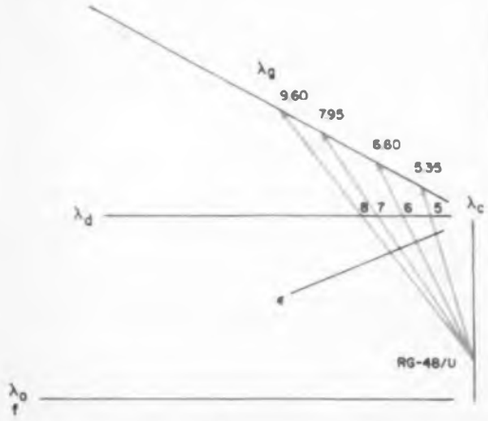


Fig. 5. Solution for example 4.

Example 4:

In air-filled RG-48/U guide it is desired to know the guide wavelength as the free space wavelength is changed.

Since $\bar{\varepsilon}$ in air = 1, the λ_d scale denotes the free space wavelength. By pivoting a straight edge about the cutoff frequency for RF-48/U (see Fig. 5), λ_g for any free-space wavelength can be read directly, as for instance:

λ_o(cm)	λ_g(cm)
5	5.35
6	6.60
7	7.95
8	9.60

Note: A similar nomogram for X-Band waveguides will appear in a forthcoming edition of MicroWaves. ■ ■

MICROWAVES PRODUCT FEATURE

MW-Tube Power Supplies Have All-Electronic

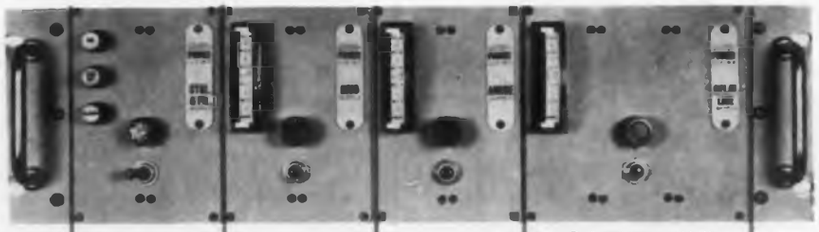
HIGH-performance power supplies are electronically controlled by a direct-coupled electrical signal. They are designed for microwave-tube applications where the rf frequency is to be controlled or programmed automatically and incidental fm is to be minimized. These instruments also have low ripple, high regulation and are packaged in a small unit.

Manufactured by Micro-Power, Inc., 20-21 Steinway St., Long Island City 5, N. Y., models 401 and 402 are provided on a catalog basis. A wide variety of electrical characteristics covers the power and control requirements for many tube types.

The direct-coupled electronic control provides rapid adjustment of the low-ripple output over the full voltage range (20 to 1) in direct relation to the control signal. The input-control signal to the supply is 30 v peak into 10-K. The output voltage responds at 500 kv per sec full load for a step waveform at the input.

The circuitry consists of a cascade of feedback amplifiers that amplify the low-level control and reference signal to the required voltage and power level.

The dc-coupled control signal is introduced at a virtual ground in the circuit so that no interaction occurs between the manual set-



Outputs	DC Filament	Grid	Anode	Delay Line or Helix	
				Electronically Controlled Model 401	Manually Controlled Model 402
Voltage	6.3 v	0-400 v	0-400 v	75-1,500 v	75-1,500 v
Current	0-2 amp	0-60 ma	0-60 ma	0-50 ma	0-50 ma
Ripple	1 mv rms	1 mv rms	1 mv rms	15 mv rms	15 mv rms
Line Regulation (105-125 v)	0.1%	8 mv	8 mv	30 mv	30 mv
No-Load to Full-Load Regulation	0.1%	20 mv	20 mv	75 mv	75 mv

Fig. 1. Performance specifications for model 401 and 402 power supply.

Control

ting of the dc-output level by the manual-control amplifier and the control-signal source.

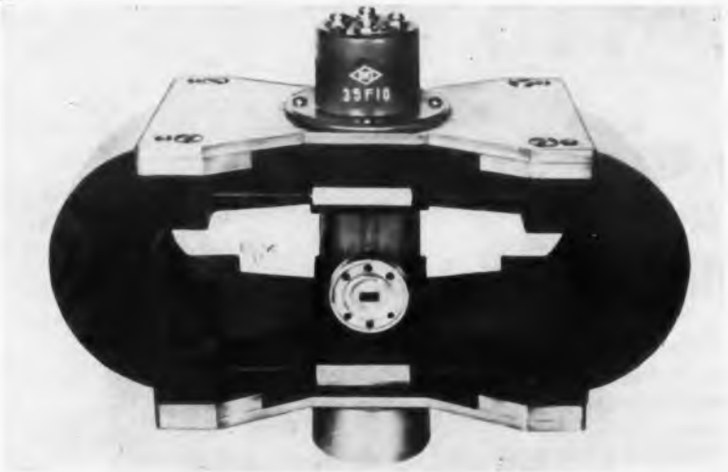
This technique facilitates the incorporation of a shaping network further down the amplifier chain that shapes both the control signal and the dc setting introduced by the manual control. A diode-segmented shaping network can be adjusted to compensate for the nonlinear relationship between the voltage vs frequency characteristics of the backward-wave oscillator and thereby provide a linear relationship between the control signal and the output rf frequency for all settings of the manual control or operating-center frequency.

For protection, the maximum current supplied to the tube electrodes can be set by means of a current-limit adjustment. Helix overload current will cause removal of all power to the tube.

The electrical performance characteristics of a typical power supply unit are shown in Fig. 1. This unit is 5-1/4 in. high and mounts in a standard 19-in. rack.

Power-supply units are composed of submodules, which are selected according to the tube requirements and the electrical performance desired by the customer. Each submodule is identified with the microwave-tube electrode and is electronically or manually controlled.

Models 401 and 402 are available with a 30-day delivery at $1,980, fob Long Island City, N. Y. Power supplies for other microwave tubes range from $900 to $2,000. For more information on these electronically controlled microwave-tube power supplies, turn to the Reader Service Card and circle 724.



MM-Wave Klystron Has 7-W CW Output

THE "Laddertron" is a tunable, flatbeam, single-cavity, multi-gap, mm-wave klystron, capable of continuous power-output levels on the order of 7 w. Indications are that output levels may be increased in the near future to as high as 30 w.

OKI Electric Industry Co., Ltd., of Tokyo, represented in this country by Butler Roberts Associates, Inc., 202 E. 44th St., New York 17, N. Y., manufactures two types of the "Laddertron", models 35F10 and 50F10. They are 8.6- and 6-mm types, respectively, with power outputs of 5 to 7 w cw.

As a drift section, the "Laddertron" employs a pair of slotted-plane "ladders" in the center of a rectangular cavity, between which passes a flat, high-density electron beam. As shown in Fig. 1, twelve coupling gaps are provided in the ladders through which the interaction between the beam and the cavity field takes place. The cavity

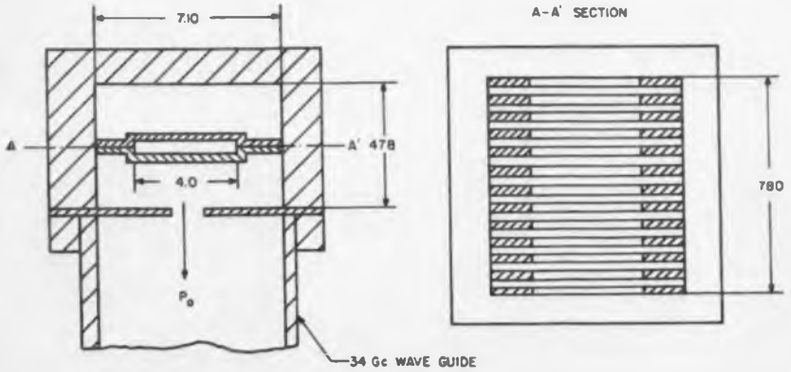


Fig. 1. Slotted-plane ladders are located in the center of a rectangular cavity. Twelve coupling gaps are provided in the ladders through which interaction between the beam and cavity takes place.

has two waveguides coupled through apertures on opposite side walls. One is used to vary the resonant frequency of the cavity by means of an adjustable plunger, the other provides output coupling to the external load. The electron gun is of the convergent confined-flow type. The electron beam is emitted by a wide surface cathode and is bunched statically and magnetically. The beam is led through a rectangular tunnel measuring 0.35 x 4 x 11.8 mm. Beam transmission of 95 per cent is obtained. Maximum transmission current is more than 115 ma, or in terms of current density, 15 amp per cm^2.

Typical operating characteristics for the 35F10 are: center frequency, 35 Gc; beam voltage, center, 1,850 v; beam current, 130 ma max; output power, 7 w max; electronic tuning range, 50 mc; mechanical tuning range, 2 Gc.

The advantages of the "Laddertron" klystron as outlined by the manufacturer are:

- High output with relatively low operating voltages.
- Linear fm with low-level input.
- Wide frequency range with mechanical tuning.
- Possibility of sub-mm applications using multipliers.

The "Laddertron" type of floating-drift klystrons will be available in January, 1962. The model 35F10 is priced at $2,350, fob, Miami, Fla; model 50F10 is $3,415, fob Miami. For further information on these tunable, mm-wave klystrons, turn to the Reader Service Card and circle 725.

MICROWAVES

MICROWAVE PRODUCTS

Crystal Detector 728

Exceptionally flat frequency response of ±1 db over the entire range of 1 to 11 Gc is provided by model D120 crystal detector. The unit, which operates from 1 to 12.4 Gc, has a vswr of less than 2.2 to 1. Sensitivity is 0.1 v per mw. Maximum input power is 20 mw. Use of the detector permits accurate oscilloscope display of rf component characteristics which vary with frequency. The flat response makes it useful for automatic gain or power control.

Alfred Electronics, Dept. ED, 3176 Porter Drive, Palo Alto, Calif.

P&A: *$90; from stock.*

Crystal Booster 729

Model Q 11 is an amplifier for increasing outputs of microwave crystals. Operating on mercury batteries the unit measures 5-1/2 x 1-5/8 x 2 in. and weighs about 1 lb. Input impedance is 50 ohms; output matches to 1 meg and the gain is 40 db.

Quantadyne, Dept. ED, P. O. Box 353, Woodland Hills, Calif.

P&A: *$95.00; immediate to 2 weeks.*

GaAs Varactors 726

High cut-off frequency gallium arsenide varactors, types MS-2602 to MS-2606 have a 30-v working voltage. These units are diffused junction mesa structures in coaxial pin packages. They are designed for use in harmonic generators, rf limiters, microwave switches and phase shifters. The coaxial pin package makes power disposition of 1-w practical. Types MS-2602 to 2606 have a zero bias capacitance range of 0.2 to 1.1 pf and a range of cut-off frequencies from 40 to 120 Gc. Types MS-2620 to 2623 have a zero bias capacitance range of 3 to 6 pf and cut-off frequencies of 10, 20, 40 and 60 Gc. Types MS-2630 to 2632 have a capacitance range of 6 to 10 pf and 10, 20 and 40 Gc cut-off frequencies.

Micro State Electronics Corp., Dept. ED, 152 Floral Ave., Murray Hill, N. J.
P&A: $35 to $250 ea, 1 to 99; 1 to 4 weeks.

Double-Throw Microwave Switch 727

Solid-state, broadband, double-throw microwave switch model X450 has the following applications: switching microwave power up to 6 w; sharing one local oscillator between two or more systems; as a fast acting radar duplexer and antenna switching for obstacle avoidance systems. Specifications are: peak power, 300 w at 0.001 duty cycle; max average power, 6 w; open channel attenuation, 20 db; closed channel attenuation, 3 db; frequency range, 8.2 to 12.4 Gc; switching rate, 0 to 200 mc; temperature range, −55 to +90 C.

Somerset Radiation Laboratory, Inc., Dept. ED, 192 Central Ave., Stirling, N. J.
P&A: $180 ea; from stock.

MICROWAVES PRODUCTS

Common Carrier Microwave Antenna 712

Five models of button-hook and taper feed common carrier microwave antennas have excellent gain, pattern and performance. Inputs are waveguide flange selected to mate with customer requirements and bleeder ports are provided to permit pressurization of the feed. Taper feed is 8- and 10-ft reflectors; button-hook in 6-, 8- and 10-ft models. Frequency range covered is 3,700 to 4,200 mc.

Technical Appliance Corp., Dept. ED, Sherburne, N. Y.

Amplifier Klystron 689

Pulse-power of 1.25 megawatt is provided by type X-841 amplifier klystron for long range radar systems. It has operated successfully at 2.5 megawatt peak power at 6% duty and 150 kw average power at better than 40% efficiency at a gain of 40 db. It stands 10-ft high and weighs over 700 lb.

Eitel-McCullough, Inc., Dept. ED, San Carlos, Calif.

Pressurizing System 713

Purifying and pressurizing gas system is for use with waveguides, cavities, duplexers and coaxial cable. It utilizes sulfur hexafluoride, a stable, non-toxic, gaseous dielectric; it is convertible to air or other gases. The system has 2-1/2 times the dielectric strength of air or nitrogen and arc-quenching ability 100 times that of air pressurization systems. Operation is completely automatic. Life is 25,000 hr min.

Applied Pneumatics, Inc., Dept. ED, 740 Colfax Ave., Kenilworth, N. J.

Inquire about Sperry Tubes from these convenient Cain & Company offices

REGIONAL OFFICES

Burbank, California
2615 W. Magnolia Blvd.
VI 9-6781

Great Neck, Long Island, N. Y.
260 Northern Boulevard
HN 6-0600

Chicago 45, Illinois
3508 Devon Avenue
OR 6-9500

St. Petersburg, Florida
410 — 150th Avenue
Madeira Beach Prof. Bldg.
391-0151

DISTRICT OFFICES

Boston, Massachusetts
Phone VO 2-5330

Philadelphia, Pennsylvania
Phone VI 8-1700

Washington, D. C.
Phone EX 3-7587

Dayton, Ohio
Phone RO 7-8661

Dallas, Texas
Phone BL 5-2050

Albuquerque, New Mexico
Phone 268-5300

San Francisco, California
Phone YO 8-0995

San Diego, California
Phone HU 8-0665

Seattle, Washington
Phone MA 3-3303

SPERRY ELECTRONIC TUBE DIVISION
SPERRY RAND CORPORATION

CIRCLE 134 ON READER-SERVICE CARD

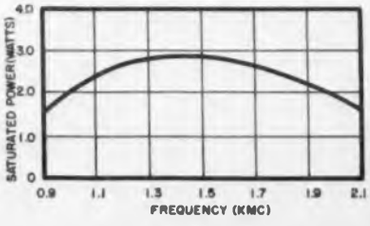
SPERRY ELECTRONIC TUBE DIVISION **microwave memo**

Sperry extends 30-day delivery to cover ECM and augmenter TWT's operating in L, S, and X bands

In a dramatic extension of its capability for delivering high-performance microwave tubes on short notice, Sperry Electronic Tube Division has added three system-proved traveling wave tubes to the list of those available in 30 days. Included in the move are tubes operating in L, S, and X bands. They cover a frequency range 1.1 to 11.0 kMc.

APPLICATION FLEXIBILITY

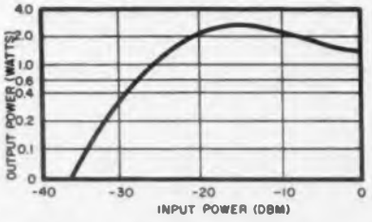
The tubes in this series are particularly suited to application in augmenters and ECM equipment. The inherent broadband characteristic and unusual ruggedness of these PPM focused tubes makes them unusually versatile in airborne applications. A full course of MIL and environment tests, as well as considerable in-system experience have verified these characteristics.



A typical saturated power versus frequency curve for an L band Sperry TWT.

INCREASED POWER POSSIBLE

Although these tubes nominally operate in the 1-2 watt power output range, optimum tuning can increase power to as much as 5 watts. A high-mu control grid adds to the versatility of these tubes by allowing remote switching, modulation control and gain adjustment.



Drive characteristics at mid-band for a typical Sperry ECM/augmenter TWT.

SYSTEM DESIGN SIMPLIFIED

Use of these Sperry tubes greatly simplifies system design problems. Low voltage and high gain reduce power supply requirements. Application is further simplified, since ambient cooling is sufficient in most applications and the tubes may be mounted in any position.

For FREE technical information on these Sperry Traveling Wave Tubes, write to Section 503, Sperry Electronic Tube Division, Gainesville, Florida.

The L-Band tube is priced at $1,900., the S-Band tube at $2,195., and the X-Band at $2,540.

For application assistance and quotation, consult your nearest Cain & Co. representative. His address and phone number appear in the adjacent column.

SPERRY ELECTRONIC TUBE DIVISION
GAINESVILLE, FLA. / GREAT NECK, N. Y.
SPERRY RAND CORPORATION

CIRCLE 135 ON READER-SERVICE CARD

MICROWAVES PRODUCTS

C-Band Oscillators 711

Tune the entire C-Band from 5.2 to 6.0 Gc. Power output is greater than 10 mw from 5.4 to 5.9 Gc and greater than 5 mw over the entire band. Type 9127C is 2-1/2 in. long x 7/8 in. in diam and weighs 3-1/4 oz. Type 2970 is 1/2 in. shorter and weighs 3 oz.

Trak Microwave Corp., Dept. ED, Tampa, Fla.

Waveguide Tuner 707

Waveguide slide screw tuner series covers 5.85 to 40.0 Gc. The series consists of 6 standard models and is used for matching microwave devices, or matching design structures in laboratories.

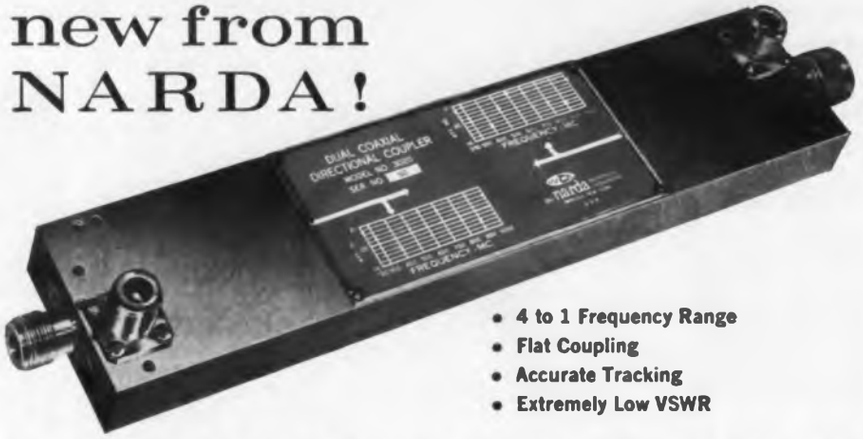
Waveline Inc., Dept. ED, Caldwell, N. J. *P&A: model 483, $135.00; 30 days.*

Radar Altimeter System 706

Pulsed X-band radar altimeter, provides real altitude information from 80,000 to 1,000 ft altitude. The system, including batteries and antenna, weighs only 6-1/2 lbs.

Wiley Electronics Co., Dept. ED, 2045 W. Cheryl Drive, Phoenix, Ariz.

new from NARDA!



- 4 to 1 Frequency Range
- Flat Coupling
- Accurate Tracking
- Extremely Low VSWR

high-directivity coax couplers

Specifically designed for REFLECTOMETER applications!

- Here are two brand new coax couplers, specifically designed by Narda to provide the extremely high directivity needed in Reflectometer set-ups. And when we say "extremely high directivity", we mean it! For example: Model 3020 (250 to 1000 mc) has a directivity of 35 db minimum, which means a maximum error in VSWR of only 1.035 can occur as a result of the finite directivity. Main line VSWR is held to 1.05 maximum; secondary line VSWR is 1.10 maximum!

- What's more, each model covers two full octaves; each features extremely accurate tracking (0.3 db maximum change in difference between forward and reverse coupling over the band); each has a power rating of 100 watts CW, 10 kw peak. Check the table for full specifications—and compare with any other units available.

- These are just two examples of the complete line of unusually fine microwave and UHF instrumentation available from Narda. Write today for your free copy of our newest catalog. Address: Dept. ED-61-4.

SPECIFICATIONS	MODEL 3020	MODEL 3022
Frequency	250 to 1000 mc	1000 to 4000 mc
Directivity	35db min	30db min
Coupling - both arms	20db nominal	20db nominal
— Frequency sensitivity	±0.6db approx.	±0.6db approx.
Max VSWR — main line	1.05	1.10
Max VSWR — secondary lines	1.10	1.15
Power Rating	100W cw	100W cw
	10kw peak	10kw peak
Tracking	0.3db total	0.3db total
Price	$200.	$185.

UHF to 90 Gc!

NARDA '61 Microwave Catalog puts all this at your fingertips:

- Complete specs and prices on attenuators, bolometers, coax couplers, ferrite devices and magnetron modulators, plus over 600 microwave instruments and components!
- Standard waveguide data chart
- Single and double ridged waveguide standards
- 17 additional pages of technical data and charts

MAIL COUPON TODAY

Gentlemen: Please send me your 1961 Catalog.

Name _____

Title _____

Company _____

Address _____

City _____ Zone _____ State _____

ED-1-a

the narda microwave corporation

PLAINVIEW, LONG ISLAND, N. Y. GE 3-9000

CIRCLE 137 ON READER-SERVICE CARD

MICROWAVES PRODUCTS

Impedance Plotter 714

Providing instantaneous display of reflection coefficient as a continuous function of frequency in the 350 to 12,000 mc range, the Smith Chart Plotter provides peak accuracy with speed and simplicity. It measures vswr to an uncertainty as low as 1.01. Ten models from 350 mc to 12.4 Gc provide two push-pull outputs for horizontal and vertical oscilloscope channels. Impedances at the coupler-swept reference point may be read directly on the oscilloscope.

Dielectric Products Engineering Co., Dept. ED, Raymond, Me.

Flange Covers 692

Low-density, polyethylene microwave flange covers are designed to provide effective all-around flange protection for interplant, masking and shipping purposes. Strict molding tolerances provide a tight fit that eliminates additional masking time and material. Styles are available for flanges with EIA waveguide designations from WR28 through WR650.

Technical Plastics Co., Dept. ED, Norwood, Mass.

Tuneable RF Probe 710

Model 229B features a fine wire probe, adjustable in depth over a wide range by a fine-pitch threaded knob. Tuning elements may be operated over the range of 900 to 18,000 mc. Either standard microwave crystals or model N-610B bolometers may be used. An rf output is also available to enable the unit to be used with microwave receivers or other external detectors.

Narda Microwave Corp., Dept. ED, 118-160 Herricks Road, Mineola, N. Y.
P&A: $145.00; stock.

Variable Attenuators 698

Four models operate at temperatures up to 130 C. Bilateral vswr is 1.20 (max), and rf leakage is negligible. The attenuating vane in models MA-527A and MA-670 is controlled by a micrometer mounted atop the control box. In models MA-580A and MA-587, the attenuating vane is controlled by a spring-loaded knob driven tuner.

Microwave Associates, Inc., Dept. ED, Burlington, Mass.

Dielectric Coating 683

Multilayer film can provide up to 99.9+% reflectivity for laser oscillators. This coating is available on new rods or can be applied to rods already in use, and can increase output gain between 7 to 1 and 8 to 1.

Adolf Meller Co., Dept. ED, Box 6001, Providence, R. I.

