

# ELECTRONIC DESIGN

ELECTRONIC DESIGN's Ninth Annual Transistor Data Chart (p 33) contains specifications for 1,714 transistor types--last year only 1,088 types were submitted in publication by semiconductor manufacturers. With close to a 60 per cent increase in the number of available types, the design engineer is now offered a greater selection of devices as well as increased sources of supply--but his search for a transistor to do a certain job is likewise increased. Thus, ELECTRONIC DESIGN's unique listing, specifically tailored for the design engineer, should prove to be a handy time-saver. Contrary to existing lists which group transistors by manufacturer or in numerical sequence (fine for salesmen, of limited use to engineers), the 1961 Data Chart has transistors organized into six application categories: AUDIO--mostly general purpose types, under 1, listed in order of increasing forward-current transfer ratio. HIGH FREQUENCY--including types ranging up to and above the vhf range and tabulated in order of increasing alpha-cut-off frequency. POWER DEVICES--transistors rated at 1 and above are listed in order of increasing collector power dissipation. HIGH-LEVEL AND LOW-LEVEL SWITCHING devices intended for switching are listed in order of increasing alpha-cut-off frequency. SPECIAL TYPES--low noise, high power/high frequency and other miscellaneous types are included. By this system of listing transistors, the design engineer is offered a rapid method of selecting a particular type based on a parameter value. In addition, close substitutes are apparent and multiple sources of supply are listed when applicable. Only U.S. manufactured types are given. One word of caution is included. Quite a few similar number types, made by several companies, were submitted with different characteristics due to the non-uniformity in test methods among manufacturers. The manufacturer whose data are used for each particular type is listed under "Mfg." Other suppliers of the same types are found under "Remarks." Please take note that the company listed under MICROWAVES. . . p 129 "Mfg." is not necessarily the prime supplier, a check source or the original EIA registrant. The final choice of supplier is obviously up to the design engineer. It is thus advisable to use this listing as a

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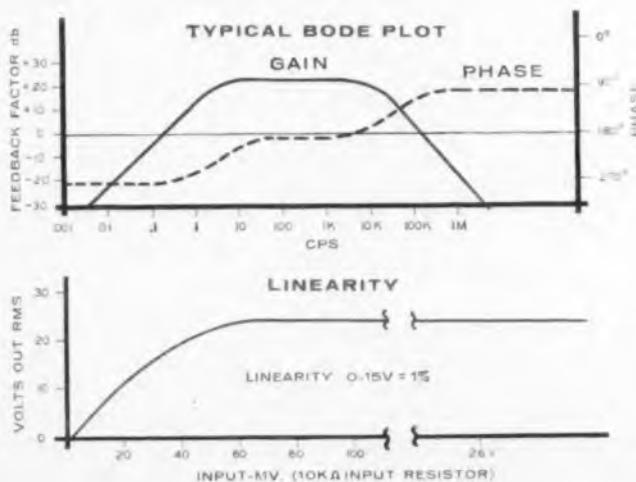
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## ELECTRONIC DESIGN

COVER: The introductory copy to ELECTRONIC DESIGN's Ninth Annual Transistor Data Chart makes an eye-catching typographical cover for this issue. For eye-filling details of transistors, consult the chart.

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### Sidelights of This Issue

#### Transistors . . . Transistors

Well, it's all there, bigger than ever and easy to use—ELECTRONIC DESIGN's Ninth Annual Transistor Data Chart, starting on p 33. Transistor types, in case you haven't guessed, are up 60 per cent this year. There are, we ruefully submit after more than three grueling months of counting and classifying, 1,714 types.

ED began its annual transistor chore early in April, when the first letters went out to manufacturers. The makers were asked to recheck their specifications on old types and furnish details on the new, if any. The rise over last year's total of 1,088 types became abundantly clear in due time. What wasn't so clear, though, was the difference in many cases between competitive types.

To make selection as easy as possible, we have organized all transistors into five basic types: audio, high-frequency, high-level switching, low-level switching and power. Then they are listed by the increasing value of the transistor's parameter.

Cash in on these valuable time-saving features when you select your transistors. And join us in a quiet "thank you" to our human data-processing machine, Miss Beverly Chesler. Beverly put in more than 150 hours collating the transistor data for you from companies over the nation. Don't mention "transistor" to her again this year.



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## A New, Better ELECTRONIC DESIGN

We hope you noticed several physical improvements in the last issue of **ELECTRONIC DESIGN**. There were three that we are particularly proud of: (a) the strongest binding available in printing—indeed, the same type of binding used in the better paperback books (thus, *ED* can be maintained in good condition for the many readers using each copy); (b) improved type faces and layouts; and (c) better reproduction of illustrations.

These changes came about as a result of our switching printing operations to the midwest. Shifting printing to the central part of the country will also insure faster distribution of **ELECTRONIC DESIGN**.

Advertisers also get a new service coincident with our getting a new printer. A limited number of ads may be inserted only 12 days preceding the issue date, or three days before the magazine is mailed.

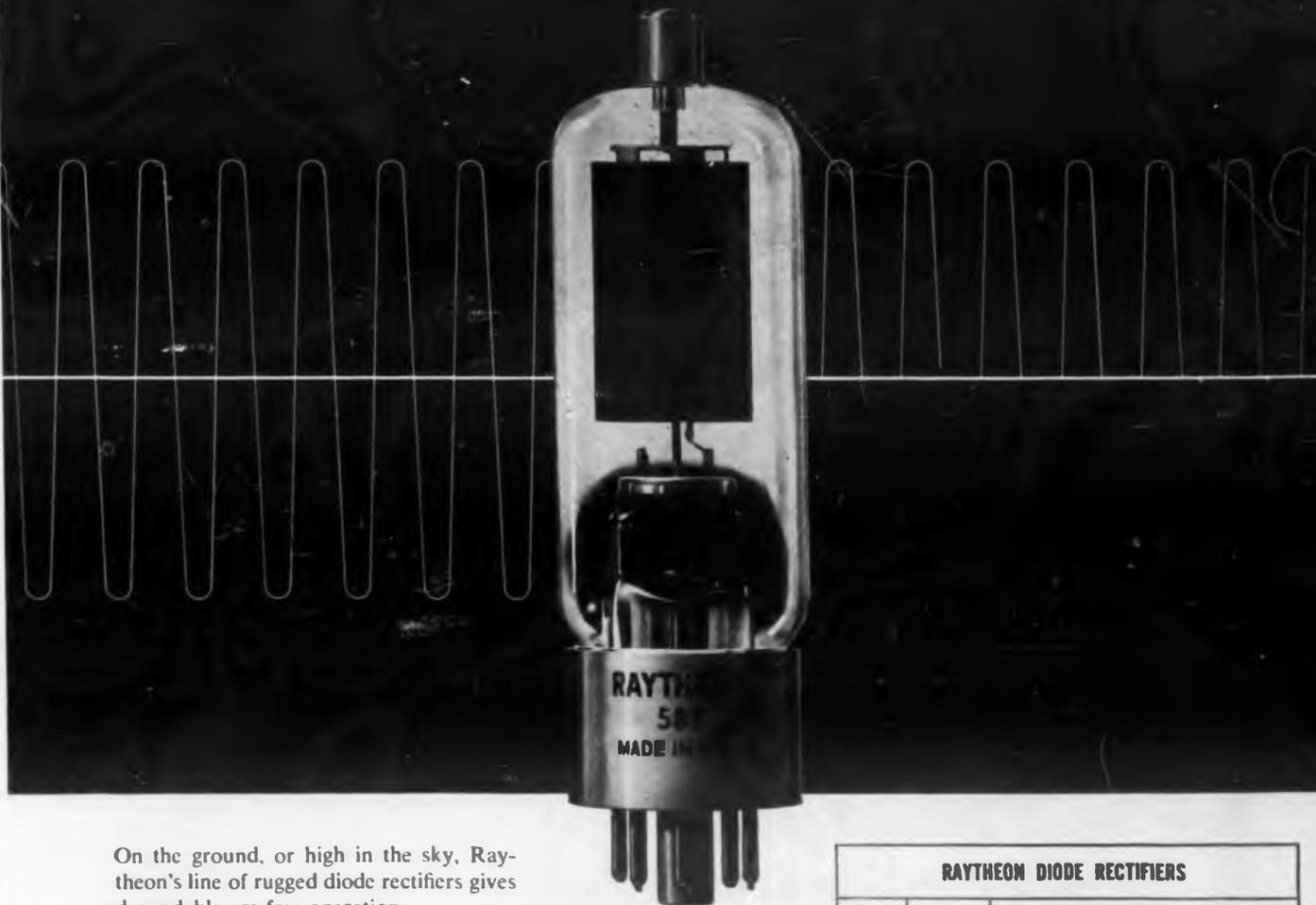
The late closing form will enable manufacturers to introduce new product advertising with minimum delay where such timing is critical.

The switchover is not without its problems. The editorial department has to rely on airlines for daily messenger service. If a plane is grounded or "diverted" (that's a neat term to describe a crisis) as we approach press time we have to set copy and give make-up instructions via teletype. Fingers crossed, we hope we won't see crossed headlines.

The end result will be even more timely news reporting for design engineer readers.

Turn to page 6, for example, for a rundown on some of the top events at last week's Fifth National Conference on Military Electronics in Washington. On page 10 readers will find an even more timely report on two hardware-oriented developments discussed at an otherwise theoretically-oriented Joint Automatic Control Conference in Boulder, Col. This meeting was held last Wednesday through Friday, June 28 to 30.

As you read through the stories in the issue notice the easy readability of the new type style used for text. We hope this will prove an added convenience to busy readers.



On the ground, or high in the sky, Raytheon's line of rugged diode rectifiers gives dependable arc-free operation.

Example: Raytheon 583, one of six Raytheon half-wave rectifier types. Operating as a clipper diode at altitudes to 36,000 feet, maximum ratings are 15,000 volts PiV, 8 amperes peak plate current. Arc-free clipping action makes sure a magnetron can be fired once *without* re-firing automatically or uncontrollably!

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583*	H. W. RECT. (to 36,000 Ft.) CLIPPER DIODE (to 36,000 Ft.)	2.5	4.9	17,000	0.250	0.063
		2.5	4.9	15,000	8.0	0.240
3B24W 1 3B24WA*	H. W. RECT. (HALF FIL.) (FULL FIL.)	2.5	3.0	20,000	0.150	0.030
		8.0	3.0	20,000	0.300	0.060
3B26	CLIPPER DIODE	2.5	4.75	15,000	8.0	0.020
3B29	H. V. RECT. (OP. 1)	2.5	4.9	16,000	0.250	0.063
	(OP. 2)			7,700	0.300	0.080
	(OP. 3) CLIPPER DIODE	2.5	4.9	10,000	8.0	0.018
4B31*	H. W. RECT. CLIPPER DIODE	5.0	5.0	16,000	0.470	0.150
		5.0	5.0	16,000	12.0	0.060

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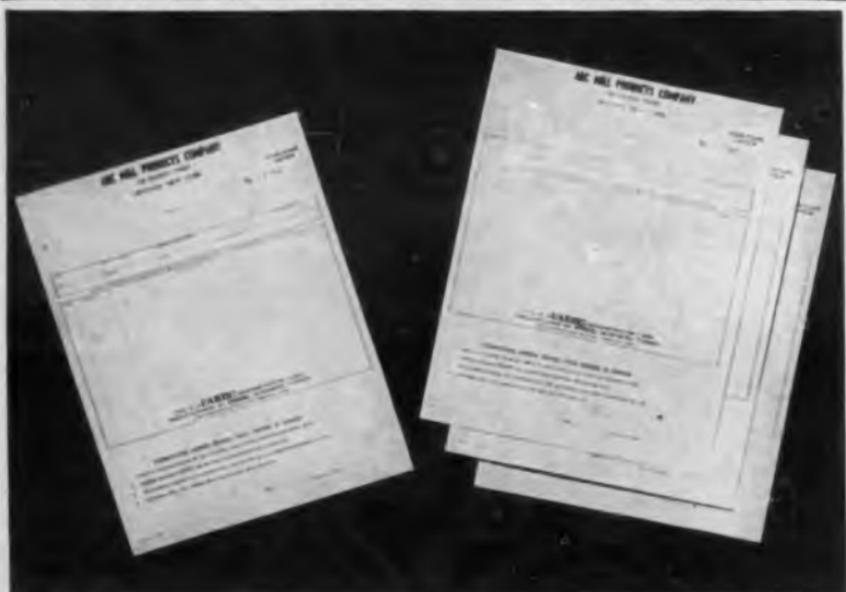
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# DRAFTING TRENDS



See how little difference can be noted between a nearly opaque original (left) and three fast, economical diazo copies (right) made with POST Super Vapo Black Paper.

## New Super Diazo Papers Make Prints From Prints

### More uses—

No longer limited to copying just thin, translucent originals, recent POST progress in formulating super-fast diazo compounds has added a new dimension to diazotype reproduction.

A selection of new POST direct positive papers can now handle, at reasonable speeds, such problems as making prints from discolored originals, letterhead correspondence, or even from old prints themselves—in short, from subjects considered too opaque for conventional diazo copying.

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One of the most impressive features of these POST Super Diazo Papers is the extra speed in reproducing normal subjects, such as engineering tracings. There's no sacrifice of shelf-life, image stability, development rate or clean backgrounds. The printing range is extremely wide.

### More economy—

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# ELECTRONIC DESIGN

Hayden Publishing Company, Inc.  
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## Coming Next Issue

The interest of the electronics industry will soon be centered on San Francisco's Cow Palace. For the duration of WESCON, Aug. 21 to Aug. 24, manufacturers will proudly display their wares for evaluation and approval.

To assist visiting engineers in making the all-important decision of what to see first, the WESCON, Aug. 2, issue of ELECTRONIC DESIGN will feature the products to be introduced for the first time. For convenience in locating these items, booth numbers will accompany the product descriptions.

A trend survey, conducted by the editors of ELECTRONIC DESIGN, covering recent, present and future product developments will be a highlight of the issue. Don't miss it.



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ELECTRONIC DESIGN • July 5, 1961

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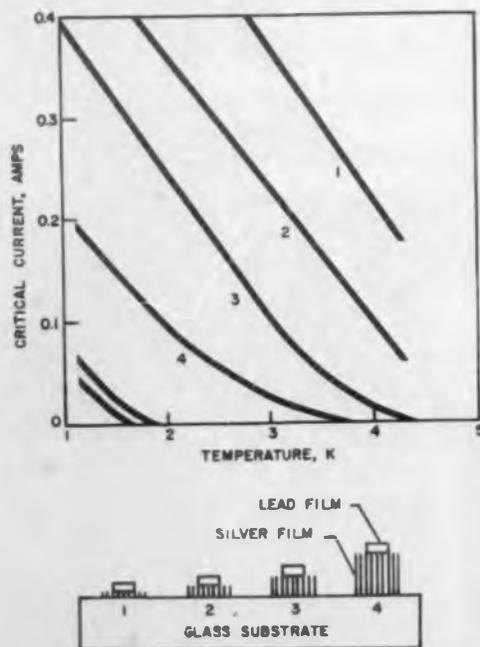
# Laminar Devices Key Superconductivity Push

*Laminating Films to Control Transition Temperature  
Among Successes Reported at Top Research Meeting*

Alan Corneretto  
News Editor

**R**ESearchers trying to exploit superconductivity have developed a technique with high promise for designers: combining normally nonsuperconductive metallic thin films with superconductive ones and achieving superconductivity in the entire assembly.

Such devices have been made by superimposing thin films of superconductive lead and normally nonsuperconductive silver. Because the films become superconductive at temper-



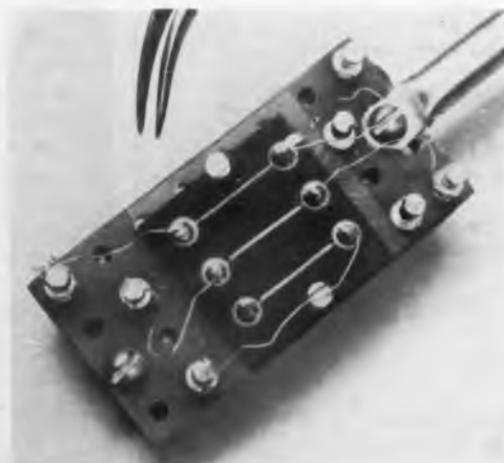
**Characteristics** of combined superconducting and normal films are dependent on thickness of films, implying devices may be made that would become superconductive at predetermined cryogenic temperatures. Curves are for configurations shown under graph. Two curves at lower left resulted from a structure different from others shown. This work was done at Arthur D. Little, Inc.

atures dependent on film thickness, multilayered devices are foreseen in which different layers would become superconductive at different predetermined cryogenic temperatures.

The development was among recent successes reported at a conference on fundamental research in superconductivity held June 15-17 at the International Business Machines research center, Yorktown Heights, N. Y. It reflected a growing interest in the field.

Two reasons are given for the spurt in interest. One is the discovery last year of tunneling in superconductive thin films (*ED*, Dec. 7, 1960, p 4), and the other the recent development of materials that remain superconductive in high magnetic fields.

Present superconductive thin-film devices are made either of naturally superconductive metals, which are limited in number, or of difficult-to-process alloys. The new combina-



**Three laminar superconductors** are formed by deposition of thin-film lead strips on wider and thicker thin-film strips of silver. Intimate superposition of strips makes normal silver become superconductive at proper cryogenic temperature. In these three separate samples on glass substrate, the lead film is about 500 Å thick, and the silver films vary from about 1,000 to 5,000 Å. Electrodes facilitate measurements.

tion, or laminar, technique is expected to make it easier to tailor the transition temperatures of superconducting films than former methods permitted.

P. H. Smith of Arthur D. Little, Inc. (ADL), Cambridge, Mass., delivered a jointly authored paper on the process at the Yorktown Heights conference. Substantially the same reports appear in the June 15, 1961, issue of *Physical Review Letters*, published by the American Physical Society. Similar work has been done by Dr. Hans Meissner at the Stevens Institute of Technology.

Both Dr. James Nicol, one of the authors of the ADL paper, and Dr. Meissner, report that the two films—normal and superconducting—must be in intimate contact with each other before the effect can be achieved. At both organizations one film is deposited immediately after the other while the original vacuum is maintained. The reasons for the phenomenon are not completely understood at present.

ADL reports that it has constructed devices by superimposing a film of one material between two films of the other, and by depositing one film on the other in an open-sandwich construction. It calls the resulting devices laminar superconductors. At the conference, Mr. Smith reported that the assembly of two metals in contact behaves as a unit having its own characteristic superconducting properties.

Films worked with at ADL measure from 500 to 10,000 Å thick, he says. Typically they are made by superimposing along the length of a 10-by-0.3-mm silver film a longer lead film 0.15 mm wide. Electrical connections are soldered to the ends of the lead film. A glass substrate with lead, tin and normally nonsuperconductive gold and silver have been used.

Addition of the silver is said to reduce the transition temperature of the assembly below that of lead alone. In one sample, a tran-

sition temperature of 1.87 K was reportedly measured. Normally, lead has a transition temperature of 7.2 K, according to ADL.

Several samples can be deposited simultaneously on the same substrate. The superconductive effects appear to be unchanged by the type of construction used or the sequence of deposition of metals, says ADL.

According to Dr. Nicol, the phenomenon apparently can be harnessed to tailor the temperature at which a device will become superconductive. Another advantage he cites for the technique is that the pure metals involved are easier to work with than alloys, which may be relatively hard to vacuum-deposit.

#### Meeting Hears Evidence Backing Theories Of Bardeen, Cooper and Schrieffer

Many of the papers delivered at the conference reported work that supported the various theories of Professors Bardeen, Cooper and Schrieffer on the nature of superconductivity. The existence of energy gaps in superconductors, the dependence of the gaps on temperature position and field strength, and the possibly paired nature of electrons in superconductive materials were all discussed at the meeting, which was attended by virtually all the top superconductivity experts in the Western countries.

One of the highlights of the conference was a report by Dr. Naebauer, of Herrsching, Germany, on the measurement, for the first time, of the flux quantization unit in a superconducting ring. The unit was given as  $4 \times 10^{-7}$  gauss  $\text{cm}^2$ . The measurement, which constitutes one of the few direct observations of a quantum effect, supports the theoretical prediction that flux in a superconducting ring occurs in discrete units. The fact that the units are discrete was said to raise the possibility that devices may be built eventually in which the quantized nature of flux in a superconducting ring may be harnessed to count or to transduce.

Also at the conference, J. E. Kunzler, Bell Telephone Laboratories, reported that ductile alloys of niobium-zirconium appear to be the most promising superconductive materials for magnets with field strengths in the 80-to-100-kilogauss range, while the characteristics of niobium-three tin in wire-like form appear to be suitable for fields of at least 200 kilogauss.

Dr. Kunzler added that the prospects for material with electrical and magnetic characteristics capable of still higher fields appear bright. ■ ■

## Which AC/DC digital voltmeter should you buy?

...seven questions to help you decide

### 1. Is it reliable, dependable?

A rather general question, and one you often get rather general answers to. But with such an important consideration, you should get answers like these:

The stepping switches in the KIN TEL 502B AC/DC digital voltmeter are guaranteed for two years. KIN TEL can make this guarantee because it operates stepping switches conservatively, driving them with DC (as in telephone service) at a rate somewhat below their peak speed. This gentler drive gives the 502B a longer life, makes it capable of more sensitive measurements, eliminates the need for stepping switch adjustments or other maintenance, and greatly reduces down time.

When servicing is ultimately needed, KIN TEL-trained personnel in 22 different maintenance shops throughout the country are prepared to put your 502B in factory condition with minimum delay.

Each 502B is manufactured on a true production-line basis. KIN TEL has used this method in building over 10,000 "standard-cell-accuracy" instruments, instruments known for their consistent, trouble-free performance.

### 2. Does it have automatic range selection for AC and DC?

Auto-ranging is a convenience. It makes your job a little easier, a little surer. It permits unattended operation with a printer to record voltages on the range giving the best resolution.

The KIN TEL 502B has it.

### 3. Does it have a single-plane readout?

A single-plane readout reduces reading errors. Each number is displayed individually. There are no superimposed outlines of "off" digits. You can read the numbers as easily from the side as from the front.

The KIN TEL 502B has a single plane readout.

### 4. Can you program it?

A programable instrument is a more useful instrument. It can be used with a printer for unattended checkout of missile components, quality control of specific items, and other automated measurements.

You can program the 502B. It's the only standard off-the-shelf digital voltmeter controllable by remote contact closures. With the AC converter control set to REMOTE, closures command any desired sequence of measurements at 10-volt AC, 100-volt AC, 1000-volt AC, auto-range AC, or auto-range DC.

### 5. Will it over-range on both AC and DC?

A loaded question, perhaps, since the KIN TEL 502B is the *only* digital voltmeter on the market with AC and DC over-ranging. But this is an important feature, not just an extra one.

The 502B displays 4 complete digits plus a 5th over-ranging digit (0 or 1). This 5th digit gives ten times more resolution at the often-measured decade points (1, 10, 100 volts) than 4-digit voltmeters that lose a digit changing from .9999 to 1.000. This means you get the useful accuracy of a 5-digit voltmeter over a large part of the measurement range while retaining the stability, reliability, and price advantage of a 4-digit instrument.

### 6. Does it offer the highest accuracy?

Of course, none of the features listed so far are worth a dime if you can't depend on what the instrument tells you. So let's be specific:

With the 502B, DC measurements are accurate to within .01% of reading  $\pm$  one digit. AC accuracy is the highest in the industry — within 0.1% of reading or  $\pm$  3 digits (0.03% of full scale) for signals between 30 cps and 10 kc up to 10,000, 100.00, or 1000.0 volts on the respective range scales. With manual or programed ranging, this same accuracy is maintained up to 15,000 or 150.00 volts for signals between 50 cps and 7 kc.

This accuracy is maintained by a constant and automatic calibration of the metering circuit against an unsaturated mercury-cadmium standard cell.

### 7. Is it worth what it costs?

The KIN TEL 502B costs \$4245, and is delivered from stock. Compare it — what it does and what it costs — with any other AC/DC digital voltmeter. We think that when you do, the 502B will rate the same answer on this question that it has on the other 6: yes.



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2. Current Regulation:  $\pm 0.02\%$  or  $\pm 50\mu$  amp
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Factory calibrated @ 100 ohms/volt  $\pm 0.25\%$
4. Remote Current Programming: Full range 15-500 ma  
Factory calibrated @ 1 mho/ampere  $\pm 1\%$
5. Voltage Limiting: Continuously adjustable 0-42 v
6. Current Limiting: Continuously adjustable 0-600 ma
7. Remote Voltage Sensing 8. Parallel Operation 9. Series Operation
10. Vernier Voltage Adjust: 5 mv resolution
11. Vernier Current Adjust: 50  $\mu$  amp resolution
12. Transient-Free 13. Short-Circuit Proof
14. Extremely Fast Response: 25  $\mu$  sec
15. Low Ripple: 500  $\mu$  volts (voltage regulation mode)  
50  $\mu$  amps (current regulation mode)
16. Convection Cooling 17. Portable 18. Regulation Mode Switch
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**NEWS**

**2.2-Gc Transmitter  
Due for Telemetry**

*Details Are Described at Mil-E-Con  
Along With Data on High-G System*

**D**ETAILS of one of the first transmitters under development for the new 2.2-Gc telemetry band were disclosed last week in Washington, D. C., at the Fifth National Convention on Military Electronics (Mil-E-Con). Also described were a high-g telemetry system said to be capable of withstanding accelerative forces of more than 150,000 g.

The transmitter, designed by Radiation, Inc., of Melbourne, Fla., will contain only solid-state components and a voltage-tunable magnetron. The device is intended for use in satellites, where it is to transmit simultaneously a number of phase-coherent carriers for a special measurement program.

Typical power output is to be 10 w for a 33-w anode power input. The transmitter will weigh 40 lb and measure approximately 17-1/2 by 8 by 5-3/4 in.

Because the magnetron must generate discrete, phase-coherent carriers, its anode voltage will be modulated by a vhf power amplifier. The frequency of this all-solid-state stage will determine the frequency separation between the carriers. Thus, says Radiation, Inc., modulation of the anode voltage will provide a frequency modulation of the magnetron center frequency. A phase-lock servo loop will provide frequency stabilization.

**Magnetron Amplifier to Have  
Efficiency of More Than 40 Per Cent**

The amplifier that will provide power to modulate the magnetron will have an efficiency of more than 40 per cent, according to the company. It will be driven by a vhf crystal oscillator. Power will be supplied by a separate package in which magnetic amplifiers and regulating circuitry are to produce efficiencies ranging from 69 to 81 per cent for input voltages ranging from 30 to 22 v, respectively. The magnetron supply voltage of 2,000 v is to be regulated over 0.2 per cent from 0 to 75 C.

Use of the 2.2-Gc telemetry band is expected to produce more stable frequencies for space communications than the 216-235-mc band now being used.

### High-G Telemetry System To Aid Projectile Speed Study

The high-g telemetry system described at the Mil-E-Con meeting is intended to aid study of the ionized shock layer generated by projectiles traveling at hyper velocities.

The airborne portion of the system is packaged as a 1.5-lb projectile and is designed to be fired down an instrumented range into an oncoming narrow uhf beam transmitted at 8.5 and 11 Gc. A video crystal detector in the package receives the pulsed signal, which, after amplification frequency, modulates a 60-mc oscillator in proportion to the amplitude of the incoming signal. A 60-mc signal is then telemetered via diplexed antennas through the solid metal shell of the projectile to range receivers.

The project, described by Essad Tahan of Sylvania Electronics Systems, Waltham, Mass., is being conducted as a joint effort of Sylvania and the Canadian Armament Research and Development Establishment.

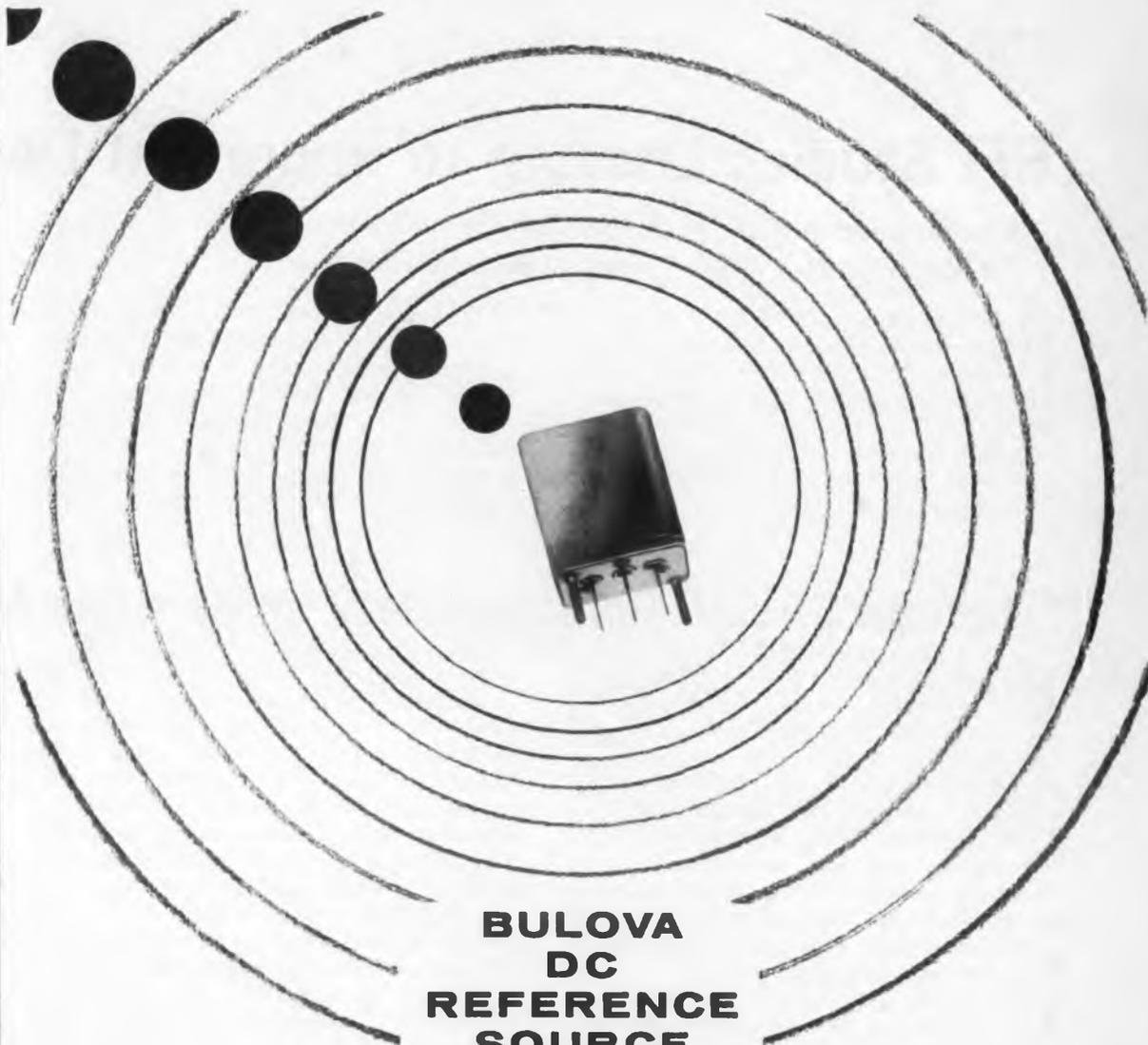
To withstand 150,000 g's for several milliseconds, the telemetry package contains special components. Transistor cases were opened up and filled with an epoxy resin, a special microwave diode had to be developed, and the entire assembly had to be potted and reinforced in a glass-cloth laminate.

### Microminiature Timer for Arming Programs Uses Micram Technique to Handle 370 W

Among the equipment on display was a 14-oz digital arming program timer designed by Diamond Ordnance Fuze Laboratories, Washington, D.C. It was said to be the first operating device using the Micram microminiature packaging technique developed by Cleveland Metal Specialities Co., Cleveland, in cooperation with several large electronic companies. In this technique standard microminiature parts are densely packed on photoetched circuitry. The timer shown was said to be packed to a density equivalent to 300,000 components per cu ft.

The modularized unit, intended for use in missiles, includes a clock, timer, and read-out and switching sections. It is said to have no moving parts. The clock uses a 24-point, 8-kc quartz-crystal oscillator having a 10-cps output and an accuracy of 10 msec.

Aggregate power-handling capacity of the power-switching circuitry of the timer is 370 w says Cleveland Metal, which built the unit for DOFL. The company reports that the unit has been test flown successfully. It was developed under the Copperhead program. Cost of the unit is said to be in the \$750-1,000 range. ■ ■



## BULOVA DC REFERENCE SOURCE

Whenever you need voltage and power "regulation" for instrumentation purposes, especially transducer circuits, the new Bulova DC Reference Source assures maximum reliability.

In this Bulova double stage Zener model, regulation is accomplished by controlling the base voltage of a series power transistor ( $Q_1$ ). With the first Zener across input, the voltage changes of unregulated source are attenuated. The second Zener acts as a voltage reference for feedback amplifier stage ( $Q_2$ ).

Potentiometer connected to the base of the high beta transistor ( $Q_3$ ) allows the voltage on the arm of potentiometer to be compared with the reference voltage across reference Zener, and then the resulting voltage error being amplified and applied to the base of power transistor ( $Q_1$ ).

A third transistor ( $Q_2$ ) is inserted to regulate the voltage of the input so that this is virtually non-existent (plus/minus



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1 mv under all conditions).

In this circuit the output voltage follows the relation  $V_o = V_i \left( \frac{R_1}{R_2} + 1 \right)$ . It is evident that the circuit has to provide a voltage gain.

Obviously, looking to the equation, this supply can operate over a wide range of output voltage by changing the multiplier ratio  $\frac{R_1}{R_2}$ .

The Zener control current automatically changes with output voltage so that the control voltage amplifier absorbs the difference. Reduced number of components achieve optimum performance with high reliability using thoroughly silicon solid state devices. The small size  $1\frac{1}{2}$ " square by  $1\frac{3}{4}$ ", permits this unit to fit in any system which requires a DC reference source.

## RFI Studies Leading to Important Design Shifts

*New Requirements to Bar Square Pulse Modulation  
For Radar; Stiffen Other Equipment Requirements*

**R**ADICALLY new designs for radar and other military equipment will be demanded soon by the Defense Dept. in the light of its attack on radio frequency interference. The new specifications will eliminate in future equipment rectangular-pulse modulation of radar and many present antenna designs.

This was disclosed at the Third Annual Symposium on Radio Frequency Interference in Washington, D. C.

First set of specifications to near completion is a revised radar standard prepared by the Joint Frequency Allocation Board of the Joint Chiefs of Staff. Sufficient data for composing a tight, practical

standard have already been gathered. The requirements of the standard will reflect latest state-of-the-art techniques and component designs.

The standard will specify stricter control of radar fundamental frequencies and improved selectivity, dynamic range, sensitivity of radar receivers. It will also re-

## 'Thermal Circuit' Removes Heat in Miniature Modules

**H**INTS on how to design "thermal circuits" which represent solid-state (no fans) solutions to heat removal in miniature module packaging were given in a paper presented before the IRE Production Group, June 14 and 15 in Philadelphia.

The paper explained how miniature circuit modules had been mounted on a heat-conductive ceramic board which provided an efficient heat removal path from the modules to a heat sink. The concept behind this type of packaging according to the paper is that with extreme miniaturization the designer may have to pay as much attention to the thermal "circuits" as he has in the past paid to the electrical ones.

The authors, Gerald Kriss and Louis Po-

laski of General Electric Co.'s Space Vehicle Dept., Philadelphia, showed how their design used the thermally conductive but electrically insulating ceramic board to integrate the heat removal, circuit interconnection, and module support functions into one solution. In a space vehicle application they said that the board would be attached to the side of the vehicle.

A beryllium oxide ceramic board was chosen for its known combination of high thermal and low electrical conductivity. Kovar studs were inserted into the 0.06-in. thick board to transfer module lead heat and provide electrical connections from the module to the board's circuits. The board's circuits consisted of moly-manganese screened

on and fired then copper plated. Electrically oversized 0.06-in. module lead wires were used to carry out part of the heat.

The modules themselves were epoxy-potted in two stages. First, a high thermal conductivity silver-flake-loaded epoxy was used around the transistor cases (which were purposely located close to the board for shortest thermal exit path of their heat). Then a less thermally conductive but more electrically insulative alumina-loaded epoxy was used for the rest of the module.

The authors pointed out that ceramic boards of this type might be the only solution for rf or high-voltage microcircuits where proximity to conventional metallic heat removal surfaces cannot be tolerated. ■ ■



**Beryllium oxide board** 3-in. square by 0.06-in. thick was used for the thermal link between the modules and the heat sink which would be clamped on one edge. Kovar studs were weld points for the module leads of nickel-plated copper.



**Slice through module** shows how two heat flow exit paths are provided out of module. The transistors are embedded in a high-thermal-conductivity silver-flake-loaded epoxy (lighter color) which is later epoxy-bonded to the ceramic board. Also, the leads are extra thick to conduct heat out to the Kovar studs.



**Modules assembled** on ceramic board. Thermocouples at hot and cold spots of modules showed that the board provided as good a thermal conduction path between the modules and heat sink (not shown) as if the modules were attached directly to the heat sink. Transistor case—heat sink drops were 6 to 8 F.

quire reduction of out-of-band modulation components and will place limits on frequency emissions.

To meet these requirements certain changes in design will have to be made. Thus, there will be a decreasing use of magnetrons, particularly at lower frequencies. It is anticipated that klystrons will be used in their place.

Rectangular pulses will no longer be permitted for radar modulation. Instead, there will be a shift to sine-cosine,  $\cos^2$  or gaussian pulses which do not cause emissions remote from the fundamental.

Antennas will have to be constructed with greater precision in order to limit off-frequency responses, spill-over, back-side emission, etc. Also, there will be a need for high-power waveguide and transmission line filters to limit the transmitter emission to the tightly specified frequency bands, and in addition to limit receiver susceptibility.

Also disclosed at the Symposium was the progress made in the Department of Defense's Electromagnetic Compatibility Program. The major effort of the Program is currently devoted to establishing a Joint Analysis and Prediction Center in Annapolis, Md. This Center, being organized by the Armour Research Foundation, is charged with devising methods for predicting the electromagnetic environment at given geographic areas. To do this it will need data on environmental conditions and equipment emission characteristics (spectrum signatures).

A first test of the possibilities of prediction will be made in the San Diego area, one of the worst areas for electromagnetic interference in the country according to RFI specialists. Environmental data for the area have already been collected. Most of the spectrum signatures are, however, still to be gathered.

Armour is currently selecting a mathematical model for the project. Several models are being reviewed, including ones developed by Melpar, AMF, Georgia Tech, and Jansky and Bailey. Also yet to be chosen is the computer in which the information will be processed. Both the STRETCH and IBM 7090 units are said to be under consideration.

It is anticipated that data will be collected by February of 1962, and the processing can begin. The Analysis and Prediction Center at Annapolis will be ready for occupancy by January of that year. ■ ■

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Collector Voltage, $V_{CB}$ .....	-20 volts
Collector Voltage, $V_{CE}$ .....	-20 volts
Collector Voltage, $V_{CEO}$ .....	-15 volts
Collector Current, $I_C$ .....	-100 ma
Total Device Dissipation @ 25°C.....	150 mw

### ELECTRICAL CHARACTERISTICS (@ 25°C)

Characteristics	Conditions	Min.	Max.	
Collector Cutoff Current, $I_{CBO}$	$V_{CB} = -5v$		3	$\mu A$
DC Current Amplification Factor, h <sub>FE</sub>	$V_{CE} = -0.5v$ $I_C = -50 ma$	35		
DC Current Amplification Factor, h <sub>FE</sub>	$V_{CE} = -0.5v$ $I_C = -10 ma$	50	300	
Collector Saturation Voltage, $V_{CE(SAT)}$	$I_C = -10 ma$ $I_B = -0.5 ma$	.050	0.140	volt
Base Input Voltage, $V_{BE}$	$I_C = -10 ma$ $I_B = -0.5 ma$	0.25	0.35	volt
Noise Storage Factor, K's	$I_B = -2.5 ma$		100	nsec
Gain Bandwidth Product, f <sub>T</sub>	$V_{CE} = -10v$ $I_E = -6ma$	150		mc

Philco's new 2N2048 is the forerunner of a broad line of 150 mw MADT switching transistors. The new power dissipation capability is available in uniformly reliable high-speed units, at surprisingly low cost, via proven MADT automation.

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## NEWS

### Two Advances Cited At Automation Parley

*Digital Speed-Control System  
And Lightweight Motor Outlined*

Robert Cushman  
Technical Editor

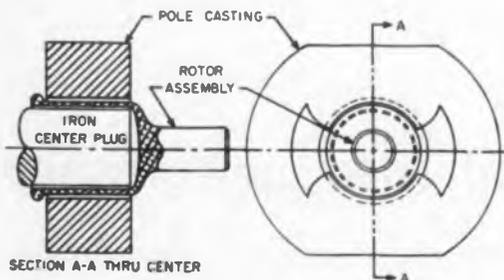
**T**WO PRACTICAL developments were described last week in Boulder, Colo., at the otherwise highly theoretical Joint Automatic Control Conference: a computer-compatible digital speed servo and a very light, compact, powerful motor.