Backward-wave Oscillator 693

Two tubes are for X-band, and are available with type 'N' or waveguide adaptor termination at the end of RG55U coax cable. The units have a life of 5,000 hr. The control grid makes possible power cutoff with low negative grid voltage, and the anode is usually employed in leveler circuits to provide ultra-flat power output characteristics.

Stewart Engineering Co., Dept. ED, Santa Cruz, Calif.

CIRCLE 141 ON READER-SERVICE CARD ▶

MICROWAVES PRODUCTS

Miniature Isolators 715

Microwave Ku-band miniature isolators are 1/2-in. long and weigh less than 1-1/4 oz. Insertion loss is 0.3 db; isolation is up to 25 db; temperature range is −40 to +85 C. Primary use of the devices is in parametric amplifier designs.

E & M Laboratories, Dept. ED, 15145 Califa St., Van Nuys, Calif.

P&A: $175; immediate.

Circular Waveguide Feed 720

Transition section is 8-in. long in this rectangular to circular waveguide feed. Field adjustment of polarization is full 360 deg. Unit can be used on 4, 6, 8, and 10 ft. parabolas, in the 6 to 8 Gc range.

Mark Products Co., Dept. ED, 5439 Fargo Ave., Skokie, Ill.

S-Band Antenna 703

Airborne cavity antenna, designated ACST-1-A, operates between 2.75 and 2.95 Gc. Vswr is less than 1.65 at continuous temperatures up to 250 F. Radiation patterns of this antenna are similar to those of a monopole. The unit weighs less than 8 oz. and meets MIL-E-5272C.

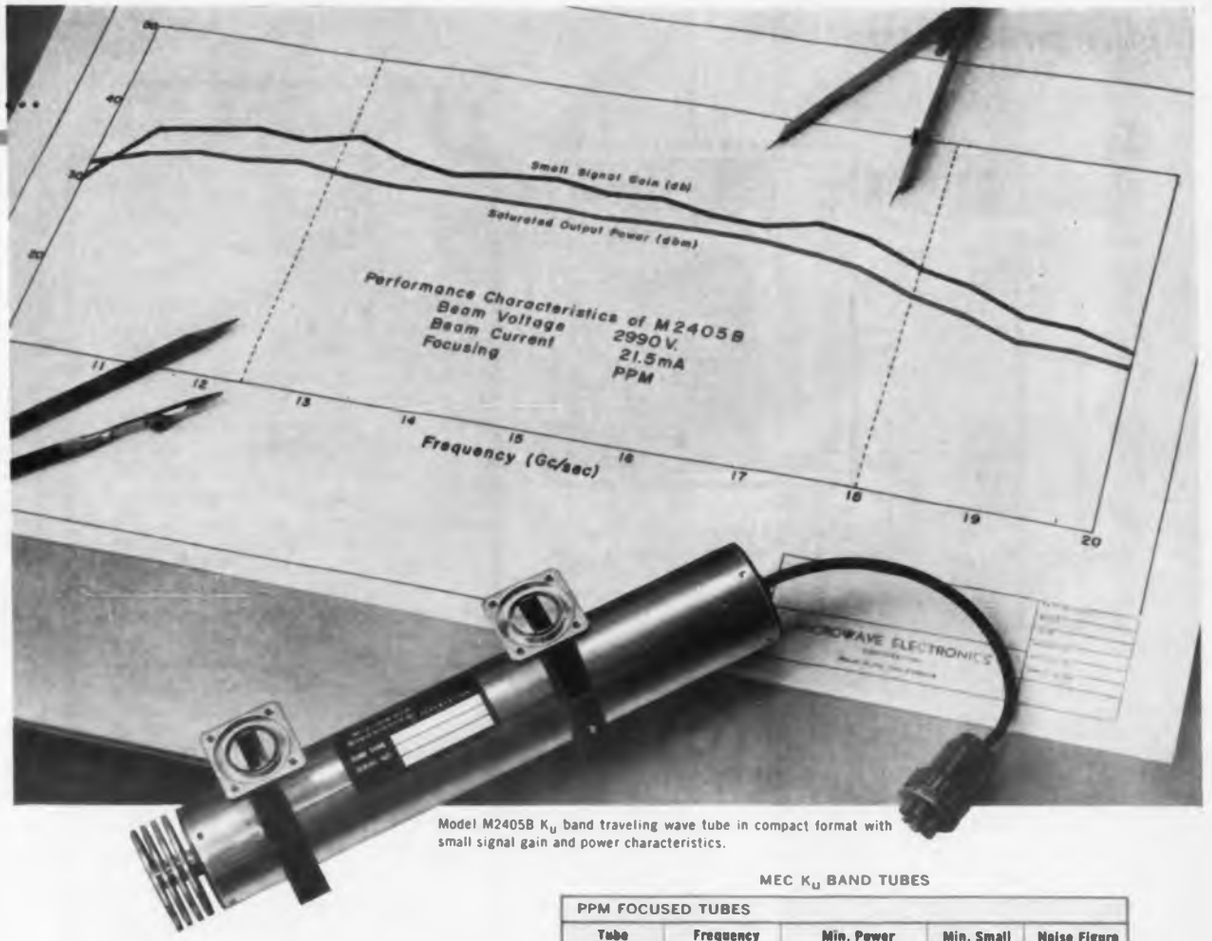
Canoga Electronics Corp., Dept. ED, 15330 Oxnard St., Van Nuys, Calif.

MEC *Reports on...*

A NEW FAMILY OF

Metal Ceramic K_u Band TWT's

9 Different PPM and Solenoid Focused Tubes Available in Production Quantities



Model M2405B K_u band traveling wave tube in compact format with small signal gain and power characteristics.

MEC now offers the first complete line of low and medium power K_u band traveling wave tubes. Rugged and reliable, these new tubes use MEC's proven design and fabrication techniques that are setting the pace for the industry.

A typical member of the MEC K_u band family is the M2405B, a PPM focused medium power amplifier designed for instrument and system applications. Metal ceramic construction allows high temperature processing and exhaust, resulting in stable operation, low spurious modulation, and high overload capacity. The magnetically shielded PPM format eliminates the effect of stray magnetic fields; tubes may be mounted close to magnetic materials and/or each other.

The M2405B delivers more than 3 watts CW power over the major portion of the 12 to 18 Gc range. Greater than 250 milliwatts power can be obtained over the 10 to 20 Gc range with the M2405H, a related tube. Another close relative of the M2405B group functions as a harmonic generator providing greater than 50 milliwatts output over the 24 to 36 Gc region.

Other tubes in the MEC K_u band family are described in the accompanying table.

Environmental Extremes

All MEC tubes are designed to meet severe environmental extremes. For military applications, tubes can be provided to satisfy the requirements of MIL-E-5400, Class 2. Tubes have been tested at 20 g shock and 15 g vibration from 5 to 2000 cps with no performance degradation.

One More Example of MEC Capability

The new K_u band family of traveling wave tubes is one more example of MEC's ability to develop and produce tubes for difficult frequency ranges. MEC tubes are reproducible in production quantities because their metal ceramic format and ceramic rod supported precision helices ensure stability and dimensional accuracy.

Results obtained in the K_u band assure similar success in the production of broadband traveling wave tubes for higher K band frequencies.

MEC K_u BAND TUBES

Tube Type	Frequency Range	Min. Power Output	Min. Small Signal Gain	Noise Figure Max.
PPM FOCUSED TUBES				
M2114B	12.4-18.0	5 mw	25 db	14 db
M2114G	12.4-18.0	5 mw	25 db	20 db
M2208B	12.4-18.0	10 mw	30 db	30 db
M2405B	12.4-18.0	1 watt	30 db	35 db
M2405H	10.0-20.0	1 (12.4-18) watt 0.250 (10-20) watt	30 db 25 db	35 db
SOLENOID FOCUSED TUBES				
M2114A	12.4-18.0	5 mw	25 db	12 db
M2114F	12.4-18.0	5 mw	25 db	17 db
M2208A	12.4-18.0	10 mw	30 db	30 db
M2405F	12.4-18.0	1 watt	30 db	35 db

TO KEEP POSTED *on current and new developments at MEC, you are invited to ask for a copy of our new catalog. For your copy, call your nearest MEC engineering sales representative or write directly to us.*

MEC

MICROWAVE
ELECTRONICS
CORPORATION
4061 Transport Street
Palo Alto, California
DAvenport 1-1770

CIRCLE 143 ON READER-SERVICE CARD

MICROWAVES PRODUCTS

Varactor Multipliers 702

Four varactor frequency multipliers consist of two doublers and two triplers. Conversion efficiency of the doublers is claimed to be 55 to 75% and that of the triplers from 40 to 60%. These solid-state units can be cascaded in various combinations. Output is 4 w, from 800 to 1,250 mc from 10 w hf or vhf source.

Micromega Corp., Dept. ED, 4134 Del Rey Ave., Venice, Calif.

Waveguide Switch 717

All solid-state microwave waveguide switch, MA-3470 2X1, is a compact unit for applications in which ultra-fast switching, typically 2 nsec, is desired. It is available in spdt for operation at X-band. Driving power required is approximately 75 mw. Insertion loss in the closed position is 4.5 db max; isolation of 60 db min is provided in the open position.

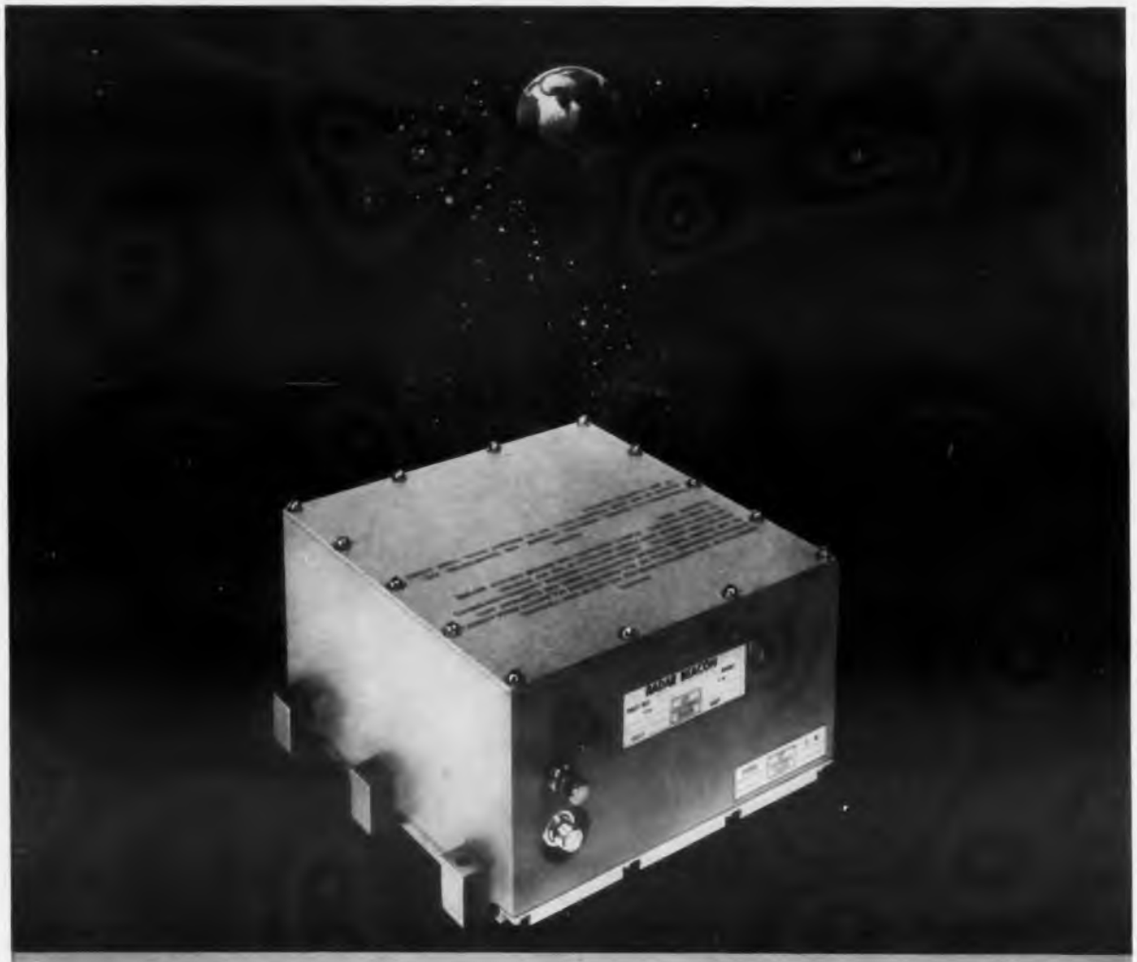
Microwave Associates, Inc., Dept. ED, Burlington, Mass.

Solenoid Actuator 721

High speed, low power solenoid actuator, type ASM has 0.002 sec operating time and average power is 2 w. Attenuator pin movement is 0.1 in. Coil energizing time is 50 μsec and mounting is directly on the plumbing.

Hathaway Denver, Dept. ED, 5800 E. Jewell Ave., Denver 22, Colo.

P&A: $100 ea, small quantities; made to order.



"ANSWERING SERVICE" IN SPACE

ACF TRANSISTORIZED RADAR BEACONS greatly extend the range to which ground radar can track satellites and missiles accurately and effectively. As a pioneer in the development of long-range Radar Beacons, ACF designs, manufactures and tests its own components and sub-assemblies. This "in-plant" capability eliminates long-lead procurement time for critical components and assures reliable, controlled performance of flight-ready units off the ACF shelf.

THE TYPE 148 RADAR BEACON is designed as an airborne, pulse-type tracking aid for long-range space or missile application in both S and C Bands. These "miniature sending stations" have exceptionally high reliability and long life, respond to coded or uncoded interrogations and provide "echo boost" at low power consumption. ACF Beacons have qualified for more major satellite and missile programs than any other beacon.

ACF ELECTRONICS
DIVISION

ACF INDUSTRIES

For technical data, write or call Paramus Plant. Free beacon range nomographs on request. 11 Park Place, Paramus, N. J. Telephone: COlfax 1-4100

CIRCLE 241 ON READER-SERVICE CARD

CIRCLE 784 THRU 795 ON READER-SERVICE CARD FOR FURTHER INFORMATION ON AIRBORNE INSTRUMENT LABORATORY ➤

CONTROL
CUTLER-HAMMER

AIL / DIVISION

Get top performance with . . .

AIL test instruments for lab or field use

. . . including the most complete line for noise figure measurement

It will pay you to know this family of test equipment. In it you'll find the most versatile line of noise figure measurement instruments available.

You'll find a growing family of transistorized devices—portable, reliable . . . equally useful in laboratory or field application.

You'll find many unique devices, including low-cost instruments that give you the measurement you want at a fraction of the cost of alternate approaches.

. . . And in *all* AIL test equipment you'll find design refinements and superior performance that stem from the company's years of scientific leadership in microwave, space and military electronic research.

Prompt attention to your inquiries from leading test instrument representatives. Prices and specifications subject to change without notice.

For more information send the coupon below or circle publication inquiry numbers 784-795

AIRBORNE INSTRUMENTS LABORATORY

Division of CUTLER-HAMMER INC.

Where applied science helps build practical products

Deer Park, Long Island, New York

Send FREE information and specifications on the following precision test instruments: (Please circle type numbers.)

Receiver test equipment Type 390A-3, 391, 393 Type 30 Type 132 Type 70 Type 71 Type 74 Type 113030

Special purpose test equipment Type 133 Type 124C Type 120 Type 50 Type 90

Please check ☐ send only literature ☐ have a representative contact me

Name_____ Title_____

Company_____

Address_____

City_____ State_____

RECEIVER TEST EQUIPMENT

(including the most and the best in noise figure measurement.)

(LEFT TO RIGHT)

TYPE 390A-3, 391, 393—Crystal Test Sets

Simplified, accurate LOW COST tests are provided by these instruments. Measure microwave or video crystals rapidly in the field or lab. Measure noise figure, pair matching, conversion loss, relative or tangential sensitivities. Price from $97 to $299. Circle publication No. 784.

TYPE 30—Precision I-F Attenuator

Get the highest available accuracy in this piston type attenuator.

FEATURES: 30 and 60 Mc standard frequencies. Continuously variable over 80 db range above minimum insertion loss. Accuracy ± .005 db per db from 10 to 80 db; ± .05 db from 0-10 db. Price $250 to $295. Circle publication No. 785.

TYPE 132—Precision Test Receiver

Many types of precise measurements of R-F circuits are possible with this excellent labora-

tory tool. Calibrate R-F attenuators and couplers. Measure noise figure and selectivity.

FEATURES: Incorporates Type 30 attenuator. 30 and 60 Mc standard frequencies. Noise figure 1.6 db at 30 Mc; 2.4 db at 60 Mc. Prices $1,350 and $1,400. Circle publication No. 786.

TYPE 70—Broad Band Noise Generators

11 Models for automatic or manual noise figure measurement.

FEATURES: Frequency range from 10 Mc to 40 Kmc. Relative excess noise temp: 15.3 db ± 0.25 db. Price $125 to $330.

Plus new, exclusive hot-cold body generator to provide highest accuracy available in 0 to 2 Kmc range, excess noise 6.83 db ± 0.1 db. Price $675. Circle publication No. 787.

TYPE 71—Power Supply

Provides Power for all nine Type 70 argon discharge noise generators when used manually. Price $165. Circle publication No. 788.

TYPE 74—Automatic Noise Figure Indicator

Widest frequency coverage is yours with this equipment. Plus maximum flexibility. Exclusive tunable I-F amplifier available.

FEATURES: R-F range 10 Mc to 40 Kmc with Type 70 noise generators. I-F range—30, 60 and 40 to 180 Mc. Noise figure ranges—0 to 25 db, ± 0.5 db; 23 to 36 db, ± 1.0 db. Prices $765 and $830. Circle publication No. 789.

Type 113030 (not illustrated)—Radar Performance Monitor. Transistorized. Measures noise figure, checks mixer crystals; checks transmitted and reflected power. Circle publication No. 790.

SPECIAL RECEIVER

NEW—TYPE 133—Parametric Amplifier

Extremely low noise amplifiers for microwave applications through X-Band featuring excellent amplitude and phase stability and simple operation. Fixed tuned narrow band, tunable narrow band and fixed tuned wide band (10%) designs available. We will gladly quote on special designs. Circle publication No. 791.

SPECIAL PURPOSE TEST EQUIPMENT (LEFT TO RIGHT)

TYPE 124C—Wide Range Power Oscillator

Watts of power over a wide range makes this Oscillator invaluable in many microwave tests.

FEATURES: 200 to 2,500 Mc. Internal or external modulation. Nominally 30 watts output. Price $2,485. Circle publication No. 792.

TYPE 120—Function Generator

Three Wave Forms are provided in one lightweight transistorized package. Sine waves, square waves or pulses with constant amplitude within ± 1 db over the 30 to 39,000 Cps range. Output amplitude and pulse width adjustable. Price $299. Circle publication No. 793.

TYPE 50—Transistorized Power Bridge

Smallest, lightest, lowest-cost power bridge on the market. You get the same accuracy as with higher-priced units.

FEATURES: Ranges 1.0 and 10 mw ±5%. R-F coverage 10 Mc to 40 Kmc, depending on thermistor used (not supplied). Circle publication No. 794.

TYPE 90—Circuit Design Reliability Tester

Prove and improve your circuit designs with this instrument. An especially valuable tool with low frequency circuits where the Customer demands ultimate in reliability. Uses "extreme values" technique on up to 16 parameters. Binary readout of circuit parameters at time of failure. Price $3,600. Circle publication No. 795.

RAYTHEON HIGH-POWER FERRITE DEVICES				
BAND	RAYTHEON MODEL	FUNCTION	POWER LEVEL Average	Peak
UHF	IUH11	Isolator	100 kW	400 kw*
L	CLH4 ILH31	Circulator Isolator	150 kW 15 kW	2.5 Mw* 3.5 Mw*
S	CSH9	Circulator	100 kW	
C	CCH5	Circulator	4 kW	2 Mw
X	CXH6	Circulator	40 kW	200 kw

*Peak power capacity can be increased by pressurization.

Devices with higher power ratings can be designed per your specifications.

Now from Raytheon...
World's most comprehensive line of HIGH-POWER FERRITE DEVICES

RAYTHEON HIGH-POWER X-BAND CIRCULATOR, typical of new high-power ferrite devices with power ratings to 150 kW, average.

WRITE FOR TECHNICAL DETAILS or tell us about your requirements. Address Special Microwave Devices Operation, Raytheon Company, Waltham Industrial Park, Waltham 54, Massachusetts.

RAYTHEON

RAYTHEON COMPANY

SPECIAL MICROWAVE DEVICES OPERATION

CIRCLE 242 ON READER-SERVICE CARD

Hybrid Junctions 677

Coupling of 3 db is provided by these hybrid couplers. Input energy is divided equally between the two outputs with a 90-deg phase separation. Three models cover frequencies from 1 to 8 Gc. Isolation between diagonally opposite terminals is 20 db min. Maximum size is 3-1/8 x 2-3/4 x 5/8 in.

Empire Devices, Inc., Dept. ED, Amsterdam, N. Y.

Slotted Lines 718

Available in all waveguide sizes from WR-430 through WR-2300, these slotted lines have a broadband probe. Tunable or rf probes are available. Residual vswr is less than 1.02; slope is less than 0.1 db. Line can be calibrated in either inches or centimeters.

Antenna Systems, Inc., Dept. ED, Hingham, Mass.

C-Band Semiconductor Switch 701

Microwave switch has a power capability of 2 w at 5,585 mc. Insertion loss is less than 2 db from 5,000 to 5,900 mc and isolation is better than 50 db over the same range. Output pulse rise and fall time is less than 0.1 μsec each. Unit meets MIL-E-5400 environmental tests.

Radio Corp. of America, Aerospace Communications and Controls Div., Dept. ED, Burlington, Mass.

Pulse Generator 700

Model 5-6826P provides 300 to 450 v, at 250 ma peak for modulating microwave amplifiers. Internal modulation rate is adjustable from 10 to 10,000 pps, or external triggering can be used with a 20 v peak pulse. Pulse duration can be adjusted from 1 to 12 μsec, with rise and fall time better than 0.5 μsec.

Alfred Electronics, Dept. ED, 3176 Porter Drive, Palo Alto, Calif.

P&A: $550.00; stock.

Variable Attenuator 682

Full range of attenuation on L, S, C, and X band. This 2-1/2 x 2 x 5/8 in., continuously variable coaxial attenuator, has an insertion loss of 0.5 db and an average power capacity of 2 w. Unit comes with type N male or female connectors and is adaptable to servo or remote control.

Mico Products, Dept. ED, 1025 W. Bonnie Brae, Ontario, Calif.

P&A: $150.00; stock.

Y-Junction Circulator 678

Uhf, L-band, three-port Y-junction circulator model CU-900 has typical frequency ranges of 1 to 1.2 or 0.965 to 1.15 Gc over a temperature range of −20 to +71 C. For operation on the near side of resonance, it uses small permanent magnets. Bandwidths of 18% are available with 20-db isolation, 0.4 db insertion loss and 1.25 vswr.

Rantec Corp., Dept. ED, Calabasas, Calif.

Miniature Compressors 695

Produce volumes to 3 cfm. Two models provide pressures to 100 psig and weigh between 3 and 8 lb with motor. The units, which operate from 3-phase, 400 cps, do not use carbon rings, thereby eliminating carbon deposits in the air system.