The digital speed-control system has been developed by Westinghouse Electric Corp. for large industrial process drives, such as those used in papermaking. It was explained that in papermaking not only is 0.1 per cent regulation desired for each drive but also, with the paper strips being driven through the mill at 3,000 ft per min by a 4,000-hp system, it is important to be able to synchronize the speeds of all the drive motors along the process.

The digital speed servo has both position and speed loops. It includes all the features normally associated with analog servos, such as time-limit acceleration and vernier speed adjustment. Therefore it can be used directly in place of existing analog systems, Westinghouse says.

As might be expected, pulse rates from a master crystal reference are compared with feedback pulse rates from a digital tachometer connected to the output drive. A coincidence canceler had to be added to prevent ambiguity when pulses arrive at the same time.

Under steady operating conditions all of the control signal is provided by the position loop error. The position loop integrates the feedback and reference pulses from the coincidence pulse canceler by feeding them into the up and down lines of a high-speed reversible binary counter. The level of this counter is then determined by the respective pulse rates between reference and feedback, going up for one and down for the other. This level is then converted into an analog current level by a weighted decoder, and the level of this current is used to



Highly efficient dc motor design is expected to produce 7-1/2 hp inside a 5-in. diam and with a weight of only 11 lb. Commutation would be by silicon-controlled rectifiers mounted in rotor and switched optically by phototransistors.

drive the power amplifier.

The speed loop, on the other hand, operates on the difference of the pulse rates. Pulses from the reference and feedback lines are made to cancel each other alternately.

Part of the significance of this type of system, according to Westinghouse, is that it facilitates digital computer control of large industrial processes.

The very lightweight, compact motor is a dc actuator, designed as a replacement for hydraulic actuators on missiles. The motor, said to be equally as efficient but more reliable than its hydraulic counterpart, was described by Prof. George C. Newton and R. W. Rasche of the Massachusetts Institute of Technology.

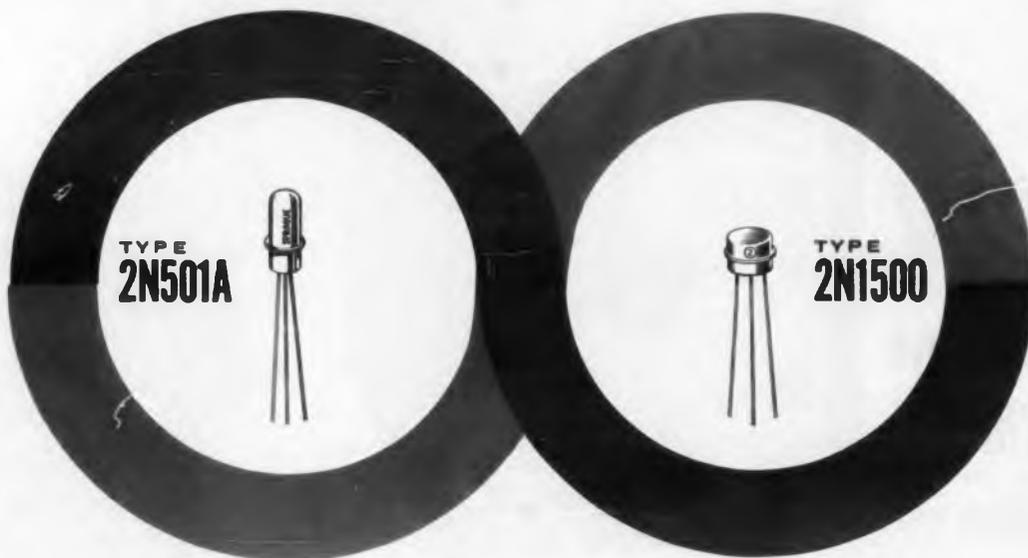
The design, which so far is only on paper, indicates a power rate of 550 kw per sec (7-1/2 hp) with a 5-in.-diam motor weighing only 11 lb. It will therefore be competitive with hydraulic actuators for missile applications, the authors contend. Hydraulic actuators have so far been much more powerful and efficient than any electric actuator, but they are less reliable because of their susceptibility to dirt.

The key to the MIT improvement is a highly efficient molded aluminum-epoxy-fiber-glass rotor with integral conductors. It would be molded as a hollow shell and supported at one end, so that a ferromagnetic plug could be used inside the rotor to increase the flux. The rotor would be evaporatively cooled by a sprayed freon fog.

Other papers at the conference covered most of the topics of current interest to theoreticians in the automatic control field: optimization schemes including "cost" feedback loops, adaptive techniques, nonlinear control and statistical control.

The conference was held last Wednesday through Friday, June 28-30. ■ ■

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**FREQUENCY:** 10 cps to 11 Mc (As a null detector, 5 cps to 30 Mc).

**ACCURACY:** % of reading anywhere on scale at any voltage. 20 cps to 2 Mc — 2%; 10 cps to 6 Mc — 4%; 10 cps to 11 Mc — 6%.

**SCALES:** Voltage, 1 to 3 and 3 to 10, each with 10% overlap. 0 to 10 db scale.

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**AMPLIFIER:** Gain of 60 db  $\pm$  1 db from 6 cps to 11 Mc; output 2.5 volts.

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## Hot TV Cooled Thermoelectrically

*Westinghouse Units Improve Operation of Vidicon Tube In Closed-Circuit System at Steel Plant Soaking Pits*



**Thermoelectrically cooled** television camera (with front cover removed). At top are the heat-radiating fins of the cooling elements, which enclose the vidicon. Motors and pulleys at the bottom control the focus and aperture of the lens.



**Cooling element** consists of three Westinghouse WX-814 bismuth telluride units connected in series. Note common hot and cold plates and single set of input terminals.

**T**HERMOELECTRIC coolers improve performance of the vidicon tube in a closed-circuit television system that monitors the operation of cranes at a steel mill.

Operating in a 140-F ambient, three Westinghouse WX-814 coolers, with a total cooling capacity of 5 w, maintain the 7735 vidicon at 90 F and dissipate heat generated by filaments and deflection and focus coils. Without this cooling, operation of the temperature-sensitive tube would be marginal.

The television system was built by General Precision Laboratory, Pleasantville, N.Y., for soaking pits at a large steel mill.

Because of the high ambient temperature and the camera's remote location (at the end of a traveling crane), thermoelectric elements were selected as the most practical cooling method.

"We couldn't use forced air at 140 F for cooling, and losses in long piping runs would have required about 250 w of mechanical refrigeration for the job," explained Murray Altman, designer of the camera. "Instead we provide the cooling directly at the point of use."

The three thermoelectric units, strapped together to provide common hot and cold junctions, draw about 16 amp and are 50 per cent efficient.

### **Reliable Operation Is Essential Because of Camera's Inaccessibility**

The rest of the camera, however, is cooled by forced air at 140 F and operates at 160 F. Reliable operation despite elevated temperatures is particularly important because of the camera's relatively inaccessible location and a need for maintaining uninterrupted three-shift operation at the mill.

Much of the circuitry normally contained in a television camera was moved to more accessible boxes elsewhere on the crane. Only a 10-mc video preamp strip was retained in the camera. Frame grid tubes, tantalum



**Interior of camera.** Left to right: aperture and focus controls, 10-mc video preamp strip, and vidicon tube enclosed within the thermoelectric coolers.

capacitors and military components rated for 125 C service are used throughout. Modular construction is employed to speed maintenance.

The camera also includes motor-driven focusing and lens-aperture controls. The aperture controls respond automatically to the video signal level and adjust the lens diaphragm and vidicon target voltage to accommodate an illumination range of more than 20,000 to 1. This readily covers the brightness range encountered between the white-hot soaking pit and the rest of the mill.

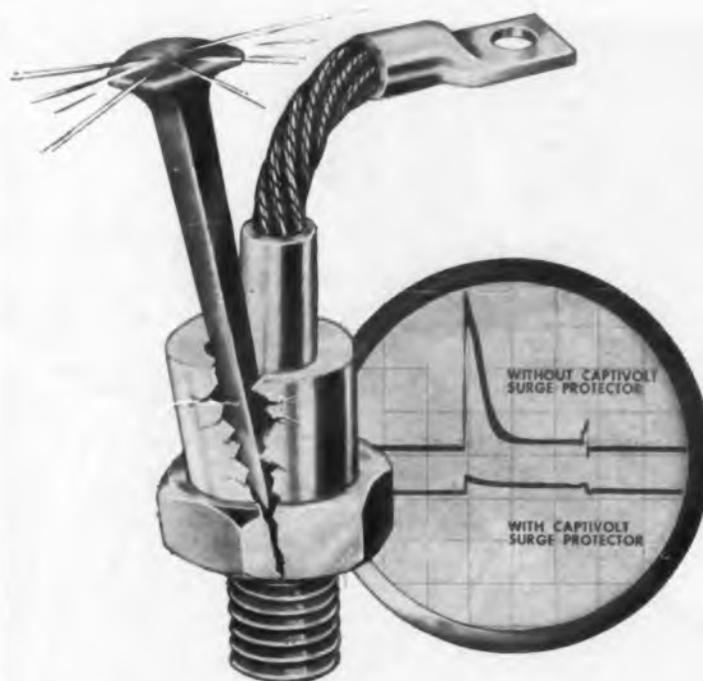
Other components of the television system, including the camera control unit, power supplies and voltage regulators are also designed for high-temperature operation. About one-third of the circuitry, including the synchronizing generator and portions of the power supply, are transistorized. Silicon units are specified.

The control unit is enclosed in a watertight case to exclude the ultrafine steel dust emanating from the soaking pits. Cooling is by means of a heat exchanger employing ambient air at 140 F.

Video signals are transmitted from the mobile crane to monitor viewers by slotted line and antenna probe arrangement.

Five of these television systems have been delivered by General Precision Laboratory. Initial units already installed are reported to be operating around the clock for several months between servicing. ■ ■

ELECTRONIC DESIGN • July 5, 1961



**VICKERS CAPTIVOLT**

**stops surges... saves cost!**

Transient high voltages—often of unpredictable magnitude—can destroy silicon power rectifiers. Even derating rectifier cells doesn't always guarantee protection.

But here's something that *does* protect against destructive surges: the Vickers Captivolt, a single simple component that provides rectifier reliability, assures extended life, and eliminates expensive derating. Yet the Captivolt itself is a dependable low-cost unit easily installed by connecting across the transformer secondary supplying AC to the rectifier. Captivolts consume less than 5 watts steady-state... but capture and absorb unpredictable surge energy up to 12,000 watts with 0.05 micro-second response.

Under normal steady-state operation, the Captivolt appears as a very high resistance shunted by capacitance. The capacitance protects by absorbing very fast transient wave-fronts. When a critical voltage level is reached, the normal high resistance falls abruptly to a very low value, shunting long-duration destructive voltage transients. Resistance decreases logarithmically with voltage increase. In summary, Captivolts (1) provide rectifier reliability and extended life, and (2) often save more than \$50 initial rectifier cost with a Captivolt cost of less than \$3.

P.S. Captivolts protect *other* circuits, too: transistors, controlled rectifiers, meters, solenoids, relays, etc.

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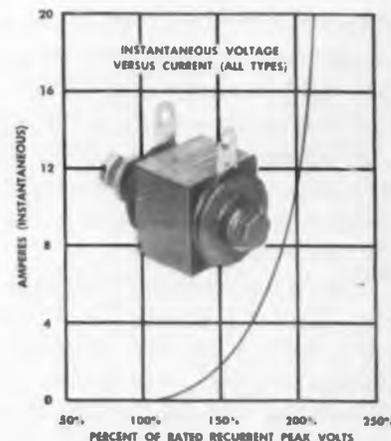
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SILICON RECTIFIERS**

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SP102	25	17.5	10	\$1.80
SP105	50	35	12	1.95
SP110	100	70	14	2.20
SP115	150	105	17	2.50
SP120	200	140	20	2.70
SP125	250	175	23	2.95
SP130	300	210	26	3.15
SP140	400	280	32	3.70
SP150	500	350	38	4.20
SP160	600	420	44	4.65

Convection cooling. If fan cooling at velocity of 600 CFM is employed, multiply watts by two (2).



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## Milestones in Engineering

When the sword was still the basic personal weapon, military swordsmen from all parts of the world converged upon Toledo, Spain, for the finest swords—the famed “Toledo blades.”

Soldiers whose very lives depended as much upon the quality of their weapons as upon their personal skill would settle for nothing less than the very best.

This first application of the principle of “Mil Spec” buying has been refined and tightened until, today, components intended for use in military equipment must be designed and built to meet the most exacting specifications, pass the most demanding tests, satisfy the most rigid requirements.



North Electric “240” 4 pole and “260” 6 pole sub-miniature sealed relays are precision designed and engineered to obtain maximum switching circuits in minimum space and meet specifications of MIL R-5757D at a breakthrough in price!

These heavy duty relays, which incorporate precision balanced rotary motors to withstand shock tests of 50 Gs and vibration tests of 1000 cps at 10 Gs, have a life expectancy in excess of 100,000 operations at rated load.

Continuous testing for over two years assures superior performance and maximum reliability in rigorous airborne and missile and industrial applications. For detailed specifications, write

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CIRCLE 14 ON READER-SERVICE CARD

## NEWS

### Foxboro Ends Exclusive Pact With RCA for Control Systems

Foxboro Co. of Foxboro, Mass., has severed its exclusive arrangement with Radio Corp. of America for joint development of industrial computer-control systems. The decision was announced in a statement that Foxboro has sent to its customers.

Foxboro, an instrumentation manufacturer, said it had become “sobered” by the many large technical and economic roadblocks to computer control of industrial processes. The company had been cooperating with RCA’s Industrial Computer Div. in nearby Needham, Mass.

Now, Foxboro says, it will be freer to pursue more immediate, smaller-scale analog computer solutions to industrial automation.

Another reason for the Foxboro move, industry sources speculate, is that the company will now be in a position to sell its “sub-loop” equipment to other digital process-control computer manufacturers.

### New National Group to Study Business Data Processing

A National Committee for Business Data-Processing is being formed under the sponsorship of the Association for Computer Machinery. Its fields of interest will include business theory, operations research, management gaming, simulation and forecasting techniques, as well as the more usual business data-processing functions.

The association said that the formal organization of the committee would be completed at its September meeting in Los Angeles.

### Mobile Ground Surveillance Radar Will Be Modified AN/TPS-25

The Army’s first mobile radar set for ground surveillance is under development by Hazeltine Corp. as a modification of the shelter-housed AN/TPS-25 set now in operational use.

Conversion of the Hazeltine-built AN/TPS-25 for use on tracked amphibious armored personnel carriers will involve three alterations: replacement of fixed antenna by a 25-ft telescoping antenna mast for “quick look” capability at longer range; a smaller plotting board; and addition of an ac to dc

converter for the 115-v, 400-cycle, gas-driven power unit.

The telescopic antenna will enable the set to detect moving targets at a range of more than 11 miles. At closer range, the set has the capability of distinguishing between the walk of a man and a woman up to a mile away.

### Device Measures Blood Volume With Improved Speed and Accuracy

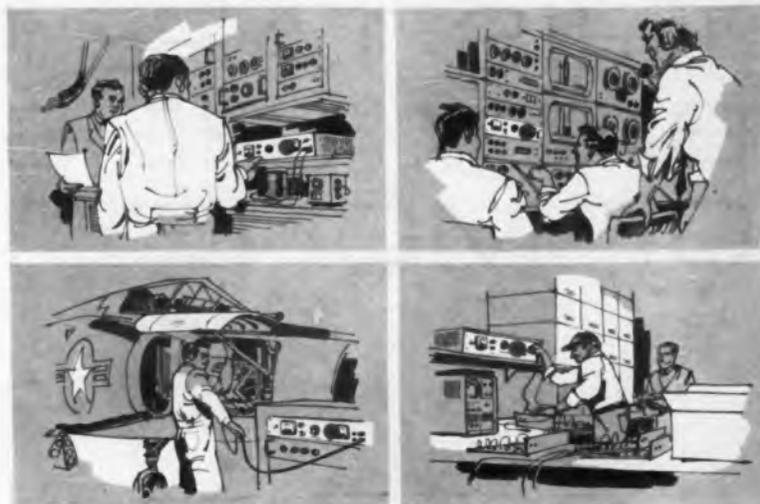
A new instrument, the Volemetron, measures blood volume—or the volume of plasma or red cells—quickly and accurately. Regarded as a boon to surgeons, the instrument obviates the usual guess-work as well as the inaccurate method of weighing blood-soaked sponges (which does not account for blood on the patient or on the drapes).

Accurate to within 5 per cent, this transistorized product of Atomium Corp., a Waltham, Mass., affiliate of Perkin-Elmer Corp., uses well-known dilution-monitoring techniques. A measured amount of radioactive iodine is injected into the blood and allowed to circulate for a few minutes. After it is diluted in the blood stream, a sample of the isotope-diluted blood is placed in the Volemetron. A calibrated meter shows the blood volume in about a minute.

The instrument should help surgeons avoid the dangers of over or under-replacement of lost blood. While the Volemetron can be used by relatively unskilled personnel, earlier isotope-dilution measurements required highly skilled personnel with very complex instrumentation. The instruments were normally located in laboratories remote from operating rooms.



Transistorized digital circuitry counts output of scintillation counter which gives indication of radioactivity in patient's blood sample. Accurate measurements are first made of background radiation in patient's blood before he receives injection of measured dose of radioactive iodine.



# 400 CYCLE SERVICE... ANYWHERE

Whether you're developing an advanced servo system, verifying inertial guidance performance, checking out aircraft instrumentation or testing radar subassemblies — the chances are you need a convenient source of 400 cycle power. With MRC's portable frequency changer, 400 cycle service is within plug-in distance of the nearest 115 volt AC outlet. There's no more need to depend on limited availability of built-in 400 cycle utility service — where troublesome line fluctuations can disrupt sensitive tests. The solid state converter weighs only 30 lbs., yet provides 100 VA's of well regulated sinewave power—free of distortion and unaffected by line or load changes. Its static, solid state design assures cool, efficient and silent operation. For added flexibility, it's packaged for either bench or rack mounting. Let this versatile unit assure you of dependable 400 cycle service... anywhere!



MRC MODEL 46-130-0 SOLID STATE FREQUENCY CHANGER. PRICE \$545.  
(slightly higher with case and meters)

#### SPECIFICATIONS

Input	105 to 130 VAC, 47 to 1000 cps, 2.5 amps max.
Output	115 volts, 400 cps, single phase sinewave; voltage adjustable from 105 to 130 volts; 100 volt amp continuous duty, 150 volt amp intermittent duty
Output Regulation	±1% over full line or load change; response time 30 milliseconds (nominal)
Harmonic Distortion	less than 2% under severest line and load conditions
Frequency Stability	±¼% over max. line and load change, or over ambient temperature range (0° to 40°C)
Frequency Setting	400 cps ±0.5%
Synchronization	25V RMS, 2000 ohms impedance; range 390 to 410 cps
Dimensions	3½" x 19" x 10½" max. depth (for standard rack mounting)
Weight	approx. 30 lbs. (rack mounting); 37 lbs. (bench mounting)
Design Features	automatic short circuit and overload protection; printed circuits. optional extras: easy vision panel meters and console case

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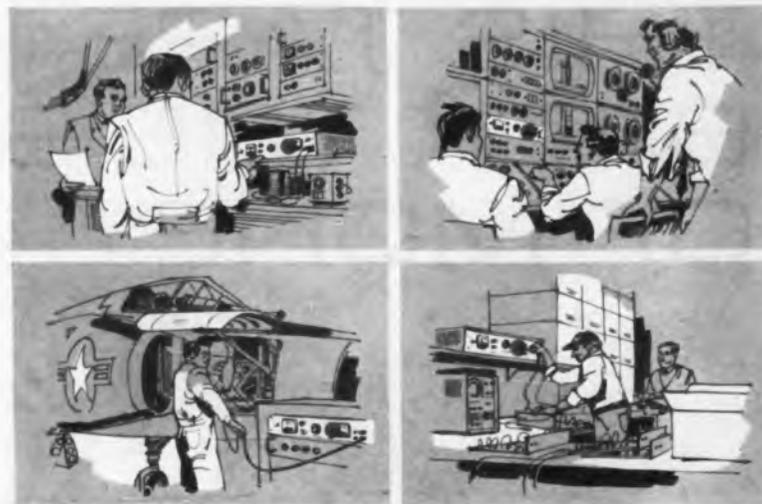
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## NEWS

### Styrofoam Antenna Can Be Built on Site

*New Radar Dish Reported to Weigh  
Fifth as Much as Metal Parabolics*

**A** LIGHTWEIGHT radar antenna of styrofoam planks is designed to be machined and assembled directly at the radar site.

It is, its developer says, only one-fifth the weight of metal parabolic dishes. Transportability and lightness are further enhanced by a novel antenna positioning device that employs a series of hydraulic jacks to steer the antenna.

The new dish was developed by Sylvania's Electronic Defense Laboratories of Mountain View, Calif. To construct it, one joins styrofoam planks into an egg-crate structure using urethane foamed-in-place seams. A computer-controlled milling machine, designed by Sylvania then automatically machines the reflector to the desired shape. For high-precision reflectors, a solid layer is first foamed-in-place over the cellular structure.

The reflective surface is then machined from this layer and is metalized by application of aluminum foil or copper mesh. A final layer of foam is then applied to protect the reflective surface and to receive the mounting plate.

#### **Milling Maching Also Shapes Front End of the Antenna**

The front of the antenna is also contoured by the milling machine. This provides a slight amount of beam focusing, but, more important, it streamlines the antenna to reduce wind drag by as much as two-thirds over conventional parabolic reflectors, the company says.

The feed system is buried in the foam for rigid support. The outer surface is then covered with a white fiber-glass skin for weather-proofing and to minimize solar heating.

The computer-controlled milling machine that shapes the antenna consists of lightweight, readily disassemblable parts that can be conveniently transported to the fabrication site. Antennas up to 20 ft in diameter can be fabricated with the present machine. Equipment and techniques to make antennas up to 50 ft across are being developed.

# AMP INCORPORATED

GENERAL OFFICES: HARRISBURG, PENNSYLVANIA

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Foam antenna is examined by its developer, Mack Suliteanu, engineer at Sylvania's Electronic Defense Laboratories. Semi-transparent fiber-glass mesh covering the face of the antenna forms a base for a subsequently applied outer plastic coating. Note feed horn buried in the foam. The antenna is supported by a series of hydraulic jacks that can be programed to impart any desired tracking motion to the antenna.

The computer itself is an analog instrument, programed to fabricate a given contour by inserting pre-calculated constants into a series of potentiometers.

A hydraulic positioning system replaces the conventional system of mounting rings, bearings and driving motors. The antenna is supported by four tripods, each consisting of three hydraulic jacks. Programed changes in the length of each leg, controlled by a digital computer and hydraulic servo steer the antenna through any desired search or track pattern.

Operation of the positioning system has been confirmed by manual programing, but the computer required for automatic operation is still in development.

This arrangement results in an unusual antenna motion. In a 360-deg horizon search, for example, the antenna rolls on its edge through a full circle. In overhead tracking, the reflector merely flips over between opposite horizons.

The hydraulic positioner is "much faster" than conventional antenna drives, according to a Sylvania spokesman. This is due to the inherently fast response of the hydraulic system and to the reduced inertial and gyrating loads of the foam antenna with its unusual rolling motion.

The antenna and positioning system were developed under a contract from the Army Signal Corps. ■ ■

## VITRAMON, INC. Develops Dramatically Improved Dielectric Material

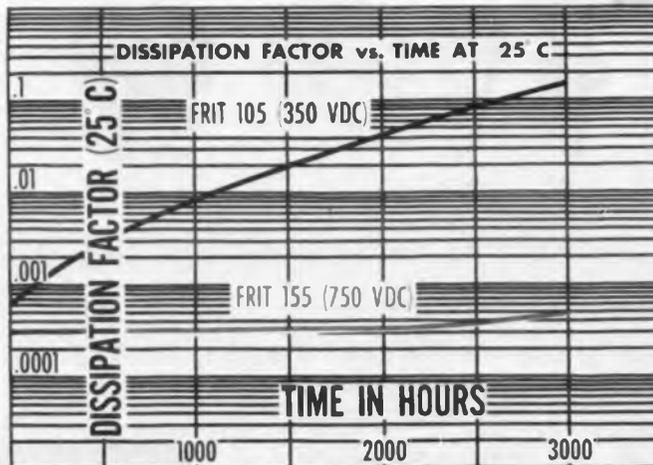


**SOLID STATE  
PORCELAIN  
CAPACITORS**

with **NEW #155 "FRIT"**

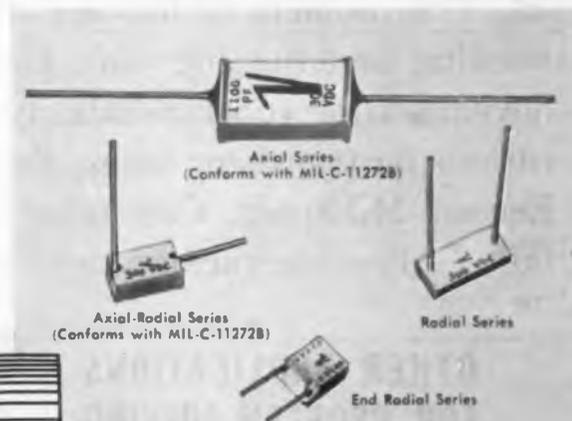
# ASSURE 10 TIMES BETTER PERFORMANCE AFTER A LIFE TEST 10 TIMES MORE DEMANDING!

Three years of intensive product research, and the desire to impose a more exacting quality control during production, have resulted in the development of a new porcelain "frit." Completely formulated and produced within our own plant, this high quality dielectric material, utilized for the improved "VY" Porcelain Capacitors, has produced dramatic results.



NOTE: Offered Exclusively For MIL-C-11272B Requirements.

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When tested at 125 C with more than twice previous test voltages applied (750 VDC vs 350 VDC and 450 VDC vs 200 VDC) and with the time extended to 2000 hours (more than 10 times as stringent a test) post-test dissipation factor is .002 max. and insulation resistance is greater than 100,000 megohms (10 times better)!

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# BEFORE YOU BUY ANY MORE TRANSISTORS,



**MAKE SURE THEY HAVE CERAMETERM\* BASES.**

(CERAMIC-METAL TERMINAL)

**THIS WILL SOLVE THREE TOUGH PROBLEMS**

**1.** Soldering heat that causes ordinary glass to crack. **2.** The problem of glass insulation cracking through shock or impact. **3.** The problem of leakage due to glass insulation failure when bending or adjusting pins. Cerameterm terminals were specially developed for super reliability on severe high-performance applications for transistor bases, diodes, rectifiers, relays, and capacitors. Exceed Mil-Specs. Can take 11,000 psi shearing stress without failure. Provide vacuum-tight seal. Ideal for encapsulated devices.

## OTHER APPLICATIONS FOR PROBLEM-SOLVING CERAMETERM TERMINALS



Special

Feed-thru

Terminal

Multiple header

Above are a few examples of how Cerameterm is applied to a wide variety of electronic components. We also design to specific needs in such problem areas as transformers, condenser banks, relays, and similar high-performance electronic equipment.

\*Trademark for Bendix' practically indestructible, alumina-insulated ceramic-metal terminal assembly.

ELECTRON TUBE PRODUCTS

**Red Bank Division**

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## NEWS

### Nationwide Data Loop Speeds Airline Work

*1,000-Station Centralized System  
Uses Both Fast and Slow Bit Rates*

**A** NATIONWIDE data-processing loop linking all ticket agents of United Air Lines to a central computer has been put into operation.

The loop has:

- A main trunk in which the data are transmitted at 1,000 bits per sec.
- Secondary lines, which feed into the main trunk at 75 bits per sec. Once the information reaches the main trunk, however, it is speeded to 1,000 bits per sec.

The system handles flight reservations from 1,000 stations around the country to a central processing terminal in Denver. Agents in major cities—about 80 per cent of all the agents—are linked directly to the fast trunk, and those in smaller cities to the slower lines. Use of the slower lines permits a considerable savings in operating costs.

The loop, called Instamatic, was designed for United Air Lines by the Teleregister Corp. of Stamford, Conn. Data communication equipment was constructed by North American Philips Co., Inc., of New York City.

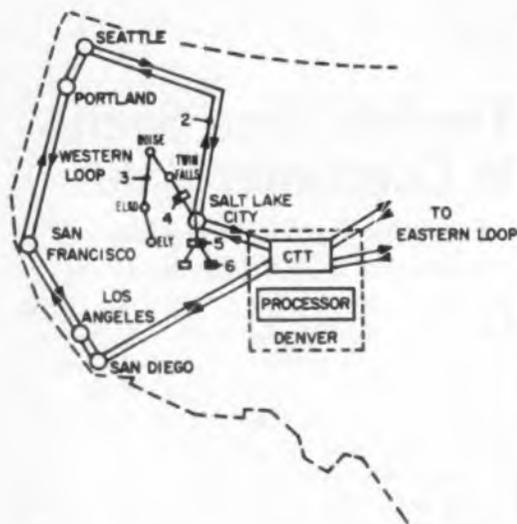
#### Central Units Include Trunk Terminal, Computer and Memory

The electronic equipment in the system includes a Central Trunk Terminal in Denver and a series of concentrators along two loops running east and west from Denver. Each loop is composed of two telephone trunk lines that carry traffic at the rate of 1,000 bits per sec in opposite directions.

A central processing computer and memory storage unit is also in Denver.

The central terminal links the trunk lines with the processor. Equipment at the terminal regulates information going into and out of the computer, handles the reception and transmission of traffic through the trunk lines, and detects errors in messages by applying horizontal and vertical parity checks.

Messages concerning such information as availability of space on a certain flight are generated and received at agent sets. These



Map of western portion of Instamatic flight-reservation network shows (1) Concentrator, (2) High-speed trunk line, (3) Low-speed line, (4) Distant Central Office Transceiver, (5) Keyset Multiple Selector, and (6) Agent set.

sets also contain printing units on which reservation confirmation information and cancellations are printed.

At the concentrators, messages are handled and operations carried out at the rate of 54,000 per hr, Philips says. The concentrators along the trunk lines continually read the addresses of all messages passing through the circuit, determining whether they are for agent sets under their control or are to be forwarded. And they check them for errors.

#### 11 Switching to Spare Unit Possible in Case of Failure

Concentrators also answer test and supervisory messages from the control center in Denver. Finally, if necessary, they can switch traffic to a spare unit should there be a mechanical or electrical failure.

Theoretically ticket agents can receive information about the availability of seats on a given flight up to a year in advance. The average elapsed time from the moment an agent on the main trunk sends the question until he receives an answer from the central terminal is 1 sec. Response time on the secondary lines is slightly longer, owing to the time lag in storage and re-transmission. Here it is about 5-1/2 sec.

Engineers have included in the system provisions for redesign and the addition of other services. These could include maintenance of passenger records, fare computations, flight-crew schedules, and anything else to insure a high operational speed. ■ ■

Extra quality at no extra cost with Bendix Semiconductors

# Bendix Bulletin

## ANOTHER BENDIX FIRST! 120-VOLT, 110°C. DAP TRANSISTORS

*Exclusive! Available with Cerameterm\* terminals that set new reliability standards*

Here's important news for you if you're a design engineer. New Bendix 10- and 25-amp DAP® diffused alloy power transistors switch high currents in *microseconds*. They also offer low input resistance for increased circuit stability over a temperature range from  $-60^{\circ}\text{C}$ . to  $+110^{\circ}\text{C}$ .

That's not all you get with these new DAP transistors. They're also available with new Cerameterm (ceramic-metal terminal) bases specially developed by Bendix for extra reliability in severe applications demanding high performance.

Only Bendix brings you all these advantages . . . plus many more . . . that open the door wide to new design ideas and applications. Write for full details.

\*TRADEMARK



Type Number	Absolute Maximum Ratings				Electrical Characteristics	
	V <sub>ce</sub> Vdc	I <sub>s</sub> Adc	P <sub>c</sub> W	T <sub>j</sub> °C.	h <sub>FE</sub>	β <sub>dc</sub>
2N 1073	40	10	60	110	20-60	5 Adc
2N 1073A	80	10	60	110	20-60	5
2N 1073B	120	10	60	110	20-60	5
*BC 1073	40	10	60	110	20-60	5
*BC 1073A	80	10	60	110	20-60	5
*BC 1073B	120	10	60	110	20-60	5
B 1274	40	10	60	110	50-120	5 Adc
B 1274A	80	10	60	110	50-120	5
B 1274B	120	10	60	110	50-120	5
*BC 1274	40	10	60	110	50-120	5
*BC 1274A	80	10	60	110	50-120	5
*BC 1274B	120	10	60	110	50-120	5
**2N 1430	100	10	60	110	20 min. 30-120	10 Adc 5
2N 1651	60	25	100	110	20 min.	25 Adc
2N 1652	100	25	100	110	20 min.	25
2N 1653	120	25	100	110	20 min.	25

\*The BC DAP transistor series uses Cerameterm ceramic-metal terminals for increased reliability.  
\*\*Designed to meet SCL 7002/25A.



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CIRCLE 19 ON READER-SERVICE CARD



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CIRCLE 20 ON READER-SERVICE CARD

## NEWS

### Twofold Rise Seen In Consumer Sales

*Executive Predicts an Industry  
Volume of \$21 Billion by 1970*

**C**ONSUMER electronic sales will double in the next decade—from \$10.2 billion last year to \$21 billion by 1970—W. Walter Watts, chairman of RCA Sales Corp., told the June 19-20 Chicago Spring Conference on Broadcast and TV Receivers.

Among the new products to be offered in the near future, he said, are multiplex adapters to receive the newly approved fm stereo broadcasts. More than 75 per cent of present fm stations have indicated they will be broadcasting stereo within a year or two.

Color TV, in which RCA pioneered, for many years, Mr. Watts said, is now included in the marketing plans of almost all major TV manufacturers. Closed-circuit TV for industrial uses and educational TV offer additional sales areas for the TV-set supplier, he added.

Other prospects listed by the electronic executive included transistorized TV sets, electronic air-conditioners and home videotape recorders. These await clever ideas by design engineers, he said.

Various approaches to the design of multiplex adapters were discussed at the conference. Major manufacturers are ready to supply adapters that are either self-powered or obtain power from the basic fm tuner or amplifier chassis, it was indicated. Several one-tube and two-tube schemes have been devised, it was brought out, but most manufacturers prefer to field-test their units rather than risk consumer drop in interest following hasty, premature product delivery.

The radio-TV industry has long awaited

**Table 1. Per Cent Tube Failures by  
Year and by Circuit Application**

Circuit	July to July Test					
	1954 1955	1955 1956	1956 1957	1957 1958	1958 1959	1959 1960
Horiz. Defl. Amp.	25	34	17	10	10	5
Vert. Defl. Amp.	25	29	16	3	5	1
Damper	33	17	9	15	9	15
VHF Amp.	22	18	7	12	10	5
UHF Osc.	—	—	—	14.6	7.4	12.4

**Table 2. Per Cent Tube Failure By Cause and Year**

Cause	1955	1956	1957	1958	1959	1960
Open Heater	1.86	1.775	1.025	1.17	0.73	0.725
Shorts	2.02	1.17	1.19	0.935	1.08	0.83
Arcing	—	0.72	0.22	0.56	0.34	0.76
Gas	1.50	0.82	0.29	0.14	0	0
Other (20 items)	1.35	1.37	1.20	1.5	1.45	1.3

stereo fm approval as a boom to a saturated and dropping TV market, conferees said privately. Pessimists were wary of rushing into production and delivery without adequate field experience.

Strides in receiving tube reliability were outlined by a company applications engineer, E. H. Boden. In 1954, he said, Sylvania began a reliability study TV receiver tubes. The tubes were operated in various manufacturers' sets under 130-v ac input for 50 min, turned off for 10 min and then turned on again. This cycle was repeated each hour for 1,500 hr. Mr. Boden noted that 59 per cent of the tube failures occurred in five circuits: horizontal-output, damper, vertical-deflection-amplifier, rf-amplifier and uhf-oscillator.

From 1955 to 1960, he said, horizontal-amplifier failure was reduced from 34 per cent to 5; vertical-amplifier from 29 per cent to 1, and rf-amplifier from 22 to 5 per cent (see Table 1 and 2). Tubes exhibiting no failure after 1500 hr at 130-v ac cycling, increased from 38.5 to 72.5 per cent. From tests comparing the life of single and double-section tubes used in similar applications, Mr. Boden reported, Sylvania concluded that no serious difference in reliability was noted. ■ ■

### Pigeon Wired for VHF Tracking



Miniature vhf transmitter riding piggyback on this homing pigeon was used to track the bird for 25 miles. The 140-mc, crystal-controlled transmitter, powered by four mercury cells, delivers about 1 mw to a modified half-wave dipole antenna. The 5-oz transmitter package was developed by American Electronics Laboratories for an animal homing instinct study of the Office of Naval Research.



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For several years Tung-Sol has been manufacturing high-power germanium transistors to the industry's most exacting standards of electrical and mechanical reliability.

They have proved themselves efficient and fully reliable in countless installations, providing rugged, long-life performance for equipment in commercial and military use.

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The Tung-Sol line offers widest applicability in high-power amplifiers, DC-to-AC converters, DC-to-AC inverters, regulated power supplies, motor controls, servo amplifiers, relay drivers and high-power switches.

Designed for wide interchangeability, they may be specified for new, improved equipment. Their features of vacuum-tight, copper-to-copper "Cold-Welded" sealing increase design flexibility and make them more reliable. Stud-mounted, single-end construction, with solid-lug terminals, simplifies

installation in all chassis and allows sufficient heat-sink design.

Ask your Tung-Sol representative for full technical details, or write: Tung-Sol Electric Inc., Newark 4, N.J. TWX: NK 199.

### TUNG-SOL HIGH-POWER GERMANIUM TRANSISTORS

TYPE	MAXIMUM RATINGS (25°C)				TYPICAL VALUES (25°C)			
	V <sub>ce</sub> Volts	V <sub>ce</sub> Volts	I <sub>c</sub> A	T <sub>J</sub> °C	MAX. I <sub>cbt</sub> mA	R <sub>θc</sub>	f <sub>os</sub> kc	MAX. T <sub>h</sub> °C/W
2N173	-80	-80	16	100	8	52	10	.8
2N174*	-70	-80	15	100	8	57	10	.8
2N174A	-70	-80	15	100	8	57	10	.8
2N277	-40	-40	15	100	8	62	10	.8
2N278	-48	-50	15	100	8	62	10	.8
2N441	-60	-60	15	100	8	30	10	.8
2N442	-48	-80	15	100	8	30	10	.8
2N443	-80	-80	15	100	8	30	10	.8
2N1089	-70	-80	15	100	8	52	10	.8
2N1100	-80	-100	15	100	8	57	10	.8
2N1388*	-70	-80	15	100	8	57	10	.8
2N1412	-80	-100	15	100	8	57	10	.8
2N1970	-80 (1)	-100	15	100	4	29	10	.8

(1) BV<sub>ceo</sub>

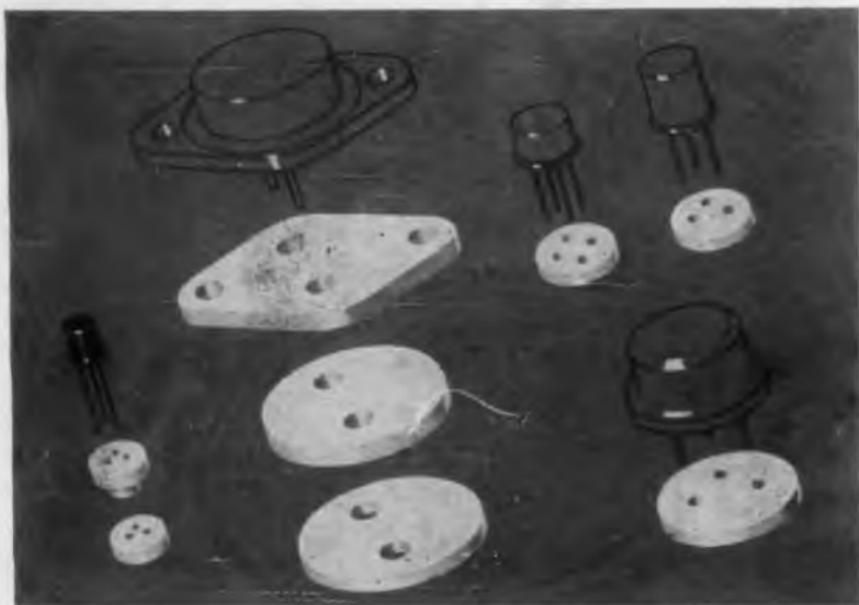
TECHNICAL ASSISTANCE IS AVAILABLE THROUGH THE FOLLOWING SALES OFFICES: Atlanta, Ga.; Columbus, Ohio; Dulver City, Calif.; Dallas, Tex.; Denver, Colo.; Detroit, Mich.; Irvington, N. J.; Metrose Park, Ill.; Newark, N. J.; Philadelphia, Pa.; Seattle, Wash. In Canada: Abbey Electronics, Toronto, Ont.

\*Also available in military versions.

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- Freedom from outgassing
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#### MECHANICAL PROPERTIES

Transverse Bending Strength 25,000 psi      Compression Strength 200,000 psi

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Dielectric Constant 1 mc 7.0, 10 mc 5.8, 8500 mc 6.0

Dielectric Loss Tangent 1 mc less than .0005, 10 mc less than .0005, 8500 mc .0008

Electrical Resistivity—greater than 10<sup>15</sup> ohm-cm      Dielectric Strength—greater than 300 volts/mil

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CIRCLE 22 ON READER-SERVICE CARD

# WASHINGTON REPORT



**John J. Christie**  
Washington Editor

## **A PREMIUM ON SPACE TALENT**

The proposed all-out acceleration of the National Space Program puts NASA in the market for a wide range of professional and technical skills. Of particular concern to the agency is its need for personnel to fill key professional and administrative posts, carrying responsibilities for which industry is willing to pay from 25 to 100 per cent higher salaries.

NASA is now seeking a bigger allotment of grades eligible for salaries above the ceiling for career Government service. Its present authorization is for 290 such positions at salaries up to \$19,000, with 17 of them earmarked for a special top bracket of \$21,000. The agency has requested Congress to authorize 135 more "excepted" positions for a total of 425, of which 30 would be in line for the \$21,000 maximum. In order to hold key personnel, NASA would reserve some of the new salary authorizations for its present staff. But, many of the new posts would have to be filled from the outside.

The agency is currently engaged in a recruiting drive to fill some 500 jobs ranging from technicians to experienced scientists. Its campaign has included the college campuses, where last year NASA representatives interviewed 3,000 grads in competition with industry's talent scouts. In fiscal '62 a 4,000 increase in personnel is projected.

***Industry's Space Work Load*** will increase sharply along with NASA'S, if, as seems likely, Congress goes along with the President's recommendation that the nation mount a crash program to gain undisputed leadership in lunar and planetary exploration. It will be primarily an R&D workload, with heavy demand for top-flight scientists.

Congress willing, the space agency's estimated expenditures in fiscal '62 will total an estimated \$1.7 billion for an increase of 43 per cent over the original budget submitted by the outgoing Eisenhower administration. Of this amount, almost \$1.3 billion is earmarked for R&D, with the man-in-space program getting the overwhelming share.

Space agency procurement officials estimate that at least 80 per cent of NASA'S R&D spending will be placed under contract with industry, the universities and other private organizations. These officials are now at work revising procedures in an effort to reduce time lags in selecting contractors and conducting contract negotiations.

## **AIR FORCE TO PUSH DATA AUTOMATION**

Incentive type CPFF contracts have been used to a limited potential of data automation techniques is the Air Force decision to set up an office to coordinate and foster improvements in automated data-processing systems for both administrative and command and control functions.

The new activity, which will become operational Aug. 1 under the Air Force Comptroller's Office, will evaluate the data requirements and existing data-processing facilities of all administrative

more precisely, to foster development of new system design concepts and to seek improvements through the re-engineering of existing facilities.

### **IN SEARCH OF COMPETITION**

Top Defense Dept. officials have promised Congress an intensive new effort to curtail sole-source procurement, which is chiefly responsible for the fact that 60 per cent of military contracting is noncompetitive.

The growing complexity of military hardware and the frequent need for telescoping development and first-run production to shorten lead time inevitably have fostered single-source buying. But while award of first-run production to development contractors is considered a justifiable expedient in most cases, defense officials readily acknowledge that the services should seek competition for follow-on production.

**Delayed Delivery of Technical Data** and manufacturing drawings accounts for a good deal of the failure to shift promptly from single-source to competitive buying. Thus the Pentagon intends to ride herd on procurement agencies to see that the Government gets the data to which it is entitled in time for competitive re-procurement. Contractors may be subject to financial penalties for failure to meet contract provisions on this score.

Such action, in turn, will require further steps to insure that the data ordered by the procurement agencies are adequate for re-procurement. Studies have indicated considerable laxity in specifying the Government's rights to data during contract negotiations.

In some cases, data are unavoidably incomplete because contractors withhold "proprietary" information. However, regulations defining such information are currently under review, and indications are that contractors will be subject to further restrictions on what they can claim as trade secrets.

Despite all efforts to correct deficiencies, some sole-source procurement will persist, even though adequate technical data and drawings are available, for the reason that quality cannot otherwise be assured.

### **NEW COST REDUCTION TACTICS**

The Pentagon has instituted what amounts to an R&D program on contracting techniques. It is investigating all sorts of schemes to achieve tighter control of costs under the controversial cost-plus-fixed-fee contracts, which now account for 42 per cent of military expenditures, compared with 24 per cent only five years ago.

CPFF contracts, like sole-source procurement, started as an expedient but rapidly became common practice owing to the difficulty of projecting costs for complex weapons systems and to the pressure for concurrent development and production.

Incentive type CPFF contracts have been used to a limited extent in an effort to capture the profit motivation and risk-taking inherent in fixed-price contracts. Defense officials now want to make greater use of incentive contracting. But they also want to provide a wider range of incentives and stiffer penalties, as well as more effective means of evaluating technical and cost performance.

**Imaginative, If Nothing Else**, is a proposed new form of incentive contract dubbed the "cost-plus-award-fee contract." It would provide that a board of assessors evaluate a contractor's technical and cost performance during the life of a contract and determine his exact fee on completion of the work.

Something  
**NEW**  
 in counting  
 techniques!



## Sprague type 73Z1 core-transistor **DECADE COUNTERS**

Sprague's Special Products Division, the largest and most complete facility in the magnetics industry, offers a simple yet versatile, low-cost yet reliable component for counter applications. Counting to speeds of 10 kc, the 73Z1 decade counter provides an output signal for every 10 input pulses, then resets in preparation for the next cycle. For higher counting, two or more counters may be cascaded. Typical characteristics are shown in the following table:

CHARACTERISTIC	INPUT	OUTPUT
Amplitude	1.5 to 8 volts	6.5 volts min.
Pulse Width	1 $\mu$ sec min.	50 $\mu$ sec nom.
Impedance	100 ohms	20 ohms

Utilizing two rectangular hysteresis loop magnetic cores and two junction transistors to perform the counting operation, the 73Z1 counter is encapsulated in epoxy resin for protection against adverse environmental conditions. It has five terminals—B+ (12v  $\pm$  10%), input, output, ground, and manual reset.

The 73Z1 decade counter is available as a standard item. However, "customer engineered" designs can be supplied when other counting cycles, speeds, and package configurations are required for special applications.

Other Special Products Division components for the digital equipment industry include: LOGILINE 5 mc/s digital circuits; 1  $\mu$ sec access time memory; magnetic shift registers and logic components; computer pulse transformers; switching transformers; precision toroidal inductors.

*For complete technical data or application assistance on the 73Z1 counter or other Sprague components, write to Special Products Division, Sprague Electric Co., 347 Marshall Street, North Adams, Massachusetts.*

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CIRCLE 24 ON READER-SERVICE CARD

## NEWS

### 400-Cps Phase-Shift Standard Useful from 0 to 180 Deg

Designers at the National Bureau of Standards, Washington, D. C., have designed a phase-angle master standard said to be capable of measuring phase shift to within 0.01 deg at 400 cps. It can do this reportedly from 0 to 180 deg.

The instrument consists of 12  $\pi$ -sections each of 14.6 deg, and three 4.3-deg  $\pi$  sections, plus switching arrangements that permit any combination of sections to be connected as a delay line. It was considered desirable, the bureau reports, to provide several different phase-shift steps and a continuously variable fine control.

The input to the delay line is used as part of an RC network that incorporates 10 capacitor steps, each giving 0.44-deg of phase shift.

According to NBS, all  $\pi$ -sections must be exactly adjusted to have the same characteristic impedance in order to prevent reflections and to make the phase shift put in by the RC circuit independent of the number of  $\pi$ -sections connected.

Similar phase-angle standards could be made for higher audio frequencies, but the upper limit in frequency would probably be about 20 kc, the bureau believes. At higher frequencies, reportedly, stray capacitance introduced by connecting and switching leads might prove troublesome. However, it might be feasible to use the same master standard over a 2-to-1 frequency range by readjustments on the  $\pi$ -sections and termination for each frequency.



Phase-angle master standard designed by National Bureau of Standards operates continuously from 0 to 180 deg at 400 cps with 0.01-deg accuracy. One of the designers, H. N. Cones, adjusts a mercury contact for a portion of  $\pi$ -section used as delay line.

CIRCLE 25 ON READER-SERVICE CARD >



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 Face may be engraved • Bulbs easily replaced from front • Adaptable to any panel thickness • Suitable for military applications

TYPE SWITCH	W/O LAMPS Model No	WITH LAMPS Model No			COLORS 6 available Red, Green, Amber, Blue, Yellow, White	ENGRAVING
		6V	12V	24V		
Less Switch	1000	1006	1012	1024	Two colors furnished per unit —state which	Up to two lines per face
Easy Push DPDT Momentary	1100	1106	1112	1124		
Easy Push DPDT Maintained	1200	1206	1212	1224		
Firm Push DPDT Momentary	1300	1306	1312	1324		
Firm Push DPDT Momentary	1400	1406	1412	1424		
Firm Push SPDT Momentary	1500	1506	1512	1524		

Price depends on Matrix configuration. Please describe fully when requesting prices.

MODEL NO	LAMPS	PRICE	COLORS 6 available: Red, Green, Amber, Blue, Yellow, White	ENGRAVING \$1.50 per face
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7012	12V	\$8.25		
7014	14V	\$8.25		
7028	28V	\$8.25		



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## RELAY NEWS from Union Switch & Signal



### Contact Redundancy in New UNION Crystal Case Relays

The UNION 2-pole double throw General Purpose Crystal Case Relay is designed to consistently meet the requirements of Mil-R-5757D and Mil-R-5757, 10. Its essential features . . . from minimum size to optimum reliability . . . permit it to be used in aircraft, guided missiles, shipboard and ground control electronic equipment.

A unique torsion-wire armature suspension system and a rugged all-welded frame construction provide a high level of vibration and shock immunity. Contact redundancy, which assures reliability in dry circuit and higher level contact loads, is provided through the use of bifurcated contacts.

Available with 0.2" grid-spaced header or "S" type header, with various mountings, terminals, and operating voltages. Write for Bulletin 1064.



### Why UNION Relays Are So Dependable

There's a good reason why our relays are the standard for reliability. For years, we've been building tough, reliable relays for use in airborne and guided missile electronic equipment and similar vital applications where perfect operation under severe environmental conditions is mandatory.

Our engineers created a compact 6-PDT miniature relay with just three major assemblies . . . instead of a fistful of small parts. This was accomplished by using a balanced rotary-type armature that provided a maximum resistance to the severe shock and vibration environment of aircraft and guided missiles. The rotary principle of operation is utilized in all our relays.

We have a reputation for building reliable electronic components and we intend to maintain our tradition for building reliable relays. And we supply these quality relays in quantity. Stocks are now available for prototype requirements in New York, Pittsburgh, Dallas and Los Angeles.

### New 4-PDT-10-amp Relay Most Compact Rotary Type Available

This new durable relay is designed to meet the requirements of Mil-R-6106. It's a rugged relay featuring exceptionally sturdy terminals and husky contacts for high current applications. Glass-coated cylindrical contact actuators attached to the rotary armature provide square mating of contact surfaces, thereby assuring longer relay life. The balanced rotary armature provides maximum resistance to severe shock and vibration.

This small 4-PDT-10-Ampere relay is currently available with 115VAC and various DC operating voltages. Various mounting styles are provided. Write for bulletin 1069.



For additional information, write for Bulletin 1017 or call Churchill 2-5000 in Pittsburgh.



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CIRCLE 26 ON READER-SERVICE CARD

## Space Center Awards \$7 Million In Work Contracts in a Month

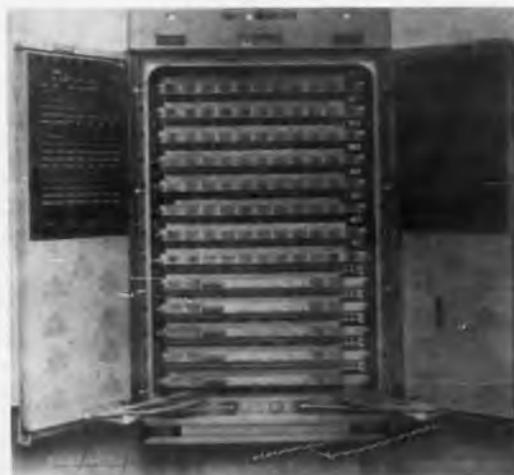
More than \$7 million in contracts were awarded in April by the George C. Marshall Space Flight Center of the National Aeronautics and Space Administration, Huntsville, Ala. Manufacturers and Government agencies in 16 states and the District of Columbia shared in the awards.

Of the total, more than \$2 million in work went to industrial concerns in Texas; \$2 million to private and Federal groups in Alabama, Florida, Georgia and Tennessee; \$800,000 in California; more than \$1 million in Connecticut, Massachusetts, New Jersey, New York, Pennsylvania and Washington, D. C., and more than \$300,000 in Indiana, Illinois, Michigan, Ohio and Wisconsin.

The contracts to manufacturers ranged from \$2,083,832 to the Chance Vought Corp. of Dallas, Tex. — the largest single award — for 70-in. fuel and oxidizer tanks for Saturn; to \$5,065 to the Interelectronics Corp. of New York City for transmitters.

Epsco, Inc., of Cambridge, Mass., has announced receipt of a \$360,000 contract from the Goddard Space Flight Center in Maryland for three pulse-code-modulation receiving stations.

## Million-Bit Computer Aids Navy



This real-time computer, designated AN/USQ-20V, collects, processes and evaluates naval tactical data in combat and recommends courses of action. The memory section contains 1 million bits of information. Thirty-bits, comprising a single word, can be drawn from any location in the memory in 2.5  $\mu$ sec. The computers are being produced by Remington Rand Univac, St. Paul, Minn., under a \$5,534,526 contract.



## Big help in thinking small: 7 times more cooling power with FC-75 and FC-43!

For substantial space-saving, weight-saving reductions in the design of electronic equipment, look to 3M Brand Fluorochemical Liquids FC-75 and FC-43! Their heat transfer capabilities are outstanding. Since these fluids boil at 100° C. (FC-75) and 180° C. (FC-43), their heats of vaporization can be used to effect heat removal by at least seven times the rate of non-volatile organic liquid coolants.

*Getting down to cases:* the heat removal capacity of FC-75 and FC-43 helped Hughes Aircraft designers to miniaturize the com-

munications power unit (shown above) by a factor of six. For Raytheon designers, a transformer was reduced by 4 to 1 in volume and by 2 to 1 in weight, without impairment of performance or power output.

*If you are designing in the electrical, electronics, missile or jet aircraft fields, look into the miniaturization help that the dielectric strength, limited solubility, thermal stability, and low pour points of FC-75 and FC-43 can offer. After reading the "Properties Profile," write for further information . . .*

### PROPERTIES PROFILE

#### on 3M Brand Inert Liquids FC-75 AND FC-43

These unique dielectric coolants possess unusual properties that can prove advantageous to the designer of electrical devices and instruments, as well as to the manufacturer. Increased range of operating temperatures, improved heat dissipation which permits miniaturization, and greatly increased protection from thermal or electrical overload are possible with their use.

FC-75 and FC-43 are non-explosive, non-flammable, non-toxic, odorless and non-corrosive. They are stable up to 750°F., and are completely compatible with most materials . . . even above the maximum temperatures permissible with all other dielectric coolants. Both are self-healing after repeated arcing in either the liquid or vapor state.

#### ELECTRICAL PROPERTIES

	FC-75	FC-43
Electrical Strength	35KV	40KV
Dielectric Constant (1 to 40 KC @ 75°F.)	1.86	1.86
Dissipation Factor (1000 cycles)	0.0005	0.0005

#### TYPICAL PHYSICAL PROPERTIES

	FC-75	FC-43
Pour Point	<-100°F.	-58°F.
Boiling Point	212°F.	340°F.
Density	1.77	1.88
Surface Tension (77°F.) (dynes/cm)	15	16
Viscosity Centistokes	0.65 min.	2.74
Thermal Stability	750°F.	600°F.
Chemical Stability	Inert	Inert
Radiation Resistance	25% change @ 1 x 10 <sup>6</sup> rads	25% change @ 1 x 10 <sup>6</sup> rads

FC-75 and FC-43 have nearly equivalent heat capacities in the liquid and gaseous states.

For more information on FC-75 and FC-43, write today, stating area of interest to: 3M Chemical Division, Dept. KAP-71, St. Paul 6, Minn.

CHEMICAL DIVISION  
**MINNESOTA MINING AND MANUFACTURING COMPANY**  
... WHERE RESEARCH IS THE KEY TO TOMORROW



CIRCLE 27 ON READER-SERVICE CARD



ting boards and other position-indicating equipment, inertial navigation equipment, bomb-director sets, anti-submarine warfare sets, and terrain-clearance radar.

The Ryanav IV employs continuous-wave electromagnetic energy at 13,300 mc. The set's antenna directs this energy toward the earth's surface in three narrow beams. The frequency of the energy back-scattered from the ground is "Doppler shifted" by an amount proportional to the aircraft's velocity along the individual beam. The three Doppler frequencies are measured and used to compute the aircraft's velocity components. This is accomplished in the converter/computer unit, which comprises a low-voltage power supply module, a frequency-tracker module, a frequency-converter and velocity-computer module, and a computer module.

The various configurations of the Ryanav IV family of Doppler ground-velocity indicators may omit, modify or add certain units to meet specific needs. Antennas can be provided to meet specialized aircraft structural or operational requirements.

## Maser Method Amplifies Sound



Direct amplification of sound waves using microwave radio energy has been achieved with this apparatus being assembled by Dr. E. B. Tucker of General Electric Research Laboratory. Amplification of the sound waves, or phonons, is accomplished by "stimulated emission" of energy by atoms as they change from higher to lower energy levels in a ruby crystal. The same mechanism is used in the maser (microwave amplification by stimulated emission of radiation) to amplify electromagnetic radiation.



### Said Isaac Newton:

*"Every particle of matter attracts every other particle with a force directly proportional to the product of their masses and inversely proportional to the square of the distances between them."*

Until recently, the thrust which propelled rocket vehicles into their coast stage, prior to orbiting, was provided by booster stages. The fuel carried by the satellite stage was used only to inject itself into orbit.

Now, however, a scientist at Lockheed Missiles and Space Division has evolved a Dual Burning Propulsion System which allows higher orbits and heavier payloads. With this system, the satellite vehicle fires immediately after the last booster stage burns out, thus augmenting the begin-coast speed. Later the satellite stage is re-started to provide orbit injection.

An even more recent development by Lockheed is a triple-burning satellite stage. This will permit a precise 24-hour equatorial orbit, even though the vehicle is launched a considerable distance from the equator.

These principles have made possible the early development of the MIDAS satellite. Moreover, they substantially increase the altitude and payload of the DISCOVERER series. Lockheed, Systems Manager for these programs and for the POLARIS FBM, is pursuing even more advanced research and development projects. As a result, there are ever-widening opportunities for creative engineers and scientists in their chosen fields.

Why not investigate future possibilities at Lockheed? Write Research and Development Staff, Dept. M-15E, 962 West El Camino Real, Sunnyvale, Calif. U.S. citizenship or existing Department of Defense industrial security clearance required.

*All qualified applicants will receive consideration for employment without regard to race, creed, color or national origin.*

## **Lockheed** / MISSILES AND SPACE DIVISION

*Systems Manager for the Navy POLARIS FBM and the Air Force AGENA Satellite in the DISCOVERER and MIDAS Programs*

SUNNYVALE. PALO ALTO. VAN NUYS. SANTA CRUZ. SANTA MARIA. CALIFORNIA • CAPE CANAVERAL, FLORIDA • HAWAII

## NEWS

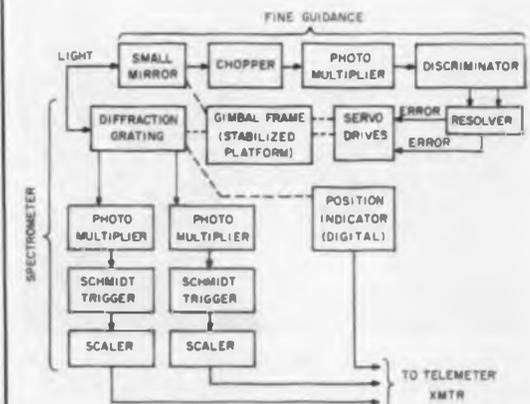
# Space 'Pointer' Slated With 6-Sec Accuracy

*Servoed System to Aim Spectrometer  
For Measuring UV Star Radiation*

**A** SPECTROMETER to be rocketed more than 62 miles above the earth will be aimed by a fine-guidance system, being designed for accuracy of  $\pm 6$  sec of arc over a  $\pm 2$ -deg field. The spectrometric system is intended to measure ultraviolet starlight in the 1,000-to-3,000-A range to a resolution of 2 A. It is planned for launching early in 1962 by Princeton University scientists working with the support of the National Aeronautics and Space Administration.

Coarse guidance will be provided by inertial gyroscopes, which are expected to stabilize the rocket to within  $\pm 1$  deg of the desired pointing position. The fine-guidance system, being developed by Perkin-Elmer Corp., Norwalk, Conn., will actuate servo controls to point the spectrometer with the anticipated 6-sec accuracy.

This system will stabilize in two axes and use a rotating-image technique that is said to be relatively simple. Servos will signal two gimbal ring mounts to adjust their axes and position the spectrometer's stabilized diffraction grating. The servo signals will be gen-



**Fine-guidance system** to aim ultraviolet spectrometer from rocket depends on rotating image formed by optical system to actuate servos that adjust gimbal ring mounts. Spectrometer is to be rocketed above the atmosphere early next year to analyze radiation from bright stars.

## NEW BORG MICROPOT<sup>®</sup> 2400 SERIES POTENTIOMETERS

- ★ 100 Ohms to 200K Ohms Resistance . . .
- ★ Meet Full Range of Military Specifications . . .

### 4 NEW SINGLE-TURNS

Feel the fine construction by turning the shaft . . . action is smooth, continuous . . . a feel of jeweled precision. See the extra strong design in the one-piece aluminum housing and front bearing mount. Note the rear covers fit precisely into machined shoulders to seal out dirt, vapors, corrosive atmospheres according to applicable mil specs.

Color-coded terminals are gold-plated for perfect solderability, corrosion-free shelf life. Element ends and terminals are welded to prevent loosening during application. All models are wirewound and linear. Standard bushing mounts have life-time lubricated sleeve bearings; standard servo mounts have two precision ball bearings. Precious metal contact and collector surfaces minimize noise, contact resistance and thermal effects over a long, trouble-free life. Complete data is yours by return mail.

REFERENCE-ACTION DATA

SPECIFICATIONS	2440 Series	2460 Series	2480 Series	2490 Series
Standard Resistance Range (ohms)*	500 to 50K	500 to 100K	100 to 125K	100 to 200K
Resistance Tolerance	$\pm 5\%$ to 10K $\pm 3\%$ over 10K	$\pm 5\%$ to 5K $\pm 3\%$ over 5K	$\pm 5\%$ to 5K $\pm 3\%$ over 5K	$\pm 5\%$ to 5K $\pm 3\%$ over 5K
Temperature Range ( $^{\circ}$ C)	-55 to +125	-55 to +125	-55 to +125	-55 to +125
Power Rating (watts)	3	4	5	6
Standard Linearity Tolerance (%)	$\pm 5$	$\pm 5$	$\pm 5$	$\pm 5$
Data Sheet	BED-A186	BED-A189	BED-A190	BED-A191

\*Other resistances available.

### BORG EQUIPMENT DIVISION

Amphenol-Borg Electronics Corporation  
Janesville, Wisconsin • Phone Pleasant 4-6616



3" Dia.  
2490 Series

ALL  
SHOWN  
ACTUAL  
SIZE

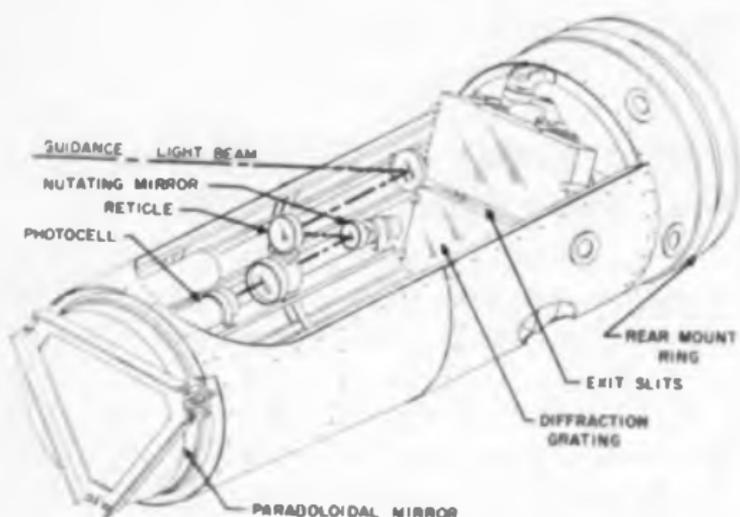
2" Dia.  
2480 Series

1-7/16" Dia.  
2460 Series

7/8" Dia.  
2440 Series



WRITE FOR  
DATA SHEETS OR  
CONTACT YOUR NEAREST  
BORG TECHNICAL  
REPRESENTATIVE



**Spectrometer** portion of system will fit in 30-in. long by 14-in. diam volume. Before fine-guidance system takes over, coarse positioning will be provided by inertial gyroscopes.

erated when a star's light beam is picked up on a rotating, tilted mirror and directed through a reticle. The segmented reticle will modulate the beam passing through it according to the amount and direction of error. The system is designed to scan its portion of the UV spectrum in units of 30 Å per sec.

The modulated beam, which is to contain information on the position of the star's image, will be focused on a phototube. The position data will be converted into error signals by an fm discriminator and resolver.

The 100-lb spectrometer package is to be 35 in. long by 14-1/4 in. diam. Radiation from stars will enter through an opening in the nose section of the rocket and will arrive at the instrument already collimated. After being diffracted, the radiation is to be focused on a photomultiplier detector to generate photon-count signals for telemetering to ground-receiving equipment. ■ ■

## Closed-Circuit TV System Used To Verify Check Signatures

A closed-circuit TV system used for verification of check signatures has been installed in the First Pennsylvania Banking and Trust Co. of Philadelphia.

The system, developed by John F. McCarthy, Inc., Philadelphia, uses cameras and components furnished by Philco Corp.

The teller phones the bank's Signature Dept., identifies his numbered station, and requests the specific account. The clerk at the other end pulls the card from its alphabetical file, places it face down on one of two cameras, and the reproduction appears on the monitor.



## SAVE SPACE WITH THIN, EXTRA-STRONG ELECTRICAL TAPES OF MYLAR®

Here's a pressure-sensitive tape that packs great strength into thinner gauges (20,000 psi for 1 mil). Tape of Mylar\* polyester film saves space because manufacturers can use thinner gauges with no loss in performance... at lower cost per linear foot.

Want more? "Mylar" also provides —flexibility for snug wraps—high dielectric strength (4,000 v/m†)—dimensional stability at high humidities —moisture and chemical resistance —resistance to temperatures from -60°C to 150°C. And "Mylar" lasts and lasts because there's no plasticizer to dry out with age.

Insulation of "Mylar" gives motors 50 to 100% longer service-free life. Gives capacitors longer-lasting stability, greater reliability. In a wide variety of electrical applications, the advantages of "Mylar" can improve the performance, lower costs. Evaluate "Mylar" for your product. Write for free booklet (SC) detailing properties. Du Pont Co., Film Dept., Wilmington 98, Delaware.



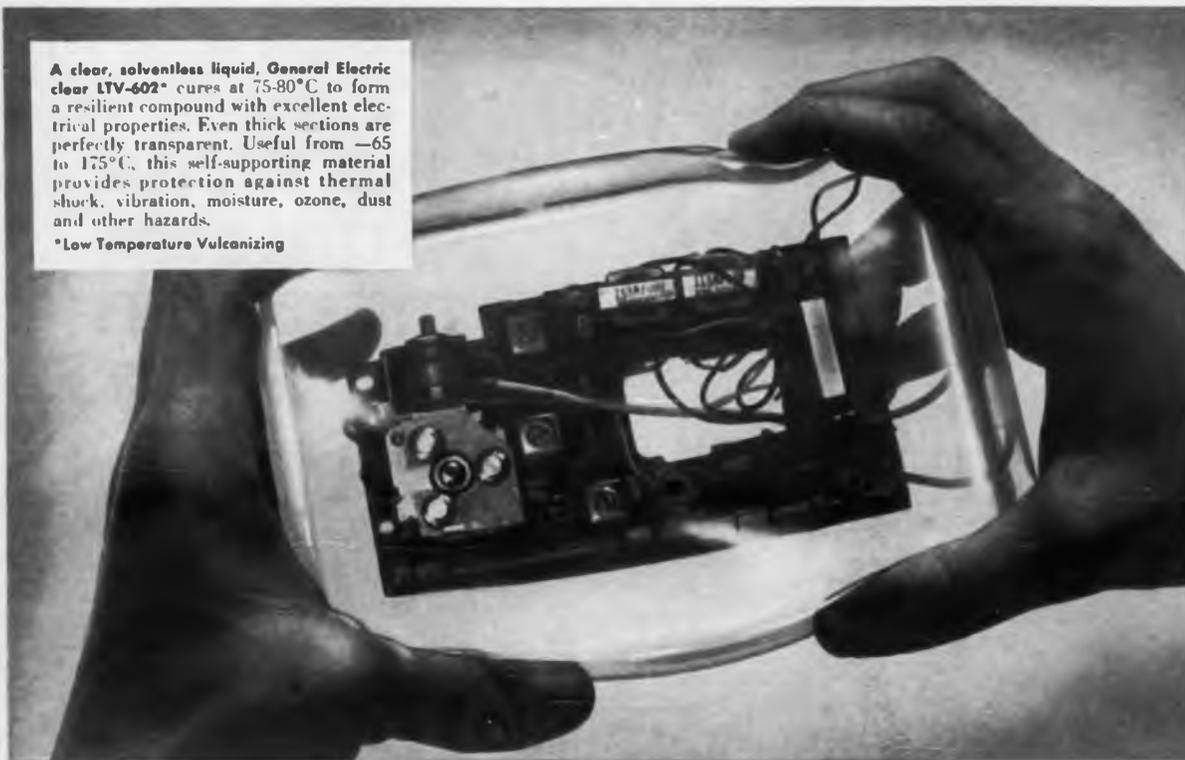
EST. U.S. PAT. OFF.  
BETTER THINGS FOR BETTER LIVING  
... THROUGH CHEMISTRY



\*Registered Du Pont trademark.  
†ASTM D-149

A clear, solventless liquid, General Electric clear LTV-602\* cures at 75-80°C to form a resilient compound with excellent electrical properties. Even thick sections are perfectly transparent. Useful from -65 to 175°C, this self-supporting material provides protection against thermal shock, vibration, moisture, ozone, dust and other hazards.

\*Low Temperature Vulcanizing



## General Electric clear LTV silicone compound for potting and embedding

*Transparent, resilient, self-supporting and easy to repair*



LTV-602 is easily applied, flows freely in-and-around complicated parts. Having a low viscosity in the uncured state, 800-1500 centipoise, LTV is ideal for potting and embedding of electronic assemblies. Unlike "gel-like" potting materials, LTV-602 cures to a flexible solid. Oven cure is overnight, or from 6 to 8 hours at 75 to 80°C.



LTV-602 is easy to work with and easy to repair. To repair parts embedded in LTV, merely cut out and remove section of material, repair or replace defective part, pour fresh LTV into opening and cure. Pot life, with catalyst added, is approximately 8 hours and may be extended with refrigeration. When desirable, LTV may also be cured at room temperature.



Resiliency offers excellent shock resistance. LTV-602 easily meets thermal shock tests described in MIL-STD-202A test condition B which specifies five temperature cycles from -65 to 125°C. Tests indicate that LTV retains protective properties even after 1800 hours aging at 175°C. Other tests confirm LTV's resistance to moisture and water immersion.

LTV-602 is the newest addition to the broad line of G-E silicone potting and encapsulating materials which also include the RTV silicone rubbers. For more information, write to General Electric Company, Silicone Products Department, Section L740, Waterford, New York.

**GENERAL  ELECTRIC**

CIRCLE 32 ON READER-SERVICE CARD

## NEWS

### Soviet Hopes to View Venus And Mars With Color TV

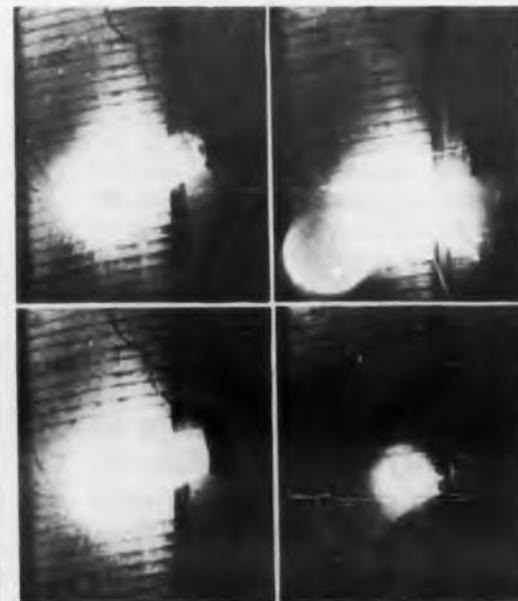
A Soviet television scientist, Dr. Pavel V. Shmakov, predicts that "in the near future" his country will observe Venus and Mars by color tv.

The prediction was one of several made at the first International Festival of TV Arts and Sciences, held in Montreux, Switzerland. Dr. Shmakov declined to elaborate on his forecast, however.

The Soviet expert was questioned about TV equipment used in recent Russian space shots. He explained that although the moon rockets did not contain true TV apparatus, more recent vehicles, such as the one that carried Maj. Yuri Gagarin, did.

Dr. Leonard Jaffe, chief of the United States space agency's Operation Relay, pre-

### Sonic 'Death' of a Light Bulb



When a 25,000-w beam of sonic power—energy equivalent to a thousand symphony orchestras playing simultaneously—is directed at a light bulb, this is what happens. Sequence shots show the actual separation of the bulb from the lamp base, the filament still glowing even though exposed to the air, and the final failure of the filament. The experiment, performed at facilities of Bolt, Beranek & Newsman, acoustical consultants of Cambridge, Mass., was televised for the public by WBZ in Boston. The photos were taken by Jonathan Karas & Associates of Durham, N. H.

dicted at the festival that a permanent translation TV link would be "bounced" from satellites within four to five years.

Another prediction, sent to the conference by David Sarnoff, president of the Radio Corp. of America, stated: "Ten years from now a billion people will watch the same TV show at the same time in color." Mr. Sarnoff added that simultaneous translation techniques would make the show understandable to all.

He suggested that new satellite television systems should be used by the heads of all nations for face-to-face discussions, and proposed that every TV set should have a special channel reserved for United Nations telecasts.

Dr. Jaffe was one of six recipients of a festival citation "in recognition of outstanding contributions to the advance of television." The others were Dr. Shmakov, of the Leningrad Technical Institute; Sir Noel Ashbridge of Great Britain, Prof. G. A. Boutry of France, Dr. Kenjiro Takayanagi of Japan, and Eric Esping of Sweden.

Thirty-two nations took part in the conference.

## Israel Seeks Electricity In Shallow Salt Waters

A group of Israeli scientists is experimenting with a principle that may make it possible to get electricity from small, shallow bodies of salt water. The principle, based on a natural phenomenon discovered in a lake in Hungary, where the bottom waters were found warmer than the top, can be explained by a difference in density.

In the heavy brine of a "dead sea," the water tends to form two distinct layers: a heavy dense layer underneath and a less dense layer on top. The top layer acts as a transparent cover over the bottom. When the water is shallow and the bottom is black, the lower layer gets hotter and hotter. The heat cannot escape because the nonmixing of the layers prevents convection. Heat thus retained could be transferred to general electricity.

Since arid countries with abundant sunshine usually have some waters too salty for human use, a curse can be turned to an advantage.

This idea, as well as many others, will be discussed at the United Nations Conference on New Sources of Energy, to be held in Rome, Italy, from Aug. 21 to 31.

# QUADRATURE-FREE AC SIGNALS!

*...now possible with two entirely new AC pots  
-precision-built by Helipot!*

Even though today's potentiometers are developed to a level of performance never before achieved, their use as AC voltage dividers introduces several problems not present under DC conditions. Most important of these are quadrature voltage and phase shift—the extraneous voltage 90% out of phase with the input signal, which results from capacitance between wire turns and metallic mandrel.

How do you eliminate quadrature? And the many other considerations associated with AC applications—what about them? Helipot solves all these problems with two new AC potentiometer series.

*Let's talk specifics.*

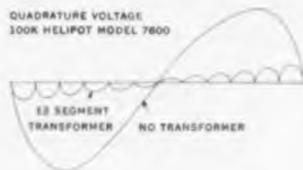
## YOU'LL WANT THE ANSWERS TO THESE 5 QUESTIONS...

### 1. WHAT IS AN AC POTENTIOMETER?

Simply stated, a pot that's specifically designed for AC-excited circuits. It differs from ordinary wire-wound pots in that quadrature effects are eliminated without the addition of elaborate compensating networks. At the same time, it provides lower output impedance, and improves linearity and reliability.

### 2. HOW DO AC POTS ELIMINATE QUADRATURE ERROR?

Helipot combines a multi-tapped pot with a multi-tapped autotransformer.



er. The voltage existing at each pot tap point is determined by the reference voltage at the corresponding

autotransformer tap. The pot resistance element is divided into a series of independent low-resistance elements—hence a reduction in quadrature.

The figure shown plots quadrature error against rotation. It illustrates the difference in phase shift between ordinary wire-wound pots and a Helipot AC unit with 12-segment autotransformer. You'll note that quadrature error is at its maximum near the midpoint between taps and is nearly zero at tap points. The result: negligible quadrature error and phase shift.

### 3. HOW ARE INPUT AND OUTPUT IMPEDANCE AFFECTED?

Input impedance remains high. Under AC applications, total pot resistance is paralleled by the AC impedance of the autotransformer. Since this impedance is 10 to 100 times greater than that of the pot, the addition of an autotransformer has a negligible effect on the input impedance.

Output impedance is much lower. The addition of an autotransformer to the basic pot results in a maximum output impedance occurring midway between each set of adjacent taps. It follows that total output impedance is greatly reduced—any energy required by the load is fed from the nearest auto-transformer tap.

### 4. HOW DOES THE AC POT IMPROVE LINEARITY?

The overall linearity of AC pots is dependent on the linearity of pot sections between taps—not total pot linearity.

An important feature of autotransformer application is the ability to easily adjust the voltage appearing at each pot tap—without affecting

the voltage ratio at any other tap. It is therefore possible to pull all tap points into the desired linearity band, regardless of basic pot linearity.

Another AC pot feature: It is capable of truly zero electrical "end coil."

### 5. ARE AC POTS MORE RELIABLE THAN BASIC POTS?

Yes—much more so. That's because a pot winding or tap lead going open affects only that portion of the pot between taps adjacent to the open. Even the opening of CW or CCW terminals has no effect beyond the adjacent tap point. Or, simply stated—the more taps, the greater the inherent reliability. Models with up to 28 taps are available as special from Helipot.



Helipot offers two AC pot series and 26 standard models with frequency ranges from 20 to 20,000 cps. Choose your linear or non-linear version of either the 3" diameter single turn Series 5800 or the 2" diameter multi-turn Series 7800. They're precision-built by Helipot to meet unusual conformities and perform in most any desired function.

Any more questions? Detailed specs and additional product information are included in a new 32-page potentiometer catalog. To get a copy, call your nearest Helipot Sales Engineering Representative...or write direct:

**Beckman**

INSTRUMENTS, INC.

**HELIPOT DIVISION**

Fullerton, Calif.

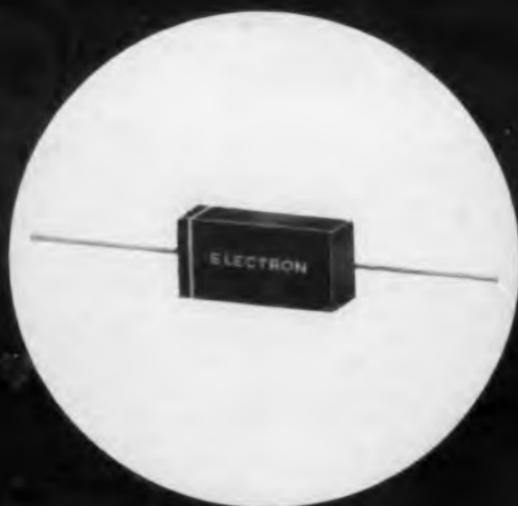
POTS : MOTORS : METERS

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CIRCLE 33 ON READER-SERVICE CARD

Electron Products

BW and BWE  
High Voltage Capacitors



### Newest-Smallest High Voltage Capacitors!

Compact configuration, lighter weight and extremely low noise are features deserved by design engineers seeking smaller, more reliable high voltage capacitors.

BWE Series epoxy tube capacitors are designed for applications as AC and DC power supply ripple filter capacitors, voltage doubler circuits and blocking capacitors. Basic construction is similar to the Mil-C-14157 Hi-Rel Spec and meets environmental test conditions of Mil-C-25. Rectangular shaped, non-metallic case eliminates need for large stand-off terminals. The BW wrap and fill version is available for similar applications in less stringent environments.