Applied Pneumatics, Inc., Dept. ED, 740 Colfax Ave., Kenilworth, N. J.

Klystron Oscillator 685

Frequency range is 26.5 to 31.5 Gc. Model GK-70 provides power output of 100 mw and has normal heater voltage of 6.3 to 7.3 at 0.7 to 0.8 amp. Beam voltage is 1,500 to 2,000 v; beam current is 20 to 30 ma. Output connection is 599/U waveguide flange. The 4-oz unit may be blower or convection cooled. Model GK-71 is the same with lock-nut tuner.

Geisler Laboratories, Dept. ED, P. O. Box 353, Woodland Hills, Calif.

Bandpass Filters 696

Butterworth and Tschebycheff designs are both available. Modu-Filters can be constructed to operate over the RG-52 waveguide range (8.2 to 12.4 Gc). Unloaded Q's of 2,200 per cavity can be realized. As an example, this filter with a center frequency of 9,010 mc and a bandwidth at 3 db points of 20 mc has a maximum insertion loss at center frequency of 1.2 db.

Scope Inc., Dept. ED, 121 Fallfax Drive, Falls Church, Va.

MICROWAVES PRODUCTS

X-Band Parametric Amplifier 709

Features single-knob tuning over a 1.1-Gc range. System noise figure is 4.5 db which includes circulator loss and normal second stage contribution. The unit features a bandwidth of 30 mc at 15-db gain, and a fixed K-band pump frequency with less than 50 mw of pump power required.

Apparatus Div., Texas Instruments Inc., Dept. ED, P. O. Box 6015, Dallas 22, Tex.

Microwave System 686

Operating in the 5,925-6,425 mc common carrier band, this broadband radio system, type 76A is fully transistorized, except for the klystrons. Baseband range is from below 30 cps to above 6 mc. The equipment features an if strip which requires no tuning. Automatic frequency control is standard in both the receiver and transmitter to maintain transmitter frequency stability of better than 0.02%.

Lenkurt Electric Co., Inc., Dept. ED, San Carlos, Calif.

***Price:** $12,000 per terminal.*

C-Band Radar Beacon 708

Operates from 5,400 to 5,900 mc. Model RB-200 includes a transmitter capable of emitting a power output of 10 w, and a receiver which has a sensitivity which exceeds −45 db per min. Power for the beacon may be switched from an external power source to an internal 6.5 — 7.5-v battery by a self-contained relay.

General Instrument Corp., Dept. ED, Andrews Road, Hicksville, N. Y.

***Availability:** stock.*

Microwave Coaxial Connector 705

Connector series, for use with large size cables, are designated QM for use with RG-217/U and QL for use with RG-218, -19, -20, -21/U. Both series are designed for frequencies to 5 Gc. Vswr of 1.27 to 1 are featured on the two series and corona extinction values from 6 kv, 60 cycles rms for the QM, to 12,500 v rms for the QL.

Microwave Div., Thompson Ramo Wooldridge, Dept. ED, 8433 Fallbrook Ave., Canoga Park, Calif.

Microwave Radomes 704

Laid-up fiberglass material is used for construction of heated or un-heated radomes. Model PRH-0804, an 8 ft dome, is a heated unit for any 8 ft parobolic antenna. Other radomes are for 4, 6, and 10 ft antennas.

Technical Appliance Corp., Dept. ED, Sherburne, N. Y.

P&A: $450.00; stock.

Radar Display Tube 719

Wideband detector, amplifier and cathode ray tube are combined in one vacuum envelope. The frequency limit of the Wamoscope (wave modulated oscilloscope is 10 Gc, but can be modified for higher frequencies. A suggested use for this tube is the visual indicator in a battlefield surveillance radar.

Sylvania Electric Products Inc., Dept. ED, 1100 Main St., Buffalo 9, N. Y.

Price: $2,500 for evaluation unit.

MICROWAVES PRODUCTS

Waveguide-Coaxial Adapters 722

Connectors are type N male and female. Adapters are available in waveguide sizes from WR187 (3.95-5.85 Gc) to WR28 (26.5-40.0). The higher frequency units (above 12.4 Gc) are designed for use in the extraction of high harmonic frequencies from relatively low-frequency sources that terminate in type N connectors. Plate flanges are standard; choke flanges can be supplied on request.

American Electronic Laboratories, Inc., Dept. ED, Richardson Road, Colmar, Pa.

RF Probe 690

Designed for use with all waveguide and coaxial slotted lines that have the standard 3/4-in. mounting hole, rf probe model 229B has a smooth and precise tuning adjustment. Either standard microwave crystals or type N-610B bolometers may be employed for use with microwave receivers or other external detectors.

Narda Microwave Corp., Dept. ED, 118-160 Herricks Road, Mineola, N. Y.

P&A: *$145; from stock.*

Resistance Card Kit 716

A complete kit containing a varied assortment of high stability microwave attenuator material is available in easy to use card form. It includes 11 metal-film resistance cards 2-1/2 x 6 in., and one metallized mica resistance card 2 x 2-1/2 in., plus fabrication instructions. Attenuation values up to 70 db are available with vswr held to less than 1.10 over broad bands.

Filmohm Corp., Dept. ED, 48 W. 25th St., New York 10, N. Y.

P&A: *$40; immediate.*

Graphical Techniques Help Multiply and Divide Complex Phasors

A. Moses
425 W. Chestnut St.
Las Cruces, N. M.

GRAPHICAL techniques commonly used for adding and subtracting phasors can also be used to multiply and divide, and with a considerable saving of time.

Let us look at multiplication. First, draw the phasors on the complex plane. Then draw a line from the head of one phasor, Z_1, to the point $1 + j0$. This phasor, the line, and the real axis form a triangle. Next, draw a similar triangle in which the second phasor, Z_2, corresponds to the part of the first triangle along the real axis. The leg of the second triangle corresponding to Z_1 is the product.

As an example, multiplication of $0.4 + j0.3$ by $1.5/45°$ is shown in Fig. 1. The product is measured to be $0.75/82°$.

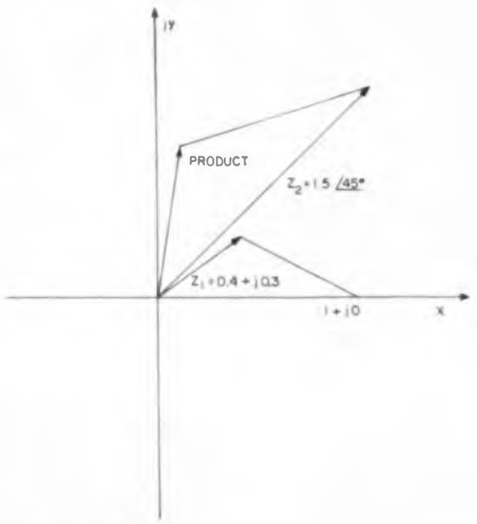


Fig. 1 Application of the graphical technique to multiplying complex phasors Z_1 and Z_2.

Division is done by multiplying by an inverse phasor. First, draw the phasor, Z_1, whose inverse is desired. Draw a circle of unit radius. Draw the reflection of Z_1 in the real axis, that is, a phasor making the same angle with the real axis, but on the opposite side.

If Z_1 lies within the unit circle, draw a perpendicular through the end of the reflected phasor. The perpendicular will be a chord of the unit circle. Draw a tangent to the unit circle where the perpendicular cuts it. The tangent will intersect the reflected phasor, determining the head of the phasor inverse to Z_1.

If the head of Z_1 lies outside of the unit circle, the process is reversed. First draw a tangent to the unit circle from the head of Z_1. Draw a chord perpendicular to Z_1 and passing through the point of tangency. The point of intersection of the chord and Z_1 is then reflected through the real axis, determining the head of the inverse phasor.

As an example, the inverse of $0.4 + j0.3$ is constructed in Fig. 2. ■ ■

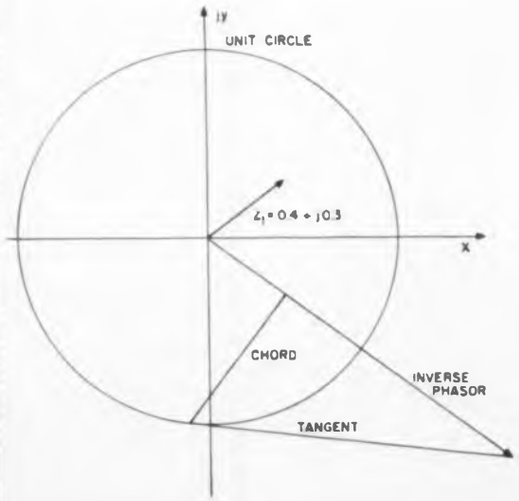


Fig. 2 To divide, one must multiply by the inverse phasor. This illustration shows how to construct the inverse of Z_1.

NEW LITERATURE

Heat Transfer 260

The "Heat Transfer Design Manual" gives "graphical" solutions in BTUs/sq ft/hr and watts/sq ft versus temperature difference to a variety of types of heat transfer problems. It also contains additional data on heat transfer coefficients and specific heat and thermal conductivities. Electrofilm, Inc., 7116 Laurel Canyon Blvd., North Hollywood, Calif.

Electrical Products 261

A 96-page illustrated catalog describes over 1,500 electrical wiring devices, switches and receptacles, transformers, extension and cord sets, fuses, wall plates, pushbuttons and lamps. Products are cross-indexed for easy locating. Underwriters' listings and Federal Specification numbers are also included. Eagle Electric Manufacturing Co., Inc., 23-10 Bridge Plaza S., Long Island City 1, N. Y.

Multiple Connectors 262

Three separate lines of multiple connectors, with a specific data sheet included for each line, are described in a six-page folder. Fastin-Faston connectors for appliance and automotive uses; Ampeez, for major appliance equipment, and Amp-Lok connectors for TV and commercial electronics, are described. AMP, Inc., Eisenhower Blvd., Harrisburg, Pa.

Retention/Cooling Units 263

More than 10,000 electronic cooling and/or retention devices are described in eight-page catalog 1-W. Units include clamps for retaining tubes and components, tube top-holding retainers, JAN shield inserts for tubes, transistor retaining clips, and transistor/component heat radiators. The Birtcher Corp., Industrial Div., 745 S. Monterey Pass Road, Monterey Park, Calif.

Potentiometers 264

A 16-page catalog, 11-60 section 4, provides description, complete technical specifications, dimensional drawings and photographs of eight series of composition element potentiometers and their military versions, plus power switches. Clarostat Manufacturing Co., Inc., Dover, N. H.

Inductors 265

A wide line of electrically variable Vari-L inductors is covered in 16-page catalog No. 61. Application data, characteristics charts and curves, operating principles and much other information are provided. Vari-L Co., Inc., P. O. Box 1433, Stamford, Conn.

Zener Diodes

A 6-page catalog (SR-265) provides ratings, characteristics, applications and power dissipation data on over 270 JEDEC and IR "High Spec" diode types. *Write on company letterhead to International Rectifier Corp., Dept. ED, 233 Kansas St., El Segundo, Calif.*

Solid-State Amplifiers 266

A four-page short-form catalog provides detailed specifications on instrumentation, telemetry and laboratory testing applications. A variety of differential dc amplifiers is included. Video Instruments Co., Inc., 3002 Pennsylvania Ave., Santa Monica, Calif.

Insulating Resins 267

The "Maraset Electrical Resins Selector," a six-page chart-folder, is a guide to resins and their uses for potting, encapsulating, and coating electrical and electronic products, parts, and assemblies. Marblette Corp., 37-31 30 St., Long Island City 1, N. Y.

RF Power Bridges 268

Precision power bridges, thermistor mounts and X-band power standards are described in this 12-page technical brochure. It also includes data on precise methods of determining rf power levels. Weinschel Engineering, 10503 Metropolitan Ave., Kensington, Md.

NEW LITERATURE

Microwave Equipment 269

General data and key specifications on microwave sweep generators, the "LAB-CVR" laboratory receiver, and miniature and ultra-miniature ferrite components are provided in a six-page condensed catalog (No. 8-61). Details are also provided on this firm's facilities for work in the Gc to millimeter frequency regions. Melabs, 3300 Hillview Ave., Stanford Industrial Park, Palo Alto, Calif.

Transistor Cooling 270

A 48-page IERC Test Report, 172A, "Evolution of IERC U-P Type Transistor Heat Dissipators," gives dissapation for power transistors in a variety of natural and forced air environments. The report evaluates an advanced dissipator design twice as efficient as conventional fin-types of equal volume. IERC Div., International Electronic Research Corp., 135 W. Magnolia Blvd., Burbank, Calif.

Damped Laminates 271

Damped laminates for control of structural resonant response are described in "Built-In Structural Damping," an eight-page bulletin (No. 719). The advantages of standard and custom-engineered Dyna-damp structures in protecting sensitive equipment exposed to random, high-intensity vibration, shock and noise are discussed in detail. Lord Manufacturing Co., Erie, Pa.

Mechanical Differentials 272

Brochure 8101, a 36-page publication, provides general information on differentials and design criteria. A special section contains 27 drawings of stock and pre-engineered differentials. The drawings are "A" size and printed on perforated pages; they can be reproduced by Ozalid or traced. Dynamic Gear Co., Inc., Amityville, N. Y.

Power Rectifiers

The revised "Guide to Semiconductor Power Rectifiers," a 56-page catalog, describes rectifiers for applications including: anodizing, aircraft ground power supplies, battery chargers, capacitor manufacturing, current limiting, electron tube testing, relay testing, shop power supplies, and complete semiconductor power conversion systems. *Write on company letterhead, indicating whether electroplating or industrial supplier literature is wanted, to The Meaker Co., Dept. ED, Nutley 10, N. J.*

Frequency Synthesizers 273

Development of quartz crystal radio frequency synthesizers is discussed in a 16-page booklet. Supported by circuit diagrams, curves, drawings, and photographs, it traces the historical development of these synthesizers, discussing ideal performance parameters to be achieved. Manson Laboratories, Inc., 375 Fairfield Ave., Stamford, Conn.

High-Density Packaging 274

Facilities for producing miniaturized electronic assemblies of high density by the Weldbloc technique are described and illustrated in a six-page bulletin. Numerous typical products are illustrated, and the Weldbloc approach to packaging is discussed in detail. Kearfott Div., General Precision, Inc., Little Falls, N. J.

Vibration Control 275

"Lord vibration/shock/noise control," a 16-page capabilities brochure, presents comprehensive background material on this firm and its many products. Lord Manufacturing Co., Erie, Pa.

Oscillators 276

A line of transistorized audio tone oscillators is illustrated and described in detail in a 12-page bulletin. Specifications, circuit diagrams, and numerous other data are included. MF Electronics Corp., 118 E. 25 St., New York 10, N. Y.

NEW LITERATURE

Miniature Connectors 277

Complete technical descriptions and specifications are provided for a wide range of TPS plugs, jacks, receptacles, adapters, etc. in the firm's new 8-page TPS catalog. General RF Fittings, Inc., 702 Beacon St., Boston 15, Mass.

Epoxy Resins 278

Four-page folder compares 17 of the firm's epoxy resins, their components, primary uses, handling characteristics, and physical and electrical properties. Material is in comparison chart form. Mitchell-Rand Manufacturing Corp., 51 Murray St., New York 7, N. Y.

Plastic Components 279

A new 6-page brochure, which includes a handy materials guide and design data sheet, describes the firm's capabilities in the custom fabrication of plastic electronic components. Emmco Plastics Corp., Everett, Mass.

Instruments and Systems 280

Scientific instruments and systems are featured in a new 16-page catalog No. S/I-1-61 which covers the company's line for electronics, missile and nuclear applications. Physical Sciences Corp., 389 N. Fair Oaks Ave., Pasadena, Calif.

Reconnaissance Systems 281

An analysis of space-age reconnaissance systems developed by the firm for both industry and government is outlined in a pamphlet just released. Planning Research Corp., 1333 Westwood Blvd., Los Angeles 24, Calif.

Polyurethane Coated Wire 282

Technical information on polyurethane coated magnet wire, along with physical and electrical property data are contained in the firm's four-page bulletin MW-1003. Hudson Wire Co., Magnet Wire Div., Winsted, Conn.

Power Supplies 283

Selection guide No. 4-2 for solid-state power supplies and transducer control modules for telemetry, data processing and laboratory testing applications is available. Video Instruments Co., Inc., 3002 Pennsylvania Ave., Santa Monica, Calif.

Automated Test Facilities 284

Manual R-73 contains data on facilities for determining continuity, resistance, leakage current and dielectric strength of electrical and electronic devices. Associated Research, Inc., 3777 W. Belmont Ave., Chicago 18, Ill.

Turbine Flow Transducer 285

An electrical pulse output type transducer, applicable to any liquid or gas and that will withstand line pressure of up to 5,000 psi, is described in a four-page brochure. Principles of operation, specifications and other data are provided. Hydropoise, Inc., 230 S. Wells Fargo Drive, Scottsdale, Ariz.

Industrial Expositions 286

Results of an intensive study of visitors' desires and needs at industrial expositions have been combined into a useful 16-page booklet, titled "What They Want." Clapp & Poliak, Inc., 341 Madison Ave., New York 17, N. Y.

Traveling Wave Tubes 287

A line of metal-ceramic traveling wave tubes, in both ppm and solenoid focused formats, is illustrated and described in an eight-page catalog. Low-noise, medium-power, low-power, serrodyne, and special-purpose units are included. Microwave Electronics Corp., 4061 Transport St., Palo Alto, Calif.

Modern Mapmaking 288

A short illustrated course on the production of modern charts and maps is provided in an informative 12-page, 7-color brochure. Title is "Map Production with Stabilene Film." Keuffel & Esser Co., Hoboken, N. J.

NEW LITERATURE

Digital Data System 289

An eight-page brochure describes the Series 7000 line of modular digital data systems for alarm scanning and digital recording of virtually any type or combination of analog values. System features, applications, and a variety of building blocks and subassemblies are covered. Monitor Systems, Inc., Epsco, Inc., Dept. 33, Fort Washington Industrial Park, Fort Washington, Pa.

Ground Support Equipment

A new 29-page book describes the capabilities and electronic devices manufactured by the company in missile ground support equipment, electronic testing gear for weapons systems, and devices for automating production machinery and office equipment such as billing and shipping machines. *Write on company letterhead to Kidde Aero-Space Div., Dept. ED, Belleville 9, N. J.*

Data Gathering System 290

The model S-3100 Portable Data Gathering System is described in a four-page brochure. Capable of recording up to 100 analog voltage inputs on tape in suitable format for direct entry to a digital computer, the system is in two aluminum carrying cases. Detailed specifications are provided. Systems Div., Epsco, Inc., 275 Massachusetts Ave., Cambridge 39, Mass.

Dials and Verniers 291

The capabilities of the Instrumentation and Apparatus Div., as well as many of its products, are delineated in a 24-page brochure. Products include dials and verniers, with arcs and segments accurate to 1 sec of arc; tapered spindles accurate to 0.00005 in; and precision level-vial assemblies. C. L. Berger & Sons, Inc. 37 Williams St., Boston, Mass.

Carrier 292

A 12-page brochure describes the MX-106 transistorized carrier, which can provide up to 600 voice channels over microwave radio. A technique which generates carrier pulses by use of a controlled delay line is also discussed. Microwave Systems Div., Alpha Corp., Dallas, Tex.

System Checkout Set 293

A six-page brochure describes an armament control system checkout test set which permits remote flightline and production line testing of radar systems. Specifications, features, function and other data are provided. Kearfott Div., General Precision, Inc., Little Falls, N. J.

Waveguide Windows 294

Electrical and mechanical data on a variety of solderable and flange pressure windows are provided in catalog WD-61. Dimensions, general information, illustrations and other data are provided. Microwave Development Laboratories, Inc., Natick, Mass.

Components 295

This 140-page catalog No. 100 features such items as precision gears, magnetic clutches and brakes, differentials, couplings, gear heads, limit stops, bearings and electronic hardware. Siamco Div., Tech-Ohm Electronics, Inc., 36-11 33rd St., Long Island City 6, N. Y.

Transistors 296

An eight-page catalog of condensed specifications, "Kearfott Semiconductor Devices," provides ratings, switching, small signal and other characteristics of a wide variety of transistor types. Kearfott Semiconductor Corp., Kearfott Div., General Precision, Inc., West Newton, Mass.

Connectors 297

An expanded line of precision microminiature electronic connectors, made by Continental Connector Corp., is described in a six-page brochure (Form MM-861). Connectors are rectangular plug and socket types. De-Jur-Amsco Corp., 45-01 Northern Blvd., Long Island City 1, N. Y.

NEW LITERATURE

Radio Frequency Interference 298

A 4-page color brochure entitled "RFI Control" has been published listing the firm's testing equipment, engineering personnel backgrounds and corporate experience. Electro-International, Inc., Box 391, Annapolis, Md.

Traveling Wave Tubes 299

Twenty-three types of traveling wave tubes and backward-wave oscillators are described in this catalog. Principal electrical characteristics and major dimensions are provided. Sylvania Electric Products, Inc., 1100 Main St., Buffalo 9, N. Y.

Slip Rings 300

Slip rings, brush assemblies, rotary switches and commutators are described and illustrated in this 16-page catalog, which also furnishes a description of the facilities of the firm. Slip Ring Co. of America, 3612 W. Jefferson Blvd., Los Angeles 16, Calif.

Capacitors 301

Two two-page data sheets describe types STA polar and types STAN non-polar high-μf solid-tantalum capacitors. Ten ratings of each type are covered. Electrical ratings, dimensional diagrams and performance curves are provided. Fansteel Metallurgical Corp., North Chicago, Ill.

Multi-Switches 302

Both non-illuminated and illuminated types of multi-switches in many different combinations of stations, rows, functions, solenoid releases, and stack types, are described in 12-page catalog S-306. Included is information on a new "Push-Push Switch." Switchcraft, Inc., 5555 N. Elston Ave., Chicago 30, Ill.

Raysistor Applications 303

Applications of the Raysistor, including use as a control element in AGC vacuum tube circuits, SSB suppressed carrier receivers and "DE-Q" transistor circuits, and use as a switching element for low-level signals, are described in a 12-page bulletin. Operating data on this electro-optical component are also provided. Raytheon Co., Industrial Components Div., 55 Chapel St., Newton 58, Mass.

MOVING AIR IS CHILD'S PLAY

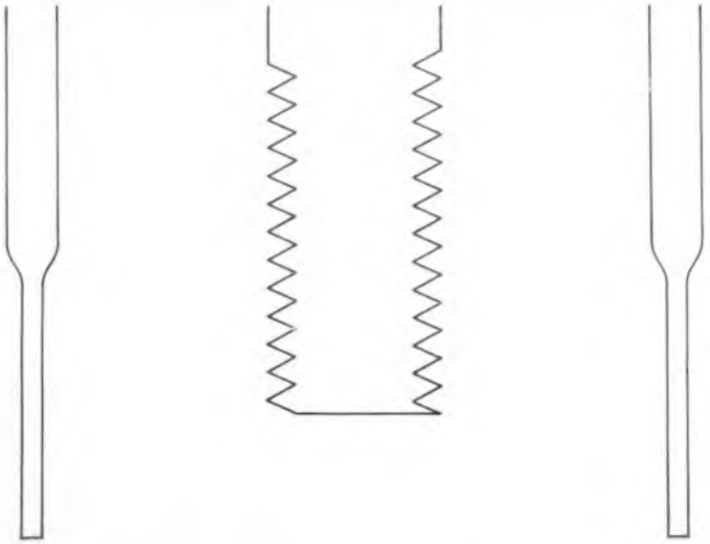
CONTROLLING IT TAKES AN EXPERT

Dexterity is achieved through patience and practice. Our ability to solve the most complex air moving and cooling problems depends partly on these qualities, but mostly on imaginative design, which comes only with experience . . . and maturity. Brochure 102 gives our background. Write for it.