Up to 30,000V operation with standard capacity from .001 to .2 mfd. Standard capacity tolerance  $\pm 20\%$  (also available to  $\pm 1\%$ ). Competitively priced against other less sophisticated versions. Technical information and test data available upon request.

#### Specifications:

Operating Temperature:	-55°C to +125°C
Insulation Resistance:	30,000 M $\Omega$ min. @ 25°C
Dissipation Factor:	1.0% max. @ 25°C
Test Voltage:	200% of rated voltage

## ELECTRON PRODUCTS

430 North Halstead Street, Pasadena, California

 division of Marshall Industries

CIRCLE 34 ON READER-SERVICE CARD

# EDITORIAL

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## Transistor Reliability Specs Well on Way

In last year's Transistor Data Chart issue our editorial called for reliability figures to be included with other important transistor characteristics contained in data sheets. Military specifications for components, including transistors, had been lax in reliability specifications due to lack of definitions and environmental standards. We cannot report this data this year, but progress is being made.

Since the release of the Darnell Report (Parts Specification Management for Reliability), improvement in component specifications has been in evidence. Perhaps the most significant in terms of semiconductor specifications is the use of LTPD (lot tolerance per cent defective) in newly prepared MIL-S-19500 documents in place of AQL (acceptable quality level) found in early MIL-STD-105 specs. AQL is normally considered the quality level for which the producer takes a 5 per cent risk of having a good lot rejected while LTPD is generally defined as the quality level for which the customer takes a 10 per cent risk of accepting a defective lot. Therefore the manufacturer's risk is linked with AQL and LTPD is a measure of the customer's risk. Based on sample size, an AQL of 4 per cent can exist with LTPD figures ranging from 12 to 38 per cent. Thus, MIL-STD-105 clearly defines the manufacturer's obligation but offers rather a vague reliability promise to the customer responsible for producing reliable equipment from his incoming components.

With newer transistor specifications outlining specific LTPD values and environmental conditions, the customer is fully aware of the confidence he can place on his incoming devices. Manufacturers can determine their acceptance number from the charts included in the specs.

Other improvements in reliability specifications soon to be adopted include the listing of failure-rate figure for components placed on the Qualified Products List. In addition, products will remain on the QPL only as long as they meet specification requirements; failure to maintain a given quality level will result in deletion from QPL.

Based on the earnest efforts being applied by government personnel responsible for the preparation of components specifications, meaningful reliability will be contracted and delivered. Reliability figures may appear in next year's Transistor Data Chart if the rate of effort and enthusiasm generated by the Darnell Report is maintained by the military and industry.

*Howard Bierman*

CIRCLE 35 ON READER-SERVICE CARD ➤

ELECTRONIC DESIGN • July 5, 1961

OFF THE SHELF...

**PSI™ TRANSISTORS  
FOR EVERY COMPUTER,  
COMMUNICATION  
AND POWER NEED!**

2N919  
2N1709  
PT600  
2N1342

**NEWEST LOGIC SWITCH!**

- Highly advanced version of 2N706
- $V_{CE\ SAT} = .2V$  Max at  $I_C = 10mA$ ,  $I_B = 1mA$
- Broadest  $h_{FE}$  vs.  $V_{CE}$  linearity ever offered

**NEWEST VHF POWER AMPLIFIER!**

- Even higher power-frequency performance than 2N1506
- Five watt power output at 30 mc, 12 db power gain

**NEWEST MEDIUM POWER SWITCH!**

- $V_{CE\ SAT} = 1.0V$  Max at  $I_C = 1$  Amp,  $I_B = 100mA$
- 13 watts at 25 °C case temperature
- $t_r = 30\mu s$  typical at  $I_C = 1$  A,  $I_B = I_C = 100mA$
- $R_{\theta} = 11$  ohms,  $V_{CC} = 12V$

**NEWEST HIGH VOLTAGE POWER AMPLIFIER!**

- 300 mW power output at 100 mc, 10 db power gain
- $V_{CBO} = 150V$  Min,  $V_{CES} = 125V$  Min

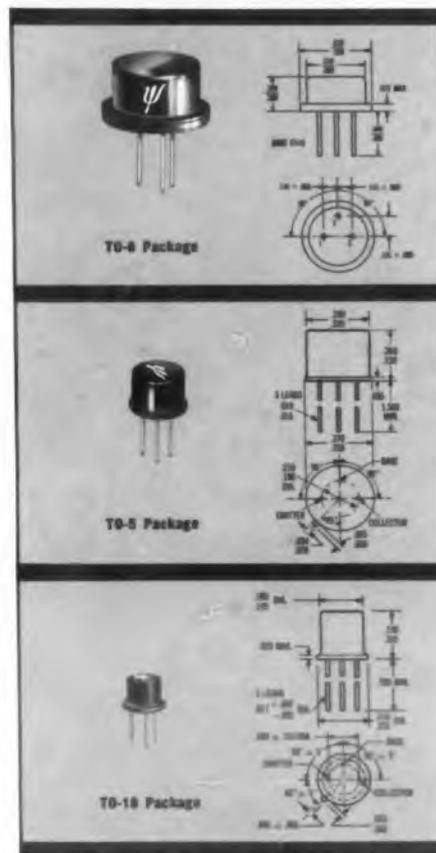


See inside for the most extensive line of high performance silicon transistors available today! ♦

# SWITCHING TRANSISTORS

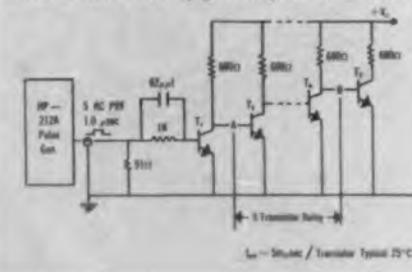
NPN TRIPLE DIFFUSED SILICON MESA

Wide Range of Types  $\mu$ A to 10 Amps .2V to 140V

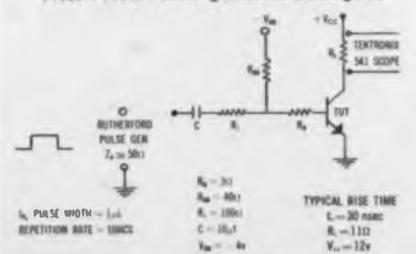


**DIMENSIONAL DRAWINGS**  
All dimensions shown in inches

2N706 - 2N919 DCTL Propagation Delay Measurement Circuit



PT600 - PT601 Switching Circuit and Switching Time



## TO-18 PACKAGE HIGH SPEED TRANSISTORS

TYPE	TOTAL POWER AT 25°C CASE Watts	V <sub>CE0</sub> Min.	V <sub>CE1A</sub> Min.	V <sub>CE0</sub> Min.	f <sub>t</sub> mc TYP.	h <sub>FE</sub> *	V <sub>CE sat</sub> * Max.
2N706	1.0	25	20	3	350	20 min	.60
2N706A	1.0	25	20	5	350	20-60	.60
2N706B	1.0	25	20	5	350	20-60	.40
2N753	1.0	25	20	5	350	40-120	.60
2N919	1.2	25	20	5	400	20-60	.20
2N920	1.2	25	20	5	400	40-120	.20
2N921	1.2	50	30	5	400	20-60	.25
2N922	1.2	50	30	5	400	40-120	.25

## TO-8 PACKAGE HIGH SPEED TRANSISTORS

2N1252	2.0	30	20	5	210	15-45	1.5
2N1253	2.0	30	20	5	210	30-90	1.5

## TO-5 PACKAGE PREMIUM TRANSISTORS

2N1837	2.0	80	50	8	210	40-120	.80
2N1837A	2.8	80	50	8	210	40-120	.80
2N1409	2.0	30	25	4	230	15-45	.80
2N1409A	2.8	30	25	4	230	15-45	.80
2N1410	2.0	45	30	4	230	30-90	.80
2N1410A	2.8	45	30	4	230	30-90	.80
PT850	2.0	120	80	5	200	40-120	2.0
PT850A	2.8	120	80	5	200	40-120	2.0

## STANDARD TRANSISTORS

TYPE	TOTAL POWER AT 25°C CASE Watts	V <sub>CE0</sub> Min.	V <sub>CE1A</sub> Min.	V <sub>CE0</sub> Min.	f <sub>t</sub> mc TYP.	h <sub>FE</sub> *	V <sub>CE sat</sub> * Max.	PKG
2N696	2.0	60	40	5	200	20-60	1.5	TO-5
2N697	2.0	60	40	5	200	40-120	1.5	TO-5
2N698	2.0	120	80	5	190	20 min	5.0	TO-5
2N699	2.0	120	80	5	190	40-120	5.0	TO-5
2N717	1.5	60	40	5	200	20 min	1.5	TO-18
2N718	1.5	60	40	5	200	40-120	1.5	TO-18
2N719	1.5	120	80	5	190	20 min	5.0	TO-18
2N720	1.5	120	80	5	190	40-120	5.0	TO-18
2N1420	2.0	60	30	5	170	100-300	1.5	TO-5

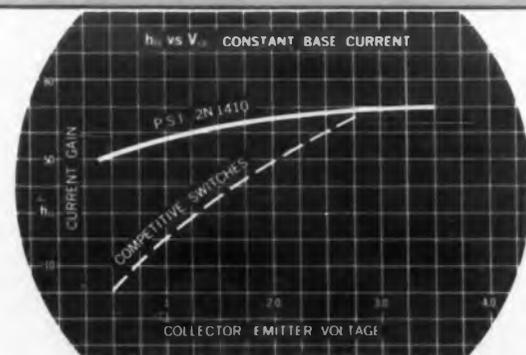
## TO-9 PACKAGE GENERAL PURPOSE TRANSISTORS

2N1336	2.8	40	25	3	190	—	—	—
2N1838	2.0	45	30	4.5	190	40-150	1.4	—
2N1839	2.0	45	30	4.5	170	12-50	1.4	—
2N1840	2.0	25	20	5	150	10 min	1.4	—

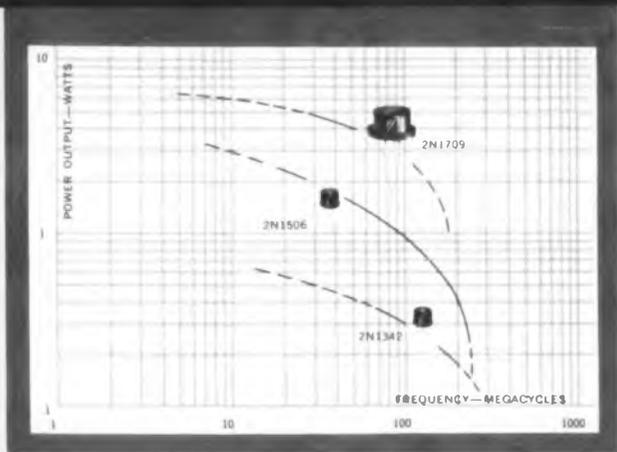
## SPECIAL PURPOSE TRANSISTORS

TYPE	TOTAL POWER AT 25°C CASE Watts	V <sub>CE0</sub> Min.	V <sub>CE1A</sub> Min.	V <sub>CE0</sub> Min.	f <sub>t</sub> mc TYP.	h <sub>FE</sub> *	V <sub>CE sat</sub> * Max.	PKG
2N1340	2.8	150	100	5	220	5 min	0.7	TO-5
PT601	13.0	60	45	4	210	30-90	1.0	TO-8
PT600	13.0	60	45	4	210	15-45	1.0	TO-8
2N1900	125.0	140	100	5	50 min	10-20	2.0	POWER
2N1901	125.0	140	100	5	50 min	15-40	2.0	POWER

\*SEE DATA SHEETS FOR CONDITIONS

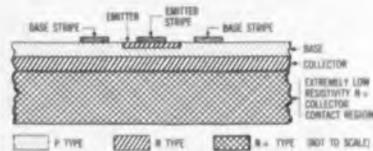


Extremely flat Beta vs. Collector Voltage is one of the many advantages made possible by the PSI Triple Diffusion Process.



FREQUENCY-POWER OUTPUT RANGE  
OF PSI COMMUNICATIONS TRANSISTORS

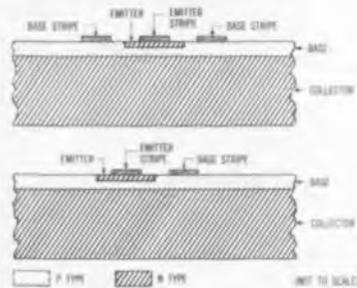
#### PSI TRIPLE DIFFUSED PROCESS



PSI triple diffusion makes possible these outstanding performance characteristics: Low  $V_{CE}$  saturation, faster switching, excellent high current beta, high small signal beta and broad VHF versatility.

The triple diffusion process, above, provides manufacturing control unmatched by any other process.

#### OTHER MESA PROCESSES

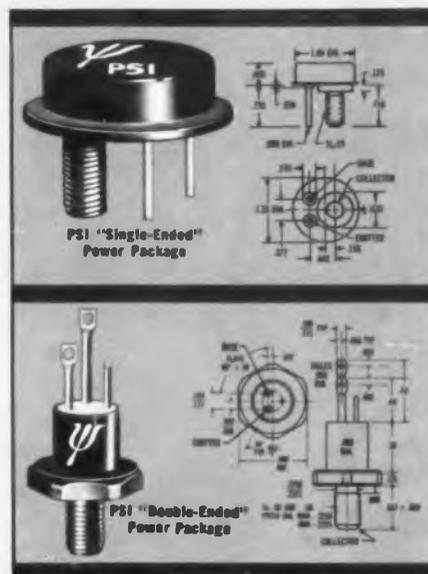


## COMMUNICATION TRANSISTORS

### NPN TRIPLE DIFFUSED SILICON MESA

Wide Range of Types

mW to Watts 10 to 100+ Source Voltages



DIMENSIONAL DRAWINGS  
All dimensions shown in inches

## HF HIGH POWER TRANSISTORS

### NPN TRIPLE DIFFUSED SILICON MESA

Wide Range of Types . . . for many new applications.

TYPE	$V_{BE}$ Min.	$V_{CE}$ Min.	$V_{CE0}$ Min.	$h_{FE}$	10mc $h_{FE}$	f, mc	5 mc Class C AMPLIFIER Power Out	Power Gain	PACKAGE
2N1899 (formerly PT901)	140	100	5	10 min	3	50 min	125W	10db	Single End
2N1900	140	100	5	10-20	3	50 min	125W	10db	Single End
2N1901	140	100	5	15-40	3	50 min	125W	10db	Single End
2N1902	140	100	5	10 min	3	50 min	125W	10db	Double End
2N1903	140	100	5	10-20	3	50 min	125W	10db	Double End
2N1904	140	100	5	15-40	3	50 min	125W	10db	Double End
PT900	80	50	5	10 min	3	50 min	125W	10db	Single End

KILOWATT MEGACYCLES AMPERES NANoseconds — Now possible with PSI Load Tested Silicon Mesa Power Transistors. In a typical switching application the rate of current rise can be as high as 100 million Amperes per second. Selected Beta ranges now available.

Power Switching at higher speeds and RF Power Generation at higher levels than previously attainable are now possible.

Availability: Single Ended packages are available in production quantities. Double Ended in Engineering quantities.

#### VERY HIGH FREQUENCY

TYPE	TOTAL POWER AT 25°C CASE Watts	$V_{BE}$ Min.	$V_{CE}$ Min.	$V_{CE0}$ Min.	POWER GAIN AT f = 30mc Typ.	POWER GAIN AT f = 70mc Typ.	POWER GAIN AT f = 100 mc Typ.	PKG
2N1338	2.8	80	50	3	18 db $P_o = 0.35W$	10.5db $P_o = 0.35W$	7db $P_o = 0.35W$	TO-5
2N1342	2.8	150	125	5		13db $P_o = 0.4W$	10db $P_o = 0.3W$	TO-5
2N1505	3.0	50	40	3	10db $P_o = 1.8W$	8db $P_o = 1.2W$	6db $P_o = 1W$	TO-5
2N1506	3.0	60	40	4	12db $P_o = 1.8W$	10db $P_o = 1.2W$	8.5db $P_o = 1W$	TO-5
2N1710	13.0	60	45	3	10db $P_o = 5W$	6db $P_o = 6W$	5db $P_o = 6W$	TO-8
2N1709	13.0	75	60	4	12db $P_o = 5W$	8db $P_o = 7W$	6db $P_o = 7W$	TO-8

THESE TRANSISTORS OFFER THE DESIGNER A WIDE SELECTION OF CHARACTERISTICS:  
SUPPLY VOLTAGE — 10 VOLTS TO 125 VOLTS  
OPERATING CURRENT — 1 mA TO SEVERAL Amps  
OPERATING FREQUENCY — UP TO SEVERAL HUNDRED mc (HIGHER WITH VARICAP® DOUBLING CIRCUITS)  
POWER OUTPUT — MILLIWATTS TO NEARLY 10 WATTS  
The 2N1338, 2N1342, 2N1505, 2N1506 are available in production quantities.  
The 2N1709 and 2N1710 are available in prototyping quantities.

# PICO-TRANSISTORS and MICRO-TRANSISTORS

PSI Pico and Micro transistors are ultra miniature triple diffused silicon mesa devices. They are designed for low level amplification and for low power, high speed switching applications. These unique transistors are extremely valuable where weight and size are prime design and operational factors.

The remarkable high reliability standards of PSI Micro-Diodes are the result of simplified construction and advanced surface passivation techniques. These same techniques are employed in the manufacture of PSI Micro Transistors.

The surface passivation process and coating materials provide protection from extreme environmental conditions of heat, moisture, thermal shock, mechanical stresses and electrical load.

After manufacture all devices are subjected to environmental testing to assure reliability and device parameters.

- Meet MIL-S-19500B and MIL-STD-202A
- 200 hr. 200°C Reliability Assurance
- -65°C to 200°C temperature range
- 100 mW power dissipation
- Pico size 1/1000 of TO-5 package
- Micro size 1/100 of TO-5 package
- Companion components to PSI Micro-Diode

## ABSOLUTE MAXIMUM RATINGS (25°C)

TYPES	V <sub>CE</sub>	V <sub>BE</sub>	V <sub>EB</sub>	T <sub>J</sub>	P <sub>tot</sub>
PMT 011-111	25v	5v	5v	150°C	100 mW
PMT 012-112	25v	5v	5v	150°C	100 mW
PMT 013-113	40v	5v	5v	150°C	100 mW
PMT 014-114	40v	5v	5v	150°C	100 mW
PMT 015-115	50v	5v	5v	150°C	100 mW
PMT 016-116	25v	25v	5v	150°C	100 mW
PMT 018-118	25v	40v	5v	150°C	100 mW
PMT 019-119	25v	40v	5v	150°C	100 mW

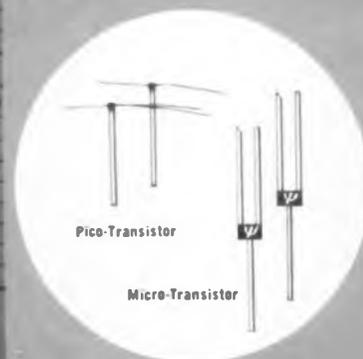
## ELECTRICAL CHARACTERISTICS

TYPES	I <sub>CE</sub>	V <sub>CE(sat)</sub>	V <sub>BE(sat)</sub>	C <sub>in</sub>	f <sub>T</sub> (MHz)	f <sub>max</sub> (THz)
PMT 011-111	10 $\mu$ A (20v)	1.2v	1.1v	20 pf	15 (10mA-10v)	3.5
PMT 012-112	10 $\mu$ A (20v)	1.2v	1.1v	20 pf	30 (10mA-10v)	3.5
PMT 013-113	1 $\mu$ A (30v)	1.2v	1.1v	20 pf	30 (10mA-10v)	4.0
PMT 014-114	1 $\mu$ A (30v)	1.2v	1.1v	20 pf	40 (10mA-10v)	4.0
PMT 016-116	3 $\mu$ A (8v)	1.2v	1.1v	20 pf	40 (10mA-10v)	3.5
PMT 018-118	5 $\mu$ A (15v)	3v	4v	5 pf	20 (10mA-1v)	4.0
PMT 019-119	1 $\mu$ A (10v)	3v	4v	20 pf	10 (10mA-1v)	4.0
PMT 019-119	1 $\mu$ A (10v)	3v	4v	20 pf	30 (10mA-1v)	4.0

NOTE: Pulse Conditions. Length  $\leq 100\mu$  sec. Duty Cycle  $\leq 2\%$

## EQUIVALENT TYPES

PSI PICO	MICRO	EQUIVALENTS
PMT 011	PMT 111	2N1409
PMT 012	PMT 112	2N1410
PMT 013	PMT 113	2N886
PMT 014	PMT 114	2N887
PMT 015	PMT 115	2N1837
PMT 016	PMT 116	2N706
PMT 018	PMT 118	Low Level Premium 2N888
PMT 019	PMT 119	Low Level Premium 2N887



## Pacific Semiconductors, Inc.

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Howard Bierman  
Technical Editor

## ELECTRONIC DESIGN's Ninth Annual **TRANSISTOR DATA CHART**

ELECTRONIC DESIGN's Ninth Annual Transistor Data Chart contains specifications for 1,714 transistor types—last year only 1,088 types were submitted for publication by semiconductor manufacturers. With close to a 60 per cent increase in the number of available types, the design engineer is now offered a greater selection of devices as well as increased sources of supply—but his search time for a transistor to do a certain job is likewise increased. Thus, ELECTRONIC DESIGN's unique listing, specifically tailored for the design engineer, should prove to be a handy time-saver.

Contrary to existing lists which group transistors by manufacturer or in numerical sequence (fine for salesmen, of limited use to engineers), the 1961 Data Chart has transistors organized into six application categories:

**Audio**—mostly general purpose types, under 1 w, listed in order of increasing forward-current transfer ratio, ( $h_{fe}$  or  $h_{FE}$ ).

**High frequency**—including types ranging up to and above the vhf range and tabulated in order of increasing alpha-cut-off frequency, ( $f_{\alpha c}$ ).

**Power devices**—transistors rated at 1 w and above are listed in order of increasing collector power dissipation.

**Special types**—low-noise, high-power/high-frequency and other miscellaneous types are included.

**High-level and low-level switching**—devices intended for switching are listed in order of increasing alpha-cut-off frequency, ( $f_{\alpha c}$ ).

By this system of listing transistors, the design engineer is offered a rapid method of selecting a particular type based on a parameter value. In addition, close substitutes are apparent and multiple sources of supply are listed when applicable. Only U. S. manufactured types are given.

One word of caution is included. Quite a few similar number types, made by several companies, were submitted with different characteristics due to the nonconformity in test methods among manufacturers. The manufacturer whose data are used for each particular type is listed under "Mfg." Other suppliers of the same types are found under "Remarks." Please take note that the company listed under "Mfg." is not necessarily the prime supplier, a cheaper source or the original EIA registrant. *The final choice of supplier is obviously up to the design engineer.* It is thus advisable to use this listing as a guide to selection and then follow up with a detailed evaluation of specific test methods and data as outlined in each manufacturer's spec sheet.

A cross index is included to identify a type number with its listed category. The JEDEC type numbers are tabulated in numerical order and the category group is indicated.

Audio . . .	p 34
High Frequency . . .	p 42
Power . . .	p 48
Special . . .	p 54
High Level . . .	p 56
Low Level . . .	p 60
Cross Index . . .	p 68

For a free reprint of the Transistor Data Chart, circle 251 on the Reader-Service card.



# TRANSISTORS - 1961

## Audio

Type No.	Mfg.	Type	h <sub>fe</sub> or h <sub>FE</sub>	Maximum Ratings				Characteristics				Remarks	
				W <sub>c</sub> (mw)	T <sub>j</sub> (c)	m <sub>w</sub> /c	V <sub>c</sub> v	I <sub>c</sub> ma	I <sub>co</sub> μa	NF db	C <sub>c</sub> μμf		f <sub>αe</sub> mc
2N160	RRD	npn,GJ,si	0.93	150	175	-	40	25	0.2	25	7	4	
2N160A	RRD	npn,GJ,si	0.93	150	175	-	40	25	0.2	25	7	4	
2N349	RRD	npn,GJ,si	0.96	750	175	-	125	40	10	-	-	3	
2N161	RRD	npn,GJ,si	0.96	150	175	-	40	25	0.2	25	7	5	
2N161A	RRD	npn,GJ,si	0.96	150	175	-	40	25	0.2	25	7	5	
2N348	RRD	npn,GJ,si	0.96	750	175	-	90	50	10	-	-	3	
2N1096	RRD	npn,GJ,si	0.96	500	175	-	90	30	6	-	-	3	
2N347	RRD	npn,GJ,si	0.98	750	175	-	60	60	10	18	7	3	
2N1095	RRD	npn,GJ,si	0.98	500	175	-	60	40	5	-	-	3	
2N163	RRD	npn,GJ,si	0.99	150	175	-	40	25	0.2	25	7	6	
2N163A	RRD	npn,GJ,si	0.99	150	175	-	40	25	0.2	25	7	6	
952	TI	npn,GJ,si	6	750	150	6	80	50	6	-	-	8	2N1155
951	TI	npn,DJ,si	9	750	150	6	50	60	5	-	-	8	2N1154
2N953	TI	npn,GJ,si	9	750	150	6	120	40	8	-	-	8	2N1156
2N1154	NA	npn,DM,si	9	750	150	5	50	60	5	-	-	-	
2N1155	NA	npn,DM,si	9	750	150	5	80	50	6	-	-	-	
2N1156	NA	npn,DM,si	9	750	150	5	120	40	8	-	-	-	
2N117	TI	npn,GR,si	9-20	150	175	1	45	25	2	20	-	4	TR, USN
2N332	TI	npn,GR,si	9-20	150	175	1	45	25	2	20	-	6	GE, TR, RRD, NA, RA
2N332A	NA	npn,MS,si	9-20	150	175	0.86	45	-	2	-	30	-	GE
2N333A	NA	npn,MS,si	9-20	500	175	2.8	45	-	0.5	-	15	-	GE
2N903	TI	npn,GJ,si	9-20	150	175	1	45	25	2	25	-	4	2N1149
2N1149	TR	npn,DJ,si	9-20	150	150	-	30	25	0.1	25	7	7	NA
2N243	TI	npn,GJ,si	9-32	750	150	6	60	60	1	-	-	7	NA
2N472A	TR	npn,DG,si	10-25	200	200	-	45	25	0.02	22	7	8	100% reliability assurance processed
2N470	TR	npn,GJ,si	10-25	200	200	-	15	25	0.02	22	7	8	
2N471	TR	npn,GJ,si	10-25	200	200	-	30	25	0.02	22	7	8	
2N472	TR	npn,GJ,si	10-25	200	200	-	45	25	0.02	22	7	8	
2N102/13	SY	npn,AJ,ge	10.5	1w	75	20	30	1.5a	5ma	-	-	-	
2N144/13	SY	npn,AJ,ge	10.5	1w	75	20	60	0.8a	5ma	-	-	-	
2N45*	GI	npn,AJ,ge	12	150	100	2	45	-	10	22	40	-	*MIL audio/med. power
2N1439	NA	pnp,AJ,si	12	400	200	2.28	50	100	0.01	12	25	1	
2N756	NA	npn,DM,si	12-20	500	200	2.5	45	-	9.2	-	-	-	
2N756A	NA	npn,DM,si	12-20	500	200	2.5	60	-	0.1	-	-	-	
CK64B	RA	pnp,AJ,ge	13.5	75	85	1.25	45	100	10	-	-	-	Sub min
CK64C	RA	pnp,AJ,ge	13.5	75	85	1.25	45	100	10	-	-	-	Sub min
2N935	SSD	pnp,AJ,si	14	385	160	2.85	40	50	.005	18	70	2	TO-18
2N284	AMP	pnp,AJ,ge	15	125	75	2.5	32	125	-	-	-	-	
2N284A	AMP	pnp,AJ,ge	15	125	75	2.5	60	125	-	-	-	-	
2N339A	TR	npn,DJ,si	15	1000	200	8	55	1	-	-	-	-	Beta specs at 3 I <sub>c</sub> levels
2N340A	TR	npn,DJ,si	15	1000	200	8	85	0.1	1	-	-	-	Beta specs at 3 current levels.
2N341A	TR	npn,DJ,si	15	1000	200	8	125	0.1	1	-	-	-	Beta specs at 3 current levels.
2N927	NA	pnp,AJ,si	15	150	200	2.5	70	-	.005	-	12	.8	
2N938	SSD	pnp,AJ,si	15	250	175	1.7	35	100	.001	-	7	2	TO-18
2N1247	NA	npn,DM,si	15	30	150	0.2	6	5	1.5	-	12	-	TR
2N1248	TR	npn,GJ,si	15	300	150	-	6	5	0.02	6	15	-	
2N1440	NA	pnp,AJ,si	15	400	200	2.28	50	100	0.01	12	25	1	audio/med. power
2N1623	RA	pnp,AJ,si	15	250	160	0.54	20	50	.005	18	70	.1	
2N1655	RA	pnp,AJ,si	15	250	160	0.54	125	50	.005	18	70	.2	
TR34	IND	pnp,AJ,ge	15	120	85	3	40	150	10	15	15	1.6	
2N925	NA	pnp,AJ,si	16	150	200	2.5	50	-	.005	-	12	.8	
2N529	G, I	-	17	100	85	2	15	-	0.3	14	14	-	matched pnp, npn
2N118	TI	npn,GR,si	18-40	150	175	1	45	25	2	20	-	5	TR
2N333	TI	npn,GR,si	18-40	150	175	1	45	25	2	20	-	8	GE, TR, NA, RA
2N334A	NA	npn,MS,si	18-36	500	175	2.8	45	-	0.5	15	-	-	
2N757	NA	npn,MS,si	18-36	500	200	2.5	45	-	0.2	-	-	-	
2N757A	NA	npn,MS,si	18-36	500	200	2.5	60	-	0.1	-	-	-	
2N904	TI	npn,GR,si	18-40	150	175	1	45	25	2	25	-	5	2N1150
2N1150	NA	npn,DM,si	18-40	150	175	0.86	45	25	2	-	7	1	
2N334	TI	npn,GR,si	18-90	150	175	1	45	25	2	20	-	10	GE, TR, NA, RA
2N758	NA	npn,MS,si	18-90	500	200	2.5	45	-	0.2	-	-	-	
2N758A	NA	npn,DM,si	18-90	500	200	2.5	60	-	0.1	-	-	-	
2N904A	TI	npn,GR,si	18-90	150	175	1	45	25	2	25	-	8	2N1151
2N1151	NA	npn,DM,si	18-90	150	175	0.86	45	25	2	-	7	8	TR
2N129	SPR	pnp,AJ,ge	20	30	85	-	3	5	-	-	-	30	
2N923	NA	pnp,AJ,si	20	150	200	2.5	40	-	.005	-	12	.8	
2N1051	WE	npn,DD,si	20	600	150	0.25	60	-	0.1	-	8	70	US, MIL only
2N1670	GI	pnp,DR,ge	20	120	85	2	100	-	3	-	3	-	Hi-volt switch
OC200	AMP	pnp,PA,DT,si	20	250	150	-	25	50	10	-	-	1	
2N475A	TR	npn,DG,si	20-50	200	200	-	45	25	0.02	20	7	10	100% reliability assurance processed

## Index of Manufacturers

Abbrev.	Company	Location
AMP	Amperex Electronic Co.	Hicksville, N. Y.
BE	The Bendix Corp.	Holmdel, N. J.
CBS	CBS-Hytron, Semi-cond. Operations	Lowell, Mass.
CL	Clevite Transistor	Waltham, Mass.
CT	Crystalonics, Inc.	Cambridge, Mass.
DE	Delco Radio Div., GM Corp.	Kokomo, Ind.
EM	Electromation Co.	Venice, Calif.
FA	Fairchild Semi-cond. Corp.	Mountain View, Calif.
GE	General Electric Co.	Syracuse, N. Y.
GI	General Instrument Corp.	Newark, N. J.
HO	Hoffman Semi-cond. Div.	El Monte, Calif.
HU	Hughes Semicond. Div.	Newport Beach, Calif.
IND	Industro Transistor Corp.	Long Island City, N. Y.
KF	Kearfott Semi-cond. Corp.	West Newton, Mass.
MH	Minneapolis-Honeywell	Minneapolis, Minn.
MO	Motorola Semi-cond. Products Inc.	Phoenix, Ariz.
NA	National Semi-cond. Corp.	Danbury, Conn.
PH	Philco Corp. Lansdale Div.	Lansdale, Pa.
PSI	Pacific Semicond., Inc.	Cuiver City, Calif.
RCA	Radio Corp. of America	Somerville, N. J.
RRD	Radio Development and Research Corp.	Paterson, N. J.
RA	Raytheon Co. Semicond. Div.	Newton, Mass.
RH	Rheem Semicond. Corp.	Mountain View, Calif.
SE	Secoa Electronic Corp.	Westbury, L. I., N. Y.
STC	Silicon Transistor Corp.	Clare Place, L. I., N. Y.
SSD	Sperry Semicond. Div.	South Norwalk, Conn.
SPR	Sprague Electric Co.	North Adams, Mass.
SY	Sylvania Semi-cond. Div.	Woburn, Mass.

# DATA CHART

## Audio (continued)

Abbrev.	Company	Location
TI	Texas Instruments Inc.	Dallas, Tex.
TR	Transitron Electronic Corp.	Wakefield, Mass.
TS	Tung-Sol Electric Inc.	East Orange, N. J.
US	U. S. Transistor Corp.	Syosset, L. I., N. Y.
WE	Western Electric Co., Inc.	Laureldale, Pa.
WT	Western Transistor Corp.	Gardena, Calif.
WH	Westinghouse Electric Corp.	Youngwood, Pa.

### Abbreviation of Terms

AJ	Alloy Junction
DD	Double Diffused
DG	Grown Diffused
DJ	Diffused Junction
DM	Diffused Mesa
DP	Diffused Planar
Dr	Drift
Ep	Epitaxial
FA	Fused Alloy
FJ	Fused Junction
GD	Grown Diffused
Ge	Germanium
GJ	Grown Junction
GR	Grown Rate
MB	Meltback
MD	MADT
Ms	Mesa
RG	Rate Grown
Si	Silicon
SBT	Surface Barrier
$C_{ce}$	Collector-to-emitter capacitance measured across the output terminals with the input ac open-circuited.
$f_{\beta}$	Frequency at which the magnitude of the forward-current transfer ratio (small-signal) is 0.707 of its low-frequency value.
$f_t$	Frequency at which common emitter gain is unity.
$h_{fe}$	Common emitter-small signal forward current transfer ratio.
$h_{FE}$	Common emitter-static value of short-circuited forward current ratio.
$I_{co}$	Collector current when collector junction is reverse-biased and emitter is dc open-circuited.

Type No.	Mfg.	Type	$h_{fe}$ or $h_{FE}$	Maximum Ratings					Characteristics					Remarks
				$W_c$ (mw)	$T_j$ (c)	$m_w/d$	$V_c$ v	$I_c$ ma	$I_{co}$ $\mu$ a	NF db	$C_c$ $\mu$ mf	$I_{ae}$ mc		
2N406	SY	npn,AJ,ge	20-80	150	75	3	20	35	14	-	-	250		
2N761	NA	npn,DM,si	20-55	500	200	2.5	45	-	2	-	-	-		
2N530	GI	-	22	100	85	2	15	-	3	14	3	-	* matched npn, npn	
TR722	IND	npn,AJ,ge	22	150	2.5	3	45	200	10	15	20	2.5		
CK22A	RA	npn,AJ,ge	22.5	80	85	-	20	100	2	6-5	-	1.2	micromin	
CK64A	RA	npn,AJ,ge	22.5	80	85	-	29	100	2	22	-	0.8	micromin	
CK64	RA	npn,FA,ge	23	80	85	-	29	100	2	22	-	0.8		
2N106A	GE	npn,AJ,ge	24	200	85	4	25	200	16	-	40	0.8		
2N189	SE	npn,AJ,ge	24	75	85	2	25	50	16	15	40	0.8		
2N1476	SSD	npn,AJ,si	24	250	175	1.7	100	100	0.5	-	7	1		
2N301	SY	npn,AJ,ge	24-45	200	85	3.3	25	200	20	-	-	10		
2N44	GE	npn,AJ,ge	25	240	100	4	45	300	16	6	40	1	MIL, GI	
2N229	SY	npn,AJ,ge	25	50	75	1	10	-	100	-	-	600		
2N330A	SSD	npn,AJ,si	25	-	160	3	30	50	0.1	8	-	0.5		
2N460	TS	npn,AJ,ge	25	200	100	0.3	45	400	15	-	-	-		
2N564	IND	npn,AJ,ge	25	150	85	2.5	30	300	3	12	20	0.8	US	
2N592	GI	npn,AJ,ge	25	150	100	0.2	20	-	5	116	35	0.4	Bilateral	
2N726	TI	npn,DM,si	25	1w	175	-	25	50	.007	-	-	-		
2N1285	SY	npn,AJ,ge	25	50	85	0.9	10	100	100	-	-	600		
2N1441	NA	npn,AJ,si	25	400	200	2.28	50	100	0.01	12	25	1	audio/med. power	
2N1101	SY	npn,AJ,ge	25-50	180	75	3.6	20	100	50	-	-	0.01	RCA	
2N1102	SY	npn,AJ,ge	25-50	180	75	3.6	40	100	50	-	-	0.01		
2N34	SY	npn,AJ,ge	25-125	150	75	3	40	100	50	-	-	0.01	Driver, TI	
2N35	SY	npn,AJ,ge	25-125	150	75	3	40	100	50	-	-	0.01	Driver, TI	
2N306	SY	npn,AJ,ge	25-125	50	85	0.83	20	100	100	-	-	0.6		
2N464	MO	npn,AJ,ge	26	200	100	2.5	45	100	6	-	-	0.7	IND, RA, US, GI	
2N1474	SSD	npn,AJ,si	26	250	175	1.7	60	100	.005	-	7	1		
2N531	GI	-	27	100	85	2	15	-	3	14	14	-	* matched npn, npn	
CK65B	RA	npn,AJ,ge	27	75	85	1.25	45	100	10	-	-	-	Sub min	
CK65C	RA	npn,AJ,ge	27	75	85	1.25	45	100	10	-	-	-	Sub min	
2N936	SSD	npn,AJ,si	28	385	160	2.85	35	50	.005	18	70	2.5	TO-18	
2N244	TI	npn,GJ,si	28-90	750	160	6	60	60	1	-	-	8	NA	
2N118	T1	npn,GR,si	29	150	175	1	45	25	2	20	-	5	TR	
2N279	AMP	npn,AJ,ge	30	25	75	2.5	20	10	110	10	-	0.15		
2N524	SY	npn,AJ,ge	30	225	100	3	45	500	10	-	-	2	GE, MO	
2N594	GI	npn,AJ,ge	30	150	85	1.67	20	-	2	16	15	2	Bilateral	
2N939	SSD	npn,AJ,si	30	250	175	1.7	35	100	.001	-	7	3	TO-18	
2N1446	IND	npn,AJ,ge	30	200	85	3.33	45	400	5	6	20	2		
2N1474A	SSD	npn,AJ,si	30	250	175	1.7	60	100	.005	-	7	2		
2N1654	RA	npn,AJ,si	30	250	160	0.54	80	50	.005	18	70	.2		
2N1656	RA	npn,AJ,si	30	250	160	0.54	125	50	5	18	70	2		
CK25A	RA	npn,AJ,ge	30	80	85	-	20	400	2	-	14	4	micromin RF switch	
OC201	AMP	npn,PADT,si	30	250	150	-	25	50	10	-	-	4		
2N331	MO	npn,AJ,ge	30-70	75	85	1.2	30	-	1	20	50	.4		
2N1372	SY	npn,AJ,ge	30-90	150	100	2	25	200	100	-	-	-		
2N1373	SY	npn,AJ,ge	30-90	150	100	2	45	200	100	-	-	-		
2N1432	SY	npn,DD,ge	30-120	80	85	1.3	35	10	15	-	-	250		
2N1380	SY	npn,AJ,ge	30-300	150	100	2	15	200	14	-	-	-		
2N1381	SY	npn,AJ,ge	30-300	150	100	2	25	200	100	-	-	-		
2N532	GI	-	32	100	85	2	15	-	3	14	14	-	* matched npn, npn	
2N319	GE	npn,AJ,ge	34	225	85	4	20	200	16	-	25	2		
2N405	RCA	npn,AJ,ge	35	150	-	-	20	70	14	-	-	0.25	SY	
2N406	RCA	npn,AJ,ge	35	150	-	-	20	70	14	-	-	-		
2N593	GI	npn,AJ,ge	35	150	100	2	35	-	5	16	35	0.6	Bilateral	
2N734	T1	npn,MS,si	35	1.0	175	-	80	50	1	20	5	50	TO-18 TR, NA	
2N738	TI	npn,DM,si	35	1w	175	-	125	35	1	-	-	-	TR	
2N926	NA	npn,AJ,si	35	150	200	2.5	50	-	.005	-	12	0.8		
2N928	NA	npn,AJ,si	35	150	200	2.5	70	-	.005	-	12	0.8		
2N1010	RCA	npn,AJ,ge	35	20	55	-	10	2	10	5	-	2		
2N1564	TI	npn,MS,si	35	1.2	175	-	80	50	1	20	5	50	TO-5 TR, NA	
2N1572	TI	npn,DM,si	35	1.2w	175	-	125	50	1	-	-	-	TR	
OC57	AMP	npn,PADT,ge	35	10	55	-	7	10	1.5	-	-	1.4		
OC53	AMP	npn,AJ,ge	35	10	55	0.7	3	5	0.1	10	-	0.01	Hearing Aid	
2N383	SY	npn,AJ,ge	35-110	200	85	3.3	30	200	20	-	-	10	TS	
2N107A	GE	npn,AJ,ge	36	200	85	4	25	200	16	-	40	1		
2N190	GE	npn,AJ,ge	36	75	85	2	25	50	16	15	40	1		
2N119	TI	npn,GR,si	36-90	150	175	1	45	25	2	20	-	6	TR, USM	
2N335	TI	npn,GR,si	36-90	150	175	1	45	25	2	20	-	11	TR, GE, NA, RA	
2N335A	NA	npn,MS,si	36-90	500	175	2.8	45	-	0.5	-	-	-	GE	
2N759	NA	npn,DM,si	36-90	500	200	2.5	45	-	0.2	-	-	-		
2N759A	NA	npn,DM,si	36-90	500	200	2.5	60	-	0.1	-	-	-		
2N905	TI	npn,GR,si	36-90	150	175	1	45	25	2	25	-	6	2N1152	
2N1152	NA	npn,DM,si	36-90	150	175	0.86	45	25	2	-	7	1	TR	
2N533	GI	-	37	100	85	2	15	-	3	14	-	-	* matched npn, npn	



# TRANSISTORS - 1961

## Audio (continued)

Type No.	Mfg.	Type	h <sub>fe</sub> or h <sub>FE</sub>	Maximum Ratings				Characteristics				Remarks	
				P <sub>c</sub> (mw)	T <sub>j</sub> (c)	mW/c	V <sub>c</sub> v	I <sub>c</sub> ma	I <sub>co</sub> μA	NF db	C <sub>c</sub> μμf		f <sub>ae</sub> mc
2N742	NA	npn,MS,si	40	-	200	1.71	60	100	0.1	-	5	200	Switch
2N1009	SY	pnnp,AJ,ge	40	150	85	2.5	25	20	1	-	-	-	-
2N1176	BE	pnnp,AJ,ge	40	300	85	6.6	15	300	10	-	-	-	-
2N1176A	BE	pnnp,AJ,ge	40	300	85	6.6	40	300	10	-	-	-	-
2N1176B	BE	pnnp,AJ,ge	40	300	85	6.6	60	300	15	-	-	-	-
2N1191	MO	pnnp,AJ,ge	40	200	100	2.7	40	200	2	10	-	1.5	-
2N1678	GI	pnnp,DR,ge	40	120	85	2	60	-	3	-	3	-	Triax Driver
2N1730	TI	npn,DM,si	40	2w	175	-	60	50	0.5	-	-	-	-
CK4	RA	pnnp,AJ,ge	40	80	85	-	24	100	2	-	14	6	Submin RF switch
CK4A	RA	pnnp,AJ,ge	40	80	85	-	24	100	2	-	14	6	micromin RF switch
CK26A	RA	pnnp,AJ,ge	40	80	85	-	18	400	2	-	14	6	Micromin RF switch
TR-650	IND	pnnp,AJ,ge	40	150	85	2.5	45	400	1.0	10	20	2	2N650
TR-653	INO	pnnp,AJ,ge	40	150	85	2.5	30	400	1.0	10	20	2	-
2N382	SY	pnnp,AJ,ge	40-76	200	85	3.3	25	200	20	-	-	10	-
2N400A	TR	npn,DG,si	40-100	200	200	-	45	25	0.02	20	7	11	100% reliability assurance processed.
2N43	GE	pnnp,AJ,ge	42	240	100	4	45	300	16	6	40	1.3	-
OC79	AMP	pnnp,PADT,ge	42	550	75	-	26	300	10	-	-	1.2	-
2N104	RCA	pnnp,AJ,ge	44	150	-	-	30	50	10	12	-	0.7	-
2N215	RCA	pnnp,AJ,ge	44	150	-	-	30	50	10	12	-	0.7	-
2N525	GE	pnnp,AJ,ge	44	225	100	4	45	500	10	6	25	2.5	MO, SY
2N1924	GE	pnnp,AJ,ge	44	225	85	-	40	500	4	-	-	-	-
2N238	TI	pnnp,AJ,ge	45	150	85	.0025	25	200	6	7.5	-	1.5	-
2N291	TI	pnnp,AJ,ge	45	180	85	.003	25	200	6	7.5	-	1.5	-
2N322	GE	pnnp,AJ,ge	45	140	85	4	16	100	16	-	25	2.0	Driver
2N465	IND	pnnp,AJ,ge	45	150	85	2.5	45	200	6	15	20	0.8	MO, RA, US, GI, SY
2N595	GI	npn,AJ,ge	45	150	85	1.67	20	-	2	16	15	4	Bilateral
2N924	NA	pnnp,AJ,si	45	150	200	2.5	40	-	.005	-	12	0.8	-
2N1098	GE	pnnp,AJ,ge	45	140	85	4	16	100	16	-	25	-	Driver
2N1372	TI	pnnp,AJ,ge	45	250	100	3.3	25	200	3	7	-	1.5	-
2N1373	TI	pnnp,AJ,ge	45	250	100	3.3	45	200	3	7	-	1.5	-
2N1442	NA	pnnp,AJ,si	45	400	200	2.28	50	100	0.01	12	25	1	audio/med. power
2N1145	GE	pnnp,AJ,ge	45	140	85	4	16	100	16	-	40	-	Driver
2N1447	IND	pnnp,AJ,ge	45	200	85	3.3	45	400	5	6	20	3	-
2N1451	INO	pnnp,AJ,ge	45	200	85	3.3	45	400	7.5	9	20	1.5	-
2N1477	SSD	pnnp,AJ,si	45	250	175	1.7	100	100	0.5	-	7	1	-
CK65	RA	pnnp,FA,ge	45	80	85	-	24	100	2	22	-	1	-
CK65A	RA	pnnp,AJ,ge	45	80	85	-	24	100	2	22	-	1.0	micromin
TR721	IND	pnnp,AJ,ge	45	150	2.5	3	30	200	10	15	20	3	-
2N762	NA	npn,DM,si	45-150	500	200	2.5	45	-	0.2	-	-	-	-
2N280	AMP	pnnp,AJ,ge	47	25	75	2.5	20	10	150	10	-	0.1	-
TR320	IND	pnnp,AJ,ge	48	150	85	3	25	100	10	-	25	2.5	2N320
2N650	MO	pnnp,AJ,ge	49	200	100	2.7	45	500	3	5	-	1.5	US
2N650A	MO	pnnp,AJ,ge	49	200	100	2.0	45	500	10	15	25	1.5	Mega life
2N653	MO	pnnp,AJ,ge	49	200	100	2.0	30	250	5	10	20	1.5	SY
2N1186	MO	pnnp,AJ,ge	49	200	100	2.7	60	500	5	5	-	1.5	-
2N43A	GE	pnnp,AJ,ge	50	150	100	2	45	-	10	18	40	3.5	*MIL, GE
2N320	GI	pnnp,AJ,ge	50	225	85	4	20	200	16	-	25	2.5	-
2N331	BE	pnnp,AJ,ge	50	200	85	-	30	200	16	9	-	1.16	IND, MO, GI
2N363	IND	pnnp,AJ,ge	50	150	85	2.5	30	200	10	-	-	-	RA, US
2N368	TI	pnnp,AJ,ge	50	150	85	2.5	30	30	7	-	33	-	-
2N369	TI	pnnp,AJ,ge	50	150	85	2.5	30	50	7	-	33	1.3	-
2N422	RA	pnnp,FA,ge	50	150	85	-	20	100	6	6.5	-	0.8	-
2N941	SSD	pnnp,AJ,si	50	250	175	1.7	0	50	.001	-	7	-	TO-18
2N942	SSD	pnnp,AJ,si	50	250	175	1.7	11	50	.003	-	7	-	TO-18
2N943	SSD	pnnp,AJ,si	50	250	175	1.7	18	50	.003	-	7	-	TO-18
2N944	SSD	pnnp,AJ,si	50	250	175	1.7	18	50	.005	-	7	-	TO-18
2N945	SSD	pnnp,AJ,si	50	250	175	1.7	50	50	2	-	7	-	TO-18
2N946	SSD	pnnp,AJ,si	50	250	175	1.7	80	50	2	-	7	-	TO-18
2N1273	TI	pnnp,AJ,ge	50	150	85	.0025	15	150	3	6.5	-	-	-
2N1274	TI	pnnp,AJ,ge	50	150	85	.0025	25	150	3	6.5	-	-	-
2N1383	TI	pnnp,AJ,ge	50	200	85	-	25	200	.001	7.0	-	1.5	-
2N1917	SSD	pnnp,AJ,si	50	250	175	1.7	0	50	.001	-	7	-	TO-5
2N1918	SSD	pnnp,AJ,si	50	250	175	1.7	11	50	.003	-	7	-	TO-5
2N1919	SSD	pnnp,AJ,si	50	250	175	1.7	18	50	.003	-	7	-	TO-5
2N1920	SSD	pnnp,AJ,si	50	250	175	1.7	18	50	.005	-	7	-	TO-5
2N1921	SSD	pnnp,AJ,si	50	250	175	1.7	50	50	2	-	7	-	TO-5
2N1922	SSD	pnnp,AJ,si	50	250	175	1.7	80	50	2	-	7	-	TO-5
TR-320	IND	pnnp,AJ,ge	50	150	85	2.5	30	200	7.5	-	20	2.5	2N320
2N214	SY	npn,AJ,ge	50-100	180	85	3	40	100	50	-	-	0.01	Matched
2N228	SY	npn,AJ,ge	50-100	50	75	1	40	100	100	-	-	0.01	-
2N241A	SY	pnnp,AJ,ge	50-100	200	85	3.3	30	200	16	-	-	10	-
2N270	SY	pnnp,AJ,ge	50-100	150	85	2.5	25	75	12	-	-	0.08	-
2N321	SY	pnnp,AJ,ge	50-100	200	85	3.3	25	200	18	-	-	10	-
2N1059	SY	npn,AJ,ge	50-100	180	75	3.6	20	100	50	-	-	0.01	-
2N408	SY	pnnp,AJ,ge	50-135	150	85	2.5	20	70	14	-	-	-	-

# DATA CHART

## Audio (continued)

Type No.	Mfg.	Type	h <sub>fe</sub> h or FE	Maximum Ratings					Characteristics					Remarks	
				W <sub>c</sub> (mw)	T <sub>j</sub> (c)	mm/c	V <sub>c</sub> v	I <sub>c</sub> ma	I <sub>co</sub> μa	NF db	C <sub>c</sub> μf	f <sub>int</sub> mc			
2N109	SY	pnp,AJ,ge	50-150	50	85	0.9	25	75	12	-	-	-	-	-	-
2N217	SY	pnp,AJ,ge	50-150	-	85	-	25	75	12	-	-	-	10	-	-
2N323	SY	pnp,AJ,ge	50-150	140	85	2.3	16	100	16	-	-	-	800	-	-
2N1374	SY	pnp,AJ,ge	50-150	150	100	2	25	200	100	-	-	-	-	-	TI
2N1375	SY	pnp,AJ,ge	50-150	150	100	2	45	200	100	-	-	-	-	-	TI
2N188A	GE	pnp,AJ,ge	54	200	85	4	25	200	16	-	-	40	1.2	-	-
2N191	GE	pnp,AJ,ge	54	75	85	2	25	50	16	15	40	1.2	-	-	Driver
CK22B	RA	pnp,AJ,ge	54	75	65	1.25	35	100	10	6.5	-	-	-	-	Submin.
CK66B	RA	pnp,AJ,ge	54	75	85	1.25	35	100	10	-	-	-	-	-	Submin.
CK66C	RA	pnp,AJ,ge	54	75	85	1.25	35	100	10	-	-	-	-	-	Submin.
2N566	IND	pnp,AJ,ge	55	150	85	2.5	30	300	3	12	20	1	-	-	IUS
2N1097	GE	pnp,AJ,ge	55	140	85	4	16	100	16	-	25	-	-	-	Driver
2N1144	GE	pnp,AJ,ge	55	140	85	4	16	100	16	-	40	-	-	-	-
CK27A	RA	pnp,AJ,ge	55	80	85	-	15	400	2	-	14	11	-	-	micromin RF switch
OC54	AMP	pnp,AJ,ge	55	10	55	0.7	3	5	0.1	10	-	0.01	-	-	Hearing aid
OC58	AMP	pnp,PADT,ge	55	10	55	-	7	10	1.5	-	-	-	1.6	-	-
2N226	PH	pnp,AJ,ge	60	250	75	5.0	30	150	8	-	140	0.4	-	-	-
2N596	GI	npn,AJ,ge	60	150	85	1.67	20	-	2	16	15	6	-	-	Bilateral
2N633	IND	pnp,AJ,ge	60	150	85	2.5	35	200	10	-	-	-	0.8	-	RA, US
2N937	SSD	pnp,AJ,si	60	385	160	2.85	30	50	.005	18	70	3	-	-	TO-18
2N940	SSD	pnp,AJ,si	60	250	175	1.7	35	100	.001	-	7	3	-	-	-
2N1475	SSD	pnp,AJ,si	60	250	175	1.7	60	100	.005	-	7	1	-	-	-
OC60	AMP	pnp,PADT,ge	60	10	55	-	7	10	1.5	-	-	-	1.6	-	-
2N526	SY	pnp,AJ,ge	64	225	85	3.7	45	500	10	-	-	3	-	-	GE, TS, MO
2N1925	GE	pnp,AJ,ge	64	225	85	-	40	500	4	-	-	-	-	-	-
2N175	RCA	pnp,AJ,ge	65	50	-	-	10	2	12	6	-	-	0.85	-	-
2N220	RCA	npn,AJ,ge	65	50	-	-	10	2	12	6	-	-	0.85	-	-
2N398A	MO	pnp,AJ,ge	65	150	100	2	105	200	12	-	-	-	1	-	-
2N407	RCA	pnp,AJ,ge	65	150	-	-	20	70	14	-	-	-	-	-	SY
2N408	RCA	pnp,AJ,ge	65	150	-	-	20	70	14	-	-	-	-	-	-
2N649	RCA	npn,AJ,ge	65	100	-	-	20	100	14	-	-	-	-	-	-
2N1448	IND	pnp,AJ,ge	65	200	85	3.33	45	400	5	6	20	4	-	-	-
2N1452	IND	pnp,AJ,ge	65	200	85	3.33	45	400	7.5	9	20	2.2	-	-	-
OC56	AMP	pnp,AJ,ge	65	10	55	0.7	3	5	120	15	-	-	-	-	Hearing aid
OC74	AMP	pnp,PADT,ge	65	550	75	-	20	300	10	-	-	-	1.5	-	-
2N323	GE	pnp,AJ,ge	68	140	85	4	16	100	16	-	25	2.5	-	-	Driver
2N281	AMP	pnp,PADT,ge	70	165	75	-	32	250	4.5	-	-	-	0.9	-	-
2N361	IND	pnp,AJ,ge	70	150	85	2.5	45	200	10	-	-	-	-	-	RA, US
2N591	RCA	pnp,AJ,ge	70	100	-	-	32	40	7	-	-	-	-	-	SY
2N647	RCA	npn,AJ,ge	70	100	-	-	25	100	14	-	-	-	-	-	-
2N735	TI	npn,MS,si	70	1.0	175	-	80	50	1	20	5	50	-	-	TO-18, TR, NA
2N739	TI	npn,DM,si	70	1w	175	-	125	70	1	-	-	-	-	-	-
2N1247	TR	npn,DG,si	70	30	150	0.24	6	-	0.8	-	9	5	-	-	Low drift, dc amp.
2N1352	IND	pnp,AJ,ge	70	150	85	2.5	30	200	2.5	-	18	2.5	-	-	-
2N1565	TI	npn,MS,si	70	1.2	175	-	80	50	1	20	5	50	-	-	TR, NA
2N1573	TI	npn,DM,si	70	1.2w	175	-	125	50	1	-	-	-	-	-	TR
2N213	SY	npn,AJ,ge	70-250	150	85	2.3	40	100	50	-	-	-	0.01	-	-
2N1251	SY	npn,AJ,ge	70-250	150	85	2.5	20	100	50	-	-	-	7.5	-	-
TR-383	IND	pnp,AJ,ge	72	200	85	3.33	25	200	7.5	-	20	1.8	-	-	2N383
2N241	GE	pnp,AJ,ge	73	100	85	3	25	200	16	-	40	1.3	-	-	-
2N109	RCA	pnp,AJ,ge	75	150	-	-	25	70	14	-	-	-	-	-	-
2N192	GE	pnp,AJ,ge	75	75	85	2	25	50	16	15	40	1.5	-	-	-
2N217	RCA	pnp,AJ,ge	75	150	-	-	25	70	14	-	-	-	-	-	-
2N1192	MO	pnp,AJ,ge	75	200	100	2.7	40	200	2	10	-	2	-	-	-
2N1443	NA	pnp,AJ,si	75	400	200	2.28	50	100	0.01	12	25	1	-	-	audio/mod. power
2N1672	GI	npn,AJ,ge	75	120	85	0.5	40	-	5	-	-	-	-	-	Triax driver
GT-74	GI	pnp,AJ,ge	75	150	100	2	25	-	5	6	35	-	-	-	-
GT-81	GI	pnp,AJ,ge	75	150	100	2	25	-	5	16	35	-	-	-	-
TR-323	IND	pnp,AJ,ge	75	150	85	2.5	16	200	7.5	-	20	2.5	-	-	2N323
2N1376	SY	pnp,AJ,ge	75-150	150	100	2	25	200	100	-	-	-	-	-	-
2N1431	SY	npn,AJ,ge	75-150	180	75	3.6	25	100	50	-	-	-	10	-	-
2N1950	IND	npn,DM,si	75-250	600	175	4	20	-	0.01	-	-	-	-	-	-
2N1951	IND	npn,DM,si	75-250	600	175	4	30	-	0.01	-	-	-	-	-	-
2N1952	IND	npn,DM,si	75-250	600	175	4	40	-	0.01	-	-	-	-	-	-
2N120	TI	npn,GR,si	76-333	150	175	1	45	25	2	20	-	7	-	-	TR
2N336	TI	npn,GR,si	76-333	150	175	1	45	25	2	20	-	13	-	-	TR, GE, NA, RA
2N336A	NA	npn,MS,si	76-333	500	175	2.8	45	-	0.5	-	-	-	-	-	-
2N760	NA	npn,DM,si	76-333	500	200	2.5	45	-	0.2	-	-	-	-	-	-
2N760A	NA	npn,DM,si	76-333	500	200	2.5	60	-	0.1	-	-	-	-	-	-
2N910	TI	npn,GR,si	76-333	150	175	1	45	25	2	20	-	7	-	-	2N1153
2N1153	NA	npn,DM,si	76-333	150	175	0.86	45	25	2	-	7	1	-	-	TR
2N185	TI	pnp,AJ,ge	80	150	85	0.0025	25	150	6	6.5	-	2	-	-	-
2N321	GE	pnp,AJ,ge	80	225	85	4	20	200	16	-	25	3	-	-	-
2N527	SY	pnp,AJ,ge	80	225	85	3.7	45	500	10	-	-	3.3	-	-	TS
2N651	MO	pnp,AJ,ge	80	200	100	2.8	45	500	3	5	-	2	-	-	US, SY



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9



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75 Watts @ 25°C  
43 Watts @ 100°C  
Max. 7.5 Amp I.  
Max. 100 Volts V.

2N1487 2N1490  
2N1488 2N1069  
2N1489 2N1070

### SQUARE CASE

85 Watts @ 25°C  
45 Watts @ 100°C  
Max. 7.5 Amp I.  
Max. 100 Volts V.

2N309 2N1210  
2N424 2N1211  
2N389A 2N1620  
2N424A

### DOUBLE-ENDED STUD

85 Watts @ 25°C  
45 Watts @ 100°C  
Max. 7.5 Amp I.  
Max. 100 Volts V.

2N1616  
2N1617  
2N1618



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CIRCLE 37 ON READER-SERVICE CARD



Type No.	Mfg.	Type	h <sub>FE</sub>	Maximum Ratings			
				W <sub>c</sub> (mw)	T <sub>j</sub> (c)	mm/c	V <sub>c</sub> v
2N651A	MO	npn,AJ.ge	80	200	100	2.8	45
2N654	MO	npn,AJ.ge	80	200	100	2.8	30
2N780	TI	npn,DM,si	80	1w	175	—	45
2N1187	MO	npn,AJ.ge	80	200	100	2.7	60
2N1370	TI	npn,AJ.ge	80	150	85	.0025	25
2N1371	TI	npn,AJ.ge	80	150	85	.0025	25
2N1374	TI	npn,AJ.ge	80	250	100	3.3	25
2N1375	TI	npn,AJ.ge	80	250	100	3.3	45
2N1382	TI	npn,AJ.ge	80	200	85	—	25
2N1449	IND	npn,AJ.ge	80	200	85	3.3	45
2N1731	TI	npn,DM,si	80	2w	175	—	60
2N1926	GE	npn,AJ.ge	80	225	85	—	40
CK28A	RA	npn,AJ.ge	80	80	85	—	12
OC55	AMP	npn,AJ.ge	80	10	55	0.7	3
OC59	AMP	npn,PADT.ge	80	10	55	—	7
TR-321	IND	npn,AJ.ge	80	150	85	2.5	30
2N543A	TR	npn,DG,si	80-200	200	200	—	45
2N527	GE	npn,AJ.ge	81	225	100	4	45
2N324	GE	npn,AJ.ge	85	140	85	4	16
2N224	PH	npn,AJ.ge	90	250	75	5.0	25
2N466	MO	npn,AJ.ge	90	200	100	2.5	35
2N1706	TS	—	90	200	100	—	25
2N1707	TS	—	90	200	100	—	30
CK22	RA	npn,FA.ge	90	80	85	—	20
CK66	RA	npn,FA.ge	90	80	85	—	20
CK66A	RA	npn,AJ.ge	90	80	85	—	20
OC75	AMP	npn,PADT.ge	90	115	75	—	30
2N1376	TI	npn,AJ.ge	95	250	100	3.3	45
2N1377	TI	npn,AJ.ge	95	250	100	3.3	45
2N207	PH	npn,AJ.ge	100	50	65	1.2	12
2N207A	PH	npn,AJ.ge	100	50	65	1.25	12
2N207B	PH	npn,AJ.ge	100	50	65	1.25	12
2N360	RA	npn,AJ.ge	100	150	85	2.5	20
2N362	IND	npn,AJ.ge	100	150	85	2.5	20
2N534	PH	npn,AJ.ge	100	75	65	1.43	50
2N535	PH	npn,AJ.ge	100	50	85	0.83	20
2N535A	PH	npn,AJ.ge	100	50	85	0.83	20
2N535B	PH	npn,AJ.ge	100	50	85	0.83	20
2N568	IND	npn,AJ.ge	100	150	85	2.5	30
2N632	IND	npn,AJ.ge	100	150	85	2.5	30
2N736	TI	npn,MS,si	100	1.0	175	—	80
2N740	TI	npn,DM,si	100	1w	175	—	125
2N1124	PH	npn,AJ.ge	100	300	85	5.0	40
2N1380	TI	npn,AJ.ge	100	250	100	3.3	12
2N1381	TI	npn,AJ.ge	100	250	100	3.3	25
2N1574	TI	npn,DM,si	100	1.2w	175	—	125
TR383	IND	npn,AJ.ge	100	150	85	3	25
2N213A	SY	npn,AJ.ge	100-250	150	85	2.5	40
2N1944	IND	npn,DM,si	100-300	600	175	4	20
2N1945	IND	npn,DM,si	100-300	600	175	4	30
2N1946	IND	npn,DM,si	100-300	600	175	4	40
2N1947	IND	npn,DM,si	100-300	600	175	4	20
2N1948	IND	npn,DM,si	100-300	600	175	4	30
2N1949	IND	npn,DM,si	100-300	600	175	4	40
CK67B	RA	npn,AJ.ge	108	75	85	1.25	35
CK67C	RA	npn,AJ.ge	108	75	85	1.25	35
CK261	RA	npn,AJ.ge	54	75	85	1.25	35
CK262	RA	npn,AJ.ge	54	75	85	1.25	35
2N223	PH	npn,AJ.ge	110	250	75	5.0	18
2N265	GE	npn,AJ.ge	110	75	85	2	25
2N1705	TS	—	110	200	100	—	18
GT-109	GI	npn,AJ.ge	110	150	100	2	25
2N508	GE	npn,AJ.ge	112	140	85	4	16
2N1018	RA	npn,AJ.ge	120	80	85	—	8
2N1128	PH	npn,AJ.ge	120	150	85	2.5	25
TR-508	IND	npn,AJ.ge	125	150	85	2.5	16
2N652	MO	npn,AJ.ge	130	200	100	2.7	45
2N655	MO	npn,AJ.ge	130	200	100	2.8	45
2N655	MO	npn,AJ.ge	130	200	100	2.8	30
2N1130	PH	npn,AJ.ge	130	150	85	2.5	30
2N1188	MO	npn,AJ.ge	130	200	100	2.7	60
2N359	RA	npn,AJ.ge	150	150	85	2.5	45

## DATA CHART

(continued)

Characteristics				Remarks	Type No.
$\alpha$	NF db	C mc	f mc		
6	15	-	2.0	US	2N651A
	10	-	2.0		2N654
	-	-	-		2N780
	5	-	2		2N1187
	6.5	-	2.0		2N1370
	6.5	-	2.0		2N1371
	6.5	-	2		2N1374
	6.5	-	2		2N1375
11	6.5	-	2		2N1382
	6	20	5		2N1449
15	-	-	-	2N1731	
	-	-	-	2N1926	
	-	14	17	micromin RF switch	
15	10	-	0.01	Hearing aid	
	-	-	2.2	OC55	
	-	-	-	OC59	
15	-	20	3.1	2N321	
15	20	7	15	100% reliability as- surance processed.	
	6	25	3.3	MO	
	-	25	3	Driver	
	-	125	0.51	2N527	
	-	-	-	2N524	
	-	-	-	2N224	
	15	-	1	US, GI, RA, SY	
	-	-	3	2N466	
	-	-	3	2N1706	
	-	-	3	2N1707	
	6.5	-	1.2	CK22	
	22	-	1.2	CK66	
	22	-	1.2	micromin	
	-	-	0.75	CK66A	
	5.5	40	2	OC75	
	5.5	-	2	2N1376	
	5	-	2	2N1377	
	5	-	2	2N207	
	2	-	2	2N207A	
	2	-	2	2N207B	
	-	-	1.2	IND, US	
	-	-	-	RA, US	
	-	-	-	2N360	
	-	-	-	2N362	
	-	-	-	2N534	
	5	-	2	2N535	
	2	-	2	2N535A	
	2	-	2	2N535B	
	12	20	1.5	US	
	-	-	1	RA, US, GI	
	-	-	1	2N632	
	20	5	50	TO-18, TR, FA, NA	
	-	-	-	TR	
	-	-	1.0	2N736	
	-	-	-	2N740	
	-	-	-	2N1124	
	5.5	40	2	2N1380	
	5.5	40	2	2N1381	
	-	-	-	TR	
	-	50	1.8	2N1574	
	-	-	10	TR383	
	-	-	-	2N213A	
	-	-	-	2N1944	
	-	-	-	2N1945	
	-	-	-	2N1946	
	-	-	-	2N1947	
	-	-	-	2N1948	
	-	-	-	2N1949	
	-	-	-	CK67B	
	-	-	-	Submin.	
	-	-	-	Submin.	
	-	-	-	Submin.	
	-	-	-	Submin.	
	-	90	0.6	2K273	
	15	40	1.5	Driver	
	-	-	-	2K265	
	-	-	4	2N1705	
16	35	-	-	GT-109	
	-	25	3.5	Driver	
	-	14	25	micromin RF switch	
	-	-	-	KF	
	-	45	1	2N1128	
	-	20	3.5	2N508	
	5	-	2.5	SY	
	15	-	2.5	2N652	
	10	-	2.5	2N652A	
	-	125	0.75	US	
	-	-	-	2N655	
	-	-	-	2N1130	
	5	-	2.5	2N1188	
	-	-	1	IND, US	
	-	-	-	2N359	

New **BA** model NC-1 performs transistor tests up to

50 amps at 750W peak power!



Here's the only direct reading, variable duty cycle test set for non-destructive measurement of medium and high-power transistors. The B A Model NC-1 applies suitable pulse drive signals to the transistor under test and then peak detects the resulting current pulses so they have the same measuring value as steady state DC. Because the average pulse signal power is considerably lower than that of steady state DC, less stress is put on the transistor. This permits power tests to be made at a level many times that of rated dissipation.

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Transistor Test Set	Model GP-4
General Purpose Transistor Test Set	Model KP Series
Curve Tracer	Model MW-1
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Each system assembled from standard modules to meet particular requirements. Output choice is Go, No-Go; digital indication; printout; card or tape punch; or bin selection.



TRANSISTORS - 196

## Audio

Type No.	Mfg.	Type	h <sub>fe</sub> h <sub>FE</sub>	Maximum Ratings				
				W <sub>c</sub> (mw)	T <sub>j</sub> (c)	mw/c	V <sub>c</sub> v	I <sub>c</sub> mA
2N570	IND	npn,AJ,ge	150	150	85	2.5	30	3
2N631	IND	npn,AJ,ge	150	150	85	2.5	25	2
2N1008A	SY	npn,AJ,ge	150	400	85	6.6	40	3
2N1471	IND	npn,AJ,ge	150	200	85	3.33	12	2
2N1193	MO	npn,AJ,ge	160	200	100	2.7	40	2
2N467	MO	npn,AJ,ge	180	200	100	2.5	35	1
CK67	RA	npn,FA,ge	180	80	85	-	15	1
CK67A	RA	npn,AJ,ge	180	80	85	-	15	1
2N1129	PH	npn,AJ,ge	190	150	85	2.5	25	2
2N467	GI	npn,AJ,ge	200	120	85	2	35	1
2N572	IND	npn,AJ,ge	200	150	85	2.5	30	3
2N1378	TI	npn,AJ,ge	200	250	100	3.3	12	1
2N1379	TI	npn,AJ,ge	200	250	100	3.3	25	2
2N1185	MO	npn,AJ,ge	260	200	100	2.7	45	3
2N1194	MO	npn,AJ,ge	280	200	100	2.7	40	1
OCF70	AMP	npn,AJ,ge	-	25	65	2.5	7.5	1
2N461	MO	npn,AJ,ge	-	200	100	2.8	45	1



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Thermal conductivity considerably greater than conventional mica wafers of comparable thicknesses. Dielectric properties equal to best insulating materials. Insulate semi-conductor from chassis and dissipate the substantial heat generated at rated capacities. Extremely durable with high abrasion and corrosion resistance. Installed between semi-conductor and chassis, heat sink or other surface on which semi-conductor is mounted.

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CIRCLE 40 ON READER-SERVICE CARD



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- U. S. Transistor Corp.
- Western Electric
- Westinghouse

## Abbreviation

AJ	Alloy Junction
DD	Double Diffused
DG	Grown Diffused
DJ	Diffused Junction
DM	Diffused Mesa
DP	Diffused Planar
Dr	Drift
Ep	Epitaxial
FA	Fused Alloy
FJ	Fused Junction
GD	Grown Diffused
Ge	Germanium
GJ	Grown Junction
GR	Grown Rate
MB	Meltback
MD	MADT
Ms	Mesa
RG	Rate Grown

## DATA CHART

(concluded)

Characteristics				Remarks	Type No.
$I_{co}$ $\mu A$	NF db	$C_c$ $\mu A$	$f_{\alpha}$ mc		
3	12	20	2	RA BE	2N570
10	-	-	1.2		2N631
500	-	-	25		2N1008A
2.5	-	18	5		2N1471
2	10	-	2.5	2N1193	
6	-	-	1.2	IND, SY	2N467
2	22	-	1.5		CK67
2	22	-	-		CK67A
25	-	125	0.75	micromin	2N1129
10	16	40	0.5		2N467
3	12	20	3	MO, RA, US	2N572
3	4	40	3		2N1378
3	4	40	3		2N1379
5	5	-	3		2N1185
2	10	-	3		2N1194
325	-	-	-	Relay photo-tr. US AF	OCP70
10	20	-	0.7		2N461

### of Terms

Si	Silicon
SBT	Surface Barrier
$C_{in}$	Collector-to-emitter capacitance measured across the output terminals with the input ac open-circuited.
$f_{\alpha}$	Frequency at which the magnitude of the forward-current transfer ratio (small-signal) is 0.707 of its low-frequency value.
$f_1$	Frequency at which common emitter gain is unity.
$h_{fe}$	Common emitter-small signal forward current transfer ratio.
$h_{FE}$	Common emitter-static value of short-circuited forward current ratio.
$I_{co}$	Collector current when collector junction is reverse-biased and emitter is dc open-circuited.

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Acetic Acid, Glacial	Cobalt Carbonate	Nickelous Nitrate
Acetone	Cobalt Oxide	Nickelous Sulfate
Aluminum Nitrate	Cobalt Nitrate	Nitric Acid
Aluminum Sulfate	Ether, Anhydrous	Petroleum Ether
Ammonium Carbonate	Hydrochloric Acid	Potassium Dichromate
Ammonium Chloride	Hydrofluoric Acid	Potassium Hydroxide
Ammonium Hydroxide	Hydrogen Peroxide,	iso-Propyl Alcohol
Ammonium Phosphate	30% and 3% Solution	Radio Mixture No. 3
Antimony Trisulfide	Lithium Carbonate	Silicic Acid
Barium Acetate	Lithium Chloride	Sodium Carbonate
Barium Carbonate	Lithium Nitrate	Sodium Chloride
Barium Fluoride	Lithium Sulfate	Sodium Hydroxide
Barium Nitrate	Magnesium Carbonate	Sodium Phosphate Dibasic
Benzene	Magnesium Chloride	Strontium Carbonate
Boric Acid	Magnesium Oxide	Strontium Nitrate
Cadmium Chloride	Manganese Dioxide	Sulfuric Acid
Cadmium Nitrate	Manganese Nitrate	Toluene
Cadmium Sulfate	Manganese Sesquioxide	Trichloroethylene
Calcium Carbonate	Manganese Carbonate	Triple Carbonate
Calcium Chloride	Methanol	Xylene
Calcium Fluoride	Nickel Carbonate	Zinc Chloride
Calcium Nitrate	Nickel Oxide, Black	Zinc Nitrate
Calcium Phosphate	Nickel Oxide, Green	Zinc Oxide
Carbon Tetrachloride	Nickelous Chloride	

ELECTRONICS BUYERS' GUIDE — July 20, 1961

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CIRCLE 41 ON READER-SERVICE CARD



# TRANSISTORS - 1961

## High Frequency

Type No.	Mfg.	Type	f <sub>ce</sub>	Maximum Ratings					Characteristics				Remarks
				W c (mw)	T <sub>j</sub> (c)	mw/c	V c v	I c ma	h fe	I co μA	NF db	C c μf	
2N444A	GI	npn, AJ, ge	1	150	100	2	40	-	25	2	12	14	
2N1024	SSD	npn, AJ, si	1	150	150	1.2	15	100	9	25	-	7	NA
2N1025	SSD	npn, AJ, si	1	150	150	1.2	35	100	9-22	25	-	-	NA
2N94	SY	npn, AJ, ge	2	50	75	1	20	50	50	50	-	-	
2N139	SY	npn, AJ, ge	2 (min.)	80	85	.75	20	15	22-110	50	-	-	
2N169A	SY	npn, AJ, ge	2	65	75	.8	25	20	36-220	50	-	-	
2N193	SY	npn, AJ, ge	2	50	75	1	18	50	9	50	-	-	
2N194	SY	npn, AJ, ge	2	50	75	1	18	50	10	50	-	-	Mixer
2N194A	SY	npn, AJ, ge	2	50	75	1	18	50	10	50	-	-	Converter
2N211	SY	npn, AJ, ge	2	50	70	1.1	10	50	5-15	20	-	-	
2N233A	SY	npn, AJ, ge	2	50	75	1	18	50	30	50	-	-	
2N413A	SY	npn, AJ, ge	2	150	85	2.5	15	200	-	10	-	-	GI
2N445	CBS	npn, AJ, ge	2	100	85	1.67	15	-	6	-	12	-	
2N515	SY	npn, AJ, ge	2	50	75	1	18	10	25-50	50	-	-	
2N516	SY	npn, AJ, ge	2	50	75	1	18	10	5-15	50	-	-	
2N517	SY	npn, AJ, ge	2	50	75	1	18	10	10-60	50	-	-	
2N519A	GI	npn, AJ, ge	2	150	100	2	25	-	25	1	12	14	IND, KF
2N1026	SSD	npn, AJ, ge	2	150	150	1.2	35	100	18-44	25	-	-	
2N1469	SSD	npn, AJ, si	2	150	150	1.2	35	100	36	25	-	7	
2N413	RA	npn, FA, ge	2.5	150	85	-	18	200	30	2.0	7	-	IND, US, KF, GI
CK13	RA	npn, FA, ge	2.5	80	85	-	18	200	30	2.0	7	-	
GK13A	RA	npn, AJ, ge	2.5	80	85	-	18	200	30	2.0	7	-	Micromin
2N356	CBS	npn, AJ, ge	3	100	85	1.67	20	-	5	-	-	12	RCA, GI, SY
2N438	CBS	npn, AJ, ge	3	100	85	1.67	30	-	10	-	-	12	GI
2N438A	CBS	npn, AJ, ge	3	150	85	2.5	30	-	10	-	-	12	GI, RA
2N445A	GI	npn, AJ, ge	3	150	100	2	30	-	70	2	12	14	
2N481	RA	npn, AJ, ge	3	200	85	3	30	20	50	3	-	14	
2N482	IND	npn, AJ, ge	3.5	150	85	2.5	14	200	50	3	-	12	RA, US
TR-482	IND	npn, AJ, ge	3.5	150	85	2.5	14	200	20	3	-	12	
2N212	SY	npn, AJ, ge	4	50	75	1	18	50	20	50	-	-	Converter
2N385	CBS	npn, AJ, ge	4	150	100	2.0	25	-	35	-	-	4	SY, GI
2N414A	SY	npn, AJ, ge	4	150	85	2.5	15	200	-	20	-	-	KF, GI
2N528	WE	npn, DG, ge	4	1	100	.5	40	50	25	10	-	-	US, MIL only
2M1027	SSD	npn, AJ, si	4	150	150	1.2	15	100	18	25	-	7	
2N1058	SY	npn, AJ, ge	4	50	75	1	18	-	15	50	-	-	Converter
2N94A	SY	npn, AJ, ge	5	50	85	.8	20	50	19	50	-	-	
2N168A	SY	npn, AJ, ge	5	65	85	1.1	15	20	23-135	5	-	-	
2M292	SY	npn, AJ, ge	5	65	85	.9	15	20	6-44	5	-	-	
2N395	RA	npn, AJ, ge	5	150	85	-	25	-	40	2.0	-	12	GE
2N438	RA	npn, AJ, ge	5	100	85	-	25	400	25	3	-	9	TO-5 RF Switch
2N439	CBS	npn, AJ, ge	5	100	85	1.67	30	-	10	-	-	12	GT, SY
2N439A	CBS	npn, AJ, ge	5	150	85	2.5	30	-	10	-	-	12	RA
2N446	CBS	npn, AJ, ge	5	100	85	1.67	15	-	6	-	-	12	
2N448	GE	npn, RC, ge	5	65	85	1.1	15	20	25	5	-	2.4	
2N520A	GI	npn, AJ, ge	5	150	100	2	25	-	100	1	12	14	IND, KF
2N634	CBS	npn, AJ, ge	5	150	85	2.5	20	-	5	-	-	12	GE
2N1090	CBS	npn, AJ, ge	5	120	85	2	25	-	8	-	-	12	
2N1681	TS	-	5	180	100	-	30	200	75	3	-	-	
2N483	RA	npn, FA, ge	5.5	150	85	-	12	20	60	3.0	-	-	IND, US
2N357	CBS	npn, AJ, ge	6	100	85	1.67	20	-	5	-	-	12	RCA, GI, SY
2N377	CBS	npn, AJ, ge	6	150	100	2.0	25	-	5	-	-	12	SY
2N446A	GI	npn, AJ, ge	6	150	100	2	30	-	120	2	12	14	
OC45	AMP	npn, PADT, ge	6	83	75	-	15	10	100	0.5	-	-	
ST4150	TR	npn, DJ, si	6	5.0	200	45	60	-	25	15	-	80	
2N139	RCA	npn, AJ, ge	6.8	80	85	1	16	15	48	6	8	-	SY
2N218	RCA	npn, AJ, ge	6.8	80	85	-	16	15	48	6	-	-	
2N409	RCA	npn, AJ, ge	6.8	80	85	-	13	15	48	10	-	-	SY
2N410	RCA	npn, AJ, ge	6.8	80	85	-	13	15	75	10	-	-	
2N414	RA	npn, FA, ge	7	150	85	-	15	200	60	2.0	6	-	IND, US, TS, GE, RCA, SY, GI
2N439	RA	npn, AJ, ge	7	100	85	-	20	400	45	3	-	9	TO-5 RF Switch
2N1090	RA	npn, AJ, ge	7	150	85	-	18	100	50	3	-	9	TO-5 RF Switch
CK14	TR	npn, FA, ge	7	80	85	-	15	200	60	2.0	6	-	
ST903	RA	npn, DJ, si	7	150	150	1.0	30	-	16	0.1	25	7	
2N485	IND	npn, AJ, ge	7.5	200	85	3	30	20	50	3	-	12	RA, US
2N168A	GE	npn, RG, ge	8	65	85	1.1	15	20	40	5	-	2.4	
2N169	GE	npn, RG, ge	8	65	85	1.1	15	20	72	5	-	2.4	
2N233	GE	npn, RG, ge	8	65	85	1.1	15	20	25	5	-	2.4	
2N388	CBS	npn, AJ, ge	8	150	100	2.0	25	-	5	-	-	12	GI, SY
2N396	RA	npn, AJ, ge	8	190	85	-	20	-	80	20	-	12	TS
2N449	GE	npn, RG, ge	8	65	85	1.1	15	20	72	5	-	2.4	
2N471A	TR	npn, GJ, si	8	200	200	-	30	25	10-25	.02	22	7	
2N472A	TR	npn, GJ, si	8	200	200	-	45	25	10-25	.02	22	7	
2N581	RA	npn, AJ, ge	8	100	85	-	15	100	30	3	-	12	TO-5 RF Switch
2N1086	GE	npn, RG, ge	8	65	85	1.1	9	20	40	3	-	2.4	
2N1086A	GE	npn, RG, ge	8	65	85	1.1	9	20	40	3	-	2.4	