TORRINGTON
MANUFACTURING COMPANY
TORRINGTON CONNECTICUT

TAKE A SECOND LOOK

IT'S THE 2N174—PART OF DELCO RADIO'S POWER TRANSISTOR FAMILY WHICH HAS PROVED ITS STUFF FOR YEARS IN HUNDREDS OF MILITARY AND INDUSTRIAL APPLICATIONS: MISSILES, COMMUNICATIONS, DATA PROCESSING, AND ULTRASONICS, TO NAME A FEW. THIS MULTI-PURPOSE PNP GERMANIUM POWER TRANSISTOR HAS THE HIGH PERFORMANCE AND VERSATILITY TO MEET OR EXCEED THE MOST RIGID ELECTRICAL AND ENVIRONMENTAL REQUIREMENTS. ◖ DESIGNED FOR GENERAL USE WITH 28-VOLT POWER SUPPLIES, THE 2N174 MAY ALSO BE USED WITH 12 VOLTS WHERE HIGHER RELIABILITY IS DESIRED. MAXIMUM EMITTER CURRENT—15 AMPERES, MAXIMUM COLLECTOR DIODE RATING—80 VOLTS, THERMAL RESISTANCE—BELOW .6°C/W AND MAXIMUM POWER DISSIPATION—50 WATTS AT 71°C, MOUNTING BASE TEMPERATURE. THE 2N174'S LOW SATURATION RESISTANCE PROVIDES HIGH EFFICIENCY IN SWITCHING OPERATIONS. ◖ LIKE ALL DELCO TRANSISTORS, EVERY 2N174 MUST PASS AT LEAST A DOZEN ELECTRICAL AND ENVIRONMENTAL TESTS—BEFORE AND AFTER AGING—BEFORE IT LEAVES DELCO RADIO'S LABORATORIES. THIS 200 PERCENT TESTING, COMBINED WITH FIVE YEARS OF REFINEMENTS IN MASS PRODUCTION, MEANS CONSISTENT UNIFORMITY IN THE PRODUCT . . . AT A LOW PRICE. ◖ THE 2N174 IS JUST ONE OF MANY DEPENDABLE TRANSISTORS PRODUCED BY DELCO RADIO TO SUPPLY ALL YOUR TRANSISTOR NEEDS. FOR MORE DETAILS OR APPLICATIONS ASSISTANCE ON THE 2N174 OR OTHER DELCO TRANSISTORS, CONTACT YOUR NEAREST DELCO RADIO SALES OFFICE.



Union, New Jersey
324 Chestnut Street
MUrdock 7-3770

Santa Monica, California
726 Santa Monica Blvd.
UPton 0-8807

Chicago, Illinois
5750 West 51st Street
POrtsmouth 7-3500

Detroit, Michigan
57 Harper Avenue
TRinty 3-6560

Syracuse, New York
1054 James Street
GRanite 2-2668

DELCO RADIO
DEPENDABILITY
RELIABILITY

DIVISION OF GENERAL MOTORS • KOKOMO, INDIANA

CIRCLE 243 ON READER-SERVICE CARD

Silver-Cadmium Batteries 315

The characteristics of sealed silver-cadmium batteries, including the ability of the cadmium negative to reabsorb oxygen produced at the silver electrode during charge and over charge, is described in a paper entitled "The Sealed Silver-Cadmium Battery." Yardney Electric Corp., 40-50 Leonard St., New York 13, N.Y.

Microwave Products 316

Coaxial transmission line equipment, antennas, waveguides, accessories, components and systems are described in detail in this 12-page catalog. Photographs, schematics, cut-aways, specifications and engineering data are included. Telerad, Div. of The Lionel Corp., Route 69-202, Flemington, N. J.

Choppers 317

Models 50, 60 and 70 electronic choppers are described in three two-page bulletins. All are solidly encapsulated units. Mechanical, electronic, operating and application data are provided. Solid State Electronics Co., 15321 Raven St., Sepulveda, Calif.

Computing System 318

The hardware, software and service features of the G-20 computing system are described in a six-page brochure (BSP 07611). Also described is the customer support program of this firm, a program library, "space" programming, and on-site maintenance. Bendix Computer Div., 5630 Arbor Vitae St., Los Angeles 45, Calif.

Corona Testers 319

Complete data on a new line of integrated corona test sets, corona-free high-voltage testers, corona detectors, and corona pickup networks are provided in four-page technical bulletin 4-10.27. The equipment detects minute traces of corona and displays them on a scope. Associated Research, Inc., 3777 W. Belmont Ave., Chicago 18, Ill.

Electric Gaging 320

"Advanced Trends in Electric Gaging," an eight-page booklet, explains the function of the Hamilton electric indicator and control units and describes typical applications of electric gaging. Industrial Products Div., Hamilton Watch Co., Lancaster, Pa.

IDEAS FOR DESIGN

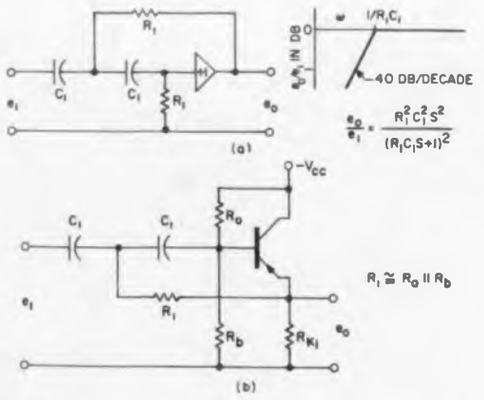


Fig. 1. High-pass filter stage: a. Ideal design, b. Practical approach.

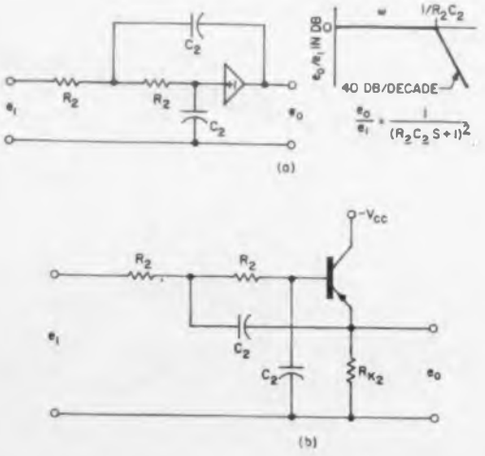


Fig. 2. Low-pass filter stage: a. Ideal design, b. Practical approach.

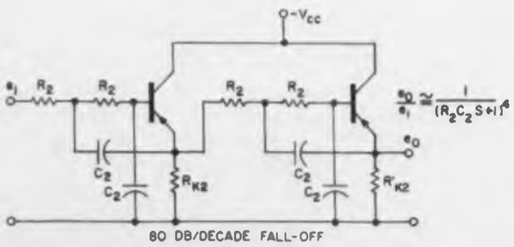


Fig. 3. Typical low-pass filter circuit.

Filter Designs Combine Bias and Frequency Components 747

Circuit designers who use only passive networks for amplitude shaping may find valuable this straightforward approach to pass-filter design. The approach is illustrated by the pass-filter building blocks shown in the figures. These circuits:

1. Use the same components to achieve both the proper bias and frequency characteristics. No components are used exclusively as biasing functions; thus, their number is reduced.
2. Limit linear transistor amplifier configurations to the emitter-follower type. Only +1 gain operational amplifiers are used having inherently great gain stability. Their reliability can approach that of passive circuits.

The circuit in Fig. 1 allows capacitive coupling to the preceding stage. Resistor R_1 is chosen in conjunction with R_{K1} for proper impedance matching, base biasing, and dc output level, without regard to preceding stage voltages.

The circuit in Fig. 2 allows direct coupling to the preceding stage. The value of R_2 is chosen for proper impedance matching and base biasing, considering the preceding stage dc level.

Because of the high-input/output impedance ratio of emitter-followers, little consideration need be given stage interdependence. As examples, the filter in Fig. 3 was designed as a pulse-width demodulator. A bandpass filter-circuit arrangement is shown in Fig. 4.

Gerald F. Allen, Electronic Engineer, General Dynamics, Pomona, Calif.

If this Idea is valuable to you, give it a vote by circling Reader-Service number 747.

Vote for Ideas Valuable to You

Vote for the Ideas which are valuable to you. Other engineers will vote for the Ideas which are most valuable to them. The Idea which receives the most "Valuable" votes will be judged "Most Valuable of Issue." Its author will receive a $50 award.

Choose the Ideas which suggest a solution to a problem of your own or stimulate your thinking or which you think are clever.

The Ideas chosen as the most valuable in each issue will be eligible for the $1,000 Idea of the Year award.

So vote for the Ideas you find most valuable. And, after you've voted, why not send in an Idea of your own?

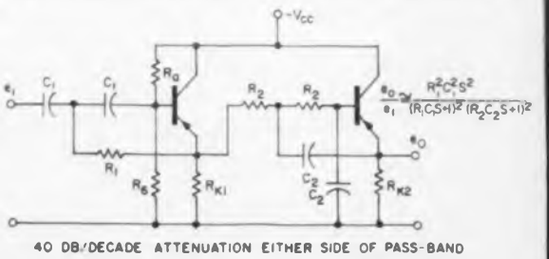


Fig. 4. Typical band-pass filter circuit.

$50 "Most Valuable of Issue" Award for Angle-Conversion Tip

Solomon L. Linder, member of the Technical Staff, Bell Telephone Laboratories, Whippany, New Jersey, has won ELECTRONIC DESIGN's fourteenth Most Valuable of Issue Award.

Mr. Linder receives the award for his Idea for Design, "Slide Rule Converts Angles to Radians Quickly," which appeared in the August 30 issue. The idea described an easy way to convert from degrees to radians on the slide rule.

How You Can Participate

Rules For Awards

Here's how you can participate in Ideas for Design's Seventh Anniversary Awards: All engineer readers of ELECTRONIC DESIGN are eligible.

Entries must be accompanied by filled-out Official Entry Blank or facsimile. Ideas submitted must be original with the author, and must not have been previously published (publication in internal company magazines and literature excepted).

Ideas suitable for publication should deal with:

1. new circuits or circuit modifications
2. new design techniques
3. designs for new production methods
4. clever use of new materials or new components in design
5. design or drafting aids
6. new methods of packaging
7. design short cuts
8. cost saving tips

Awards:

1. Each Idea published will receive an honorarium of $20.
2. The Idea selected as the most valuable in the issue in which it appears will receive $50.
3. The Idea selected as the Idea of the Year will receive a Grand Prize of $1,000 in cash.

The Idea of the Year will be selected from those entries chosen Most Valuable of the Issue.

Most Valuable of the Issue and Idea of the Year selections will be made by the readers of ELECTRONIC DESIGN. The readers will select the outstanding Ideas by circling keyed numbers on the Reader-Service cards. Payment will be made eight weeks after Ideas are published.

Exclusive publishing rights for all Ideas will remain with the Hayden Publishing Co.

SEVENTH ANNIVERSARY AWARDS

IDEAS-FOR-DESIGN

Entry Blank

Ideas-for-Design Editor
ELECTRONIC DESIGN
850 Third Ave.
New York 22, N. Y.

Idea (State the problem and then give your solution. Include sketches or photos that will help get the idea across.)

(Use separate sheet if necessary)

I submit my Idea for Design for publication in ELECTRONIC DESIGN. I understand it will be eligible for the Seventh Anniversary Awards—$20 if published, $50 if chosen Most Valuable of Issue, $1,000 if chosen Idea of the Year.

I have not submitted my Idea for Design for publication elsewhere. It is entirely original with me and does not violate or infringe any copyrights, patents or trademarks or the property rights of any other person, firm or corporation.
Hayden Publishing Company, Inc. shall have the exclusive publication rights to these Ideas for Design selected for publication in ELECTRONIC DESIGN. This right extends to the subsequent use of the Idea for Design by Hayden in any of its other publications. Honorariums, if any, for subsequent publication shall be solely in the discretion of Hayden Publishing Company, Inc.

Name _____ **Title** _____

Company Name _____

Address _____

For Additional Entry Blanks, circle **750** on Reader-Service Card.

IDEAS FOR DESIGN

Straight-Line Representations 741 Simplify Data Comparisons

A recurring problem in design work is the comparison of experimental performance with theoretical prediction. In many cases it is possible to greatly simplify this process by

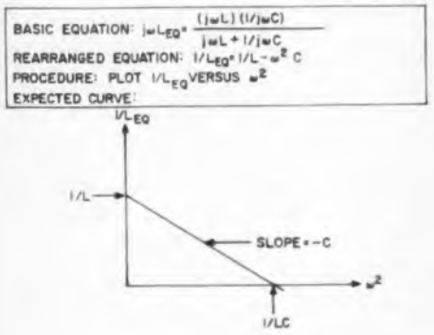


Fig. 1. Equivalent inductance of an inductor with stray shunt capacitance.

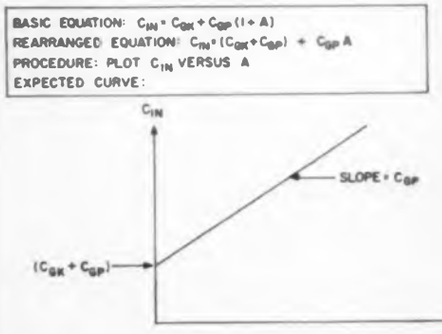


Fig. 2. Input capacitance of a grounded-cathode amplifier stage.

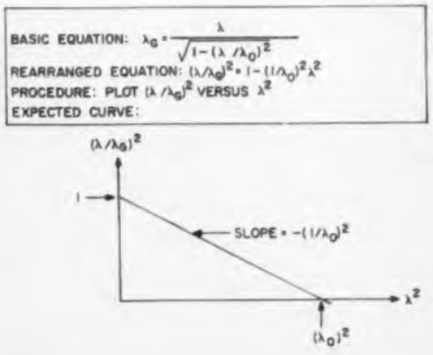


Fig. 3. Waveguide wavelength.

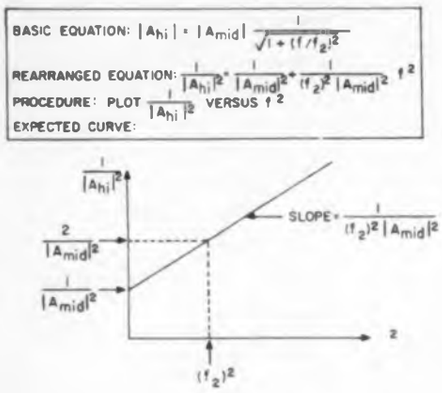


Fig. 4. High-frequency response of an RC-coupled amplifier.

plotting the experimental data so that the expected theoretical curve is a straight line.

Several examples are shown below: These examples illustrate the general procedure that can be applied to a great number of practical problems.

Odis P. McDuff, project director, Electrical Engineering Dept., University of Alabama, University, Ala.

If this idea is valuable to you, give it a vote by circling Reader-Service number 741.

Automatic Gain Control Circuit 748 Uses Unijunction Transistor

The unijunction transistor, with its negative resistance characteristic, lends itself quite simply to applications requiring limited automatic gain control. An agc circuit using a unijunction is shown in Fig. 1.

As the input rises, the current into the detector and the emitters also rises, causing the emitter-to-B_1 resistance to fall. Since the output is IZ_{BB} (Z_{BB} is the B_2 to B_1 resistance), as I increases Z_{BB} decreases.

The emitter-to-B_1 resistance (for a 2N-

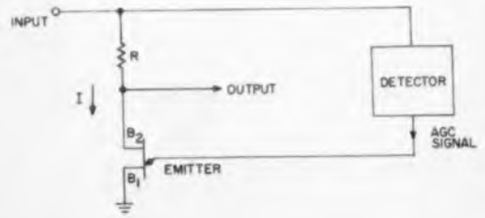


Fig. 1. The negative resistance characteristic of a unijunction transistor can be applied in this basic agc circuit.

IDEAS FOR DESIGN

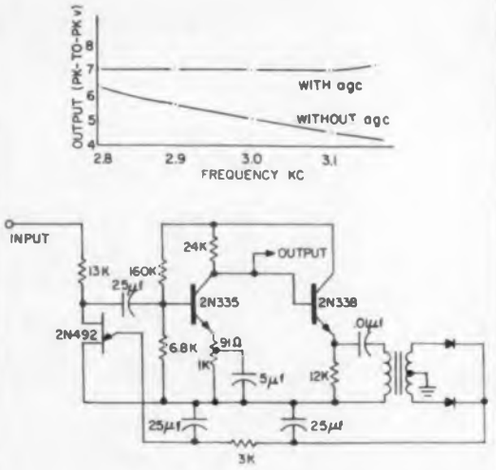


Fig. 2. Unijunction transistor is here used to compensate an oscillator whose output varied universely with frequency. Graph shows affect of agc.

492) varies from approximately 4.6 K for zero emitter current, to 150 ohm for an emitter current of 10 ma. This change in resistance is fairly linear for emitter currents of from 1 to 5 ma (emitter-to-B_1 resistance from 2 K to 240 ohm). For linear operation, these emitter current values should not be exceeded.

Fig. 2 presents a unijunction agc circuit used to compensate an oscillator whose output decreased as the frequency increased. The graph illustrates the result of this agc compensation.

This circuit is only one of many in which agc may be obtained with the unijunction transistor. Thus, the unijunction could also be used in place of the emitter resistance in an amplifier, controlling the gain by varying this resistance.

Richard S. Hughes, Electronic Engineer, U. S. Naval Ordnance Test Station, China Lake, Calif.

If this Idea is valuable to you, give it a vote by circling Reader-Service number 748.

A Two-Transistor Amplitude-Modulated Oscillator 743

This circuit was designed to modulate a phono-oscillator from a single audio stage driven by a high-impedance crystal pickup.

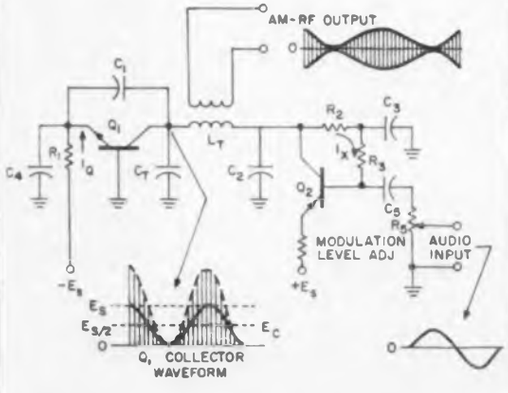
The npn-pnp biasing arrangement allows the high ac collector impedance of the grounded-base oscillator stage to be used for the ac load impedance of audio-modulating transistor Q_2. This provides a large audio gain and allows 100 per cent modulation of the oscillator output from the low-output power of a high-impedance crystal microphone or phono pickup.

Capacitor C_3 acts as an audio-bypass capacitor preventing negative feedback from the collector to the base of Q_2, which would decrease its audio gain and input impedance. The R_2, R_3 network also tends to stabilize the dc operating point of Q_1 and Q_2, and helps to maintain E_c constant during variations in ambient temperature and transistor parameters.

The audio-voltage gain of Q_2 will be approximately equal to its collector-load impedance, divided by R_4. For a typical audio transistor operating at 1 or 2 ma collector current, the ac collector impedance of Q_2 would be approximately 50 K. Thus, if R_2 also is 50 K, the total collector-load resistance of Q_2 will be approximately 25 K since the impedance looking into the collector of Q_1 will be much greater than 50 K, or approximately 2-3 meg at the audio frequencies.

The voltage gain from base to collector of Q_2 will be 25 or greater, and 100 per cent modulation can be obtained with an audio-input voltage of only 350 mv peak-to-peak.

The circuit works as follows: transistor Q_1 and its components form a simple Colpitts oscillator, with positive feedback provided by the capacitor-voltage divider network C_1 and C_2. L_1 and C_T form the oscillator-tuned cir-



High gain of single audio stage allows 100 per cent modulation of the Colpitts oscillator from the low output of a high-impedance crystal microphone or phono pickup.

cuit and determine its frequency of oscillation.

$$F_{osc} = \frac{1}{2\pi(L_t C_t)^{1/2}}$$

The value of C_1 should be included in C_t when determining the value of L_t for the desired oscillator frequency. R_1 establishes the value of the average current, I_q, drawn by Q_1 and Q_2.

$$I_q = \frac{E_s}{R_1}$$

C_2 serves as an ac ground for the oscillator stage. However, since it is desirable to keep the impedance at the collector of Q_2 high at audio frequencies, the impedance of C_2 should be approximately 50 K at the highest input audio frequency, F_h.

$$C_2 \simeq \frac{1}{2\pi F_h \times 50{,}000}$$

Eugene P. Hoyt, member of technical staff, Hughes Aircraft Corp., Westminster, Calif.
If this idea is valuable to you, give it a vote by circling Reader-Service number 743.

Photoelectric Elements Help 740 Analog Circuits Divide, Multiply

Performing multiplication, division, or other "nonlinear" operations on the basic analog computer circuit, Fig. la, requires extra circuit complexity and expense. However, if the circuit is built around photoelectric elements, as shown in Fig. lb, these operations can be much more readily performed.

In this figure, R_{p1} and R_{p2} are photoelectric elements of identical, or at least similar, characteristics. They are both illuminated by a single light source whose output varies with the voltage across it. Thus:

$$e_k = -e_1 \frac{R_{p1}}{R_1}$$

or

$$R_{p1} = \frac{1}{e_1} \times e_k R_1 = \frac{1}{e_1} \times constant$$

But, since R_{p2} is illuminated by the same light source as R_{p1},

$$R_{p2} = R_{p1} = \frac{1}{e_1} \times constant$$

Because R_{p2} and R_{p1} are electrically in-

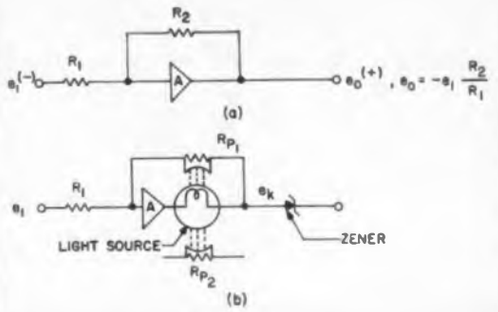
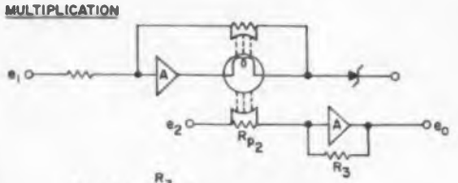


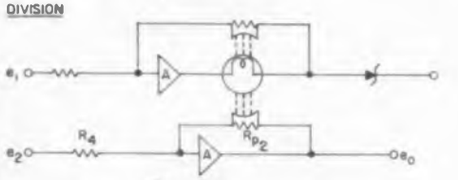
Fig. 1a. Basic analog computer circuit can perform operations such as addition, subtraction, integration with only minor circuit variations. Multiplication, division, other "nonlinear" operations require more complicated circuitry. **(b).** Basic photoelectric analog circuit can be readily modified to divide, multiply, perform non-linearly.

MULTIPLICATION



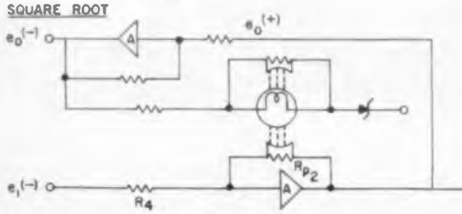
$$e_0 = -e_2 \frac{R_3}{R_{P_2}} = e_2 e_1 \times \text{CONSTANT}$$

DIVISION



$$e_0 = -e_2 \frac{R_{P_2}}{R_4} = \frac{e_2}{e_1} \times \text{CONSTANT}$$

SQUARE ROOT



$$e_0 = -\frac{R_{P_2}}{R_4} = \frac{e_i}{e_0} \times \text{CONSTANT}$$

$$\therefore e_0^2 = e_i \times \text{CONSTANT}$$

$$\text{or } e_0 = \sqrt{e_i} \times \text{CONSTANT}$$

dependent, this operating equation may be applied as shown in the functional circuits.

Note that the feed back circuit does not rely on the relationship between current and intensity of the light source, or between intensity and resistance of the photoelectric elements.

John D. Howell, Development Engineer, Wallace & Tiernan, Inc., Belleville, N. J.

If this idea is valuable to you, give it a vote by circling Reader-Service number 740.

Connector System Solves Large System

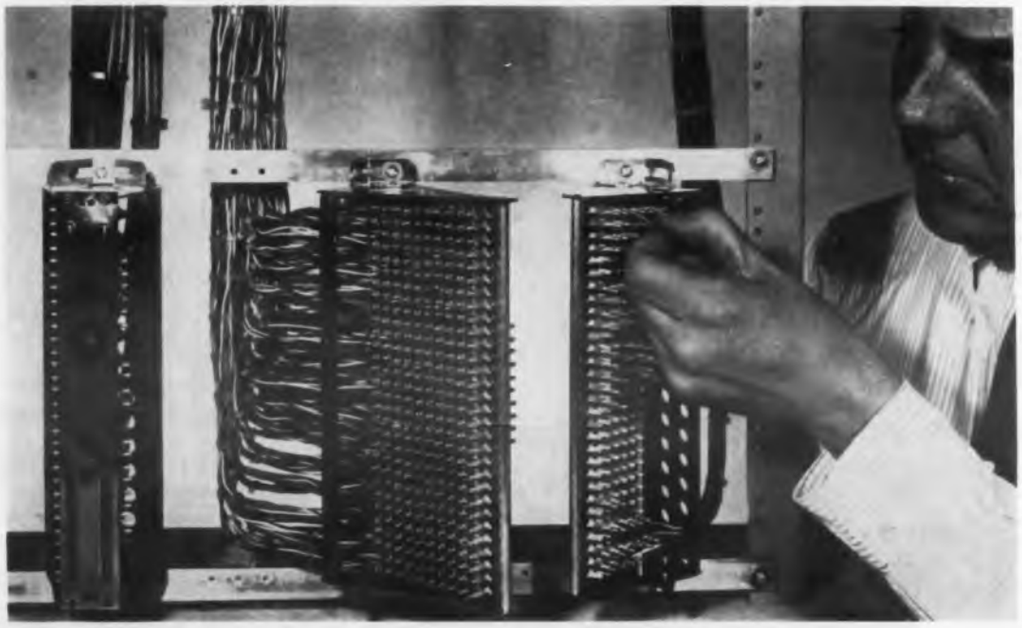


Fig. 1. Wires terminated on the new connector are dressed between the terminal pin rows as in conventional "tree-type" solder blocks. The terminal tab fittings are in direct view for quality-control inspection and for test probing.

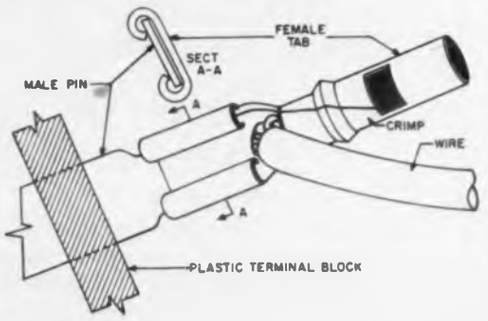


Fig. 2. Close-up sketch of connector itself. Note how, in cross section A-A, the sides of the female tab curl around to cause the edges to press into the male pin. The novelty of this connector, however, lies in the way the wires come in at the center of the tab, leaving the end free to use as a "handle" for pushing on or pulling off the tab. The free end is also meant to be a test probing and strapping point.

Connections can be a pain in the neck in large electronic installations, especially those systems such as TV networks and data systems which are subject to continual change. Here is one answer to the large-system interconnection problem. Originally devised for the Columbia Broadcasting System television network, it is now commercially available from Thomas & Betts Co., Inc.

A NEW version of the familiar push-on tab connector has been developed into an interconnection system suitable for large, multiple-rack electronic installations. The design decisions behind this interconnection system were made by a television network engineer as an answer for TV station interconnection problems. However, the resulting system has applications in data and computer systems as well.

The interconnection method is mainly concerned with subsystem-to-subsystem or rack-level interconnections. It combines the advantages of the terminal blocks and plug-in connectors usually used for these connections. On the one hand it approaches the low cost of terminal blocks and on the other it nears the quick-disconnect flexibility of plug-in connectors. Since its original development and trial in television last year, it has become a commercially available product marketed by the Thomas & Betts Co., Inc., Elizabeth, N. J., under the trade name "Connecto-Blok."

Connection System Is Mechanically Very Simple

Fig. 1 shows the audio and control circuit version of the new connector. It is similar in appearance to "tree-type" solder ter-

Problems

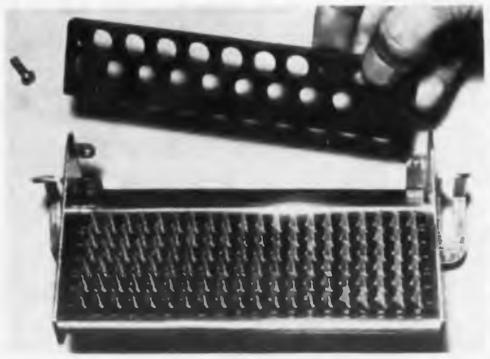


Fig. 3. Removable high-impact plastic fanning strip on each side of the boards permits wiring harnesses to be fabricated independently of one another, either in place or on the bench. The holes in the fanning strips align the wire bundles to facilitate final connections.

minal blocks and is designed to be mounted in place of regular solder-terminal blocks in rack-mounted equipment.

But the essential novelty of the new connector system lies in the tabs themselves. Unlike the usual crimped-on tab where the wire comes in at the end, here the wire is brought in at the middle of the tab (see Fig. 2). As will be seen, a number of benefits accrue from this simple change. These female tabs are then pushed over the male feed-through pins in the terminal blocks. Similar connections made on the other side carry the circuit on, it being easy enough to rotate the boards around in their mounting brackets for access to either side.

As Fig. 3 shows, each terminal board assembly is made up of a matrix array of feed-through pins (up to 300 pins per board are available) and a special "fanning strip" used to mechanically guide the laced wire bundles to each row.

Video frequency versions of the connector

DESIGN DECISIONS

blocks, Fig. 4, are necessarily less dense because of the physical size of the coaxial cable and the need for isolation between lines.

As the photos show, the matrix array of pins provides an ordered, centralized location for system trouble-shooting. Because the wires come out at right angles from the middle of the female tabs, handy circuit protrusions are available for test probing, whether the tabs are on the pins or not. Further, the protruding back ends of the female tabs have convenient holes to put the test probes in, or for superimposing strapping connections to gang up B+ or relay points (see Fig. 5).

The accessible layout of these boards and the ease with which the tabs can be pulled off and replaced with other tabbed wires make these terminals an orderly starting point for the system revisions and modifications so important in both TV and data systems or in fact in any system subject to evolutionary growth.

TV System Needs Not Be Too Different From Rest of Electronics

The engineer, Charles J. Neenan, who is in the Columbia Broadcasting System's Television Network engineering department, said that by now his connection system has been in use for over a year in several extensive CBS network installations in both New York and Los Angeles. He said that the new system cut the installation costs of these systems 20 to 40 per cent. In systems where this type of connector would be replacing multiple-pin, plug-in connectors, savings on connector hardware alone might amount to 70 to 80 per cent, he estimated.

The same features that make the new con-

Fig. 4. Video version of connector has 70-db isolation between each line at video frequencies.

Fig. 5. Strapping for power supply distribution or relay ganging is easily superimposed by pushing special tabs on the strapping into the free ends of the female tabs.

nector attractive in television installations should make it attractive to engineers in the computer and data system fields, Mr. Neenan believes.

"In TV we have been living, day-in, day-out, with much the same sort of interconnection problems which plague the computer and data system people," he said. "We have to make multiple connections throughout the system. These connections must be reliable. They should be accessible to use as test points. They should lend themselves to naturally frequent system alterations and emergency replacements.

"That we have achieved some degree of reliability and flexibility you can judge by the amount of time you have a picture on your TV screen and the shortness of those intervals in which you don't," he said.

Comparisons With Other Connector Systems

Mr. Neenan's description of the shortcomings of other connection systems for TV applications helps to explain the reasons for the new system. The reasons given here are of course Mr. Neenan's; advocates of other systems will undoubtedly have their good counter-arguments.

Conventional plug-in connectors do offer the quickest means of making and breaking a multiple connection between subsystems, he said, but the connector designs that are able to handle several hundred connections at once are cumbersome, for TV at least, and require large amounts of rack space. In addition, they are expensive in terms of their original component cost, and even more expensive in terms of wiring labor. But their worst fault for TV is that their electrical connections often are not reliable when left plugged in over a period of years.

Further, Mr. Neenan said, CBS has found

DESIGN DECISIONS

that circuit trouble-shooting and wiring changes are difficult to make with plug-in connectors, therefore time-consuming and expensive. (The expense in terms of down-time during trouble-shooting goes beyond those costs which are immediately obvious: there is also the "expense" to a supplier's reputation as his equipment's percentage of availability begins to tumble.)

Ordinary terminal blocks on the other hand, particularly the tree-type with soldered connections, do permit a higher degree of space-wise concentration of connections and are more reliable than conventional connectors. But again, the wiring labor costs are high, especially on-the-site interconnections between equipment racks. Normal practice of fanning out and lacing the ends of a cable, skinning each wire, wrapping the wire around a terminal, and finally soldering each connection is awkward and costly. The fact that the terminal blocks are invariably located at either the tops or bottoms of rack assemblies does not help matters. In the case of terminals at the tops of racks, scaffolds have to be set up for the wiremen. But the wiring at the bottom of the racks is even more difficult, with the men being forced to make the tedious, closely-spaced soldered connections in a back-breaking position.

New Terminals Ease Each Production—Checkout—Use Step

The new connection system is a workable compromise between the faults and virtues of the above systems, Mr. Neenan says. In addition, it has some virtues of its own, he added.

To begin with, the connections in the new system are forced-on sliding-contact types. From six to ten pounds are needed to force each female tab on a male pin. Obviously, this amount of force per pin far exceeds the amount feasible with a multiple-pin, plug-in connector and explains why this joint, although also a sliding contact type, is more reliable.

In these types of tabs, the push-on operation causes the curled-over edges of the female tabs to make high-pressure sliding contacts with the male pins. It is believed that the tin-plated phosphor bronze terminals will give 10 to 20 years service, before they start developing contact resistance. No contact trouble has been experienced so far in the

CBS installation, even on the 3-μa, 400-μv microphone circuits which are well below the military definition of dry circuits (30 mv and 10 ma), Mr. Neenan said.

His figures show that the new connections have proved 10 times more reliable than previous solder joints from the standpoint of installation failures (workmen are less apt to leave off a tab than they are to forget to follow up and solder a terminal). The long term failure rate of the new connection system shows indications of approaching the reliability goal set up by the Army Signal Corps of one failure in 250,000 connections for 10,000 hours of operation (as against one failure in 10,000 for solder), he said.

System Said to be Highly "Installable"

One advantage this type of connection system shares with plug-in connectors over soldered terminals is that a large portion of the assembly can be done in the home plant before shipment. Wiring harnesses can be prefabricated complete with the female end tabs and the staggered lengths of the wires in each row's bundle can be used to later indicate which pin each wire belongs to. The female tabs themselves can be crimped on at the rate of one every five seconds by a reel-fed machine. Fortunately the same size female tab will cover all wire sizes from No. 24 AWG to No. 16 AWG stranded.

With factory prewiring, the field connections can be pushed on at the rate of two-thousand in four hours, an amount that would take about two weeks of on-the-job wiring with solder-type terminal blocks, Mr. Neenan said.

As was previously mentioned, the orderly arrays of accessible, numbered points are ideal for running continuity checks during field installation. Although blatantly simple, this ease-of-probing can be an important consideration. More than one data system has had additional failures induced by a slipping probe during trouble shooting. The fact that the wires are naturally dressed out of the way also helps during probing, Mr. Neenan pointed out.

Video Version Has 70-Db Isolation

The video frequency version of the connection system has only 30 terminals and incorporates an electrostatic shield. A minimum of 70 db of isolation has been achieved between the adjacent terminals at video frequencies. ■ ■

PATENTS

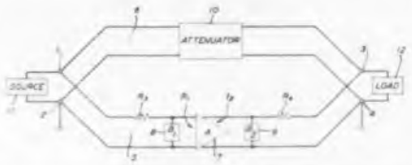
Benjamin Bernstein

Delay Network

Patent No. 2,991,425. W. R. Lundry (Assigned to Bell Telephone Labs.)

Maximum delay-bandwidth product is provided by a network consisting of two parallel paths, one a resistive attenuator and the other an amplifier shunted by two reactive impedance branches. The zeroes of one susceptance correspond in frequency with the poles of the other susceptance. The amplifier gain must exceed the loss in the attenuator by 12 db.

Source *11* feeds line *6*, containing the attenuator *10*, and line *5*, comprising amplifier *7* in parallel with susceptances B_1 and B_2 and isolating resistors R_3 and R_4. Susceptance B_1 is made up of available reactive components which satisfy the zeroes of the network delay-frequency characteristic. The product of the susceptances is then determined by the magnitudes of the isolating resistance and the amplifier input and output impedances.

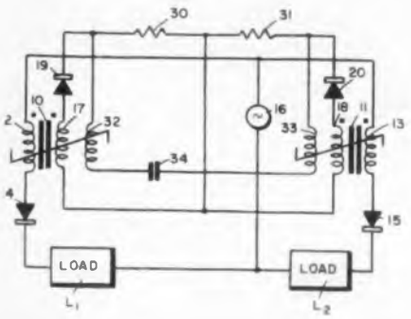


Saturable Magnetic Multivibrator

Patent No. 2,991,427. T. J. Schulze (Assigned to North American Aviation, Inc.)

With separate load and feedback circuitry, a magnetic multivibrator operates independently of the load impedance. Feedback occurs only when the applicable reactor is in reset.

Assume reactor *10* is unsaturated while reactor *11* is in a saturated state. Diode *14* conducts alternating current from source *16* through load L_1. Magnetic flux links feedback

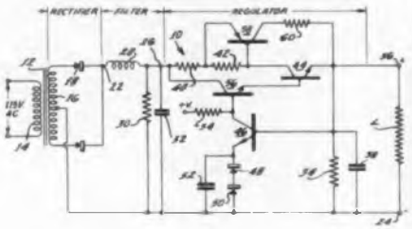


winding *17*. A voltage drop exists across resistor *30* and capacitor *34* charges until core *10* saturates. The capacitor then discharges through control winding *33* to reset reactor *11*. The switching cycle is completed when the capacitor charges in the opposite direction to reset reactor *10*.

Power Supply

Patent No. 2,967,991. D. E. Deuitch (Assigned to RCA).

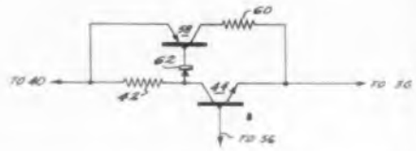
A transistorized, regulated power supply contains two paralleled transistors under heavy load. As the load current decreases one of the two transistors is biased to cut off and the second transistor acts alone as the



series regulating element.

Transistor *44* passes the load current for small load. The bias voltage developed across resistor *42* holds transistor *58* cut off. As load current increases, transistor *58* becomes conducting and the voltage drop across resistor *60* maintains the output voltage at the specified value.

Another version of the circuit uses zener diode *62* to maintain transistor *58* cut off until the voltage across resistor *42* causes the diode to conduct. In effect, this replaces the two paralleled transistors.



BOOKS

Transform Calculus For Electrical Engineers

Roger Legros and A. V. J. Martin, Prentice-Hall, Inc., Englewood Cliffs, N. J., 342 pp, $12.

Fourier series and integral, and Fourier and Laplace transforms are presented and applied, mainly in the field of electronics.

Principles Of Control Systems Engineering

Vincent Del Toro and Sydney R. Parker, McGraw-Hill Book Co., Inc., 330 W. 42 St., New York 36, N. Y., 686 pp, $14.50.

Discusses feedback control systems at the senior-graduate level. Sections include time-domain, frequency-domain, root locus and computer approaches.

The Design of Small Direct-Current Motors

A. F. Puchstein, John Wiley & Sons, Inc., 440 Fourth Ave., New York 16, N. Y., 410 pp, $12.

Presents methods for solving the problems involved in the calculation and design of direct-current machines. Precise instructions, alternate procedures and many numerical examples are given.

Linear Systems Analysis

Paul E. Pfeiffer, McGraw-Hill Book Co., Inc., 330 W. 42 St., New York 36, N. Y., 540 pp, $12.50.

Discussed theory as applied to passive linear circuits, linear electronic circuits, linear servomechanisms, and mechanical vibrating systems. Mathematical solutions are based on Laplace transformations.

Theory Of Microwave Valves
S. D. Gvozdover, Pergamon Press, Inc., 122 E. 55 St., New York 22, N. Y., 527 pp, $12.50.

Russian translation deals with cavity resonators, planar diodes, klystrons, magnetrons, traveling wave tubes.

Ultrasonics and Its Industrial Applications
O. I. Babikov, Consultants Bureau Enterprises, 227 W. 17 St., New York 11, N. Y., 224 pp, $9.75.

Algebraic Equations
Edgar Dehn, Dover Publications, Inc., 180 Varick St., New York 14, N. Y., 225 pp, $1.45 (paperbound).

Engineering Drawing and Geometry, Second Edition
Randolph P. Hoelscher and Clifford H. Springer, John Wiley & Sons, Inc., 440 Fourth Ave., New York 16, N. Y., 3,050 pp, $8.95.

Electronic Drafting Handbook
Nicholas M. Raskhodoff, The Macmillan Co., 60 Fifth Ave., New York 11, N. Y., 402 pp, $14.75.

Electromagnetic Fields and Waves
Robert V. Langmuir, McGraw-Hill Book Co., Inc., 330 W. 42 St., New York 36, N. Y., 230 pp, $9.75.

Basic text on electromagnetic phenomena, including Maxwell's equations, waveguide techniques.

Theory of Maxima and Minima
Harris Hancock, Dover Publications, Inc., 180 Varick St., New York 14, N. Y., 210 pp, $1.50 (paperbound).

Transistors
Gernsback Library, Inc., 154 W. 14 St., New York 11, N. Y., 96 pp, $1.95 (paperbound).

Filters and Attenuators
Alexander Schure, Editor; John F. Rider Publisher, Inc., 116 W. 14 St., New York, N. Y., 96 pp, $2.25 (paperbound).

Management Guide For Maintenance Cost Reduction
Bernard T. Lewis and William W. Pearson, John F. Rider Publisher, Inc., 116 W. 14 St., New York, N. Y., 80 pp, $1.50 (paperbound).

RUSSIAN TRANSLATIONS

J. George Adashko

Designing Phototransistor Circuits

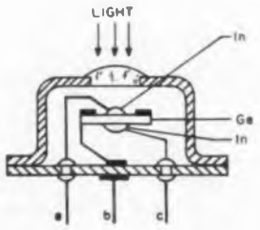


Fig. 1. Construction of phototransistor is similar to ordinary germanium unit.

ONE OF THE most sensitive light receivers known for visible and near-infrared radiation ($\lambda_{max} = 1.5$ microns, end-point wavelength 1.8 microns) is the germanium phototransistor. Only photomultipliers have greater sensitivities. Phototransistors have other advantages, such as comparatively stable frequency characteristics, relatively low noise level, great mechanical strength, small dimensions and weight, and long life. Further, circuits with phototransistors do not require high-voltage power supplies.

Table 1. Main Design Equations for Fixed and Self Biased Phototransistor Circuits

Formula No.	Fixed bias circuit (Fig. 4)	Formula No.	Self bias circuit (Fig. 7)
	Specified Φ_m		Specified Φ_m
I	$\varphi_i = \beta\varphi_{pn} = 3\times10^{-2}\beta$ amp/lumen		Design by formulas: I, II, III, IV, V
II	$R_b = (10 \text{ to } 100)R_{in}$	VI	$E_{com} = E_c + E_b$
III	$E_b = I_{b\,opt}$	VII	$E_c = R_b \dfrac{I_{b\,opt}}{I_{co} + (U_{c\,max} - U_m)/R_{22} - \beta I_{b\,opt}}$
IV	$R_L = \dfrac{(U_{c\,max} - U_m)R_{22}}{\varphi_i R_{22}\Phi_m - (U_{c\,max} - U_m)}$	VIII	$C = \dfrac{10 \text{ to } 100}{2\pi f R_e}$
V	$E_C = U_{c\,max} + \left[I_{co} - \beta I_{b\,opt} + \right]\dfrac{U_{c\,max} - U_m}{R_{22}} R_L$	IX	$\delta = \dfrac{\Delta I_c}{\Delta I_c} = 1 - \dfrac{\beta}{\beta + 1 + R_b/R_e} \cdot 100\%$
	Specified φ_m		Specified φ_m
	Design by formulas: I, II, III		Design by formulas: I, II, X, V*, VII, VIII, IX
IV*	$R_L = \dfrac{E_c - U_{c\,max}}{I_{co} - \beta I_{b\,opt} + (U_{c\,max} - U_m)/R_{22}}$	X	$R_L = \dfrac{E_{com} - U_{c\,max} - R_b I_{b\,opt}}{I_{co} - \beta I_{b\,opt} + (U_{c\,max} - U_m)/R_{22}}$
V*	$\Phi_m = \dfrac{U_{c\,max} - U_m}{\varphi_i}\left(\dfrac{1}{R_{22}} + \dfrac{1}{R_L}\right)$		

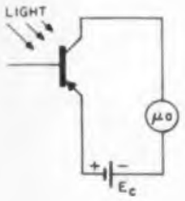


Fig. 2. Simplest phototransistor circuit has "floating" base.

This article describes the optimum operating conditions of phototransistors and procedures to be followed for their circuit design.

Equivalent Circuit Helps Describe Operating Principles

The construction of a phototransistor is similar to that of a germanium transistor. Both consist of either a pnp or an npn junction with three electrodes—emitter, base, and collector, Fig. 1. The germanium crystal of the phototransistor is illuminated on the emitter side. Its sensitive surface is in the form of a ring with an area of 2 to 3 mm².