# DATA CHART

## High Frequency (continued)

Type No.	Mfg.	Type	f <sub>ao</sub>	Maximum Ratings					Characteristics					Remarks
				W <sub>c</sub> (mw)	T <sub>j</sub> (c)	mW/d	V <sub>c</sub> V	I <sub>c</sub> ma	h <sub>fe</sub>	I <sub>co</sub> μa	NF db	C <sub>c</sub> μμf		
2N1087	GE	npn, RG, ge	8	65	85	1.1	9	20	40	3	-	2.4		
2N1121	GE	npn, RG, ge	8	65	85	1.1	15	20	72	5	-	2.4		
S500	SSD	npn, AJ, si	8	150	150	1.2	25	100	9	25	-	7		
2N358	CBS	npn, AJ, ge	9	100	85	1.67	20	-	-	5	-	12	GI, SY	
2N447	CBS	npn, AJ, ge	9	100	85	1.67	15	-	-	6	-	12		
2N521A	GI	npn, AJ, ge	9	150	100	2	25	-	150	1	12	14		
5T904	TR	npn, GR, si	9	150	150	1.0	30	-	31	0.1	25	7		
2N140	RCA	npn, AJ, ge	10	80	85	-	16	15	75	6	8	-	SY	
2N219	RCA	npn, AJ, ge	10	80	85	-	16	15	75	6	-	-		
2N411	RCA	npn, AJ, ge	10	80	85	-	13	15	75	10	-	-	SY	
2N148	IND	npn, AJ, ge	10	200	85	2.5	14	200	90	3	-	12	IND, KF	
2N416	RA	npn, FA, ge	10	150	85	-	12	200	80	2.0	4	-	IND, US, GI, TS, KF	
2N440	CBS	npn, AJ, ge	10	100	85	1.67	30	-	-	10	-	12	GI, SY, RA	
2N40A	CBS	npn, AJ, ge	10	150	85	2.5	30	-	-	10	-	12	GI, RA	
2N47A	GI	npn, AJ, ge	10	150	100	2	30	-	150	2	12	14		
2N473	TR	npn, GR, si	10	200	200	-	15	25	20-50	.02	20	7		
2N474	TR	npn, GR, si	10	200	200	-	30	25	20-50	.02	20	7		
2N474A	TR	npn, GJ, si	10	200	200	-	30	25	20-50	.02	20	7		
2N475	TR	npn, GR, si	10	200	200	-	45	25	20-50	.02	20	7		
2N479A	TR	npn, GJ, si	11	200	200	-	30	25	40-100	.02	20	7		
2N484	RA	npn, FA, ge	10	150	85	-	12	20	90	3.0	-	-	US	
2N635	CBS	npn, AJ, ge	10	150	85	2.5	20	-	-	5	-	12	GE	
2N1091	CBS	npn, AJ, ge	10	120	85	2	25	-	-	8	-	12		
CK16	RA	npn, FA, ge	10	80	85	-	12	200	80	2.0	4	-		
GK16A	RA	npn, AJ, ge	10	80	85	-	12	200	80	2.0	4	-	Microman	
5T905	TR	npn, GR, si	10	150	150	1.0	30	-	65	0.1	25	7		
2N118A	TR	npn, GR, si	11	150	175	-	30	25	19-90	0.1	27	7	JAN, T1	
2N478	TR	npn, GR, si	11	200	200	-	15	25	40-100	0.2	20	7		
2N479	TR	npn, GR, si	11	200	200	-	30	25	40-100	.02	20	7		
2N480	TR	npn, GR, si	11	200	200	-	45	25	40-100	.02	20	7		
2N1417	TR	npn, GR, si	11	150	150	-	15	25	30-200	0.1	19	7		
2N1418	TR	npn, GR, si	11	150	150	-	30	25	30-200	0.1	19	7		
5T15	TR	npn, GR, si	11	200	200	-	15	25	10-100	.02	22	7		
5T35	TR	npn, GR, si	11	200	200	-	30	25	10-100	.02	22	7	2N332	
5T45	TR	npn, GR, si	11	200	200	-	45	25	10-100	.02	22	7		
5T904A	TR	npn, GR, si	11	150	150	1.0	30	-	60	0.1	25	7		
5T910	TR	npn, GR, si	11	150	150	1.0	30	-	140	0.1	20	7		
2N397	RA	npn, AJ, ge	12	150	85	-	15	-	80	2.0	-	12	TO-5, RF Switch, KF	
2N486	IND	npn, AJ, ge	12	-	85	3	30	20	100	3	-	12	RA, US	
2N751	RA	npn, DJ, si	12	150	+175	0.75	20	50	4	0.01	-	6		
2N1390	RA	npn, DJ, si	12	300	+175	0.5	20	50	4	0.01	-	6		
2N541	TR	npn, GR, si	15	200	200	-	15	25	80-200	.02	20	7	NA	
2N542	TR	npn, GR, si	15	200	200	-	30	25	80-200	.02	20	7	NA	
2N542A	TR	npn, GJ, si	15	200	200	-	30	25	80-200	.02	20	7		
2N543	TR	npn, GR, si	15	200	200	-	45	25	80-200	.02	20	7	NA	
2N636	CBS	npn, AJ, ge	15	150	85	2.5	20	-	-	5	-	12	GE	
2N1091	RA	npn, AJ, ge	15	150	85	-	15	100	70	3	-	9	TO-5 RF switch	
OC44	AMP	npn, PAD T, ge	15	83	75	-	15	10	100	0.5	-	8		
2N476	TR	npn, GJ, si	17	200	200	-	15	25	30-60	.02	19	8		
2N477	TR	npn, GJ, si	17	200	200	-	30	25	30-60	.02	19	8		
2N522A	GI	npn, AJ, ge	17	150	100	2	25	-	200	1	12	14	KF	
2N582	RA	npn, AJ, ge	18	100	85	-	14	100	60	3	-	12	TO-5 RF switch	
2N1118	PH	npn, SAT, si	18	150	140	1.3	25	50	20	.002	-	6	SPR	
2N1118A	PH	npn, SAT, si	18	150	140	1.3	25	50	25	1.0	-	6	SPR	
2N232	PH	npn, SBT, ge	20	9	55	0.9	1.5	3	39	6	-	6	SPR	
2N417	RA	npn, FA, ge	20	150	85	-	10	200	140	2.0	4	-	IND, US, GI, TS	
2N602	GI	npn, Dr, ge	20	120	85	2	20	-	-	3	14	4		
CK17	RA	npn, FA, ge	20	80	85	-	10	200	140	2.0	4	-		
CK17A	RA	npn, AJ, ge	20	80	85	-	10	200	140	2.0	4	-	microman	
2N495	PH	npn, SA, si	21	150	140	1.3	25	50	20	.002	-	7		
2N523A	GI	npn, AJ, ge	23	150	100	2	20	-	300	1	12	14	IND	
2N1428	PH	npn, SAT, si	23	100	140	0.86	6	50	45	.001	-	7		
2N1429	PH	npn, SAT, si	23	100	140	0.86	6	50	45	.001	-	7		
2N1065	GI	npn, Dr, ge	25	120	85	2	40	-	-	4	12	3		
2N1900	PSI	npn, DM, si	25	125w	150	1000	140	5a	10	20ma	-	0.1	hi freq., hi pwr.	
2N1901	PSI	npn, DM, si	25	125w	150	1000	140	5	19	20ma	-	1	hi freq., hi pwr.	
2N274	RCA	npn, Dr, ge	30	80	85	-	35	10	60	16	-	-		
2N370	RCA	npn, Dr, ge	30	80	85	-	20	10	60	20	-	-	SY	
2N371	RCA	npn, Dr, ge	30	80	85	-	20	10	-	20	-	-	SY	
2N372	RCA	npn, Dr, ge	30	80	85	-	20	10	60	20	-	-	Mixor, SY	
2N373	RCA	npn, Dr, ge	30	80	85	-	25	10	60	8	-	-	SY	
2N374	RCA	npn, Dr, ge	30	80	85	-	25	10	60	8	-	-	converter, SY	
2N1109	TI	npn, Cd, ge	30	30	85	.5	16	5	-	5	-	1.5		
2N1224	SY	npn, OD, ge	30	120	100	1.6	40	10	20-175	12	-	-		
2N1224	RCA	npn, Dr, ge	30	120	85	-	40	10	60	12	-	-		
2N1226	RCA	npn, Dr, ge	30	120	85	-	60	10	60	16	-	-		

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... Offering efficient switching in the 1-200 mA range and peak pulse current capability to 10 amperes, in the miniature TO-18 package.



- High sensitivity . . . 20  $\mu$ A firing
- Close firing control . . . within  $\pm .08V$
- Voltage ratings to 200V
- MIL-S-19500 capability

Type	Maximum Anode Voltage (DC or Peak AC) $\pm$ Volts	Maximum Average Forward Current 75°C mA	Maximum Gate Current to "Fire" $\mu$ A	Gate Voltage to Fire + Volts	
				Min.	Max.
2N884	15	200	20	.44	.60
2N885	30	200	20	.44	.60
2N886	60	200	20	.44	.60
2N887	100	200	20	.44	.60
2N888	150	200	20	.44	.60
2N889	200	200	20	.44	.60

**Now in TO-18**

Available for the first time in the miniature TO-18 case, these units offer the same high sensitivity and close characteristics control introduced by SSPI in pioneering PNP devices for control and logic applications.

The precise firing characteristics of these devices make them ideal for timing and time delay circuits, voltage limit detectors, high gain static switching, logic circuits, and related applications.

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Designed to meet the requirements of MIL-S-19500, these units are subjected to extensive temperature storage and cycling, as well as 100% acceptance testing, as a regular part of the manufacturing procedure.

Write for Bulletin C420-03.  
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# TRANSISTORS - 1961

## High Frequency (continued)

Type No.	Mfg.	Type	f <sub>sw</sub>	Maximum Ratings					Characteristics					Remarks
				W <sub>c</sub> (mw)	T <sub>j</sub> (°C)	mW/c	V <sub>c</sub>	I <sub>c</sub> ma	h <sub>fe</sub>	I <sub>co</sub> μA	NF db	C <sub>c</sub> μf		
2N1395	RCA	pnp,Dr,ge	30	120	85	-	40	10	90	16	-	-		
2N1750	PH	pnp,SBT,gn	30	15	75	0.5	14	5	-	2	-	6		
2N1425	RCA	pnp,Dr,ge	33	80	71	-	24	10	50	12	-	-		
2N1426	RCA	pnp,Dr,ge	33	80	71	-	24	10	130	12	-	-		
2N1524	RCA	pnp,Dr,ge	33	80	71	0.4	24	10	60	16	-	2		
2N1525	RCA	pnp,Dr,ge	33	80	71	0.4	24	10	60	16	-	2		
2N1526	RCA	pnp,Dr,ge	33	80	71	0.4	24	10	130	16	-	-		
2N1527	RCA	pnp,Dr,ge	33	80	71	0.4	24	10	130	16	-	-		
2N1108	TI	pnp,GD,ge	35	30	85	0.5	16	5	-	5	-	1.5		
2N1110	TI	pnp,GD,ge	35	30	85	0.5	16	5	-	5	-	1		
2N1111	TI	pnp,GD,ge	35	30	85	0.5	20	5	-	5	-	1.5		
2N1111A	TI	pnp,GD,ge	35	30	85	0.5	20	5	-	5	-	1.5		
2N1111B	TI	pnp,GD,ge	35	30	85	0.5	20	5	-	5	-	1.5		
2N603	GI	pnp,Dr,ge	40	120	85	2	30	-	-	3	14	3		
2N750	RA	npn,DJ,si	40	150	175	0.75	50	50	7	10	-	6		
2N1307	TI	pnp,GD,ge	40	30	85	0.5	16	5	-	5	-	1.5		
2N1389	RA	npn,DJ,si	40	300	175	0.5	50	50	7	10	-	6		
2N1633	RCA	pnp,Dr,ge	40	80	71	0.4	34	10	75	16	-	-		
2N1634	RCA	pnp,Dr,ge	40	80	71	0.4	34	10	75	16	-	-		
2N1636	RCA	pnp,Dr,ge	40	80	71	0.4	34	10	75	7	-	2		
2N3746	RCA	pnp,Dr,ge	40	80	71	-	34	20	.985	16	-	3.8		
2N640	RCA	pnp,Dr,ge	42	80	85	0.75	34	10	60	5	-	-		
2N641	RCA	pnp,Dr,ge	42	80	85	0.75	34	10	60	7	-	-		
2N642	RCA	pnp,Dr,ge	42	80	85	0.75	34	10	60	7	-	-		
2N754	TR	npn,DJ,si	44	300	175	-	60	50	20-80	1	-	8		
2N755	TR	npn,DJ,si	44	300	175	-	100	50	20-80	1	-	8		
2N839	TR	npn,DJ,si	44	300	175	-	45	25	20-45	0.1	15	-	TMT839 (150mw)	
2N840	TR	npn,DJ,si	44	300	175	-	45	25	40-90	0.1	15	8	TMT840 (150mw)	
TMT842	TR	npn,DJ,si	44	150	175	-	45	25	20	0.1	-	6		
2N1196	HU	pnp,MS,si	45	385	200	2	70	25	-	4	-	4		
2N1631	RCA	pnp,Dr,ge	45	80	71	0.4	34	10	80	16	-	2		
2N1632	RCA	pnp,Dr,ge	45	80	71	0.4	34	10	80	16	-	2		
2N1635	RCA	pnp,Dr,ge	45	80	71	0.4	34	10	75	16	-	-		
2N1636	RCA	pnp,Dr,ge	45	80	71	0.4	34	10	75	16	-	-		
2N1637	RCA	pnp,Dr,ge	45	80	71	0.4	34	10	80	5	-	-		
2N1639	RCA	pnp,Dr,ge	45	80	71	0.4	34	10	75	7	-	2		
2N248	TI	pnp,GD,ge	50	30	75	0.6	25	5	20	5	-	L2		
2N344	PH	pnp,SB,ge	50	20	55	1.33	5	5	22	0.7	-	3	SPR	
2N345	PH	pnp,SA,ge	50	20	55	1.33	5	5	35	0.7	-	3	SPR	
2N393	PH	pnp,MA,ge	50	25	100	0.63	6	50	155	5	-	2	SPR,GI	
2N604	GI	pnp,Dr,ge	50	120	85	2	30	-	-	4	14	3		
2N1899	PSI	npn,DM,si	50	125w	150	1000	140	10a	10	10ma	-	6	hi freq., hi pow. tetrode	
3N63	GE	npn,MB,ge	50	30	85	0.5	6	20	2.2	3	-	2		
PT900	PSI	npn,DM,si	50	125w	150	1000	80	10a	3	10ma	-	1	hi freq., hi pow.	
PT901	PSI	npn,MB,si	50	125w	150	1000	140	10a	10	30	-	1	hi frequency, high power	
2N1197	HU	pnp,MS,si	55	385	200	2	70	-	-	-	-	4		
2N128	PH	pnp,SB,ge	60	25	85	0.4	10	5	40	0.6	10	2.5	SPR	
2N749	RA	npn,DJ,si	60	150	175	0.75	45	50	10	10	-	6		
2N1388	RA	npn,DJ,si	60	300	175	0.5	45	50	10	10	-	6		
2N841	TR	npn,DJ,si	64	300	175	-	45	25	80-330	0.1	15	8	TMT841 (150 mw)	
TMT843	TR	npn,DJ,si	64	150	175	-	45	25	40	0.1	-	6		
2N1516	AMP	pnp,PADT,ge 70°	83	-	-	1.7	20	10	100	-	-	-	*I <sub>T</sub> , RF-IF	
2N1517A	AMP	pnp,PADT,ge 70°	100	-	-	1.7	40	10	150	-	-	-	*I <sub>T</sub>	
PADT20	AMP	pnp,PADT,ge 70°	83	-	-	1.7	20	10	150	-	-	-	*I <sub>T</sub> , RF amp	
PADT21	AMP	pnp,PADT,ge 70°	83	-	-	1.7	20	10	150	-	-	-	*I <sub>T</sub> , Converter	
PADT22	AMP	pnp,PADT,ge 70°	83	-	-	1.7	20	10	150	-	-	-	*I <sub>T</sub> , IF amp	
PADT23	AMP	pnp,PADT,ge 70°	100	-	-	1.7	35	10	150	-	-	-	*I <sub>T</sub> , RF amp	
PADT24	AMP	pnp,PADT,ge 70°	100	-	-	1.7	35	10	150	-	-	-	*I <sub>T</sub> , IF amp	
PADT25	AMP	pnp,PADT,ge 70°	-	-	-	-	-	-	-	-	-	-	*I <sub>T</sub> , IF amp	
PADT26	AMP	pnp,PADT,ge 70°	-	-	-	-	-	-	-	-	-	-	*I <sub>T</sub> , RF amp	
PADT27	AMP	pnp,PADT,ge 70°	100	-	-	1.7	35	10	150	-	-	-	*I <sub>T</sub> , osc	
PADT31	AMP	pnp,PADT,ge 70°	100	-	-	1.7	35	10	-	-	-	-	*I <sub>T</sub> , Mixer osc.	
2N346	PH	pnp,SB,ge	75	20	55	1.3	5	5	35	0.7	-	3	SPR	
2N696	FA	npn,DP,si	80	2w	175	13.3	40	-	40	0.1	-	18	RH, PSI, HO, TR, TI, IND, SY, SSD, NA	
2N698	FA	npn,DP,si	80	2w	175	13.3	80	-	30	0.1	-	12	RH, IND, TR, NA	
2N699	FA	npn,DP,si	80	2w	175	13.3	80	-	65	.01	-	12	RH, NA	
2N706	FA	npn,DP,si	80	1w	175	6.7	28	-	12	.005	-	5	RH, NA	
2N1252	FA	npn,DP,si	80	2w	175	13.3	20	-	35	0.1	-	30	RH, TR	
2N844	TR	npn,DJ,si	86	300	175	-	60	50	40-120	1	-	8		
2N845	TR	npn,DJ,si	86	300	175	-	100	50	40-120	1	-	8		
3N37	GE	npn,MB,ge	90	30	85	0.5	6	20	L1	3	-	1.5	broda	
2N394	RCA	pnp,Dr,ge	100	80	85	-	30	10	60	16	-	-		
2N887	FA	npn,DP,si	100	2w	175	13.3	40	-	75	.01	-	18	RH, PSI, HO, TR, SSD, SY, NA	

# DATA CHART

## High Frequency (continued)

Type No.	Mfg.	Type	f <sub>oe</sub>	Maximum Ratings					Characteristics					Remarks
				W c (mw)	T <sub>j</sub> (c)	m w/g	V c v	I c ma	h <sub>fe</sub>	I <sub>co</sub> μa	NF db	C c μμf		
2N1180	RCA	pnp,Dr,ge	100	80	71	-	30	10	80	12	-	-		
2N1225	RCA	pnp,Dr,ge	100	120	85	-	40	10	60	12	-	-		
2N1253	FA	npn,DP,si	100	2w	175	13.3	20	-	45	0.1	-	30	RH	
2N1396	RCA	pnp,Dr,ge	100	120	85	-	40	10	90	16	-	-		
2N1420	FA	npn,DP,si	100	2w	175	13.3	30	-	130	0.1	-	20	RH, NA	
2N1613	FA	npn,DP,si	100	3w	200	17.2	50	-	80	.0004	-	18	RH	
2N1748	PH	pnp,MD,ge	100	60	100	.8	25	-	45	1.5	-	1.3		
2N1748A	PH	pnp,MD,ge	100	60	100	.8	25	50	70	1.5	-	1.3		
2N1749	PH	pnp,MD,ge	100	75	100	1	40	10	45	1.5	-	1.3		
3N34	TI	npn,GD,si	100	125	150	1	30	20	4	0.4	20	-	tetrode	
OC171	AMP	pnp,DJ,ge	100	60	75	2	20	5	-	-	-	-		
2N1752	PH	pnp,MD,ge	106	60	100	.8	12	50	250	0.8	-	1		
2N497	RH	npn,MS,si	120	4w	175	26.5	60	500	25	0.1	-	20	NA, GE	
2N498	RH	npn,MS,si	120	4w	175	26.5	100	500	25	0.1	-	20	NA, GE	
2N656	RH	npn,MS,si	120	4w	175	26.5	60	500	60	0.1	-	20	NA, GE	
2N657	RH	npn,MS,si	120	4w	175	26.5	100	500	60	0.1	-	20	NA, GE	
2N1023	RCA	pnp,Dr,ge	120	120	85	-	40	10	60	12	-	-		
2N1066	RCA	pnp,Dr,ge	120	120	85	-	40	10	60	12	-	-		
2N1397	RCA	pnp,Dr,ge	120	120	85	-	40	10	90	16	-	-		
2N1409	RH	npn,MS,si	120	2.8w	150	22.5	30	500	30	0.1	-	20	PSI	
2N1410	RH	npn,MS,si	120	2.8w	150	22.5	30	500	50	0.1	-	20	PSI	
2N1420	RH	npn,DD,si	120	2w	175	13.2	60	500	200	.003	-	20	PSI, TR, GI	
2N1507	RH	npn,DD,si	120	2w	175	13.2	60	500	200	.003	-	20	TI	
PT600	PSI	npn,DM,si	120	13w	175	86.7	60	-	12	1	-	40	hi freq, hi pwr.	
PT601	PSI	npn,DM,si	120	13w	175	86.7	60	-	14	1	-	40	hi freq, hi pwr.	
RT5001	RH	npn,MS,si	120	3w	175	20	60	1000	40	0.1	-	30		
RT5002	RH	npn,MS,si	120	3w	175	20	60	1000	60	0.1	-	30		
RT5003	RH	npn,MS,si	120	3w	175	20	100	1000	40	0.1	-	30		
RT5004	RH	npn,MS,si	120	3w	175	20	100	1000	60	0.1	-	30		
2N715	TI	npn,MS,si	125	1.2w	175	8	50	-	1	.001	-	3	HF 10-50, NA	
2N716	TI	npn,MS,si	125	1.2w	175	8	70	-	1	.001	-	3	HF 10-50, NA	
2N1785	PH	pnp,MD,ge	125	45	85	.75	10	50	-	2	-	1.5		
2N1786	PH	pnp,MD,ge	125	45	85	.75	10	50	-	2	-	1.7		
2N1787	PH	pnp,MD,ge	125	45	85	.75	15	50	-	1.5	-	1.5		
2N1864	PH	pnp,MD,ge	125	60	100	.8	20	50	60	1.5	-	1.6		
2N1177	RCA	pnp,Dr,ge	140	80	71	-	30	10	100	12	-	-		
2N1178	RCA	pnp,Dr,ge	140	80	71	-	30	10	40	12	-	-		
2N1179	RCA	pnp,Dr,ge	140	80	71	-	30	10	80	12	-	-		
2N728	TR	npn,JO,si	150	300	175	-	15	25	20	.25	-	8		
2N729	TR	npn,DJ,si	150	300	175	-	30	25	20	.25	-	8		
2N1505	PSI	npn,MS,si	150	3w	175	0.2	50	-	7	-	-	1.5	high freq, high power	
2N1726	PH	pnp,MD,ge	150	60	100	0.8	20	50	-	1.5	-	1.5		
2N1727	PH	pnp,MD,ge	150	60	100	0.8	20	50	-	1.5	-	1.5		
2N1728	PH	pnp,MD,ge	150	60	100	0.8	20	50	-	1.5	-	1.5		
2N1788	PH	pnp,MD,ge	150	60	100	0.8	35	50	-	1.5	-	1.5		
2N1789	PH	pnp,MD,ge	150	60	100	0.8	35	50	-	1.5	-	1.5		
2N1790	PH	pnp,MD,ge	150	60	100	0.8	35	50	-	1.5	-	1.5		
3N35	TI	npn,GD,si	150	125	150	1	30	20	4	0.4	14	-	Tetrode	
2N1335	PSI	npn,MS,si	170	2.8w	150	24	120	75	13	8	-	4	High freq, high power	
2N1336	PSI	npn,MS,si	170	2.8w	150	24	120	75	13	8	-	4	High freq, high power	
2N1337	PSI	npn,MS,si	170	2.8w	150	24	120	75	13	8	-	4	High freq, high power	
PADT30	AMP	pnp,PADT,ge	200*	83	-	1.7	25	10	-	-	-	-	*IT, RF amp	
2N1506	PSI	npn,MS,si	210	3w	175	2	60	9	-	-	-	8	High frequency, high power	
2N1339	PSI	npn,MS,si	220	2.8w	150	24	120	75	-	8	-	4	High freq., high power	
PADT28	AMP	pnp,PADT,ge	220*	100	-	1.7	35	10	120	-	-	-	*IT, RF amp	
2N1746	PH	pnp,MD,ge	235	60	100	.8	20	50	-	2	-	3		
2N1709	PSI	npn,DM,si	240	13w	175	86.7	75	1.2a	-	-	-	40	Hi freq., hi pwr.	
2N1710	PSI	npn,DM,si	240	13w	175	86.7	60	1.2a	-	-	5.0	40	Hi freq., hi pwr.	
2N588	PH	npn,MD,ge	250	30	85	0.75	15	50	-	18	3.8	-	SPR, GI	
2N710	MO	pnp,MS,ge	250	300	100	4	15	50	40	.2	-	-	TI	
2N1340	PSI	npn,MS,si	250	28w	2.8w	24	120	75	-	8	-	4	High freq., high power	
2N1491	RCA	npn,MS,si	250	3w	175	20	30	50	50	10	-	-		
2N1837	PSI	npn,DM,si	250	2w	175	13.3	80	-	9	.001	-	11	Hi freq., hi power	
2N1837A	PSI	npn,DM,si	250	2.8w	175	18.6	80	-	9	.001	-	11	Hi freq., hi power	
2N1838	PSI	npn,DM,si	250	2w	175	13.3	45	-	9	0.1	-	9	Hi freq., hi power	
2N1838A	PSI	npn,DM,si	250	2.8w	175	18.6	45	-	9	0.1	-	9	Hi freq., hi power	
2N1839	PSI	npn,DM,si	250	2w	175	13.3	45	-	9	0.1	-	9	Hi freq., hi power	
2N1839A	PSI	npn,DM,si	250	2.8w	175	18.6	45	-	9	0.1	-	9	Hi freq., hi power	
2N502A	PH	pnp,MD,ge	260	75	100	1.0	30	-	-	1.3	6	1.0		
2N502	PH	pnp,MD,ge	260	60	85	1.0	20	-	-	1	-	1.0		
2N1492	RCA	npn,MS,si	275	3w	175	20	60	50	10	-	-	-		
2N1341	PSI	npn,MS,si	280	2.8w	150	24	120	75	-	8	-	4	High freq., high power	
2N635	MO	pnp,DM,ge	300	75	100	1	15	50	40	0.2	-	3.5	GE	
2N1493	RCA	npn,MS,si	300	3w	175	20	100	50	50	10	-	-		



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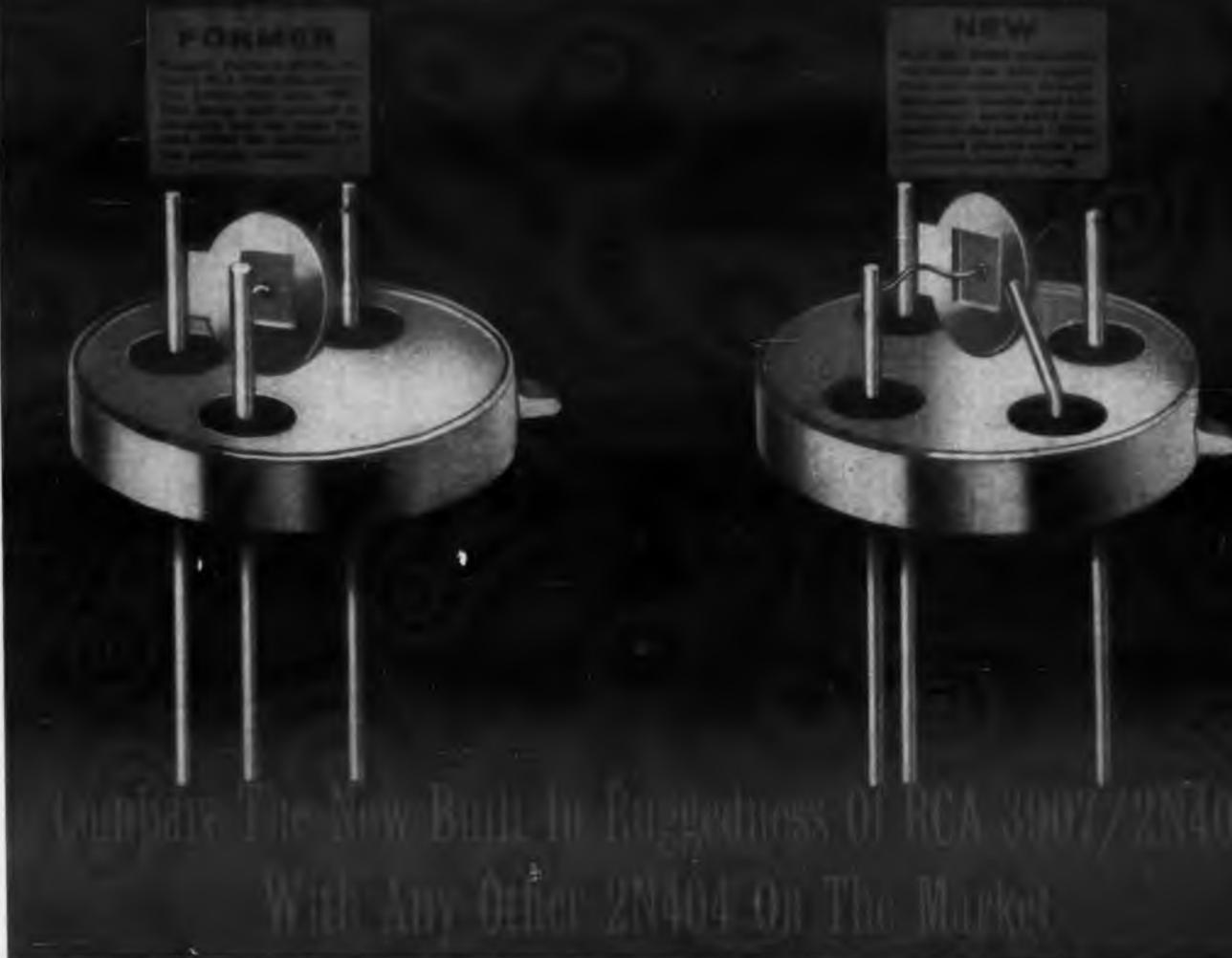
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SWITCHING SERVICE Maximum Ratings, Absolute Maximum Values 3907/2N404	
COLLECTOR TO BASE-VOLTAGE	-25 MAX
COLLECTOR TO-EMITTER VOLTAGE with V <sub>EB</sub> = -1v	-24 MAX
EMITTER TO-BASE VOLTAGE	-12 MAX
COLLECTOR CURRENT	-200 MAX
EMITTER CURRENT	200 MAX
TRANSISTOR DISSIPATION: At ambient temperature of: 25°C 55°C 71°C	150 MAX 75 MAX 35 MAX
AMBIENT TEMPERATURE RANGE: Operating Storage	-65 to +85°C -65 to +100°C
LEAD TEMPERATURE: For immersion in molten solder for 10 seconds max	255 MAX °C

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# TRANSISTORS - 1961

## High Frequency (continued)

Type No.	Mfg.	Type	I <sub>ce</sub>	Maximum Ratings				Characteristics					Remarks
				V <sub>c</sub> (mw)	T <sub>j</sub> (c)	mW/d	V <sub>c</sub> v	I <sub>c</sub> ma	h <sub>fe</sub>	I <sub>co</sub> μA	NF db	C <sub>c</sub> μF	
2N503	PH	npn, MD, ge	320	25	85	0.63	20	50	4.2	3	-	1.0	GI Amp VHF
2N499	PH	npn, MD, ge	340	30	85	0.75	30	50	6.5	1.0	-	1.3	
2N741	MO	npn, MS, ge	360	300	100	4	15	100	25	.2	7	6	
2N741A	MO	npn, DM, ge	360	300	100	4	20	100	25	0.2	7	6	
2N1407	TI	npn, MS, ge	375	75	100	1	30	50	6	2	7	-	
2N919	PSI	npn, DM, si	400	1.2w	100	6.7	25	220	4	.005	-	5	
2N920	PSI	npn, DM, si	400	1.2w	200	6.7	25	220	4	.005	-	5	
2N921	PSI	npn, DM, si	400	1.2w	200	6.7	50	200	4	.005	-	4	
2N922	PSI	npn, DM, si	400	1.2w	200	6.7	50	200	4	.005	-	4	
2N1405	TI	npn, MS, ge	450	75	100	1	30	50	8	2	5	-	
2N1406	TI	npn, MS, ge	450	75	100	1	30	50	8	2	6	-	
2N1143	TI	npn, DB, ge	480	750	100	10	25	100	8	.7	-	1.5	PG=22db @ 200mc
2N1562	MO	npn, MS, ge	500	3w	100	40	25	500	10db	1.5	-	7	High freq., high power
2N1561	MO	npn, MS, ge	500	3w	100	40	25	500	10db	1.5	-	7	High freq., high power
2N700	MO	npn, DM, ge	600	75	100	1	25	50	10db	0.4	6	1.1	UHF Amp.
2N700A	MO	npn, DM, ge	600	75	100	1	25	50	5db200mc	0.4	6	1.1	MIL
2N1142	TI	npn, DB, ge	600	750	100	10	30	100	10	0.7	-	1.5	PG=26db @ 200mc
2N1645	WE	npn, DJ, ge	700	-	100	12.5	35	0.3	50	.0015	-	10	
2N537	WE	npn, DG, ge	750	250	100	.3	-	100	10	2	-	2.0	U.S. MIL only
2N1094	WE	npn, DM, ge	750	150	100	0.3	-	40	13	1.2	-	4	U.S. MIL only
2N1141	TI	npn, DB, ge	750	750	100	10	35	100	12	0.7	-	1.5	PG=30db @ 200mc
2N1196	WE	npn, DM, ge	750	250	100	0.3	30	40	13	1.2	-	4	MO
2N218	SY	npn, AJ, ge	-	80	85	1.3	20	-	22-110	50	-	-	
2N231	PH	npn, SBT, ge	-	9	55	0.9	4.5	3	66	3	-	-	SPR
2N233	SY	npn, AJ, ge	-	50	75	1	10	50	10	50	-	-	
2N247	SY	npn, Dr, ge	-	.080	100	1	40	10	20-175	50	-	-	
2N312	CBS	npn, AJ, ge	-	75	85	-	15	-	60	-	-	12	SY, GI
2N410	SY	npn, AJ, ge	-	50	75	1	20	-	22-110	5	-	-	
2N504	SPR	npn, MD, ge	-	30	85	-	35	50	16	100	-	-	
2N544	SY	npn, DJ, ge	-	80	85	1.3	18	10	20-175	4	-	-	
2N624	SY	npn, DJ, ge	-	100	100	1.3	20	-	20	30	-	-	
2N706C	SY	npn, DM, si	-	360	200	2	40	50	20-60	.025	-	-	
2N743	SY	npn, MS, si	-	300	175	2	20	200	20-60	1	-	-	Epitaxial
2N744	SY	npn, MS, si	-	300	175	2	20	200	40-120	1	-	-	Epitaxial
2N753	PSI	npn, MS, si	-	1w	175	6.7	25	50	-	0.5	-	5	
2N768	SPR	npn, MD, ge	-	35	100	-	12	100	40	1	-	-	PH
2N769	SPR	npn, MD, ge	-	35	100	-	12	100	55	0.3	-	-	PH
2N773	PH	npn, SA, si	-	150	150	1.2	20	100	11	0.1	-	1.3	
2N774	PH	npn, SA, si	-	150	150	1.2	20	100	20	0.1	-	1.3	
2N775	PH	npn, SA, si	-	150	150	1.2	20	100	50	0.1	-	1.3	
2N776	PH	npn, SA, si	-	150	150	1.2	20	100	11	0.1	-	1.3	
2N777	PH	npn, SA, si	-	150	150	1.2	20	100	20	0.1	-	1.3	
2N778	PH	npn, SA, si	-	150	150	1.2	20	100	50	0.1	-	1.3	
2N781	SY	npn, MS, ge	-	150	100	2	15	200	25	3	-	-	Epitaxial
2N782	SY	npn, MS, ge	-	150	100	2	12	200	20	3	-	-	Epitaxial
2N783	SY	npn, MS, si	-	300	175	2	40	200	20-60	.25	-	-	Epitaxial
2N784	SY	npn, MS, si	-	300	175	2	30	200	25	.25	-	-	
2N1158	PH	npn, MD, ge	-	80	100	0.8	20	100	50	5	-	3	
2N1158A	PH	npn, MD, ge	-	75	100	1	20	100	50	5	-	2.8	
2N1204	SPR	npn, MD, ge	-	200	100	-	20	500	40	7	-	-	PH
2N1264	SY	npn, DD, ge	-	50	75	1	20	10	15	50	-	-	
2N1266	SY	npn, AJ, ge	-	80	85	1.3	10	-	10	100	-	-	
2N1267	PH	npn, SADT, si	-	150	150	0.8	20	100	11	.01	-	1.5	
2N1268	PH	npn, SADT, si	-	150	150	0.8	20	100	20	.01	-	1.5	
2N1269	PH	npn, SADT, si	-	150	150	0.8	20	100	50	.01	-	1.5	
2N1270	PH	npn, SADT, si	-	150	150	0.8	20	100	11	.01	-	1.5	
2N1271	PH	npn, SADT, si	-	150	150	0.8	20	100	20	.01	-	1.5	
2N1272	PH	npn, SADT, si	-	150	150	0.8	20	100	50	.01	-	1.5	
2N1398	TI	npn, MS, ge	-	50	85	-	30	10	2.3	10	5	-	
2N1399	TI	npn, MS, si	-	50	85	-	30	10	2.3	10	6	-	
2N1400	TI	npn, MS, ge	-	50	85	-	30	10	1.6	10	-	-	
2N1401	TI	npn, MS, ge	-	50	85	-	30	10	2	10	-	-	
2N1401A	TI	npn, MS, ge	-	50	85	-	30	10	2	10	-	-	
2N1402	TI	npn, MS, ge	-	50	85	-	30	10	2.2	10	-	-	
2N1450	SY	npn, AJ, ge	-	120	100	L6	30	100	20	10	-	-	
2N1494	SPR	npn, MD, ge	-	400	100	-	20	500	15	7	-	-	PH
2N1515	AMP	npn, PADT, ge	-	83	75	-	20	10	60	-	-	-	OC169
2N1646	SY	npn, MS, ge	-	150	100	2	15	50	20	3	-	-	
2N1676	PH	npn, SAT, si	-	100	140	-	4.5	50	10.5	.001	-	-	SPR, chopper
2N1677	PH	npn, SAT, si	-	100	140	-	4.5	50	30	.001	-	-	SPR, chopper
2N1684	SY	npn, AJ, ge	-	100	100	1.3	25	100	-	5	-	-	
2N1742	PH	npn, MD, si	-	60	100	0.8	20	-	-	0.8	4.9	-	
2N1743	PH	npn, MD, ge	-	60	100	0.8	20	-	-	0.8	10	-	

# DATA CHART

## High Frequency (concluded)

Type No.	Mfg.	Type	$f_{oe}$	Maximum Ratings					Characteristics				Remarks	
				$W_c$ (mw)	$T_j$ (c)	$m_w/c$	$V_c$ v	$I_c$ ma	$h_{FE}$	$I_{CO}$ $\mu A$	NF db	$C_c$ $\mu F$		
2N1744	PH	pnp,MD,ge	-	60	100	0.8	20	-	-	1	-	-	-	
2N1745	PH	pnp,MD,ge	-	60	100	0.8	20	50	-	2.5	-	-	-	
2N1747	PH	pnp,MD,ge	-	60	100	0.8	20	50	-	2	-	-	-	
2N1782	SY	pnp,AJ,ge	-	100	100	1.3	30	100	30-150	6	-	-	-	
2N1783	SY	pnp,AJ,ge	-	100	100	1.3	30	100	30-90	5	-	-	-	
2N1784	SY	pnp,AJ,ge	-	100	100	1.3	30	100	20	4	-	-	-	
2N1840	PSI	npn,DM,si	-	2w	175	13.3	24	-	9	-	-	-	11	hi freq., hi pwr.
2N1840A	PSI	npn,DM,si	-	2.8	175	18.6	25	-	9	-	-	-	11	hi freq., hi pwr.
2N1841	WE	npn,DM,si	-	15.4	150	75	2	35	.005	100mc	-	-	-	
2N1865	PH	pnp,MD,ge	-	60	100	0.8	20	50	-	2	-	-	-	
2N1866	PH	pnp,MD,ge	-	60	100	0.8	35	50	-	2	-	-	-	
2N1867	PH	pnp,MD,ge	-	60	100	0.8	35	50	-	2	-	-	-	
2N1868	PH	pnp,MD,ge	-	60	100	0.8	20	50	-	2.5	-	-	-	
2N1958	SY	npn,MS,si	-	600	175	4	60	500	20-60	0.5	-	-	18	Epitaxial
2N1959	SY	npn,MS,si	-	600	175	4	60	500	40-120	0.5	-	-	18	Epitaxial
2N1960	SY	npn,MS,ge	-	150	100	2	15	200	25	3	-	-	-	Epitaxial
2N1961	SY	npn,MS,ge	-	150	100	2	12	200	20	3	-	-	-	Epitaxial
2N1962	SY	npn,MS,si	-	400	175	2.6	40	200	20-60	.25	-	-	3	Epitaxial
2N1963	SY	npn,MS,si	-	400	175	2.6	30	200	25	.25	-	-	3.5	Epitaxial
2N1964	SY	npn,MS,si	-	400	175	2.6	60	500	20-60	0.5	-	-	18	Epitaxial
2N1965	SY	npn,MS,si	-	400	175	2.6	60	500	40-120	0.5	-	-	18	Epitaxial
2N1969	SY	npn,AJ,ge	-	150	100	2	30	400	50-200	5	-	-	20	
GT1665	GI	pnp,AJ,ge	-	150	100	2	100	-	25	4	-	-	-	Drift
MA-1	SPR	pnp,MAT,ge	-	25	75	-	6	50	40	10	-	-	-	
MA-2	SPR	pnp,MAT,ge	-	20	75	-	3	50	40	10	-	-	-	
PT850	PSI	npn,DM,si	-	2w	175	13.3	120	-	2	2	-	-	-	hi freq., hi pwr.
PT850A	PSI	npn,DM,si	-	2.8w	175	18.6	120	-	2	2	-	-	-	hi freq., hi pwr.
SO-1	SPR	pnp,SBT,ge	-	20	65	-	5	5	10	10	-	-	-	
SO-2	SPR	pnp,SBT,ge	-	15	65	-	3	5	10	10	-	-	-	
SO-3	SPR	pnp,SBT,ge	-	20	65	-	5	5	10	10	-	-	-	
ST3081	TR	npn,DJ,si	-	150	175	-	-	-	-	-	-	-	-	

### Abbreviation of Terms

<b>AJ</b>	Alloy Junction	<b>FJ</b>	Fused Junction
<b>DD</b>	Double Diffused	<b>GD</b>	Grown Diffused
<b>DG</b>	Grown Diffused	<b>Ge</b>	Germanium
<b>DJ</b>	Diffused Junction	<b>GJ</b>	Grown Junction
<b>DM</b>	Diffused Mesa	<b>GR</b>	Grown Rate
<b>DP</b>	Diffused Planar	<b>MB</b>	Meltback
<b>Dr</b>	Drift	<b>MD</b>	MADT
<b>Ep</b>	Epitaxial	<b>Ms</b>	Mesa
<b>FA</b>	Fused Alloy	<b>RG</b>	Rate Grown

**Si** Silicon

**SBT** Surface Barrier

**$C_{oe}$**  = Collector-to-emitter capacitance measured across the output terminals with the input ac open-circuited.

**$f_{oe}$**  = Frequency at which the magnitude of the forward-current transfer ratio (small-signal) is 0.707 of its low-frequency value.