Illumination of the germanium crystal imparts the energy of the light quanta to the valence electrons bound to the crystal lattice atoms. If the quantum energy h_ν is greater than the activation energy ΔE (0.7 ev in the case of germanium), a pair of current carriers is formed—an electron and a hole.

In principle it is immaterial which area is illuminated—that of the emitter, base, or collector. The free electrons, carried by the field set up by the contact potential difference in the two pn junctions, move from the emitter and collector regions to the base regions. An external field causes the holes to diffuse predominantly into the collector. This produces a negative space charge in the base. Illumination makes the base potential more negative. The phototransistor amplifies this change in potential in the same manner as an ordinary transistor amplifies an external signal applied to its base.

Thus, in a practical application, the base lead of the phototransistor should be left free. The simplest circuit, Fig. 2, is called a "floating base" circuit. It is analogous to a grounded-emitter circuit, with the illumination equivalent to a current generator in the base circuit delivering

$$I_{b\varphi} = \varphi_{pn}\Phi \qquad (1)$$

where

Φ—light flux in lumens,

φ_{pn}—current sensitivity of a single pn junction, amp/lumen.

Physically, φ_{pn} represents the charge accumulating in the base per unit time when the phototransistor is illuminated at an intensity of one lumen. This is the photosensitivity of the phototransistor at a quantum yield of unity (according to Shive[1] $\varphi_{pn} = 3 \times 10^{-2}$ amp/lumen).

The current in the collector circuit can be determined from the formula

$$I_c = I_{co} + \beta I_b\varphi \qquad (2)$$

where

β—gain in grounded-emitter circuit

I_{co}—dark current in the collector circuit with zero current in the base circuit

From Eqs. 1 and 2

$$I_c = I_{co} + \beta\varphi_{pn}\Phi \qquad (3)$$

and the current photosensitivity will be

$$\varphi_i = \frac{dI_c}{d\Phi} = \beta\varphi_{pn} \qquad (4)$$

or

$$\varphi_i = 3 \times 10^{-2}\beta \text{ amp/lumen} \qquad (5)$$

Tests on many phototransistors have shown that Eq. 5 is accurate enough for most practical applications.

From Eq. 5 it is evident that if the phototransistor pnp junctions have β values of 50 and higher, the photosensitivity will be greater than 1.5 amp/lumen. In practice, sensitivities of 10 amp/lumen can be obtained.

The equivalent circuit of the phototransistor can be represented as an active, linear two-port network, as shown in Fig. 3. The notation is analogous to that used for the conventional grounded-emitter circuit. The new element is the ideal current generator in the input circuit, providing the photocurrent in accordance with Eq. 1.

The parameters r_e, r_b, r_c, and r_g can be determined by the same methods used for ordinary transistors. The parameters are de-

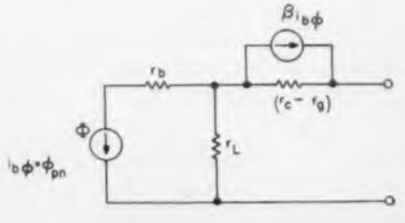


Fig. 3. Phototransistor can be represented by linear, two-port network.

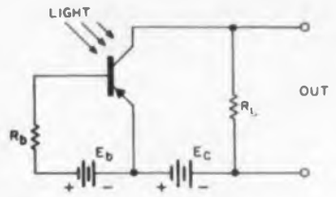


Fig. 4. Circuit with "fixed" base improves phototransistor parameters for use in low light-level application.

termined with the transistor darkened. However, the optimum operating point is chosen in a different manner.

Dynamic Mode Parameters Obtained From T Network

To calculate the dynamic mode parameters, the equivalent T network of the phototransistor is presented as a two-port network. This makes the determination of the parameters simpler because the illumination behaves as if it were supplied by an ideal current generator with infinite resistance. Therefore the output resistance R_{out} (internal resistance of the two-port network) is

$$R_{out} = R_{22} = \frac{1}{h_{22}} = r_e + r_c - r_g = r_c' \quad (6)$$

Other parameters of the phototransistor are analogous to the parameters of usual photocells. The static current and voltage sensitivities are respectively

$$\varphi_i = \varphi_{in}\,\beta; \quad (7)$$
$$\varphi_u = \varphi_i R_{22}.$$

The dynamic values of these parameters can be determined from the formulas

$$\varphi_{id} = \varphi_i \frac{R_{22}}{R_L + R_{22}} \quad (8)$$

$$\varphi_{ud} = \varphi_u \frac{R_L}{R_L + R_{22}}; \quad \varphi_{ud} = \varphi_{ie} R_L \quad (9)$$

Choosing the Optimum Modes of Phototransistor Operation

The phototransistor circuit of Fig. 2 is used when the load resistance is low (meter, relay, etc.) and the incident light flux is relatively high. With this circuit the current sensitivity of the phototransistor, φ_i, is of interest.

If the light flux is low and voltage amplification is used, stringent requirements are imposed on the phototransistor parameters. In particular, it is necessary to have maximum values for R_{22} and $U_{c\,max}$ and a minimum I_{cd}, where

RUSSIAN TRANSLATIONS

R_{ss}—static input ac resistance in the absence of light,

$U_{c\ max}$—allowable collector voltage,

I_{cd}—darkness currents in the collector circuit.

These parameters can be improved by applying positive bias on the base, Fig. 4, through a resistor much larger than the input resistance of the phototransistor (R_b = 0.1 to 10 meg). Here, the base lead is practically free-floating with respect to the variations in its potential induced by the illumination.

The maximum value of the input resistance can be estimated from the formula

$$R_{in} = r_b + r_e (1 + \beta) \qquad (10)$$

Typical curves, showing the dependence of the parameters of the phototransistor on the bias current, are shown in Fig. 5. These curves indicate the optimum bias for which the principal parameters are most suitable for the registration of small light fluxes.

On changing from the floating-base circuit to the circuit with "fixed" base, the principal parameters are measured when

I_{cd} is reduced to about one-tenth (to 5 μa)

R_{22} is increased tenfold (to 10^7 ohms)

$U_{c\ max}$ is increased (to approximately 12 v).

The photosensitivity φ_1 is decreased relatively little (one-half) to 4 amp/lumen. The static voltage sensitivity is increased almost 100 times, to 4 x 10^7 v/lumen.

Design Procedure For Fixed-Biased Phototransistor Circuits

The fixed-biased phototransistor circuit is best designed to satisfy the specified static volt-ampere characteristics obtained in darkness. The same circuit as in Fig. 4 can be used to plot these characteristics.

A typical family of output volt-ampere

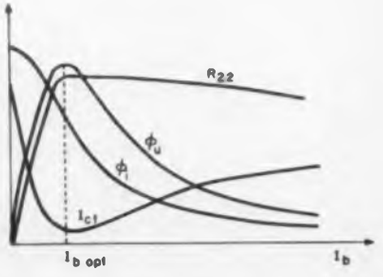


Fig. 5. Static parameters of the phototransistor depend upon value of base bias current.

For your convenience ELECTRONIC DESIGN makes checking READER-SERVICE CARD easier with FOLD-OUT CARDS

To use:

1

Fold out card.

2

Leave card folded out, and read magazine. No need to turn pages to reach card, or to tear out card until ready to mail. Circle to your heart's content.

3

Tear out card with items circled. Fill out name and address, and drop in mail box. Fold back remaining card for future use. ED will process your card within 24 hours of receipt.

VIA AIR MAIL

FIRST CLASS
Permit No. 725
New York, N. Y.

BUSINESS REPLY MAIL
No Postage Stamp Necessary If Mailed In U. S.

POSTAGE WILL BE PAID BY

ELECTRONIC DESIGN
ONE DAY READERS INQUIRY SERVICE
850 Third Avenue
New York 22, New York

VIA AIR MAIL

FIRST CLASS
Permit No. 725
New York, N. Y.

BUSINESS REPLY MAIL
No Postage Stamp Necessary If Mailed In U. S.

POSTAGE WILL BE PAID BY

ELECTRONIC DESIGN
ONE DAY READERS INQUIRY SERVICE
850 Third Avenue
New York 22, New York

ELECTRONIC DESIGN · ONE DAY SERVICE USE BEFORE JANUARY 3, 1962

Name _____ Title _____

Company _____

Company Address _____ City _____ Zone _____ State _____

	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190	200	210	220	230	240	250	260	270	280	290
1	11	21	31	41	51	61	71	81	91	101	111	121	131	141	151	161	171	181	191	201	211	221	231	241	251	261	271	281	291
2	12	22	32	42	52	62	72	82	92	102	112	122	132	142	152	162	172	182	192	202	212	222	232	242	252	262	272	282	292
3	13	23	33	43	53	63	73	83	93	103	113	123	133	143	153	163	173	183	193	203	213	223	233	243	253	263	273	283	293
4	14	24	34	44	54	64	74	84	94	104	114	124	134	144	154	164	174	184	194	204	214	224	234	244	254	264	274	284	294
5	15	25	35	45	55	65	75	85	95	105	115	125	135	145	155	165	175	185	195	205	215	225	235	245	255	265	275	285	295
6	16	26	36	46	56	66	76	86	96	106	116	126	136	146	156	166	176	186	196	206	216	226	236	246	256	266	276	286	296
7	17	27	37	47	57	67	77	87	97	107	117	127	137	147	157	167	177	187	197	207	217	227	237	247	257	267	277	287	297
8	18	28	38	48	58	68	78	88	98	108	118	128	138	148	158	168	178	188	198	208	218	228	238	248	258	268	278	288	298
9	19	29	39	49	59	69	79	89	99	109	119	129	139	149	159	169	179	189	199	209	219	229	239	249	259	269	279	289	299
300	310	320	330	340	350	360	370	380	390	400	410	420	430	440	450	460	470	480	490	500	510	520	530	540	550	560	570	580	590
301	311	321	331	341	351	361	371	381	391	401	411	421	431	441	451	461	471	481	491	501	511	521	531	541	551	561	571	581	591
302	312	322	332	342	352	362	372	382	392	402	412	422	432	442	452	462	472	482	492	502	512	522	532	542	552	562	572	582	592
303	313	323	333	343	353	363	373	383	393	403	413	423	433	443	453	463	473	483	493	503	513	523	533	543	553	563	573	583	593
304	314	324	334	344	354	364	374	384	394	404	414	424	434	444	454	464	474	484	494	504	514	524	534	544	554	564	574	584	594
305	315	325	335	345	355	365	375	385	395	405	415	425	435	445	455	465	475	485	495	505	515	525	535	545	555	565	575	585	595
306	316	326	336	346	356	366	376	386	396	406	416	426	436	446	456	466	476	486	496	506	516	526	536	546	556	566	576	586	596
307	317	327	337	347	357	367	377	387	397	407	417	427	437	447	457	467	477	487	497	507	517	527	537	547	557	567	577	587	597
308	318	328	338	348	358	368	378	388	398	408	418	428	438	448	458	468	478	488	498	508	518	528	538	548	558	568	578	588	598
309	319	329	339	349	359	369	379	389	399	409	419	429	439	449	459	469	479	489	499	509	519	529	539	549	559	569	579	589	599
600	610	620	630	640	650	660	670	680	690	700	710	720	730	740	750	760	770	780	790	800	810	820	830	840	850	860	870	880	890
601	611	621	631	641	651	661	671	681	691	701	711	721	731	741	751	761	771	781	791	801	811	821	831	841	851	861	871	881	891
602	612	622	632	642	652	662	672	682	692	702	712	722	732	742	752	762	772	782	792	802	812	822	832	842	852	862	872	882	892
603	613	623	633	643	653	663	673	683	693	703	713	723	733	743	753	763	773	783	793	803	813	823	833	843	853	863	873	883	893
604	614	624	634	644	654	664	674	684	694	704	714	724	734	744	754	764	774	784	794	804	814	824	834	844	854	864	874	884	894
605	615	625	635	645	655	665	675	685	695	705	715	725	735	745	755	765	775	785	795	805	815	825	835	845	855	865	875	885	895
606	616	626	636	646	656	666	676	686	696	706	716	726	736	746	756	766	776	786	796	806	816	826	836	846	856	866	876	886	896
607	617	627	637	647	657	667	677	687	697	707	717	727	737	747	757	767	777	787	797	807	817	827	837	847	857	867	877	887	897
608	618	628	638	648	658	668	678	688	698	708	718	728	738	748	758	768	778	788	798	808	818	828	838	848	858	868	878	888	898
609	619	629	639	649	659	669	679	689	699	709	719	729	739	749	759	769	779	789	799	809	819	829	839	849	859	869	879	889	899

For employment brochures give home address _____ City _____ Zone _____ State _____

Home Address _____

For Change of Address:

Old Company Name _____

Old Company Address _____ City _____ Zone _____ State _____

☐ I Do Design Work
☐ I Supervise Design Work
☐ I Do No Design Work

ELECTRONIC DESIGN · ONE DAY SERVICE USE BEFORE JANUARY 3, 1962

Name _____ Title _____

Company _____

Company Address _____ City _____ Zone _____ State _____

	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190	200	210	220	230	240	250	260	270	280	290
1	11	21	31	41	51	61	71	81	91	101	111	121	131	141	151	161	171	181	191	201	211	221	231	241	251	261	271	281	291
2	12	22	32	42	52	62	72	82	92	102	112	122	132	142	152	162	172	182	192	202	212	222	232	242	252	262	272	282	292
3	13	23	33	43	53	63	73	83	93	103	113	123	133	143	153	163	173	183	193	203	213	223	233	243	253	263	273	283	293
4	14	24	34	44	54	64	74	84	94	104	114	124	134	144	154	164	174	184	194	204	214	224	234	244	254	264	274	284	294
5	15	25	35	45	55	65	75	85	95	105	115	125	135	145	155	165	175	185	195	205	215	225	235	245	255	265	275	285	295
6	16	26	36	46	56	66	76	86	96	106	116	126	136	146	156	166	176	186	196	206	216	226	236	246	256	266	276	286	296
7	17	27	37	47	57	67	77	87	97	107	117	127	137	147	157	167	177	187	197	207	217	227	237	247	257	267	277	287	297
8	18	28	38	48	58	68	78	88	98	108	118	128	138	148	158	168	178	188	198	208	218	228	238	248	258	268	278	288	298
9	19	29	39	49	59	69	79	89	99	109	119	129	139	149	159	169	179	189	199	209	219	229	239	249	259	269	279	289	299
300	310	320	330	340	350	360	370	380	390	400	410	420	430	440	450	460	470	480	490	500	510	520	530	540	550	560	570	580	590
301	311	321	331	341	351	361	371	381	391	401	411	421	431	441	451	461	471	481	491	501	511	521	531	541	551	561	571	581	591
302	312	322	332	342	352	362	372	382	392	402	412	422	432	442	452	462	472	482	492	502	512	522	532	542	552	562	572	582	592
303	313	323	333	343	353	363	373	383	393	403	413	423	433	443	453	463	473	483	493	503	513	523	533	543	553	563	573	583	593
304	314	324	334	344	354	364	374	384	394	404	414	424	434	444	454	464	474	484	494	504	514	524	534	544	554	564	574	584	594
305	315	325	335	345	355	365	375	385	395	405	415	425	435	445	455	465	475	485	495	505	515	525	535	545	555	565	575	585	595
306	316	326	336	346	356	366	376	386	396	406	416	426	436	446	456	466	476	486	496	506	516	526	536	546	556	566	576	586	596
307	317	327	337	347	357	367	377	387	397	407	417	427	437	447	457	467	477	487	497	507	517	527	537	547	557	567	577	587	597
308	318	328	338	348	358	368	378	388	398	408	418	428	438	448	458	468	478	488	498	508	518	528	538	548	558	568	578	588	598
309	319	329	339	349	359	369	379	389	399	409	419	429	439	449	459	469	479	489	499	509	519	529	539	549	559	569	579	589	599
600	610	620	630	640	650	660	670	680	690	700	710	720	730	740	750	760	770	780	790	800	810	820	830	840	850	860	870	880	890
601	611	621	631	641	651	661	671	681	691	701	711	721	731	741	751	761	771	781	791	801	811	821	831	841	851	861	871	881	891
602	612	622	632	642	652	662	672	682	692	702	712	722	732	742	752	762	772	782	792	802	812	822	832	842	852	862	872	882	892
603	613	623	633	643	653	663	673	683	693	703	713	723	733	743	753	763	773	783	793	803	813	823	833	843	853	863	873	883	893
604	614	624	634	644	654	664	674	684	694	704	714	724	734	744	754	764	774	784	794	804	814	824	834	844	854	864	874	884	894
605	615	625	635	645	655	665	675	685	695	705	715	725	735	745	755	765	775	785	795	805	815	825	835	845	855	865	875	885	895
606	616	626	636	646	656	666	676	686	696	706	716	726	736	746	756	766	776	786	796	806	816	826	836	846	856	866	876	886	896
607	617	627	637	647	657	667	677	687	697	707	717	727	737	747	757	767	777	787	797	807	817	827	837	847	857	867	877	887	897
608	618	628	638	648	658	668	678	688	698	708	718	728	738	748	758	768	778	788	798	808	818	828	838	848	858	868	878	888	898
609	619	629	639	649	659	669	679	689	699	709	719	729	739	749	759	769	779	789	799	809	819	829	839	849	859	869	879	889	899

For employment brochures give home address _____ City _____ Zone _____ State _____

Home Address _____

For Change of Address:

Old Company Name _____

Old Company Address _____ City _____ Zone _____ State _____

☐ I Do Design Work
☐ I Supervise Design Work
☐ I Do No Design Work

ELECTRONIC DESIGN · ONE DAY SERVICE USE BEFORE JANUARY 3, 1962

Name Title

Company

Company Address City Zone State

	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190	200	210	220	230	240	250	260	270	280	290
1	11	21	31	41	51	61	71	81	91	101	111	121	131	141	151	161	171	181	191	201	211	221	231	241	251	261	271	281	291
2	12	22	32	42	52	62	72	82	92	102	112	122	132	142	152	162	172	182	192	202	212	222	232	242	252	262	272	282	292
3	13	23	33	43	53	63	73	83	93	103	113	123	133	143	153	163	173	183	193	203	213	223	233	243	253	263	273	283	293
4	14	24	34	44	54	64	74	84	94	104	114	124	134	144	154	164	174	184	194	204	214	224	234	244	254	264	274	284	294
5	15	25	35	45	55	65	75	85	95	105	115	125	135	145	155	165	175	185	195	205	215	225	235	245	255	265	275	285	295
6	16	26	36	46	56	66	76	86	96	106	116	126	136	146	156	166	176	186	196	206	216	226	236	246	256	266	276	286	296
7	17	27	37	47	57	67	77	87	97	107	117	127	137	147	157	167	177	187	197	207	217	227	237	247	257	267	277	267	297
8	18	28	38	48	58	68	78	88	98	108	118	128	138	148	158	168	178	188	198	208	218	228	238	248	258	268	278	288	298
9	19	29	39	49	59	69	79	89	99	109	119	129	139	149	159	169	179	189	199	209	219	229	239	249	259	269	279	289	299
300	310	320	330	340	350	360	370	380	390	400	410	420	430	440	450	460	470	480	490	500	510	520	530	540	550	560	570	580	590
301	311	321	331	341	351	361	371	381	391	401	411	421	431	441	451	461	471	481	491	501	511	521	531	541	551	561	571	581	591
302	312	322	332	342	352	362	372	382	392	402	412	422	432	442	452	462	472	482	492	502	512	522	532	542	552	562	572	582	592
303	313	323	333	343	353	363	373	383	393	403	413	423	433	443	453	463	473	483	493	503	513	523	533	543	553	563	573	583	593
304	314	324	334	344	354	364	374	384	394	404	414	424	434	444	454	464	474	484	494	504	514	524	534	544	554	564	574	584	594
305	315	325	335	345	355	365	375	385	395	405	415	425	435	445	455	465	475	485	495	505	515	525	535	545	555	565	575	585	595
306	316	326	336	346	356	366	376	386	396	406	416	426	436	446	456	466	476	486	496	506	516	526	536	546	556	566	576	586	596
307	317	327	337	347	357	367	377	387	397	407	417	427	437	447	457	467	477	487	497	507	517	527	537	547	557	567	577	587	597
308	318	328	338	348	358	368	378	388	398	408	418	428	438	448	458	468	478	488	498	508	518	528	538	548	558	568	578	588	598
309	319	329	339	349	359	369	379	389	399	409	419	429	439	449	459	469	479	489	499	509	519	529	539	549	559	569	579	589	599
600	610	620	630	640	650	660	670	680	690	700	710	720	730	740	750	760	770	780	790	800	810	820	830	840	850	860	870	880	890
601	611	621	631	641	651	661	671	681	691	701	711	721	731	741	751	761	771	781	791	801	811	821	831	841	851	861	871	881	891
602	612	622	632	642	652	662	672	682	692	702	712	722	732	742	752	762	772	782	792	802	812	822	832	842	852	862	872	882	892
603	613	623	633	643	653	663	673	683	693	703	713	723	733	743	753	763	773	783	793	803	813	823	833	843	853	863	873	883	893
604	614	624	634	644	654	664	674	684	694	704	714	724	734	744	754	764	774	784	794	804	814	824	834	844	854	864	874	884	894
605	615	625	635	645	655	665	675	685	695	705	715	725	735	745	755	765	775	785	795	805	815	825	835	845	855	865	875	885	895
606	616	626	636	646	656	666	676	686	696	706	716	726	736	746	756	766	776	786	796	806	816	826	836	846	856	866	876	886	896
607	617	627	637	647	657	667	677	687	697	707	717	727	737	747	757	767	777	787	797	807	817	827	837	847	857	867	877	887	897
608	618	628	638	648	658	668	678	688	698	708	718	728	738	748	758	768	778	788	798	808	818	828	838	848	858	868	878	888	898
609	619	629	639	649	659	669	679	689	699	709	719	729	739	749	759	769	779	789	799	809	819	829	839	849	859	869	879	889	899

For employment brochures give home address City Zone State
Home Address

For Change of Address:
Old Company Name

Old Company Address City Zone State

☐ I Do Design Work
☐ I Supervise Design Work
☐ I Do No Design Work

ELECTRONIC DESIGN · ONE DAY SERVICE USE BEFORE JANUARY 3, 1962

Name Title

Company

Company Address City Zone State

	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190	200	210	220	230	240	250	260	270	280	290
1	11	21	31	41	51	61	71	81	91	101	111	121	131	141	151	161	171	181	191	201	211	221	231	241	251	261	271	281	291
2	12	22	32	42	52	62	72	82	92	102	112	122	132	142	152	162	172	182	192	202	212	222	232	242	252	262	272	282	292
3	13	23	33	43	53	63	73	83	93	103	113	123	133	143	153	163	173	183	193	203	213	223	233	243	253	263	273	283	293
4	14	24	34	44	54	64	74	84	94	104	114	124	134	144	154	164	174	184	194	204	214	224	234	244	254	264	274	284	294
5	15	25	35	45	55	65	75	85	95	105	115	125	135	145	155	165	175	185	195	205	215	225	235	245	255	265	275	285	295
6	16	26	36	46	56	66	76	86	96	106	116	126	136	146	156	166	176	186	196	206	216	226	236	246	256	266	276	286	296
7	17	27	37	47	57	67	77	87	97	107	117	127	137	147	157	167	177	187	197	207	217	227	237	247	257	267	277	267	297
8	18	28	38	48	58	68	78	88	98	108	118	128	138	148	158	168	178	188	198	208	218	228	238	248	258	268	278	288	298
9	19	29	39	49	59	69	79	89	99	109	119	129	139	149	159	169	179	189	199	209	219	229	239	249	259	269	279	289	299
300	310	320	330	340	350	360	370	380	390	400	410	420	430	440	450	460	470	480	490	500	510	520	530	540	550	560	570	580	590
301	311	321	331	341	351	361	371	381	391	401	411	421	431	441	451	461	471	481	491	501	511	521	531	541	551	561	571	581	591
302	312	322	332	342	352	362	372	382	392	402	412	422	432	442	452	462	472	482	492	502	512	522	532	542	552	562	572	582	592
303	313	323	333	343	353	363	373	383	393	403	413	423	433	443	453	463	473	483	493	503	513	523	533	543	553	563	573	583	593
304	314	324	334	344	354	364	374	384	394	404	414	424	434	444	454	464	474	484	494	504	514	524	534	544	554	564	574	584	594
305	315	325	335	345	355	365	375	385	395	405	415	425	435	445	455	465	475	485	495	505	515	525	535	545	555	565	575	585	595
306	316	326	336	346	356	366	376	386	396	406	416	426	436	446	456	466	476	486	496	506	516	526	536	546	556	566	576	586	596
307	317	327	337	347	357	367	377	387	397	407	417	427	437	447	457	467	477	487	497	507	517	527	537	547	557	567	577	587	597
308	318	328	338	348	358	368	378	388	398	408	418	428	438	448	458	468	478	488	498	508	518	528	538	548	558	568	578	588	598
309	319	329	339	349	359	369	379	389	399	409	419	429	439	449	459	469	479	489	499	509	519	529	539	549	559	569	579	589	599
600	610	620	630	640	650	660	670	680	690	700	710	720	730	740	750	760	770	780	790	800	810	820	830	840	850	860	870	880	890
601	611	621	631	641	651	661	671	681	691	701	711	721	731	741	751	761	771	781	791	801	811	821	831	841	851	861	871	881	891
602	612	622	632	642	652	662	672	682	692	702	712	722	732	742	752	762	772	782	792	802	812	822	832	842	852	862	872	882	892
603	613	623	633	643	653	663	673	683	693	703	713	723	733	743	753	763	773	783	793	803	813	823	833	843	853	863	873	883	893
604	614	624	634	644	654	664	674	684	694	704	714	724	734	744	754	764	774	784	794	804	814	824	834	844	854	864	874	884	894
605	615	625	635	645	655	665	675	685	695	705	715	725	735	745	755	765	775	785	795	805	815	825	835	845	855	865	875	885	895
606	616	626	636	646	656	666	676	686	696	706	716	726	736	746	756	766	776	786	796	806	816	826	836	846	856	866	876	886	896
607	617	627	637	647	657	667	677	687	697	707	717	727	737	747	757	767	777	787	797	807	817	827	837	847	857	867	877	887	897
608	618	628	638	648	658	668	678	688	698	708	718	728	738	748	758	768	778	788	798	808	818	828	838	848	858	868	878	888	898
609	619	629	639	649	659	669	679	689	699	709	719	729	739	749	759	769	779	789	799	809	819	829	839	849	859	869	879	889	899

For employment brochures give home address City Zone State
Home Address

For Change of Address:
Old Company Name

Old Company Address City Zone State

☐ I Do Design Work
☐ I Supervise Design Work
☐ I Do No Design Work

VIA AIR MAIL

FIRST CLASS
Permit No. 725
New York, N. Y.

BUSINESS REPLY MAIL
No Postage Stamp Necessary If Mailed In U. S.

POSTAGE WILL BE PAID BY

ELECTRONIC DESIGN
ONE DAY READERS INQUIRY SERVICE
850 Third Avenue
New York 22 New York

VIA AIR MAIL

FIRST CLASS
Permit No. 725
New York, N. Y.

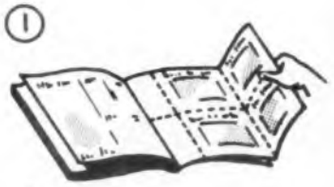
BUSINESS REPLY MAIL
No Postage Stamp Necessary If Mailed In U. S.

POSTAGE WILL BE PAID BY

ELECTRONIC DESIGN
ONE DAY READERS INQUIRY SERVICE
850 Third Avenue
New York 22 New York

For your convenience ELECTRONIC DESIGN makes checking READER-SERVICE CARD easier with FOLD-OUT CARDS

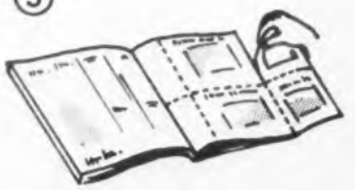
To use:

① 

Fold out card.

② 

Leave card folded out, and read magazine. No need to turn pages to reach card, or to tear out card until ready to mail. Circle to your heart's content.

③ 

Tear out card with items circled. Fill out name and address, and drop in mail box. Fold back remaining card for future use. ED will process your card within 24 hours of receipt.

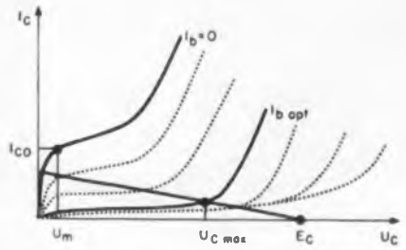


Fig. 6. Family of volt-ampere characteristics of phototransistor with positive base bias.

characteristics is shown in Fig. 6. The principal values of the voltages and currents necessary for the circuit design are represented by the solid lines. The optimum base current is obtained from the condition that the static voltage sensitivity be a maximum

$$\beta R_{22} = \varphi_{u\,max},$$

where

$\beta = \Delta I_c / \Delta I_b$ is determined for a collector voltage

$U_c = U_m$, corresponding to the start of the plateau in the output characteristics

R_{22} — ac output resistance at $I_b = I_{b\,opt}$

$U_{c\,max}$ — maximum permissible collector voltage, corresponding to the end of the plateau of the characteristic, also obtained for $I_b = I_{b\,opt}$.

The dark current I_{co} is determined from the point corresponding to $U_c = U_m$ on the curve plotted with $I_b = 0$.

The starting point for formulating the design equations is the volt-ampere characteristic of the phototransistor. This is a function of three independent variables,

$$I_c = f(I_b, I_c, \Phi)$$

Differentiating, we have

$$dI_c = \frac{\delta I_c}{\delta I_b} dI_b + \frac{\delta I_c}{\delta U_c} dU_c + \frac{\delta I_c}{\delta \Phi} d\Phi,$$

where the partial derivatives are the static parameters of the phototransistor. Thus:

$$dI_c = \beta dI_b + \frac{1}{R_{22}} dU_c + \varphi_i d\Phi \qquad (11)$$

Changing over to finite differences and assuming that, to a first approximation, the volt-ampere characteristic is linear when $U_c = U_m + U_{c\,max}$, where $I_c + I_{co} + \Delta I_c$, the equation for the linear portion of the volt-ampere characteristic, corresponding to $I_b = I_{b\,opt}$, can be represented by

$$I_c = I_{co} + \beta(\varphi_{pn}\Phi - I_p) \qquad (12)$$
$$+ \frac{1}{R_{22}}(U_c - U_m)$$

RUSSIAN TRANSLATIONS

Eq. 12 takes into account that when the base bias is positive, I_c decreases with increasing I_b (ΔI reverses sign).

Solving Eq. 12 simultaneously with the equation $E = U_c + I_c R_L$, and Eq. 8, we can determine all the elements of the circuits shown in Fig. 4.

The table lists the main design equations, assuming (as already mentioned) that the parameters $I_{b\ opt}$, I_{co}, R_{22}, β, $U_{c\ max}$, U_m have been determined from the output volt-ampere characteristics.

If the circuit of Fig. 4 is to measure a wide range of light fluxes, it is necessary to specify the maximum light flux Φ_m up to which the light-response characteristic should be linear. In this case, as shown in the table, the load resistance R_L and the supply voltages E_b and E_c must be calculated from formulas I to V.

When the circuit is set to measure very small light fluxes, the design sequence is somewhat modified. It is then advantageous to select as large a value of E_c as possible (to 50 or 100 v). R_L and Φ_m are determined from formulas IV* and V* in the table.

Design Procedure For Self-Biased Phototransistor Circuits

By employing current self-bias on the base as shown in Fig. 7, the phototransistor can be used in stabilization circuits. Additional nonlinear elements are not required and the dc component of the light flux does not influence the output signal.

The design procedure for a circuit with self bias is the same as for a circuit with fixed bias. It can be carried out in two ways —to fit a specified Φ_m, or to fit a specified E_{com} (voltage of common power supply).

It is necessary to calculate the resistance R_e in the emitter circuit, using formula VII of the table, derived from the condition

$$R_e = R_b \frac{I_{b\ opt}}{I_{e\ opt}} = R_b \frac{I_{b\ opt}}{I_{c\ opt} - I_{b\ opt}},$$

and also the capacitance C, determined from the specified frequency of modulation of the received light signal, f.

Complete temperature compensation and stabilization with respect to changes in a constant light signal cannot be obtained with this circuit. However, when β and R_b are large the instability amounts to a fraction of

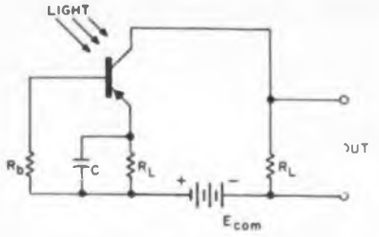


Fig. 7. Phototransistor circuit with self bias.

one per cent and can always be estimated by using Eq. 9. In the cases noted here, the value of the voltage dynamic sensitivity φ_{ud} must be calculated from Eq. 9 and R_{in} can be estimated by using Eq. 10

The equations for the circuit with fixed bias can also be used to design circuits with floating base, Fig. 2. For this case, $I_{b\,opt} = 0$.

This circuit, however, is usually used with low-resistance loads and large light fluxes, and where maximum output power is desired. The load resistance is usually chosen to satisfy the equality $R_L = R_{out}$. The value of the supply voltage E_c and the maximum light flux Φ_m are calculated from the following:

$$E_c = I_{cs} R_L + 2U_{c\,max} - U_m$$

$$\Phi M = \frac{2(U_{c\,max} - U_m)}{\varphi_i R_L}$$

Translated from "A Procedure For The Design Of Phototransistor Circuits," S. D. Rodkevich, Leningrad Institute of Precision Mechanics and Optics News of the Universities, *Instrument Building, Vol. IV, No. 1, Jan.-Feb., 1961.*

References

1. Effect of Radiation on Semiconductors and Insulators, collection of translation, S. M. Ryvkin, ed. M., 1954, pp 203-212.
2. Ryvkin, S. M. On the Kinetics of Phototransistors. J. Tech. Phys. (U.S.S.R.), No. 6, 1958. (Translation published by American Institute of Physics).
3. Yanovich, V. S., Krolevets, K. M. and Altaiskii, Y. M. High-sensitivity Germanium Phototransistor. Automation and Instrument Building (Institute of Automation of the State Planning Comm., Ukr. SSR), 1959, No. 1.
4. Photocells, *Wireless World,* 1958, Vol. 64, No. 8, pp 391-394.
5. Schulz-Methke, H. D. Erfahrung mit Fototransistoren, *Elektronik,* 1958, vol. 5, p 152-154.
6. Gorlikh, P., Krohs, A., Lang, W. Photowiderstande, *Photodioden, und Phototransistoren.* Arch. techn. Messen, 1958, No. 272, p 182, No. 274, p 235, and No. 275, p 247.
7. Rodkevich, S. D., Golubkov, A. P., Zagreba, V. A. Prospects for the application of phototransistors based on P6 transistors, and their characteristic when used in various circuits. "Motion Picture and Television Engineering" No. 12, p 56, 1960.

GERMAN ABSTRACTS

E. Brenner

Pulse-Filter Design

TRANSFER functions whose pole-zero distribution follows the regular pattern of Fig. 1 have particularly simple time-frequency domain relationships. In addition, filters with such transfer functions readily can be realized with exact consideration given to circuit component losses. Transfer functions of filters with the pole pattern of Fig. 1 have the form:

$$H(s) = \frac{K}{\prod_{k=0}^{n} \left[(s + \sigma)^2 + k^2\omega_0^2 \right]}$$

Or, normalizing with respect to ω_0, let

$$\lambda = \frac{s}{\omega_0}$$

$$\eta = \frac{\sigma}{\omega_0}$$

and

$$H(\lambda) = \frac{K}{\omega_0^n} \cdot \frac{1}{\prod_{k=0}^{n} \left[(\lambda + \eta)^2 + k^2 \right]}$$

The response of such a filter to the unit impulse input is shown in Fig. 2. The equa-

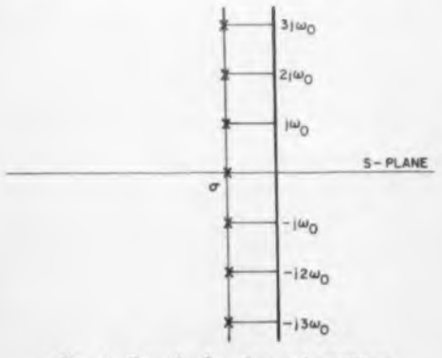


Fig. 1. Transfer-function pole pattern.

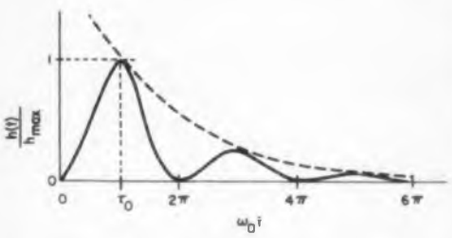


Fig. 2. Filter response to unit impulse.

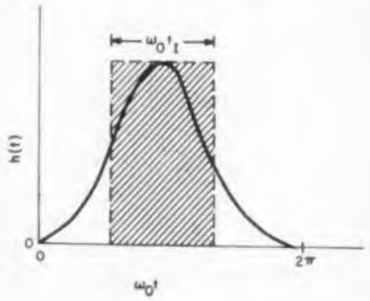


Fig. 3. Filter output can be represented by a single pulse, with equivalent time duration given by the shaded rectangle.

tion of this output wave shape can be shown to be

$$\frac{h(t)}{h(t_0)} = A_n\ e^{B_n}\ e^{-\eta\omega_0 t}\ \sin^{n-1}\left(\frac{\omega_0 t}{2}\right)$$

where

$$A_n = \left[1 + \left(\frac{2}{n-1}\right)^2 \eta^2\right]^{(n-1)/2}$$

$$B_n = 2\eta\ \tan^{-1}\left[(n-1)/(2\eta)\right]$$

The peak value of the response occurs at

$$t = t_0\ \ (\omega_0 t_0 = \tau_0)$$

where

$$\tau_0 = 2\ \tan^{-1}\frac{n-1}{2\eta}$$

The second peak of the response waveform has the value

$$e^{-2\eta\pi}\ h(\tau_0)$$

and can be reduced arbitrarily by increasing η. For example, the value $\eta = 0.733$ results in a second peak, which is 1 per cent of the first peak.

When the second (and subsequent) peak is made negligibly small, the filter output can be considered to be a single pulse, Fig. 3.

GERMAN ABSTRACTS

The effective output-pulse duration is defined as the duration of the shaded rectangle, Fig. 3, whose area is identical with the area under the pulse. The relationship between this effective duration, t_l and η is shown in Fig. 4 with n as a parameter. When n exceeds 9, the approximate formula

$$t_l = \frac{2\pi}{\omega_0} \frac{(n-1)!}{\left[\left(\frac{n-1}{2}\right)!\right]^2 \cdot 2^{n-1}}$$

results in less than 1 per cent error. Since the step function is the integral of the impulse, the response of the filter to the unit step has a rise time approximated by t_l.

To realize the filter one can use reactance synthesis because all poles are on a line

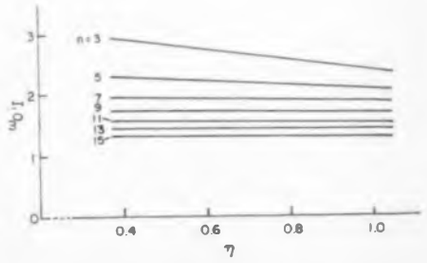


Fig. 4. Output-pulse duration as a function of damping, η, with n as parameter.

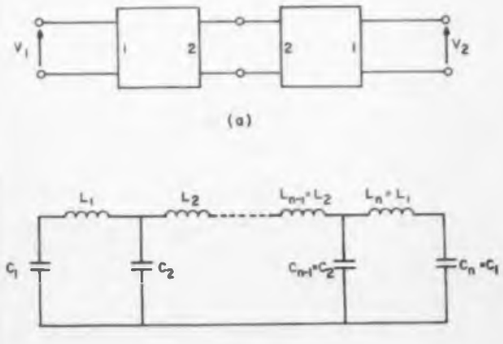


Fig. 5. Symmetrical network and lossless configuration.

parallel to the imaginary ($j\omega$) axis. The transformation

$$s' = s + \sigma$$

results in a reactance function. Once the corresponding LC network is realized every inductance L_m is replaced by the series branch, $R_m - L_m$. Every capacitance C_j is replaced by a parallel $R_j - C_j$ branch where

$$\frac{R_m}{L_m} = \frac{1}{R_j\, C_j} = \sigma$$

The reactance transfer function can be realized as a symmetrical structure, Fig. 5. With the pi-configuration used to minimize the number of inductances, a capacitance is at the plane of symmetry if there are $4m+1$ elements; an inductance if the element number is $4m-1$. Developing the half section from the plane of symmetry, the network is developed as a ladder from driving point functions.

If $n = 4m + 1$, the normalized driving point admittance

$$\frac{Y_2}{\omega_0 Y_0} = \frac{\lambda(\lambda^2+4)\,(\lambda^2+16)\ldots\left(\lambda^2+\left(\frac{n-1}{2}\right)^2\right)}{(\lambda^2+1)\,(\lambda^2+9)\ldots\left(\lambda^2+\left(\frac{n-3}{2}\right)^2\right)}$$

applies. For $n = 4m - 1$, the normalized driving point impedance:

$$\frac{Z_2}{\omega_0 Z_0} = \frac{(\lambda^2+1)\,(\lambda^2+9)\ldots}{(\lambda)\,(\lambda^2+4)(\lambda^2+16)}$$

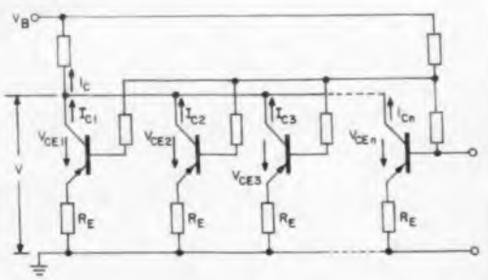
is developed.

Abstracted from an article by K. Uhl, Archiv der Elektrischen Uebertragung, *Vol. 15, No. 3, March 1961, pp 109-114.*

Parallel Operation Of Pulse Transistors

WHEN transistors are operated in parallel—that is with emitters and collectors connected directly—the individual collector currents differ because of the variations in equivalent collector-emitter resistances. Insertion of small ohmic emitter resistances,

GERMAN ABSTRACTS



Power transistors connected in parallel

R_E, shown in the figure, improves the uniformity of current distribution.

The optimum value of R_E is determined as follows: the collector current of the m^{th} transistor in the parallel array of n transistors is

$$I_{Cm} = (I_C/n) + \Delta I$$

If the maximum deviation of collector-emitter voltage from the average value is ΔV and if it is assumed that all transistors except the m^{th} have

$$V_{CE} = (V_{CE})_{av} + \Delta V$$

while for the m^{th} transistor

$$V_{CE} = (V_{CE})_{av} - \Delta V$$

then (in this most unfavorable case) the maximum deviation in collector current is

$$\Delta I_{max} = \frac{2(n-1)}{n} \cdot \frac{\Delta V}{R_E}$$

Or, assuming that this maximum deviation is prescribed, the corresponding optimum emitter resistance is

$$R_E = \frac{2(n-1)}{n} \cdot \frac{\Delta V}{(\Delta I)_{max}}$$

If, for example, three transistors, rated at maximum collector current of 9 amps are connected in parallel to furnish 24 amps, the average collector current is 8 amps and ΔI_{max} is 1 amp. Assuming a 50 mv maximum deviation in collector-emitter voltage, the corresponding value of R_E is 0.066 ohm.

Abstracted from an article by F. W. Dietl, Elektronische Rundschau, *Vol. 15, No. 7, July 1961, p 308.*

Automatic Character Identification

THE INCREASING use of electronic computers has given great impetus to the development of automatic reading machines. The ideal machine for character and symbol identification must be judged by three criteria: it must be able to identify various typefaces and, eventually, handwriting; the process should not be noise sensitive (noise refers here to variation of contrast, intensity, paper-surface, etc.); and the machine should work rapidly, employing a minimum of equipment and personnel. In practice, there are two types of errors—the inability of the machine to identify a symbol and the misreading of a symbol.

Reading machines can be classified into eight categories that depend upon the principle used in character identification. The oldest principle (1928) is based on direct optical comparison using stencils and masks. The second uses special machine marks in addition to, or in place of, ordinary numerals. (It can be argued that such procedures are not true character identification processes.) The third method is the index-control method. Here, certain discrete points in the symbol (employing a special font) are sampled for identification. A fourth method consists of using linear zones in place of characteristic points.

The technique of evaluating the percentage of dark surface by scanning in two directions, which is used in American banking (The Stanford System), falls into the fifth category. Various sampling processes form category six. In another procedure, the locations of darkened points or regions in columns is used. The final category consists of methods using the curvature and direction changes of lines in the recognition process.

The preceding categories are suggested by Ingolf Sieburg in the July, 1961, issue of *Nachrichtentechnische Zeitschrift*. The author furnishes an extensive bibliography consisting of 144 references and including 45 references to German, American and British patents.