**$f_t$**  = Frequency at which common emitter gain is unity.

**$h_{FE}$**  = Common emitter-small signal forward current transfer ratio.

**$h_{FE}$**  = Common emitter-static value of short-circuited forward current ratio.

**$I_{CO}$**  = Collector current when collector junction is reverse-biased and emitter is dc open-circuited.

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**MECHANICAL RUGGEDNESS**—guaranteed by the only process that combines the best qualities of both the alloy and the diffusion methods. As a result, the PADT-40 is resistant to vibration and shock.

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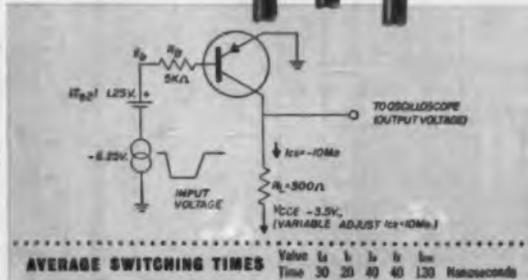
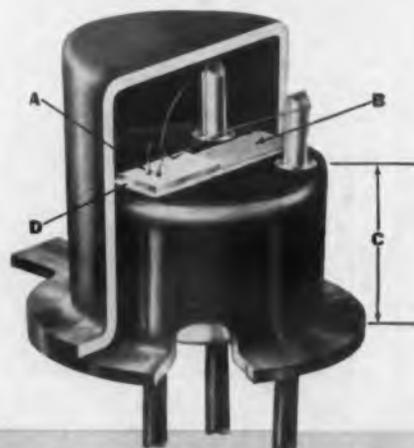
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- B** Flat bed attachment for good heat dissipation
- C** Long path prevents weld contamination of transistor
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  - Extremely high cut-off frequency
  - High Beta • Low resistivity germanium

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# TRANSISTORS - 1961

## Power

Type No.	Mfg.	Type	W <sub>c</sub>	Max. Ratings				Characteristics					Remarks
				w/c	T <sub>j</sub> c	V <sub>c</sub> v	I <sub>c</sub> amp	f <sub>he</sub>	I <sub>co</sub> ma	f <sub>ae</sub> kc	Pow. Gain db	Pow. Out. w	
2N339	TI	npn,GR,si	1.0	0.008	150	55	.06	9-90	.001	6	30	-	TR
2N340	TI	npn,GR,si	1.0	0.008	150	85	.06	9-90	.001	6	30	-	TR
2N341	TI	npn,GR,si	1.0	0.008	150	125	.06	9-90	.001	6	30	-	TR
2N341A	TR	npn,DJ,si	1	0.008	200	125	.1	15-90	.001	-	-	-	-
2N342	TI	npn,GR,si	1.0	0.008	150	60	.06	9-32	.001	6	30	-	TR
2N342A	TI	npn,GR,si	1.0	0.008	150	85	.06	9-32	.001	6	30	-	TR
2N343	TI	npn,GR,si	1.0	0.008	150	60	.06	20-90	.001	8	30	-	TR
2N343A	TR	npn,DJ,si	1	.008	150	85	-	29-90	.001	-	-	-	TR
2N1206	TR	npn,GR,si	1.0	10	200	60	-	15-19	1	-	-	-	-
2N1207	TR	npn,GR,si	1.0	10	200	125	-	15-90	1	-	-	-	-
2N1566	TI	npn,MS,si	1.2	-	175	80	50	100	1	50	-	-	TR,NA
2N1335	PSI	npn,MS,si	2.8	0.024	150	120	.075	13	.008	170mc	-	-	high freq., high pwr.
2N1336	PSI	npn,MS,si	2.8	0.024	150	120	.075	13	.008	170mc	-	-	high freq., high pwr.
2N1339	PSI	npn,MS,si	2.8	0.024	150	120	.075	-	.008	220 mc	-	-	high freq., high pwr.
2N1340	PSI	npn,MS,si	2.8	0.024	150	120	.075	-	.008	250 mc	-	-	high freq., high pwr.
2N1341	PSI	npn,MS,si	2.8	0.024	150	120	.075	-	.008	280 mc	-	-	high freq., high pwr.
2N1505	PSI	npn,MS,si	3	0.2	175	50	-	7	-	150 mc	-	-	high freq., high pwr.
2N1506	PSI	npn,MS,si	3	0.2	175	60	-	9	-	210 mc	-	-	high freq., high pwr.
2N1561	MO	pnp,MS,si	3	.04	100	25	.25	10	.0015	500 mc	-	-	high freq., high pwr.
2N1562	MO	pnp,MS,si	3	.04	100	25	.25	10	.0015	450 mc	-	-	high freq., high pwr.
2N1682	MO	pnp,MS,ge	3	.04	100	25	.25	10 db	.0015	500 mc	6	0.5	-
2N1693	MO	pnp,MS,ge	3	.04	100	25	.25	10 db	.0015	-	6	.4	-
OC30	AMP	pnp,PADT,ge	3.6	-	75	32	1.4	35	.012	-	-	-	-
2N497	TI	npn,DJ,si	4.0	.023	200	60	200	12-36	10	9 mc	-	-	TR, RH, FA, NA, RCA
2N498	TI	npn,DJ,si	4.0	.023	200	100	200	12-36	10	9 mc	-	-	TR, RH, FA, NA
2N656	TI	npn,DJ,si	4.0	.023	200	60	200	30-90	10	8 mc	-	-	TR, RH, FA, NA, RCA, GE
2N657	TI	npn,DJ,si	4.0	.023	200	100	200	30-90	10	8 mc	-	-	TR, RH, FA, NA, GE
2N1479	RCA	npn,DJ,si	4	-	175	60	1.5	50	10	1.5 mc	-	-	-
2N1480	RCA	npn,DJ,si	4	-	175	100	1.5	50	10	1.5 mc	-	-	-
2N1481	RCA	npn,DJ,si	4	-	175	60	1.5	50	10	1.5 mc	-	-	-
2N1482	RCA	npn,DJ,si	4	-	175	100	1.5	50	10	1.5 mc	-	-	-
2N1067	STC	npn,DJ,si	5	28.6	175	60	0.5	35	5	1.5	-	-	RCA
2N1210	SY	npn,AJ,ge	6	0.1	85	45	2	40-100	3	7	-	-	-
ST4201	TR	npn,DJ,si	6	.03	200	45	0.5	12-36	.001	-	-	-	-
ST4202	TR	npn,DJ,si	6	.03	200	75	0.5	12-36	.001	-	-	-	-
ST4203	TR	npn,DJ,si	6	.03	200	45	0.5	30-90	.001	-	-	-	-
ST4204	TR	npn,DJ,si	6	.03	200	75	0.5	30-90	.001	-	-	-	-
2N326	SY	npn,AJ,ge	7	0.11	85	35	2	45	3	150	-	-	-
2N1172	DE	pnp,AJ,ge	7.5	.1	100	40	1.5	-	0.01	17	34	-	driver
2N1183	RCA	pnp,AJ,ge	7.5	-	100	45	3	20	.03	500	-	-	-
2N1183A	RCA	pnp,AJ,ge	7.5	-	100	60	3	20	.03	500	-	-	-
2N1183B	RCA	pnp,AJ,ge	7.5	-	100	80	3	20	.03	500	-	-	-
2N1184	RCA	pnp,AJ,ge	7.5	-	100	45	3	40	.03	500	-	-	-
2N1184A	RCA	pnp,AJ,ge	7.5	-	100	60	3	40	.03	500	-	-	-
2N1184B	RCA	pnp,AJ,ge	7.5	-	100	80	3	40	.03	500	-	-	-
2N122	TI	npn,GR,si	0.75	.070	150	120	140	3	10	1	28	-	-
2N176	SY	pnp,AJ,ge	10	0.15	90	30	3	4.5	0.3	-	35.5	-	RCA, MO, BE
2N350	SY	pnp,AJ,ge	10	0.13	100	40	3	40	-	5	32	-	MO
2N351	RCA	pnp,AJ,ge	10	1	90	40	3	65	3	-	33.5	4	MO, SY
2N376	RCA	pnp,AJ,ge	10	1	90	40	3	78	3	-	35	4	MO
2N669	MO	pnp,AJ,ge	10	1.5	90	30	3	90	3	5	40	2	-
2N1068	IND	npn,AJ,si	10	0.133	175	60	1.5	38	0.5	-	-	-	STC,RCA
2N1714	TI	npn,MS,si	10	.134	175	60	1	-	.002	20 mc	-	-	-
2N1715	TI	npn,MS,si	10	.134	175	100	1	-	.002	20 mc	-	-	-
2N1716	TI	npn,MS,si	10	.134	175	60	1	-	.002	20 mc	-	-	-
2N1717	TI	npn,MS,si	10	.134	175	100	1	-	.002	20 mc	-	-	-
2N1718	TI	npn,MS,si	10	.134	175	60	1	-	.002	20 mc	-	-	-
2N1719	TI	npn,MS,si	10	.134	175	100	1	-	.002	20 mc	-	-	-
2N1720	TI	npn,MS,si	10	.134	175	60	1	-	.002	20 mc	-	-	-
2N1721	TI	npn,MS,si	10	.134	175	100	1	-	.002	20 mc	-	-	-
2N1755	CL	pnp,AJ,ge	10	2.5	95	40	3	-	7	15	30-75	-	-
2N1756	CL	pnp,AJ,ge	10	2.5	95	60	3	-	7	15	30-75	-	-
2N1757	CL	pnp,AJ,ge	10	2.5	95	80	3	-	7	8	30-75	-	-
2N1758	CL	pnp,AJ,ge	10	2.5	95	100	3	-	7	10	30-75	-	-
2N1759	CL	pnp,AJ,ge	10	2.5	95	40	3	-	7	10	60-150	-	-
2N1760	CL	pnp,AJ,ge	10	2.5	95	60	3	-	7	10	60-150	-	-
2N1761	CL	pnp,AJ,ge	10	2.5	95	80	3	-	7	6	60-150	-	-
2N1762	CL	pnp,AJ,ge	10	2.5	95	100	3	-	7	6	60-150	-	-
CDT1310	CL	pnp,AJ,ge	10	1.5	95	40	5	-	15	5	40-120	-	-
CDT1311	CL	pnp,AJ,ge	10	1.5	95	60	5	-	15	5	40-120	-	-
CDT1312	CL	pnp,AJ,ge	10	1.5	95	80	5	-	15	5	40-120	-	-
CDT1313	CL	pnp,AJ,ge	10	1.5	95	100	5	-	15	5	40-120	-	-

# DATA CHART

## Power (continued)

Type No.	Mfg.	Type	W <sub>c</sub>	Max. Ratings				Characteristics					Remarks
				w/c	T <sub>j</sub> c	V <sub>c</sub> v	I <sub>c</sub> amp	h <sub>fe</sub>	I <sub>co</sub> ma	I <sub>ce</sub> kc	Pow. Gain db	Pow. Out. w	
CST1740	CL	pnp,AJ,ge	10	2.5	95	40	3	-	3	7	28-33	-	
CST1741	CL	pnnp,AJ,ge	10	2.5	95	40	3	-	3	7	32-35	-	
CST1742	CL	pnnp,AJ,ge	10	2.5	95	40	3	-	3	7	34-37	-	
CST1743	CL	pnnp,AJ,ge	10	2.5	95	40	3	-	3	7	36-39	-	
CST-1744	CL	pnnp,AJ,ge	10	2.5	95	80	3	-	3	7	28-37	-	
CST1745	CL	pnnp,AJ,ge	10	2.5	95	80	3	-	3	7	28-33	-	
CST1746	CL	pnnp,AJ,ge	10	2.5	95	80	3	-	3	7	32-37	-	
CTP1104	CL	pnnp,AJ,ge	10	2.0	85	40	3	-	2	4	28	1.2	
CTP1105	CL	pnnp,AJ,ge	10	2.0	85	40	3	-	2	5	30	1.2	
CTP1108	CL	pnnp,AJ,ge	10	2.0	85	20	3	-	2	4	27	0.6	
CTP1109	CL	pnnp,AJ,ge	10	2.0	90	20	3	-	2	6	35	0.6	
CTP1111	CL	pnnp,AJ,ge	10	2.0	90	80	3	-	5	4	29	1.2	
CST1739	CL	pnnp,AJ,ge	10	2.5	95	40	3	-	3	7	28-39	-	
2N301	RCA	pnnp,AJ,ge	11	-	91	40	3	70	0.1	-	-	-	
2N301A	SY	pnnp,AJ,ge	12	0.2	85	60	2	-	5	5	35	-	CL, RCA, BE, CBS
2N1314/OC26	AMP	pnnp,PADT,ge	11	-	90	32	3.5	33	<0.1	150	-	-	
2N1315/OC27	AMP	pnnp,PADT,ge	12.5	-	90	32	7.5	75	<0.1	300	-	-	OC27
2N1709	PSI	npn,DM,si	13	86.7	175	75	1.2a	-	10 max	240 mc	10 db	-	hi freq., hi pow.
2N1710	PSI	npn,DM,si	13	86.7	175	60	1.2a	-	10 max	240 mc	8 db	-	hi freq., hi pow.
2N307	BE	pnnp,AJ,ge	15	2.0	75	35	LJ	-	0.35	-	-	-	2N234A
2N1658	MH	pnnp,AJ,ge	15	0.2	100	80	1	50	0.5	700	-	-	
2N1659	MH	pnnp,AJ,ge	15	0.2	100	80	1	50	0.5	700	-	-	
2N307A	SY	pnnp,AJ,ge	17	0.34	75	35	2	25	-	5	33	-	BE
2N155	CBS	pnnp,AJ,ge	20	.33	85	30	3	20	1	5	-	2	CL, BE
2N156	CBS	pnnp,AJ,ge	20	0.33	85	30	3	20	1	5	-	2	
2N157	CBS	pnnp,AJ,ge	20	0.33	85	60	3	20	1	5	-	2	
2N157A	CBS	pnnp,AJ,ge	20	0.33	85	100	3	20	1	5	-	2	
2N158	CBS	pnnp,AJ,ge	20	0.33	85	60	3	20	1	5	-	2	
2N158A	CBS	pnnp,AJ,ge	20	0.33	85	80	3	20	1	5	-	2	
2N255	BE	pnnp,AJ,ge	20	2.0	85	15	3	-	1.0	5	-	19-26	2N234A, CL
2N255A	CBS	pnnp,AJ,ge	20	0.5	85	15	3	-	1.0	5	25	2	
2N256	BE	pnnp,AJ,ge	20	2.0	85	30	3	-	1.0	5	-	22-29	2N234A, CL
2N256A	CBS	pnnp,AJ,ge	20	0.5	85	25	3	-	1	5	25	2	
2N401	BE	pnnp,AJ,ge	20	1.2	90	40	3	-	1.3	-	30	5	
2N500	EM	-	20	.18	95	30	3	30 (min)	2	7	25	20w	
2N1042	TI	pnnp,AJ,ge	20	.27	100	40	3	20-60	0.75	-	-	-	TR
2N1043	TI	pnnp,AJ,ge	20	.27	100	60	3	20-60	0.75	-	-	-	TR
2N1044	TI	pnnp,AJ,ge	20	.27	100	80	3	20-60	0.75	-	-	-	TR
2N1045	TI	pnnp,AJ,ge	20	.27	100	100	3	20-60	0.75	-	-	-	TR
2N1078	CBS	pnnp,AJ,ge	20	0.33	85	60	3	30 min	0.5	5	-	2	
2N1291	CBS	pnnp,AJ,ge	20	0.33	85	30	3	30 min	0.5	5	-	2	
2N1292	CBS	pnnp,AJ,ge	20	0.33	85	30	3	30 min	0.5	5	-	2	
2N1293	CBS	pnnp,AJ,ge	20	0.33	85	60	3	30 min	0.5	5	-	2	
2N1294	CBS	pnnp,AJ,ge	20	0.33	85	60	3	30 min	0.5	5	-	2	SY
2N1295	CBS	pnnp,AJ,ge	20	0.33	85	80	3	30 min	0.5	5	-	2	SY
2N1296	CBS	pnnp,AJ,ge	20	0.33	85	80	3	30 min	0.5	5	-	2	
2N1297	CBS	pnnp,AJ,ge	20	0.33	85	100	3	30 min	0.5	5	-	2	
2N1298	CBS	pnnp,AJ,ge	20	0.33	85	100	3	30 min	0.5	5	-	2	
2N1320	CBS	pnnp,AJ,ge	20	0.33	85	30	3	30 min	0.5	5	-	2	TO-10
2N1321	CBS	pnnp,AJ,ge	20	0.33	85	30	3	30 min	0.5	5	-	2	TO-10
2N1322	CBS	pnnp,AJ,ge	20	0.33	85	60	3	30 min	0.5	5	-	2	TO-10
2N1323	CBS	pnnp,AJ,ge	20	0.33	85	60	3	30 min	0.5	5	-	2	TO-10
2N1324	CBS	pnnp,AJ,ge	20	0.33	85	80	3	30 min	0.5	5	-	2	TO-10
2N1325	CBS	pnnp,AJ,ge	20	0.33	85	80	3	30 min	0.5	5	-	2	TO-10
2N1326	CBS	pnnp,AJ,ge	20	0.33	85	100	3	30 min	0.5	5	-	2	TO-10
2N1327	CBS	pnnp,AJ,ge	20	0.33	85	100	3	30 min	0.5	5	-	2	TO-10
2N1328	CBS	pnnp,AJ,ge	20	0.33	85	30	3	30 min	0.5	5	-	2	TO-13
2N1329	CBS	pnnp,AJ,ge	20	0.33	85	30	3	30 min	0.5	5	-	2	TO-13
2N1330	CBS	pnnp,AJ,ge	20	0.33	85	60	3	30 min	0.5	5	-	2	TO-13
2N1331	CBS	pnnp,AJ,ge	20	0.33	85	80	3	30 min	0.5	5	-	2	TO-13
2N1332	CBS	pnnp,AJ,ge	20	0.33	85	80	3	30 min	0.5	5	-	2	TO-13
2N1333	CBS	pnnp,AJ,ge	20	0.33	85	100	3	30 min	0.5	5	-	2	TO-13
2N1334	CBS	pnnp,AJ,ge	20	0.33	85	100	3	30 min	0.5	5	-	2	TO-13
2N1437	CBS	pnnp,AJ,ge	20	0.33	85	100	3	20 min	0.5	5	-	2	TO-13
2N1438	CBS	pnnp,AJ,ge	20	0.33	85	100	3	20 min	0.5	5	-	2	TO-10
2N1465	CBS	pnnp,AJ,ge	20	0.33	85	120	3	20 min	0.5	5	-	2	TO-13
2N1466	CBS	pnnp,AJ,ge	20	0.33	85	120	3	20 min	0.5	5	-	2	TO-10
2N1504	CBS	pnnp,AJ,ge	20	0.33	85	80	3	20 min	0.5	5	-	2	
CDT1319	CL	pnnp,AJ,ge	20	1.5	100	40	5	20-60	15	5	-	-	
CDT1320	CL	pnnp,AJ,ge	20	1.5	100	60	5	20-60	15	5	-	-	
CDT1321	CL	pnnp,AJ,ge	20	1.5	100	80	5	20-60	15	5	-	-	
CDT1322	CL	pnnp,AJ,ge	20	1.5	100	100	5	20-60	15	5	-	-	
LT-11	CBS	pnnp,AJ,ge	20	0.33	85	80	3	-	1	5	-	-	



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19 TYPES ■ high-conductance diodes—Types 1N482-1N488A (Data sheet No. 135)

11 TYPES ■ fast-recovery diodes—Types 1N625-1N629, 1N643, 1N659-1N662 (Data sheets Nos. 132 & 134)

19 TYPES ■ zener reference diodes—Types 1N821-1N824, 1N935-1N939B (Data sheets Nos. 124 & 146)

176 TYPES ■ zener regulators—Types 1N702-1N742, 1N746-1N759, 1N957A-1N989A (Data sheets Nos. 139 & 140)



### M1 CASE

26 TYPES ■ general-purpose diodes—1N137A & 1N138A, 1N200-1222, 1N431 (Data sheets Nos. 101, 102, 103)

6 TYPES ■ economical general-purpose diodes—HB1-HB6 (Data sheet No. 133)

2 TYPES ■ zener general-purpose diodes—RS-6 & RT-6 (Data sheet No. 121)

11 TYPES ■ zener low-voltage diodes—1N465-1N470, 1N471-1N475 (Data sheets Nos. 108 & 109)

24 TYPES ■ zener medium-voltage diodes—1N1313-1N1327, 1N225-1N233 (Data sheets Nos. 110 & 111)

17 TYPES ■ zener reference diodes—1N429 & USAF-1N429, "strings" (Data sheet No. 115)



### S1E CASE

436 TYPES ■ 10-watt zener regulators—1N1351-1N1375, 1N1603-1N1609, 1N1805-1N1812, 1N1816-1N1836, 1N2008-1N2012, 1N2043-1N2049, 1N2498-1N2500, 1N2970A-1N3011A (Data sheet No. 127)



### TO-3 CASE

144 TYPES ■ 50-watt zener regulators—1N2808A-1N2843A (Data sheet No. 120)



### P1 CASE

2 TYPES ■ temperature-compensated zener reference devices—1N1530, 1N1530A (Data sheet No. 114)



### M3 CASE

4 TYPES ■ temperature-compensated zener reference devices—1N430, USN-1N430, 1N430A, 1N430B (Data sheet No. 114)



### HIGH-EFFICIENCY SOLAR CELLS

#### 120C TYPE

4 TYPES ■ silicon solar cells—120C-8 to 120-11 (Data sheet No. 126)



#### 120CG TYPE

4 TYPES ■ silicon "Solagrid" cells—120CG-10 to 120CG-14 (Data sheet No. 136)



#### 220C TYPE

3 TYPES ■ silicon solar cells—220C-8 to 220C-10 (Data sheet No. 126)



### TO-18 CASE



2 TYPES ■ silicon mesa transistors—2N717 & 2N718 (Data sheet No. 147)

14 TYPES ■ silicon tunnel diodes—1N2928-1N2934 (Data sheet No. 137)

12 TYPES ■ silicon Uni-Tunnel diodes—HU5-HU100A (Data sheet No. 131)

### SOLAR CELLS AND MODULES



#### H5 TYPE

2 TYPES ■ solar modules—H5B & H5C (Data sheet No. 138)  
7 TYPES ■ 2A, 120C, 110C, 52C, 51C, 55C & 58C (Data sheet No. 129)

### PHOTO-VOLTAIC DEVICES

#### EA7 TYPE

4 TYPES ■ photo-voltaic capsules—EA7E1, EA7E2, EA7E3, EA7E5 (Data sheet No. 119)



#### HPC TYPE

8 TYPES ■ photo-voltaic assemblies—HPC-4-01, HPC-5-01, HPC-6-01, HPC-7-01, HPC-8-01, HPC-9-01, HPC-10-01, HPC-10-02 (Data sheet No. 128)



### TO-5 CASE



3 TYPES ■ silicon mesa transistors—2N696-2N697, 2N1644 (Data sheets Nos. 143 & 144)

12 TYPES ■ 1-AMP silicon-controlled rectifiers—HCR-30P—HCR-400P, HCR-30N—HCR-200N (Data sheet No. 142)

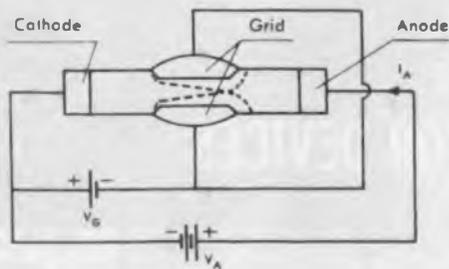
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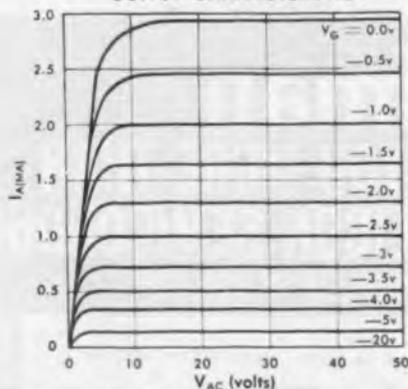


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- *Negligible offset voltage (less than 1 $\mu$  V)*
- *Unprecedented gain stability*

The silicon field-effect transistors from Crystalonics combine almost all advantages of vacuum tubes and conventional transistors. They are silicon majority carrier devices presently available in the TO-5 package, and have three terminals; anode, cathode, and grid. The transistor action takes place entirely within the bulk of the silicon material and completely away from the surface, giving rise to an unprecedented gain stability of the unit. The radiation resistance of the field-effect transistors exceeds that of the conventional units approximately ten times.

The new devices are recommended as first stages to high input, low noise amplifiers, low level switching circuits such as choppers, analog multipliers, and electronically variable resistors.

### Low Noise Amplifiers:

Field-effect transistors are inherently low noise devices and have noise figures considerably below that of the best selected low noise transistors and tubes. Unlike the conventional bipolar transistor, the field-effect unit does not pass any working current through the junctions, and it does not rely for its operation on minority carriers which eventually recombine to produce base current of the conventional unit. Both processes, the passing of current through emitter and collector junctions and carrier recombination are inherently noisy, and are completely eliminated in the new device. The result is a transistor series (C620) with maximum noise figures of 0.5 dB with 1 M $\Omega$  generator impedance. To obtain optimum performance for the low noise field-effect transistors, the grid bias should be kept at zero and the anode potential at approximately 3 volts.

### High Input Impedance Amplifiers:

The input impedance of the field-effect transistor is effectively equivalent to a reverse biased silicon diode and is of the order of 1000 M $\Omega$ . The output characteristics of the C613 field-effect transistor is shown below. They are identical with those of a thermionic pentode. In fact, the field-effect transistor can be used in a manner analogous to vacuum pentodes and, therefore, no new circuit techniques are required.

### Low Level Switching:

Unlike the conventional transistor which is a normally "off" switch, the field-effect unit is a normally "on" switch. In the "on" condition, the unit, therefore, is merely a passive silicon resistor without any "offset" voltage. The only equivalent of "offset voltage" in the field-effect transistors is the noise generated by this silicon resistor, and is of the order of .1 $\mu$  Volt. No matching of units is therefore required, and only one device has to be used instead of the usual two.

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Crystalonics Inc. Types

C610	C611	C612	C613	C614
C615	C650	C651	C652	C653

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## TRANSISTORS — 1961

### Power

Type No.	Mfg.	Type	W <sub>c</sub> w	Max. Ratings			
				m/c	T <sub>j</sub> c	V <sub>c</sub> v	I <sub>c</sub> amp
LT-12	CBS	ppp,AJ,ge	20	0.33	85	100	3
LT-13	CBS	ppp,AJ,ge	20	0.33	85	120	3
LT-14	CBS	ppp,AJ,ge	20	0.33	85	150	3
LT-15	CBS	ppp,AJ,ge	20	0.33	85	200	3
2N234A	BE	ppp,AJ,ge	25	1.2	90	30	3
2N235A	BE	ppp,AJ,ge	25	1.2	90	40	3
2N235B	BE	ppp,AJ,ge	25	1.2	90	40	3
2N236A	BE	ppp,AJ,ge	25	1.2	95	40	3
2N265A	BE	ppp,AJ,ge	25	1.2	95	40	3
2N296	SY	ppp,AJ,ge	25	0.33	100	60	2
2N399	BE	ppp,AJ,ge	25	1.2	90	40	3
2N400	BE	ppp,AJ,ge	25	1.2	95	40	3
2N1146	CL	ppp,AJ,ge	25	0.7	95	40	15
2N1146A	CL	ppp,AJ,ge	25	0.7	95	60	15
2N1146B	CL	ppp,AJ,ge	25	0.7	95	80	15
2N1146C	CL	ppp,AJ,ge	25	0.7	95	100	15
2N1147	CL	ppp,AJ,ge	25	0.7	95	40	15
2N1147A	CL	ppp,AJ,ge	25	-	95	60	15
2N1147B	CL	ppp,AJ,ge	25	-	95	80	15
2N1147C	CL	ppp,AJ,ge	25	-	95	100	15
2N1245	CBS	ppp,AJ,ge	25	0.5	85	25	3
2N1246	CBS	ppp,AJ,ge	25	0.5	85	25	3
2N1483	RCA	npn,DJ,si	25	-	200	60	3
2N1484	RCA	npn,DJ,si	25	-	200	100	3
2N1485	RCA	npn,DJ,si	25	-	200	60	3
2N1486	RCA	npn,DJ,si	25	-	200	100	3
B-177	BE	ppp,AJ,ge	25	1.2	90	30	3
B-178	BE	ppp,AJ,ge	25	1.2	90	30	3
B-179	BE	ppp,AJ,ge	25	1.2	90	40	3
CTP1500	CL	ppp,AJ,ge	25	1.0	95	100	15
CTP1503	CL	ppp,AJ,ge	25	1.0	95	80	15
CTP1504	CL	ppp,AJ,ge	25	1.0	95	60	15
CTP1505	CL	ppp,AJ,ge	25	1.0	95	40	15
CTP1544	CL	ppp,AJ,ge	25	1.0	95	60	25
CTP1545	CL	ppp,AJ,ge	25	1.0	95	80	25
CTP1552	CL	ppp,AJ,ge	25	1.0	95	40	25
CTP1553	CL	ppp,AJ,ge	25	1.0	95	100	25
2N2368	CBS	ppp,AJ,ge	30	-	85	40	3
2N242	SY	ppp,AJ,ge	30	0.33	100	45	2.0
2N257	BE	ppp,AJ,ge	30	2.0	90	40	3
2N268	BE	ppp,AJ,ge	30	2.0	90	-	3
2N538	MH	ppp,AJ,ge	32	0.45	95	80	3
2N539	MH	ppp,AJ,ge	32	0.45	95	80	3.0
2N540	MH	ppp,AJ,ge	32	0.45	95	85	3.0
2N1202	MH	ppp,AJ,ge	32	0.45	95	80	3
2N1203	MH	ppp,AJ,ge	32	0.45	95	120	3
2N1261	MH	ppp,AJ,ge	32	0.45	95	80	3
2N1262	MH	ppp,AJ,ge	32	0.45	95	80	3
2N1263	MH	ppp,AJ,ge	32	0.45	95	80	3
2N1501	MH	ppp,AJ,ge	32	0.45	95	60	3
2N1502	MH	ppp,AJ,ge	32	0.45	95	40	3
2N463	WE	npn,AJ,ge	35	-	-	60	5
2N1011	BE	ppp,AJ,ge	35	0.2	95	-	3
2N178	MO	ppp,AJ,ge	40	1.4	90	40	3
2N554	MO	ppp,AJ,ge	40	1.4	90	15	3
2N555	MO	ppp,AJ,ge	40	1.4	90	30	3
2N1047	STC	npn,AJ,si	40	0.2	200	80	2
2N1047A	TI	npn,MS,si	40	0.228	200	80	0.5
2N1048	STC	npn,DJ,si	40	0.2	200	120	2
2N1048A	TI	npn,MS,si	40	0.228	200	120	0.5
2N1049	STC	npn,DJ,si	40	0.2	200	80	2
2N1049A	TI	npn,MS,si	40	0.228	200	80	0.5
2N1050	STC	npn,DJ,si	40	0.2	200	120	2
2N1050A	TI	npn,MS,si	40	0.228	200	120	0.5
2N1453	CBS	ppp,AJ,ge	40	0.66	85	30	5
2N1454	CBS	ppp,AJ,ge	40	0.66	85	30	5
2N1455	CBS	ppp,AJ,ge	40	0.66	85	60	5
2N1456	CBS	ppp,AJ,ge	40	0.66	85	60	5
2N1457	CBS	ppp,AJ,ge	40	0.66	85	80	5
2N1458	CBS	ppp,AJ,ge	40	0.66	85	80	5
2N1461	CBS	ppp,AJ,ge	40	0.66	85	30	5
2N1462	CBS	ppp,AJ,ge	40	0.66	85	30	5
2N1463	CBS	ppp,AJ,ge	40	0.66	85	60	5
2N1464	CBS	ppp,AJ,ge	40	0.66	85	60	5
2N1647	TR	npn,DJ,si	40	0.27	175	80	3



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# DATA CHART

(continued)

Characteristics					Remarks	Type No.
f <sub>o</sub>	I <sub>co</sub>	f <sub>cut</sub>	Power Gain db	Power Out. w		
-	1	5	-	-		LT-12
-	1	5	-	-		LT-13
-	1	5	-	-		LT-14
-	1	5	-	-		LT-15
-	1	-	-	34	CBS	2N234A
-	1.0	-	-	36	CBS, CL	2N235A
-	1.0	-	-	38		2N235B
-	1.0	-	-	35		2N236A
-	1.0	-	-	39	hFE 20 min.	2N285A
20	2.0	4	-	-		2N296
-	1.5	-	33	-		2N399
-	1.3	-	35	6		2N400
-	25	4	-	-		2N1146
-	25	4	-	-		2N1146A
-	25	4	-	-		2N1146B
-	25	4	-	-		2N1146C
-	25	4	-	-	solder lugs	2N1147
-	25	4	-	-	solder lugs	2N1147A
-	25	4	-	-	solder lugs	2N1147B
-	25	4	-	-	solder lugs	2N1147C
-	1	5	-	-		2N1245
-	1	5	-	-		2N1246
45	15	1.25 mc	-	-	STC, SE	2N1483
45	15	1.25 mc	-	-	STC, SE	2N1484
45	15	1.25 mc	-	-	STC, SE	2N1485
45	15	1.25 mc	-	-	STC, SE	2N1486
-	1.0	-	-	36		B-177
-	1.0	-	-	30-36		B-178
-	1.0	-	-	25-30		B-179
30-75	8	-	-	-		CTP1500
30-75	8	-	-	-		CTP1503
30-75	8	-	-	-		CTP1504
30-75	8	-	-	-		CTP1508
25-75	15	3	-	-		CTP1544
25-75	15	3	-	-		CTP1545
25-75	15	3	-	-		CTP1552
25-75	15	3	-	-		CTP1553
-	1.0	5	37	4	BE	2N236B
-	3.0	-	36	-	CL, BE, TS	2N242
-	-	-	-	33	CL	2N257
-	2	-	-	35	SY, CL	2N268
30	2	200	-	-		2N538
43	2	200	-	-		2N539
64	2	200	-	-		2N540
86	2	200	-	-		2N1202
37	2	200	-	-		2N1203
30	2	200	-	-		2N1261
43	2	200	-	-		2N1262
64	2	200	-	-		2N1263
45	2	200	-	-		2N1501
45	2	200	-	-	Sat. volt = 0.15v	2N1502
60	100	15	-	-	U.S. MIL only	2N463
30-75	15	-	-	-	M1	2N1011
50	-	6	30	-		2N178
50	-	6	35	-		2N554
50	-	6	35	-		2N555
12-36	.015	-	-	-	TR	2N1047
12-36	.0015 8 mc	-	-	-	TR	2N1047A
12-36	.015	-	-	-	TR	2N1048
12-36	.0015 8 mc	-	-	-	TR	2N1048A
30-90	.015	-	-	-	TR	2N1049
30-90	.0015 7 mc	-	-	-	TR	2N1049A
30-90	.015	-	-	-	TR	2N1050
30-90	7 mc	-	-	-	TR	2N1050A
50	1.0	5	-	4	TO-13	2N1453
100	1.0	5	-	4	TO-13	2N1454
50	1.0	5	-	4	TO-13	2N1455
100	1.0	5	-	4	TO-13	2N1456
50	1.0	5	-	4	TO-13	2N1457
100	1.0	5	-	2	TO-13	2N1458
50	1.0	5	-	4	TO-10	2N1461
100	1.0	5	-	4	TO-10	2N1462
50	1.0	5	-	4	TO-10	2N1463
100	1.0	5	-	4	TO-10	2N1464
15-45	.025	10 mc	-	-		2N1647