Abstracted from Nachrichtentechnische *Zeitschrift, Vol. 14, No. 7, July 1961, pp 349-357.*

REPORT BRIEFS

Leaky-Wave Antennas

The design and performance are described of a flat, leaky-wave antenna in which the inductive, leaky surface is backed with a slab of dielectric. The analysis uses transverse resonance phenomena to determine the physical dimensions of the antenna for a certain specified aperture distribution. An antenna was built to compare the theoretical behavior with the measured performance. Ways of forming the dielectric to the antenna were also tested. *A Dielectric-Loaded Leaky-Wave Antenna, J. Aasted and R. C. Honey, Stanford Research Institute, Menlo Park, Calif., March 27, 1961, 41 pp., $4.60. Order AD-260245 from OTS, Washington 25, D. C.*

Tunnel Diodes

When low capacitance tunnel diodes are switched very rapidly, a higher output voltage is obtained than would be predicted from the static *V-I* characteristic of the diode. This indicates that the diode does not have good limiting properties in the thermal region. An attempt was made to verify the existence of this phenomenon and to obtain quantitative data. Observations of the transient response of tunnel diodes during high speed (1 μsec) switching are discussed with special attention to the lack of limiting. Techniques for measuring diode characteristics are also presented. *Tunnel Diodes Characteristics and Circuit Considerations, E. A. Fisch, General Electric Co., Syracuse, N. Y., June 12, 1961, 47 pp, $4.60. Order AD275334 from OTS, Washington 25, D. C.*

High-Power Waveguides

Research was concerned with the effects in waveguide systems that lead to failures at ultrahigh power levels. Subjects discussed include: (1) breakdown in nonuniform fields that result from waveguide discontinuities and the nature of the propagating modes, (2) properties of gases other than air, and (3) effects of heating of the waveguide. Some preliminary experiments on breakdown and high average power effects are also presented. *High Power Capabilities of Waveguide Systems, Meyer Gilden, Microwave Associates, Inc., Burlington, Mass., June 12, 1961, 48 pp, $4.60. Order AD-260111 from OTS, Washington 25, D. C.*

Emission From Semiconductors

A study of hot electron emission was made including: (1) basic investigation of hot electron emission, with the voltage applied across a semi-conductor pn junction varying over a wide range; (2) production of low electron affinity surfaces by suitable activation processes with alkali metals; (3) attempts to produce pn junctions parallel to the vacuum interface to obtain electron emission from larger areas. A review of the prebreakdown hot electron effects in semiconductors is also presented. *Research in Electron Emission from Semiconductors, R. E. Simon and E. K. Gatchell, David Sarnoff Research Center, Princeton, N. J., Dec. 31, 1960, 49 pp, $4.60. Order PB 157597 from OTS, Washington 25, D. C.*

Radar Return

Program investigated the reradiation properties of terrain at near-vertical incidence at 415 and 3800 mc, using narrow-pulse type radar at altitudes of 2000 to 12000 ft. At frequencies over 400 mc most terrain acts as a scatterer of energy even at near-vertical incidence. The backscattering "radiation pattern" of the ground drops off rapidly for most target areas as the angle of incidence is increased from the vertical reference position. The experimental backscattering patterns agree reasonably well with predictions based on a simplified statistical model for ground roughness. *Radar Return at Near-Vertical Incidence, A. R. Edison, R. K. Moore and B. D. Warner, New Mexico University Engineering Experiment Station, Albuquerque, Sept., 1959, 84 pp, $8.10. Order PB 157 661 from OTS, Washington 25, D. C.*

Elliptically-Polarized Radiators

Three general theorems giving conditions for a radiating system to exhibit stationary polarization, stationary gain and the coincidence of stationary polarization and gain in a prescribed direction are presented. These differ significantly from the earlier theorems of Bouix because of a sign error in his work. The theorems are applied to a number of circularly polarized sources and antennas which are broadly directional. *Polarization Variation of Elliptically-Polarized Radiators, T. S. Chu and R. G. Kouyomjiam, Antenna Laboratory, Ohio State University Research Foundation, Columbus, Aug. 10, 1961, 42 pp, $4.60. Order AD-261 020 from OTS, Washington 25, D. C.*

REPORT BRIEFS

Magnetic Recording

Tests were made on the electronic portion of a wideband magnetic recording system to determine the effects of multiplexing on the video signal. A demultiplexer pulse generator was developed to aid in reconstructing the original signal from its samples. Pulses, identical in height and width (about 30 v and 0.15 μsec), were obtained. The alignment procedure for the electronic portion of the system is described. *Wide-Band Magnetic Recording System, General Electric Co., Syracuse, N. Y., July 31, 1958, 83 pp, $8.10. Order PB 157263-2 from OTS, Washington 25, D. C.*

Intrinsic-Barrier Transistors

The design theory for a 200 mc, 100 mw silicon transistor indicates that this must be an n-p-i-n, intrinsic-barrier transistor. The fabrication of a suitable structure requires the use of solid-state diffusion. Processes have been developed for a 100 mc, lower power transistor. These processes are shown to be in good control and npn transistor characteristics are given. *Intrinsic-Barrier Transistor Techniques (Silicon), J. L. Buie, M. A. Clark and others, Pacific Semiconductors, Inc., Culver City, Calif., Oct. 15, 1957, 35 pp, $3.06. Order PB 152305 from OTS, Washington 25, D. C.*

UHF-VHF Antenna

A solution to the problem of the scattering of plane waves from a material sphere was derived. Results indicate the regions of high energy density within the sphere that may make possible the design of small antennas with large effective apertures. Substantial progress was made in the solution of plane wave scattering from a material cylinder. Measurements on ferrite antennas were begun and problems of rf technique were partially solved. *Study and Investigation of a UHF-VHF Antenna, A. T. Adams, R. M. Kalafus and others, Research Institute, University of Michigan, Ann Arbor, Aug. 8, 1961, 63 pp, $6.60. Order AD-260 866 from OTS, Washington 25, D. C.*

LF Ferrites

Development work is reported on low-frequency, broadband ferrite components. A four-wire line, an asymmetrically loaded stripline, and a stripline Y-circulator were

investigated. The Y-circulator was useful at frequencies as low as about 100 mc. High power measurements (1 megawatt peak) were performed on this structure. Performance and design data are given for all three structures. *Low-Frequency Broadband Ferrite Components, F. V. Buehler and A. F. Eikenberg, Electronic Communications, Inc., Timonium, Md., June 30, 1961, 119 pp., $9.60. Order AD-260699 from OTS, Washington 25, D. C.*

Masers

Four investigations were continued in the field of microwave solid-state masers: (1) Gadolinium in calcium tungstate as a maser material; (2) Harmonic spin coupling, an analytic study of the pumping of paramagnetics with harmonically related energy levels; (3) Space harmonic analysis of the comb-type slow-wave structure; (4) Characteristics of a 6.4 Gc traveling-wave maser. *Solid-State Maser Research, H. E. D. Scovil, Bell Telephone Laboratories, Inc., Whippany, N. J., Aug. 14, 1961, 44 pp, $4.60. Order AD-261 145 from OTS, Washington 25, D. C.*

Nuclear Batteries

Three tritium battery components: the tritium source, the collector, and the enclosure were investigated. Two foils were made in the tritium-source production system, and were cut into smaller pieces for use in all battery types. Several enclosure types were designed with 2 different terminals. Models of 2 tritium battery types were fabricated and tested. The model R and R1 series produced 0.1 μa and the model R2 produced over 1.0 μa. A third battery producing 10 μa was designed to determine the upper limit. *Nuclear Batteries, John H. Coleman, Radiation Research Corp., N. Y., May 15, 1957, 35 pp. $3.60. Order PB 157679 from OTS, Washington 25, D. C.*

C-Band Amplifiers

Reported here is the design, development, and fabrication of tunable C-band reactance amplifiers with tunable range of 5250 to 5750 mc, bandwidth greater than 50 mc, power gain greater than 20 db, noise figure less than 4 db (at room temperature), phase stability less than 1 deg, and gain stability less than 0.1 db. *Development of Tunable C-Band Reactance Amplifiers, Airborne Instruments Laboratory, Inc., Mineola, N. Y., Aug. 14, 1961, $2.60. Order AD-261 150 from OTS, Washington 25, D. C.*

YOUR CAREER

East is East, Etc., And How the Twain Met

Reader Charles D. McIntosh, Reseda, Calif., submits a summary of his company's solution to East-West Coast recruiting competition:

Last year, my company, Ecstatic Engineering, Inc. of Los Angeles was still using the standard smogland approach in its East Coast advertising for engineers:

ENGINEERS AND SCIENTISTS: COME TO SUNNY CALIFORNIA!

Tired of bucking winter blizzards and scorching summers? Weary of wringing humidity out of your collar, and seeing your automobile rust right out from under you? Come to sunny California! Enjoy balmy year-'round weather, skiing, Mexico, boating, fishing and hunting, all within an hour or two of your home.

ECSTATIC ENGINEERING INC.
L. A. 4787, Calif.

Meanwhile, our rival on the Atlantic Coast, Magnificent Missiles, Ltd., would come out in the West Coast papers with:

SCIENTISTS AND ENGINEERS: COME BACK EAST!

Sighing for four honest seasons again? Desert dust and smog got you gasping for breath? Wish you could see a Broadway show? Come back East! Enjoy clean autumn air, crisp winter coziness, green spring newness, and balmy summer skies.

MAGNIFICENT MISSILES, LTD.
RFD No. 1
Burgsville, N. Y.

All this proved expensive and not very successful. So I imagine our stockholders and their stockholders were pleased when our president had a flash of inspiration. He merged the two companies to form Ecstatic Magnificences & Co. Our new company makes the same items on both coasts (the fact that the government agencies duplicate their missile and space programs has made this possible) and the new personnel policy made possible by the merger is proving most satisfactory.

Briefly, it consists of a master plan

Advancement Your Goal?

Use CONFIDENTIAL Action Form

ELECTRONIC DESIGN'S Confidential Career Inquiry Service helps engineers "sell" themselves to employers—as *confidentially and discreetly as they would do in person.* The service is fast. It is the first of its kind in the electronics field and is receiving high praise from personnel managers.

To present your job qualifications immediately to companies, simply fill in the attached resume.

Study the employment opportunity ads in this section. Then circle the numbers at the bottom of the form that correspond to the numbers of the ads that interest you.

ELECTRONIC DESIGN will act as your secretary, type neat duplicates of your application and send them to all companies you select—*the same day the resume is received.*

The standardized form permits personnel managers to inspect your qualifications rapidly. If they are interested, they will get in touch with you.

Painstaking procedures have been set up to ensure that your application receives complete, confidential protection. We take the following precautions:

- All forms are delivered unopened to one reliable specialist at ELECTRONIC DESIGN.
- Your form is kept confidential and is processed only by this specialist.
- The "circle number" portion of the form is detached before the application is sent to an employer, so that no company will know how many numbers you have circled.
- All original applications are placed in confidential files at ELECTRONIC DESIGN, and after a reasonable lapse of time, they are destroyed.

If you are seeking a new job, act now!

ELECTRONIC DESIGN CAREER INQUIRY SERVICE

USE BEFORE JAN. 3, 1962

After completing, mail career form to ELECTRONIC DESIGN, 850 Third Avenue, New York, N. Y. Our Reader Service Department will forward copies to the companies you select below. (24)

(Please print with a soft pencil or type.)

Name _____ *Telephone* _____

Home Address _____ *City* _____ *Zone* _____ *State* _____

Date of Birth _____ *Place of Birth* _____ *Citizenship* _____

Position Desired _____

Educational History

College	*Dates*	*Degree*	*Major*	*Honors*

Recent Special Training _____

Employment History

Company	*City and State*	*Dates*	*Title*	*Engineering Specialty*

Outstanding Engineering and Administrative Experience _____

Professional Societies _____

Published Articles _____

Minimum Salary Requirements (Optional) _____

Use section below instead of Reader Service Card. Do not write personal data below this line. This section will be detached before processing.

Circle Career Inquiry numbers of companies that interest you

900	901	902	903	904	905	906	907	908	909	910	911	912	913	914	915	916	917	918	919	920	921	922	923	924
925	926	927	928	929	930	931	932	933	934	935	936	937	938	939	940	941	942	943	944	945	946	947	948	949

YOUR CAREER

whereby each engineer and scientist gets an automatic promotion to the next higher salary level (10 per cent increase) every two years. At the same time he and his family are transferred to the opposite coast with full per diem and moving expenses. The technical recruiting department and the advertising budget have been eliminated, and the resultant savings have enabled us to cut our bid rates to the government by 35 per cent.

The only trouble is the government is suing us under the antitrust laws.

Ramo on Contracts: Order In the Class

Dr. Simon Ramo, engineer-executive, recently proposed that the government's method of awarding military and space contracts be revised. Instead of the present bid-proposal system, which keeps pulling the best technical brains off projects-in-being to work on elaborate proposals for new work, Dr. Ramo proposed a performance-rating system. While the details of Dr. Ramo's proposed changes have been widely publicized, the pointed analogy that he drew to describe the absurdity of the present system is less well known.

Dr. Ramo compared the present industry-government relationship to a geometry class, in which during the first three days of the course, no geometry is taught, but each child gives a three-minute oral presentation telling why he should receive an A. This is accompanied by a two-page written proposal telling how smart he is, how smart his parents have been before him, and how many hours a week he intends to spend studying geometry. The parents also telephone the teacher.

At the end of three days, the teacher decides on two students who will receive A's seven B's, twenty-two C's, six D's, and four who flunk. Four students will not get a passing grade, no matter how hard they work. Naturally, Dr. Ramo said, the teacher works hard to help the A student. He is committed to do this at the beginning of the course.

Incentive, Competition Drop by the Wayside

This system provides competition and incentive only for the preliminary days. Once the school year begins, competition and in-

centives are trivial factors.

Some claim there is protection in this system for next year's trigonometry, Dr. Ramo said. During the three-day proposal period that opens that course, the trigonometry teacher will remember that some of the students who rated A and B in geometry did not come up to expectation. Their proposals will now be taken with a grain of salt—that is, if the high school and the teacher are the same as last year's; and if the teacher studies the records, and has a good record system, thereby being able to correlate proposals with performance as a means of judging the next proposal.

Dr. Ramo's own method of awarding contracts, by contrast, follows the rating system actually used in classrooms. All the contractors start off equal, like the children at the beginning of the term. But as they pass tests (perform well on contracts) the contractors build up their "performance ratings" with the government. As a reward for good grades, the contractors are allowed progressively greater profits on their contracts.

Education Lead Time Governs Nation's Research Directions

Is the solution of earth-bound problems more important than the exploration of space? Would it be better, for example, to spend the nation's space budget on cancer research?

One reason against making quick changes in the national research objectives was voiced at the recent Space Flight Report to the Nation, sponsored by the American Rocket Society. At the end of a paper on arms control in space, Raytheon's Clark C. Apt said the question of diverting the military and space budget into human research, such as disease, was really academic because it would take at least 10 years to produce the manpower needed for such research programs.

"The first ghost to be laid aside is the idea of a conservative system among technological resources," Mr. Apt said. "No one has yet ventured to explain how the thousands of astronautical engineers (now in the space effort) could contribute to cancer research in lieu of space projects."

Redirection of Projects In Short Time Ruled Out

Mr. Apt continued:

"Although it is true that within a generation radical re-allocation of national man-

YOUR CAREER

power resources can change the relative proportion of skilled professional personnel available to different types of activity, this cannot be achieved by any substantial extent within the decade.

"Thus, most of the earth-bound projects so often recommended as superior alternatives to space exploration are not limited so much by financial support as by the long lead time needed to develop the skilled personnel.

"Personnel is an extremely long lead-time item not only because of the time it takes to educate professional personnel, but also because of the time it takes first to train the instructors of this professional personnel," he said. "If we had complete power over what courses college students take, we might in seven or eight years largely re-allocate the number of teachers available in various fields. The effect of this would not make itself felt to any substantial degree before some 10 years has elapsed from the decision time. . . . It must be concluded that those who would have us allocate less effort to space exploration and more to earthbound projects had best plan some 10 years in advance. This then puts the burden on them to prove that, 10 years hence, their decision has a good chance of having been the correct one."

Career-Counselling Service For Theoretical Sciences

A division of theoretical sciences has been established by the employment-counselling firm, Cadillac Associates, Inc., Chicago.

This division will offer professional guidance to physicists, chemists, mathematicians, statisticians as well as chemical, industrial and mechanical engineers, metallurgists and those in operations research.

Salaries in these fields range from $10,000 to $25,000 for heads of departments, the firm said.

* * *

A broadened merit-raise program has been instituted at the Western Electric Co. to take the place of general salary increases. As reported in Western Electric's "Engineering Personnel Relations Notes," the increased emphasis on merit raises will help stop salary compression, and put more weight on true merit. The company still intends to adjust over-all salary ranges from time to time to reflect changes in the general level of salaries.

Boeing openings in Design Reliability Assurance and Design For Maintainability

Expanding space and missile programs at Boeing's Aero-Space Division offer exceptional career opportunities to specialists in design reliability and design for maintainability. Requirements are a BS degree in Engineering, Physics or Mathematics/Statistics, plus one year of experience in Applied Mathematical Statistics and aircraft and/or missile systems equipment, development or analysis.

Assignments are available . . .

1. *to establish engineering design reliability assurance policies; reliability goals for weapon and space exploration systems; reliability and maintainability design and evaluation methods; reliability monitoring, growth evaluation and display methods,*
2. *to select, evaluate, and improve electromechanical, electrical and electronic components,*
3. *to analyze and develop preferred circuits, and*
4. *to represent Boeing with customers, vendors and associate contractors.*

Salaries are competitively commensurate with education and experience. These positions are in Seattle, in the uncongested Pacific Northwest, famous for mild year-round climate, unexcelled recreational facilities, housing and schools.

Send your resume today, to Mr. William B. Evans, The Boeing Company, P. O. Box 3707 - ESI, Seattle 24, Washington. The Boeing Company is an equal opportunity employer.

BOEING

CIRCLE 907 ON CAREER INQUIRY FORM ➤

The Making of History was not only His Privilege

. . . It was His Goal

If you are an advanced degree physicist, scientist or electronic management engineer who seeks to shape air and space vehicles to their unique environmental problems rather than stretch existing designs for marginal success, you are needed at McDonnell.

Write R. F. Kaletta, Professional Placement, McDonnell Aircraft, St. Louis 66, Missouri

AN EQUAL OPPORTUNITY EMPLOYER

YOUR CAREER

Financial-Management Course in Electronics

A course on credit and financial management for the electronics industry is offered by Dun & Bradstreet, Inc.

The course is tailored for credit personnel and engineers. It is designed to develop an understanding of special industry financial problems.

Subjects include credit policies, selling terms, analysis and accounting procedures, sources of information and government procurement.

ENGINEER-IMPROVEMENT COURSES AND SEMINARS

Seminar on Space Vehicles

The Second Annual Seminar On Reliability in Space Vehicles will be held Dec. 5 at the Rodger Young Auditorium, Los Angeles. It will be sponsored by the Los Angeles chapters of the IRE Professional Groups on Reliability and Quality Control, Electron Devices and Component Parts.

The morning session will stress systems, including a discussion on a transistorized computer circuit and reliability in space. The afternoon session will consider components and devices, including discussions of nuclear-radiation problems, reliability of solar arrays and welding of electronic modules for space environments.

For registration information write: *Nick Khoury, Space Technology Laboratories, P. O. Box 95001, Los Angeles 45, Calif.*

Computer Management Seminar

The Government & Industrial Group, Computer Div. of Philco Corp., is presenting a one-day seminar on computer management. It will be held at the Philco Computer Center in Willow Grove, Pa., on the following dates: Nov. 2 and 21, Dec. 5 and 19, Jan. 9 and 23, Feb. 6 and 20, and March 6 and 20.

Designed for executives and management personnel, the seminar will deal with large electronic data-processing systems, their use in commercial and scientific applications, and their installation. Emphasis will be on the Philco 2000 and 2400 computers.

For information, write *C. A. Leventhal, manager of computer education, Philco Computer Div., 3900 Welsh Road, Willow Grove, Pa.*

ADVERTISERS' INDEX

November 22, 1961

*Manufacturers' catalog appears in 1960-1961 ELECTRONIC DESIGNERS' CATALOG

This is an employment advertisement

Number 11 in a series

CAREERS

Wanted:

GEOLOGIST

with 4 years' experience on MARS or SATURN

Job function: to direct expansion of present line of precision switches and indicator lights to include controls suitable for extraterrestrial applications.

Write for details of present product line.

CONTROLS COMPANY OF AMERICA
CONTROL SWITCH DIVISION
1420 Delmar Drive, Folcroft, Pennsylvania

Manufacturers of the Electrosnap and Hetherington full line of switches, controls and indicators for all military and commercial applications. All standard units stocked for immediate delivery by leading parts Distributors

CIRCLE 911 ON CAREER-INQUIRY FORM

**Manufacturers' catalog appears in 1960-1961 Electronic Designers' Catalog*

*Manufacturers' catalog appears in 1960-1961 ELECTRONIC DESIGNERS' CATALOG

*Manufacturers' catalog appears in 1960-1961 ELECTRONIC DESIGNERS' CATALOG

Advertising Representatives

Manager of Advertising Services: Alvin D. Ross

New York: Robert W. Gascoigne, James P. Quinn, Charles J. Stillman, Jr., John M. Weber, Thomas P. Barth, Newman R. Ladabouche, Gerard S. Mullin, *850 Third Avenue, Plaza 1-5530*

Boston: Richard Parker, *Copley 7-0288*

Philadelphia: Blair McClenachan, *Mohawk 7-0625*

Chicago: Thomas P. Kavooras, Fred T. Bruce, *664 N. Michigan Avenue, Superior 7-8054*

Cleveland: Douglas H. Boynton, *1597 Hawthorne Drive, 442-5055*

Los Angeles: John V. Quillman, Kenneth M. George, Pierre J. Braudé, *3257 Wilshire Blvd., Dunkirk 2-7337*
San Francisco: John C. Hildreth, *Da 5-3271 (Palo Alto)*

Southeastern: Pirnie & Brown, Morgan Pirnie, Harold V. Brown, G. H. Krimsier, *1722 Rhodes-Haverty Bldg., Atlanta, Ga., Jackson 2-8113*

London, W1: Brayton Nichols, *7 Blenheim Street*

Tokyo: Karl H. Bachmeyer Associates, *27 Morimoto-cho, 1-chome, Azabu, Minato-ku*

ELECTRONIC DESIGN

Publisher: James S. Mulholland, Jr.

Editor: Edward E. Grazda

Managing Editor: Howard Bierman

Technical Editors: R. H. Cushman, M. W. Meisels, A. Rosenblatt, D. Christiansen

News Editors: R. Haavind, *Chief;* A. Corneretto, L. Iannuzzelli, R. N. Ross

Copy Editor: C. A. Goldstein

New Products Editors: A. W. Solda, *Chief;* D. N. Kapsack, J. A. Strasser

Washington Editor: W. H. Baldinger

West Coast Editor: T. E. Mount

Contributing Editors: J. G. Adashko, E. Brenner, B. Bernstein

Editorial Production: D. S. Viebig, G. S. Goodman

Art Director: R. A. Schulze

Art Assistant: R. Podhirny

Technical Illustrator: C. Westphal

Production Manager: T. V. Sedita

Asst. Prod. Mgr.: H. De Polo

Production Assistants: P. Bergang, M. Spector

Circulation Manager: N. M. Elston

Asst. Circ. Mgr.: H. A. Hunter

Reader-Service: L. Blair

Hayden Publishing Company, Inc.

Chairman of the Board:
T. Richard Gascoigne

President: James S. Mulholland, Jr.

Accuracy Policy

Recognizing the power of the printed word to influence, it is ELECTRONIC DESIGN's policy:

To make all reasonable efforts to insure accuracy of editorial matter.
To publish promptly corrections brought to our attention.
To not knowingly publish misleading advertisements.
To reserve the right to refuse any advertisement.

Readers noting errors or misstatements of facts are encouraged to write the editor.

Subscription Policy

ELECTRONIC DESIGN is circulated only to qualified design engineers of U. S. manufacturing companies, industrial consultants and government agencies. If design for manufacturing is your responsibility, you qualify for subscription without charge provided you send us the following information on your company's letterhead: Your name and engineering title, your company's main products and description of your design duties. The letter must be signed by you personally.

ANY ADDRESS CHANGES FOR OLD SUBSCRIBERS NECESSITATE A RESTATEMENT OF THESE QUALIFICATIONS.

Please include a copy of your old address stencil with your request. Allow six weeks for change to become effective. Subscription rate for nonqualified subscribers—$25.00 per year U.S.A., $35.00 per year all other countries. Single copy $1.50.

CONTROLLED CIRCULATION POSTAGE PAID AT CHICAGO, ILLINOIS

ELECTRONIC DESIGN

HAYDEN PUBLISHING COMPANY, INC.
850 Third Avenue, New York 22, N. Y.