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# TRANSISTORS - 1961

## Power (continued)

Type No.	Mfg.	Type	W c	Max. Ratings					Characteristics					Remarks
				w/c	T j c	V c v	I c amp	h fe	f co mc	f ca kc	Pow. Gain db	Pow. Out. w		
2N1640	TR	npn,DJ,si	40	.27	175	120	3	15-45	.025	10	mc	-	-	
2N1649	TR	npn,DJ,si	40	.27	175	80	3	30-90	.025	10	mc	-	-	
2N1650	TR	npn,DJ,si	40	.27	175	120	3	30-90	.025	10	mc	-	-	
2N1886	TR	npn,DJ,si	40	.27	175	60	5	20-80	.35	8	mc	-	-	
2N2018	TR	npn,DJ,si	40	.27	175	150	-	20-60	.01	10	mc	-	-	
2N2019	TR	npn,DJ,si	40	.27	175	200	-	20-60	.01	10	mc	-	-	
2N2020	TR	npn,DJ,si	40	.27	175	150	-	40-120	.01	10	mc	-	-	
2N2021	TR	npn,DJ,si	40	.27	175	200	-	40-120	.01	10	mc	-	-	
2N1120	BE	ppp,AJ,ge	45	L0	95	80	15	20-50	.15	-	-	-	-	MO
2N250	TI	ppp,AJ,ge	50	.27	100	30	5	60	2	-	-	30	-	CL
2N251	TI	ppp,AJ,ge	50	.27	100	60	5	60	2	-	-	30	-	
2N653	DE	ppp,AJ,ge	50	L5	100	80	5	-	.02	25	-	-	-	
2N665	DE	ppp,AJ,ge	50	L5	100	80	5	-	.02	25	-	-	-	JAN2N665
2N1014	RCA	ppp,AJ,ge	50	L0	100	100	10	75	.1	-	-	26	30	
2N1069	STC	npn,DJ,si	50	.29	175	60	4	20	1	1	-	-	-	RCA
2N1070	STC	npn,DJ,si	50	.29	175	60	4	20	1	1	-	-	-	RCA
2N1722	TI	npn,MS,si	50	.67	175	80	7.5	-	1	20	mc	-	-	
2N1724	TI	npn,MS,si	50	.67	175	80	7.5	-	1	20	mc	-	-	
2N1905	RCA	ppp,DJ,ge	50	0.7	-	60	10	90	.15	-	-	-	-	
2N1906	RCA	ppp,DJ,ge	50	0.7	-	100	10	125	.15	-	-	-	-	
2N1470	RA	npn,DJ,si	55	3.0	200	60	2	50	10	10	-	-	-	Diamond Package
2N1657	RA	npn,DB,si	55	.33	200	60	2	50	10	10	mc	-	-	
2N419	BE	ppp,AJ,ge	60	L2	95	45	3	-	0.5	-	-	-	5	
2N639	BE	ppp,AJ,ge	60	L2	100	40	5	15-30	1.0	-	-	-	-	
2N639A	BE	ppp,AJ,ge	60	L2	100	70	5	15-30	1.0	-	-	-	-	
2N639B	BE	ppp,AJ,ge	60	L2	100	80	5	15-30	2.2	-	-	-	-	
2N1073	BE	ppp,AJ,ge	60	L0	100	40	10	20-6	2.0	L5	-	-	-	
2N1073A	BE	ppp,AJ,ge	60	L0	100	80	10	20-6	1.5	-	-	-	-	
2N1073B	BE	ppp,AJ,ge	60	L0	100	120	10	20-6	2.0	L5	-	-	-	
2N1136	BE	ppp,AJ,ge	60	L2	100	40	6	-	0.5	-	-	-	-	
2N1136A	BE	ppp,AJ,ge	60	L2	100	70	6	-	2	-	-	-	-	
2N1136B	BE	ppp,AJ,ge	60	L2	100	80	6	-	2	-	-	-	-	
2N1137	BE	ppp,AJ,ge	60	L2	100	40	6	-	0.5	-	-	-	-	
2N1137A	BE	ppp,AJ,ge	60	L2	100	70	6	-	2	-	-	-	-	
2N1137B	BE	ppp,AJ,ge	60	L2	100	80	6	-	2	-	-	-	-	
2N1138	BE	ppp,AJ,ge	60	L2	100	40	6	-	0.5	-	-	-	-	
2N1138A	BE	ppp,AJ,ge	60	L2	100	70	6	-	2.0	-	-	-	-	
2N1138B	BE	ppp,AJ,ge	60	L2	100	80	6	-	2	-	-	-	-	
2N1210	TR	npn,DJ,si	60	.27	175	60	5	15-75	50	15	mc	-	-	STC
2N1211	TR	npn,DJ,si	60	.27	175	70	5	15-75	50	15	mc	-	-	STC
2N1487	RCA	npn,DJ,si	60	-	175	60	6	30	25	1	mc	-	-	STC, SE
2N1488	RCA	npn,DJ,si	60	-	175	100	6	30	25	1	mc	-	-	STC, SE
2N1489	RCA	npn,DJ,si	60	-	175	60	6	30	25	1	mc	-	-	STC, SE
2N1490	RCA	npn,DJ,si	60	-	175	100	6	30	25	1.25	mc	-	-	STC, SE
2N1616	TR	npn,DJ,si	80	.27	175	60	5	15-75	50	15	mc	-	-	
2N1617	TR	npn,DJ,si	60	.27	175	70	5	15-75	90	15	mc	-	-	
2N1618	TR	npn,DJ,si	60	.27	175	80	5	15-75	50	15	mc	-	-	
ST440	TR	npn,DJ,si	60	.27	150	60	5	10	1	-	-	-	-	SE
ST450	TR	npn,DJ,si	60	.27	150	60	5	10	1	-	-	-	-	
2N174A	TS	ppp,AJ,ge	75	-	95	80	15	37	8	10	-	-	-	MO
3N45	MH	ppp,AJ,ge	75	L0	100	60	10	50	3.0	750	-	-	-	Sat. volt=0.15v
3N46	MH	ppp,AJ,ge	75	L0	100	80	10	40	3.0	450	-	-	-	Sat. volt=0.15v
3N47	MH	ppp,AJ,ge	75	L0	100	40	10	50	3	750	-	-	-	Sat. volt=0.15v
3N48	MH	ppp,AJ,ge	75	L0	100	60	10	40	3	450	-	-	-	Sat. volt=0.15v
2N389	TI	npn,DJ,si	85	.40	200	60	2	12-60	10	7	mc	-	-	STC, TR, RA
2N424	TI	npn,DJ,si	85	.40	200	80	2	12-60	10	6	mc	-	-	STC, TR, RA SE
2N1619	TR	npn,DJ,si	85	.27	200	80	5	30	0.1	15	mc	-	-	
2N1660	RA	npn,DB,si	85	0.5	200	60	2	90	10	40	mc	-	-	
2N1661	RA	npn,DB,si	85	0.5	200	80	2	90	10	40	mc	-	-	
2N1662	RA	npn,DB,si	85	0.5	200	100	2	90	10	40	mc	-	-	
2N1894	RA	npn,DB,si	85	0.5	200	60	2	30	.01	-	-	-	-	
2N1895	RA	npn,DB,si	85	0.5	200	80	2	30	.01	-	-	-	-	
2N1896	RA	npn,DB,si	85	0.5	200	60	2	90	.01	-	-	-	-	
2N1897	RA	npn,DB,si	85	0.5	200	80	2	90	.01	-	-	-	-	
2N1898	RA	npn,DB,si	85	0.5	200	100	2	90	.01	-	-	-	-	
STC1101	STC	npn,DJ,si	85	-	200	60	6	10-50	.025	1	mc	-	-	
STC1102	STC	npn,DJ,si	85	-	200	100	6	10-50	.025	1	mc	-	-	
STC1103	STC	npn,DJ,si	85	-	200	60	6	25-75	.025	1	mc	-	-	
STC1104	STC	npn,DJ,si	85	-	200	100	6	25-75	.025	1	mc	-	-	
2N297A	MO	ppp,AJ,ge	90	L2	100	80	3	40-100	3	5	-	-	-	DE, BE
2N850A	MO	ppp,AJ,ge	90	L4	100	50	3	30	3	5	33	-	-	
2N351A	MO	ppp,AJ,ge	90	L4	100	50	4	45	3	5	33	-	-	
2N376A	MO	ppp,AJ,ge	90	L4	100	50	5	60	3	5	35	-	-	
2N627	MO	ppp,AJ,ge	90	L2	100	40	10	10-30	4	5	38	-	-	
2N628	MO	ppp,AJ,ge	90	L2	100	60	10	10-30	4	5	38	-	-	

# DATA CHART

## Power (continued)

Type No.	Mfg.	Type	W <sub>c</sub>	Max. Ratings				Characteristics					Remarks
				w/c	T <sub>c</sub>	V <sub>c</sub>	I <sub>c</sub>	f <sub>h</sub>	f <sub>co</sub>	f <sub>ae</sub>	Power Gain db	Power Out. w	
2N629	MO	pn-p, A <sub>1</sub> , ge	90	1.2	100	80	10	10-30	4	5	38	-	
2N630	MO	pn-p, A <sub>1</sub> , ge	90	1.2	100	100	10	10-30	4	5	38	-	
2N677	BE	pn-p, A <sub>1</sub> , ge	90	1.2	100	50	15	45	1	-	-	-	
2N677A	BE	pn-p, A <sub>1</sub> , ge	90	1.2	100	60	15	45	1	-	-	-	
2N677B	BE	pn-p, A <sub>1</sub> , ge	90	1.2	100	90	15	45	1	-	-	-	
2N677C	BE	pn-p, A <sub>1</sub> , ge	90	1.2	100	100	15	45	1	-	-	-	
2N678	BE	pn-p, A <sub>1</sub> , ge	90	1.2	100	150	15	75	1	-	-	-	
2N678A	BE	pn-p, A <sub>1</sub> , ge	90	1.2	100	60	15	75	1	-	-	-	
2N678B	BE	pn-p, A <sub>1</sub> , ge	90	1.2	100	90	15	75	1	-	-	-	
2N678C	BE	pn-p, A <sub>1</sub> , ge	90	1.2	100	100	15	75	1	-	-	-	
2N1031	BE	pn-p, A <sub>1</sub> , ge	90	0.8	100	30	15	20-60	1.0	-	-	-	
2N1031A	BE	pn-p, A <sub>1</sub> , ge	90	0.8	100	40	15	20-60	1.0	-	-	-	
2N1031B	BE	pn-p, A <sub>1</sub> , ge	90	0.8	100	70	15	20-60	1.0	-	-	-	
2N1031C	BE	pn-p, A <sub>1</sub> , ge	90	0.8	100	80	15	20-60	2.0	-	-	-	
2N1032	BE	pn-p, A <sub>1</sub> , ge	90	0.8	100	30	15	50-100	1.0	-	-	-	
2N1032A	BE	pn-p, A <sub>1</sub> , ge	90	0.8	100	40	15	50-100	1.0	-	-	-	
2N1032B	BE	pn-p, A <sub>1</sub> , ge	90	0.8	100	70	15	50-100	2.0	-	-	-	
2N1032C	BE	pn-p, A <sub>1</sub> , ge	90	0.8	100	80	15	50-100	2	-	-	-	
2N1162	MO	pn-p, A <sub>1</sub> , ge	90	1.2	100	50	25	15-65	3	4	-	-	
2N1162A	MO	pn-p, A <sub>1</sub> , ge	90	1.2	100	50	25	15-65	15	4	-	-	
2N1163	MO	pn-p, A <sub>1</sub> , ge	90	1.2	100	50	25	15-65	3	4	-	-	
2N1163A	MO	pn-p, A <sub>1</sub> , ge	90	1.2	100	50	25	15-65	15	4	-	-	
2N1164	MO	pn-p, A <sub>1</sub> , ge	90	1.2	100	80	25	15-65	3	4	-	-	
2N1164A	MO	pn-p, A <sub>1</sub> , ge	90	1.2	100	80	25	15-65	15	4	-	-	
2N1165	MO	pn-p, A <sub>1</sub> , ge	90	1.2	100	80	25	15-65	3	4	-	-	
2N1165A	MO	pn-p, A <sub>1</sub> , ge	90	1.2	100	80	25	15-65	15	4	-	-	
2N1166	MO	pn-p, A <sub>1</sub> , ge	90	1.2	100	80	25	15-65	3	4	-	-	
2N1166A	MO	pn-p, A <sub>1</sub> , ge	90	1.2	100	100	25	15-65	15	4	-	-	
2N1167	MO	pn-p, A <sub>1</sub> , ge	90	1.2	100	100	25	15-65	3	4	-	-	
2N1167A	MO	pn-p, A <sub>1</sub> , ge	90	1.2	100	100	25	15-65	15	4	-	-	
2N1359	MO	pn-p, A <sub>1</sub> , ge	90	1.2	100	50	3	35-90	3	7	-	-	
2N1360	MO	pn-p, A <sub>1</sub> , ge	90	1.2	100	50	3	60-140	3	5	-	-	
2N1362	MO	pn-p, A <sub>1</sub> , ge	90	1.2	100	100	3	35-90	3	7	-	-	
2N1363	MO	pn-p, A <sub>1</sub> , ge	90	1.2	100	100	3	60-140	3	5	-	-	
2N1364	MO	pn-p, A <sub>1</sub> , ge	90	1.2	100	120	3	35-90	3	7	-	-	
2N1365	MO	pn-p, A <sub>1</sub> , ge	90	1.2	100	120	3	60-140	3	5	-	-	
2N1529	MO	pn-p, A <sub>1</sub> , ge	90	1.2	100	40	5	20-40	2	10	-	-	
2N1529A	MO	pn-p, A <sub>1</sub> , ge	90	1.2	100	40	5	20-40	2	10	-	-	
2N1530	MO	pn-p, A <sub>1</sub> , ge	90	1.2	100	40	5	20-40	2	10	-	-	
2N1530A	MO	pn-p, A <sub>1</sub> , ge	90	1.2	100	60	5	20-40	2	10	-	-	
2N1531	MO	pn-p, A <sub>1</sub> , ge	90	1.2	100	80	5	20-40	2	10	-	-	
2N1531A	MO	pn-p, A <sub>1</sub> , ge	90	1.2	100	80	5	20-40	2	10	-	-	
2N1532	MO	pn-p, A <sub>1</sub> , ge	90	1.2	100	100	5	20-40	2	10	-	-	
2N1532A	MO	pn-p, A <sub>1</sub> , ge	90	1.2	100	100	5	20-40	2	10	-	-	
2N1533	MO	pn-p, A <sub>1</sub> , ge	90	1.2	100	120	5	20-40	2	10	-	-	TR
2N1534	MO	pn-p, A <sub>1</sub> , ge	90	1.2	100	40	5	35-70	2	8.5	-	-	
2N1534A	MO	pn-p, A <sub>1</sub> , ge	90	1.2	100	40	5	35-70	2	8.5	-	-	
2N1535	MO	pn-p, A <sub>1</sub> , ge	90	1.2	100	60	5	35-70	2	8.5	-	-	
2N1535A	MO	pn-p, A <sub>1</sub> , ge	90	1.2	100	60	5	35-70	2	8.5	-	-	
2N1536	MO	pn-p, A <sub>1</sub> , ge	90	1.2	100	80	5	35-70	2	8.5	-	-	
2N1536A	MO	pn-p, A <sub>1</sub> , ge	90	1.2	100	80	5	35-70	2	8.5	-	-	
2N1537	MO	pn-p, A <sub>1</sub> , ge	90	1.2	100	100	5	35-70	2	8.5	-	-	
2N1537A	MO	pn-p, A <sub>1</sub> , ge	90	1.2	100	100	5	35-70	2	8.5	-	-	
2N1538	MO	pn-p, A <sub>1</sub> , ge	90	1.2	100	120	5	35-70	2	8.5	-	-	
2N1539	MO	pn-p, A <sub>1</sub> , ge	90	1.2	100	40	5	50-100	2	4	-	-	
2N1539A	MO	pn-p, A <sub>1</sub> , ge	90	1.2	100	40	5	50-100	2	4	-	-	
2N1540	MO	pn-p, A <sub>1</sub> , ge	90	1.2	100	60	5	50-100	2	4	-	-	
2N1540A	MO	pn-p, A <sub>1</sub> , ge	90	1.2	100	60	5	50-100	2	4	-	-	
2N1541	MO	pn-p, A <sub>1</sub> , ge	90	1.2	100	80	5	50-100	2	4	-	-	
2N1541A	MO	pn-p, A <sub>1</sub> , ge	90	1.2	100	80	5	50-100	2	4	-	-	
2N1542	MO	pn-p, A <sub>1</sub> , ge	90	1.2	100	100	5	50-100	2	4	-	-	
2N1542A	MO	pn-p, A <sub>1</sub> , ge	90	1.2	100	100	5	50-100	2	4	-	-	
2N1543	MO	pn-p, A <sub>1</sub> , ge	90	1.2	100	120	5	50-100	2	4	-	-	
2N1544	MO	pn-p, A <sub>1</sub> , ge	90	1.2	100	40	5	75-150	2	4	-	-	
2N1544A	MO	pn-p, A <sub>1</sub> , ge	90	1.2	100	40	5	75-150	2	4	-	-	
2N1545	MO	pn-p, A <sub>1</sub> , ge	90	1.2	100	60	5	75-150	2	4	-	-	
2N1545A	MO	pn-p, A <sub>1</sub> , ge	90	1.2	100	60	5	75-150	2	4	-	-	
2N1546	MO	pn-p, A <sub>1</sub> , ge	90	1.2	100	80	5	75-150	2	4	-	-	
2N1546A	MO	pn-p, A <sub>1</sub> , ge	90	1.2	100	80	5	75-150	2	4	-	-	
2N1547	MO	pn-p, A <sub>1</sub> , ge	90	1.2	100	100	5	75-150	2	4	-	-	
2N1547A	MO	pn-p, A <sub>1</sub> , ge	90	1.2	100	100	5	75-150	2	4	-	-	
2N1548	MO	pn-p, A <sub>1</sub> , ge	90	1.2	100	120	5	75-150	2	4	-	-	
2N1549	MO	pn-p, A <sub>1</sub> , ge	90	1.2	100	40	15	10-30	3	10	-	-	
2N1549A	MO	pn-p, A <sub>1</sub> , ge	90	1.2	100	40	15	10-30	3	10	-	-	
2N1550	MO	pn-p, A <sub>1</sub> , ge	90	1.2	100	60	15	10-30	3	10	-	-	



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# TRANSISTORS - 1961

## Power (continued)

Type No.	Mfg.	Type	W <sub>c</sub>	Max. Ratings					Characteristics					Remarks
				w/c	T <sub>j</sub> c	V <sub>c</sub> v	I <sub>c</sub> amp	f <sub>te</sub>	I <sub>co</sub>	f <sub>ae</sub> kc	Power Gain db	Power Out. w		
2N1550A	MO	npn,AJ,ge	90	1.2	100	60	15	10-30	3	10	-	-		
2N1551	MO	npn,AJ,ge	90	1.2	100	80	15	10-30	2	10	-	-		
2N1551A	MO	npn,AJ,ge	90	1.2	100	80	15	10-30	3	10	-	-		
2N1552	MO	npn,AJ,ge	90	1.2	100	100	15	10-30	2	10	-	-		
2N1552A	MO	npn,AJ,ge	90	1.2	100	100	15	10-30	3	10	-	-		
2N1553	MO	npn,AJ,ge	90	1.2	100	40	15	30-60	2	6	-	-		
2N1553A	MO	npn,AJ,ge	90	1.2	100	40	15	30-60	3	6	-	-		
2N1554	MO	npn,AJ,ge	90	1.2	100	60	15	30-60	2	6	-	-		
2N1554A	MO	npn,AJ,ge	90	1.2	100	60	15	30-60	3	6	-	-		
2N1555	MO	npn,AJ,ge	90	1.2	100	80	15	30-60	3	6	-	-		
2N1555A	MO	npn,AJ,ge	90	1.2	100	80	15	30-60	3	6	-	-		
2N1556	MO	npn,AJ,ge	90	1.2	100	100	15	30-60	3	6	-	-		
2N1556A	MO	npn,AJ,ge	90	1.2	100	100	15	30-60	3	6	-	-		
2N1557	MO	npn,AJ,ge	90	1.2	100	40	15	50-100	3	6	-	-		
2N1557A	MO	npn,AJ,ge	90	1.2	100	40	15	50-100	3	6	-	-		
2N1558	MO	npn,AJ,ge	90	1.2	100	60	15	50-100	3	5	-	-		
2N1558A	MO	npn,AJ,ge	90	1.2	100	60	15	50-100	3	5	-	-		
2N1559	MO	npn,AJ,ge	90	1.2	100	80	15	50-100	3	5	-	-		
2N1559A	MO	npn,AJ,ge	90	1.2	100	80	15	50-100	3	5	-	-		
2N1560	MO	npn,AJ,ge	90	1.2	100	100	15	50-100	3	5	-	-		
2N1560A	MO	npn,AJ,ge	90	1.2	100	100	15	50-100	3	5	-	-		
2N392	DE	npn,AJ,ge	94	.8	100	60	5	-	0.065	6	-	-		
2N669	DE	npn,AJ,ge	94	1.2	100	40	3	-	0.065	10	-	-		
2N1159	DE	npn,AJ,ge	94	0.8	100	80	5	-	0.065	10	-	-		
2N1160	DE	npn,AJ,ge	94	0.8	100	80	7	-	0.065	10	-	-		
2N1168	DE	npn,AJ,ge	94	0.8	100	50	5	-	0.065	10	-	-		
3N49	MH	npn,AJ,ge	94	1.25	100	60	10	50	3	750	-	-	Sat. volt = 0.15v	
3N50	MH	npn,AJ,ge	94	1.25	100	80	10	40	3	450	-	-	Sat. volt = 0.15v	
3N51	MH	npn,AJ,ge	94	1.25	100	40	10	50	3	750	-	-	Sat. volt = 0.15v	
3N52	MH	npn,AJ,ge	94	1.25	100	60	10	40	3	450	-	-	Sat. volt = 0.15v	
2N574	MH	npn,AJ,ge	100	1.43	95	60	15	14	7	75	-	-		
2N574A	MH	npn,AJ,ge	100	1.43	95	80	15	14	20	75	-	-		
2N575	MH	npn,AJ,ge	100	1.43	95	60	30	25	7	75	-	-		
2N575A	MH	npn,AJ,ge	100	1.43	95	80	30	25	20	75	-	-		
2N1157	MH	npn,AJ,ge	100	1.43	95	60	30	50	7	75	-	-		
2N1157A	MH	npn,AJ,ge	100	1.43	95	80	30	50	20	75	-	-		
2N1651	BE	npn,DJ,ge	100	1.2	110	60	25	30	2.0	-	-	-	Sat. volt = 1.0v	
2N1662	BE	npn,DJ,ge	100	1.2	110	100	25	30	2.0	-	-	-	Sat. volt = 0.5v	
2N1653	BE	npn,DJ,ge	100	1.2	110	120	25	30	2.0	-	-	-	Sat. volt = 0.5v	
2N1936	TI	npn,MS,si	100	1.34	175	60	15	-	20	7 mc	-	-		
2N1937	TI	npn,MS,si	100	1.34	175	80	15	-	20	7 mc	-	-		
PT900	PSI	npn,DM,si	125	1	150	80	10	3	10	50 mc	10	100	hi freq., hi power	
PT901	PSI	npn,MS,si	125	1	150	140	10	10	30	50 mc	-	-	hi freq., hi power	
2N1899	PSI	npn,DM,si	125	1	150	140	10	10	20	50 mc	10	100	hi freq., hi power	
2N1900	PSI	npn,DM,si	125	1	150	140	5	10	20	25 mc	-	-	hi freq., hi power	
2N1901	PSI	npn,DM,si	125	1	150	140	5	10	20	25 mc	-	-	hi freq., hi power	
2N173	DE	npn,AJ,ge	150	0.5	100	60	0.5	-	0.1	10	-	20	MO, TS, TI, RCA	
2N174	DE	npn,AJ,ge	150	0.5	100	80	15	-	0.1	10	-	40	TS, MO, TI, RCA	
2N277	DE	npn,AJ,ge	150	0.5	100	40	15	-	0.1	10	-	20	MO, TS, TI, RCA	
2N278	DE	npn,AJ,ge	150	0.5	100	50	15	-	0.1	10	-	20	MO, TS, TI, RCA	
2N441	DE	npn,AJ,ge	150	0.5	100	40	15	-	0.1	10	-	20	MO, TS, TI, RCA	
2N442	DE	npn,AJ,ge	150	0.5	100	50	15	-	0.1	10	-	20	MO, TS, TI, RCA	
2N443	DE	npn,AJ,ge	150	0.5	100	60	15	-	0.1	10	-	20	MO, TS, TI, RCA	
2N511	TI	npn,AJ,ge	150	2	100	40	25	20-60	5	-	-	-	Sat. volt = 0.2v	
2N511A	TI	npn,AJ,ge	150	2	100	60	25	20-60	5	-	-	-	Sat. volt = 0.02v	
2N511B	TI	npn,AJ,ge	150	2	100	80	25	20-60	5	-	-	-		
2N512	TI	npn,AJ,ge	150	2	100	40	25	20-60	5	-	-	-		
2N512A	TI	npn,AJ,ge	150	2	100	60	25	20-60	5	-	-	-		
2N512B	TI	npn,AJ,ge	150	2	100	80	25	20-60	5	-	-	-		
2N513	TI	npn,AJ,ge	150	2	100	40	25	20-60	5	-	-	-	Sat. volt = 0.4v	
2N513A	TI	npn,AJ,ge	150	2	100	60	25	20-60	5	-	-	-	Sat. volt = 0.4v	
2N513B	TI	npn,AJ,ge	150	2	100	80	25	20-60	5	-	-	-	Sat. volt = 0.4v	
2N514	TI	npn,AJ,ge	150	2	100	40	25	20-60	5	-	-	-	Sat. volt = 0.5v	
2N514A	TI	npn,AJ,ge	150	2	100	60	25	20-60	5	-	-	-	Sat. volt = 0.5v	
2N514B	TI	npn,AJ,ge	150	2	100	80	25	20-60	5	-	-	-	Sat. volt = 0.5v	
2N1021	TI	npn,AJ,ge	150	2	100	100	10	30-90	2	-	-	-	TR	
2N1022	TI	npn,AJ,ge	150	2	100	120	10	30-90	2	-	-	-	TR	
2N1099	DE	npn,AJ,ge	150	0.5	100	80	15	-	0.1	10	-	40	TS, MO, TI, RCA	
2N1100	DE	npn,AJ,ge	150	0.5	100	100	15	-	0.1	10	-	40	TS, MO, TI, RCA	
2N1907	TI	npn,AD,ge	150	2	100	100	20	10	10	-	-	-		
2N1908	TI	npn,AD,ge	150	2	100	130	20	10	10	-	-	-		
2N1980	TI	npn,AJ,ge	150	2	100	90	15	50	6	-	-	-		
2N1981	TI	npn,AJ,ge	150	2	100	70	15	50	6	-	-	-		
2N1982	TI	npn,AJ,si	150	2	100	90	15	50	6	-	-	-		
WX1180A	MH	npn,F,si	150	2	150	50	10	1000	10	11	-	-		

# DATA CHART

## Power (concluded)

Type No.	Mfg.	Type	W <sub>c</sub> w	Max. Ratings				Characteristics				Remarks	
				w/c	T <sub>j</sub> c	V <sub>c</sub> v	I <sub>c</sub> amp	h <sub>fe</sub>	I <sub>co</sub> ma	f <sub>int</sub> kc	Pow <sub>r</sub> Gain db		Pow <sub>r</sub> Out. w
WX118UB	WH	npn,F,si	150	2	150	100	10	1000	10	11	-	-	
WX118UC	WH	npn,F,si	150	2	150	150	10	1000	10	11	-	-	
WX118XA	WH	npn,F,si	150	2	150	50	10	1200	10	11	-	-	
WX118XB	WH	npn,F,si	150	2	150	100	10	1200	10	11	-	-	
WX118XC	WH	npn,F,si	150	2	150	150	10	1200	10	11	-	-	
WX115UA	WH	npn,AJ,si	250	2.22	150	50	30	30	15	17	-	-	
WX115UB	WH	npn,AJ,si	250	2.22	150	100	30	30	15	17	-	-	
WX115UC	WH	npn,AJ,si	250	2.22	150	150	30	30	15	17	-	-	
WX115UD	WH	npn,AJ,si	250	2.22	150	200	30	30	15	17	-	-	
WX115WA	WH	npn,AJ,si	250	2.22	150	50	30	23	15	18	-	-	
WX115WB	WH	npn,AJ,si	250	2.22	150	100	30	23	15	18	-	-	
WX115WB	WH	npn,AJ,si	250	2.22	150	150	30	23	15	18	-	-	
WX115WD	WH	npn,AJ,si	250	2.22	150	200	30	23	15	18	-	-	
WX115WD	WH	npn,AJ,si	250	2.22	150	200	30	23	15	18	-	-	
WX115XA	WH	npn,AJ,si	250	2.22	150	50	30	27	15	19	-	-	
WX115XB	WH	npn,AJ,si	250	2.2	150	100	30	27	15	19	-	-	
WX115XC	WH	npn,AJ,si	250	2.22	150	150	30	27	15	19	-	-	
WX115XD	WH	npn,AJ,si	250	2.22	150	200	15	27	15	19	-	-	

## Special Types

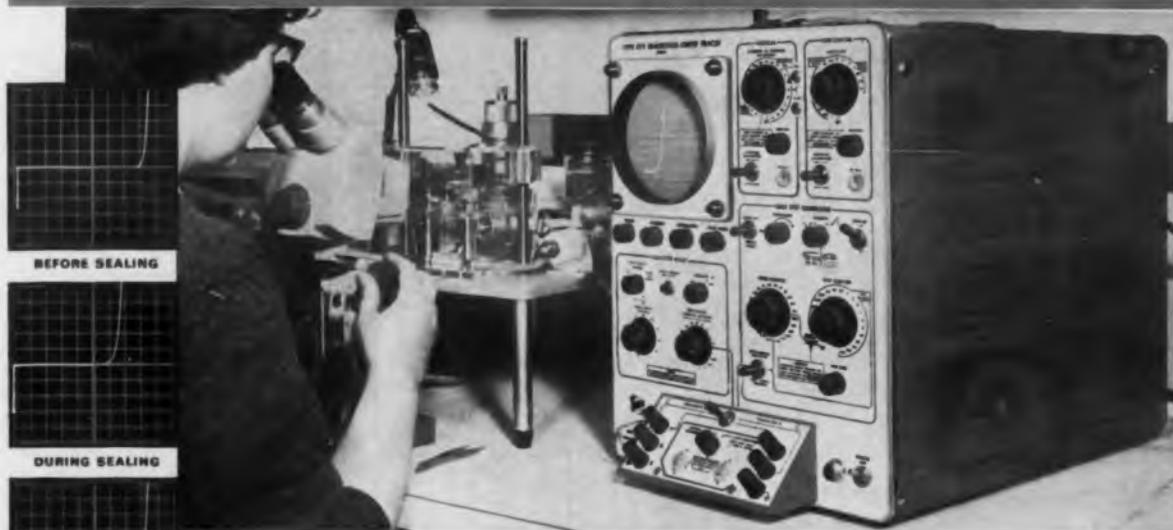
Type No.	Mfg.	Type	f <sub>ao</sub>	Max. Ratings				Characteristics				Remarks	
				W <sub>c</sub> w	T <sub>j</sub> c	mm/c	V <sub>c</sub> v	I <sub>c</sub> amp	h <sub>fe</sub>	I <sub>co</sub> ma	NF		C <sub>coe</sub>
2N409A	GI	ppn,AJ,ge	1.8 mc	50	85	0.83	20	-	75	5	16	30	photo
2N1311	GI	npn,AJ,ge	1.5 mc	120	100	1.5	75	-	25	3	10	11	high voltage
2N1312	GI	npn,AJ,ge	2 mc	120	100	1.5	50	-	30	3	10	11	high voltage
2N1322	GI	ppn,AJ,ge	1 mc	50	85	0.83	20	-	40	5	16	30	photo
2N1310	GI	npn,AJ,ge	1.0 mc	120	100	1.5	90	-	30	3	10	11	high voltage
2N1393	GI	ppn,AJ,ge	3.4 mc	50	85	0.83	20	-	160	5	16	30	photo
2N1394	GI	ppn,AJ,ge	1 mc	50	85	0.83	10	-	50	5	16	30	photo
GT1624	GI	npn,AJ,ge	3	150	100	2	40	-	75	4	-	-	high voltage
GT1200	GI	npn,AJ,ge	-	120	85	2	90	-	-	4	20	-	driver
2N1408	GI	ppn,AJ,ge	-	150	100	2	50	-	20	3	10	35	high voltage

Type No.	Mfg.	Type	w(mw)	T	mw/c	V	I(ma)	gm	Remarks
C650	CT	ppn,AJ,si	250	160	2	45	50	-	field effect
C651	CT	ppn,AJ,si	250	160	2	35	50	-	field effect
C652	CT	ppn,AJ,si	250	160	2	25	50	-	field effect
C653	CT	ppn,AJ,si	250	160	2	15	50	-	field effect
C610	CT	ppn,AJ,si	250	160	2	40	50	250	field effect
C611	CT	ppn,AJ,si	250	160	2	40	50	400	field effect
C612	CT	ppn,AJ,si	250	160	2	40	50	650	field effect
C613	CT	ppn,AJ,si	250	160	2	40	50	1000	field effect
C614	CT	ppn,AJ,si	250	160	2	40	50	250	field effect
C615	CT	ppn,AJ,si	250	160	2	40	50	750	field effect
2N1671	GE	pn,si	450	140	-	-	-	-	unijunction
2N1671A	GE	pn,si	450	140	-	-	-	-	unijunction
2N1671B	GE	pn,si	450	140	-	-	-	-	unijunction
2N1510	GE	npn,RJ,ge	75	85	-	70	20	-	unijunction

If you would like an additional copy of the Transistor Data Chart Section circle 251 on the Reader-Service Card (Quantity prices on request)

In-process testing of silicon diodes with a Type 575

## TEKTRONIX TRANSISTOR-CURVE TRACER



### INVALUABLE TOOL FOR EVALUATING SEMICONDUCTOR DEVICES

#### ... in research and development

The Type 575 is a versatile precision tool for in-process testing of semiconductor diodes—as illustrated above in the Semiconductor-Device Development Lab of Tektronix' Research Division. Viewing the display on a Type 575, a technician can easily determine the forward conduction characteristics as well as the reverse breakdown-and-leakage of a semiconductor diode prior to sealing, during sealing, and after sealing.

**NOTE:** Double-exposure waveform photos of the case-sealing operation were taken with control settings at 1 ma/div (v) and 0.2 v/div (h)—forward direction, upper right—and 20  $\mu$ a/div (v) and 20 v/div (h)—reverse direction, lower left.

#### ... in production runs

The Type 575—used by itself or with a Type 175 Adapter for increased current capability—is a convenient Quality Control tool for production testing of both PNP and NPN transistors—a simple procedure with Test-Setup Charts of front-panel layout available from your Tektronix Field Engineer. Using a Test-Setup Chart, with control settings marked with arrows, display limits drawn on the graticule, other time-saving techniques devised by a QC Engineer clearly noted, a production worker can easily change from one test procedure to another, accurately compare the characteristic curves displayed on the 5-inch crt of the Type 575 with charted standards, and speedily accept or reject the transistor under test.

#### ... in other applications

The Type 575 provides 20-ampere collector displays (10-ampere average supply current), two ranges of collector supply (0 to 20 volts, 0 to 200 volts), and 2.4-ampere base supply (positive or negative base stepping).

With a Type 575, you can plot and measure 7 different transistor characteristics. You can display 4 to 12 curves per family—with input current from 1 microampere/step to 200 milliamperes/step or input voltage from 10 millivolts/step to 200 millivolts/step—in repetitive or single-family presentations. You can select either common-emitter or common-base configurations.

Add a Type 175 Adapter and you extend the range of collector displays 10 times and the range of base supply 5 times.

#### Type 575 Calibrated Displays

**Vertical Axis—Collector Current**, 16 steps from 0.01 ma/div to 1000 ma/div. Pushbuttons are provided for multiplying each current step by 2 and dividing by 10, increasing the current range to 0.001 to 2000 ma/div.

**Horizontal Axis—Collector Voltage**, 11 steps from 0.01 v/div to 20 v/div.

**Both Axes—Base Voltage**, 6 steps from 0.01 v/div to 0.5 v/div.  
**Base Current**, 17 steps from 0.001 ma/div to 200 ma/div.  
**Base Source Voltage**, 5 steps from 0.01 v/div to 0.2 v/div.

**Type 575 Transistor-Curve Tracer** . . . . . \$975  
(price f.o.b. factory)

**Tektronix, Inc.** P. O. Box 500 • Beaverton, Oregon • Phone Mitchell 4-0161 • TWX—BEAV 311 • Cable: TEKTRONIX

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#### HIGH-CURRENT ADAPTER AVAILABLE

For measuring high-powered semiconductor devices which exceed the current capabilities of a Type 575, ask your Tektronix Field Engineer about the Type 175 High-Current Adapter. Not intended for separate use, the Type 175 depends upon the circuitry and crt of a Type 575 to provide 200-ampere collector displays, three ranges of collector supply, and 12-ampere base supply—for calibrated displays with Collector Current on the Vertical Axis and either Collector Voltage or Base Voltage on the Horizontal Axis.

**Type 175 Transistor-Curve Tracer High-Current Adapter** . . . \$1425



#### HIGH-VOLTAGE TYPE 575 AVAILABLE

Supplied on order from your Tektronix Field Engineer is a special model of the Type 575 Transistor-Curve Tracer. Although similar to the Type 575, the special model provides much higher diode breakdown test voltage (variable from zero to 1500 volts at a maximum current of 1 milliamperes) and also much higher Collector Supply (up to 400 volts, at 0.5 ampere).

For complete specifications of this special model—call your Tektronix Field Engineer.

**Type 575 Mod 122C** . . . . . \$1175  
(prices f.o.b. factory)

... for more information about evaluating semiconductor devices with a Type 575 or other Tektronix test equipment, call your Tektronix Field Engineer. He will be glad to assist you.

**CAREER OPPORTUNITIES** now exist at Tektronix in the following fields: instrument design, circuit design and engineering, cathode-ray tubes, electron physics, solid state and semiconductor devices. For information write to . . . Irving Smith, Professional Placement.

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Doesn't  
anyone  
make a  
reliable  
silicon  
rectifier

?



Rest easy friend... someone can — and has! Slater Electric applied the engineering know-how that has kept them a leader in the electrical industry and solved the problem of reliability with their new "Trim-Line" diffused junction silicon rectifiers.

This unique series directly replaces top hat types with features to spare — they require no heat sinks up to 1.5 amperes — they're miniature in size, conservatively rated and... no bones about it, they're reliable!

If silicon rectifiers have you barking up a tree — we've got the solution. Complete engineering data is available on request — simply write...

ACTUAL SIZE



CIRCLE 55 ON READER-SERVICE CARD



## TRANSISTORS - 1961

Type No.	Mfg.	Type	f <sub>max</sub> kc	Maximum Ratings			Characteristics				Switching			Remarks			
				V <sub>c</sub> (w)	T <sub>J</sub> (c)	W/c	V <sub>c</sub> v	I <sub>c</sub> a	h <sub>FE</sub>	I <sub>co</sub> ma	Pow. Gain db	Pow. Out w	Rise Time μsec		Stor. Time μsec	Sat. Volt	Leak Cur
2N1238	HU	pnp, F, si	0.8	1.0	200	—	15	0.5	14	0.1	—	—	—	—	—	—	—
2N1239	HU	pnp, F, si	0.8	1.0	200	—	15	0.5	32	0.1	—	—	—	—	—	—	—
2N1240	HU	pnp, F, si	1.0	1.0	200	—	35	0.5	14	0.1	—	—	—	—	—	—	—
2N1241	HU	pnp, F, si	1.0	1.0	200	—	35	0.5	24	0.1	—	—	—	—	—	—	—
2N1242	HU	pnp, F, si	1.0	1.0	200	—	65	0.5	14	0.1	—	—	—	—	—	—	—
2N1243	HU	pnp, F, si	1.0	1.0	200	—	65	0.5	24	0.1	—	—	—	—	—	—	—
2N1244	HU	pnp, F, si	1.2	1.0	200	—	110	0.5	14	0.1	—	—	—	—	—	—	—
2N1073	BE	pnp, DJ, ge	1.5	35	100	1.5	40	10	20-6	2.0	—	—	—	—	—	1.0	—
2N1073A	BE	pnp, DJ, ge	1.5	35	100	1.5	80	10	20-6	2.0	—	—	—	—	—	1.0	—
2N1073B	BE	pnp, DJ, ge	1.5	35	100	1.5	120	10	20-6	2.0	—	—	—	—	—	1.0	—
8-1085	BE	pnp, DJ, ge	1.5	60	100	1.0	120	10	5a	2.0	—	—	—	—	—	0.75	—
OC22	AMP	pnp, PADT, ge	2.5	10	75	—	32	1	150	30	—	—	—	—	—	—	—
OC23	AMP	pnp, PADT, ge	2.5	10	75	—	40	1	150	30	—	—	—	—	—	—	—
OC24	AMP	pnp, PADT, ge	2.5	10	75	—	32	1	150	30	—	—	—	—	—	—	—
2N1518	DE	pnp, AJ, ge	4	70	100	1.2	50	25	—	100	—	40	20	7	0.3	—	—
2N1519	DE	pnp, AJ, ge	4	70	100	1.2	80	25	—	100	—	40	20	7	0.3	—	Min. gain of 12 at 25a
2N1520	DE	pnp, AJ, ge	4	70	100	1.2	50	35	—	100	—	40	20	7	0.3	—	Min. gain of 12 at 35a
2N1521	DE	pnp, AJ, ge	4	70	100	1.2	80	35	—	100	—	40	20	7	0.3	—	Min. gain of 12 at 35a
2N1522	DE	pnp, AJ, ge	4	70	100	1.2	50	50	—	100	—	40	20	7	0.3	—	Min. gain of 12 50a
2N1523	DE	pnp, AJ, ge	4	70	100	1.2	80	50	—	100	—	40	20	7	0.3	—	Min. gain of 12 at 50a
2N297	BE	pnp, AJ, ge	5	35	90	1.5	50	5	—	3	—	—	—	—	—	1.02	—
2N297A	CL	pnp, AJ, ge	5	12	95	2.0	60	3	—	3	—	—	—	—	—	1.0	—
2N618	CL	pnp, AJ, ge	7	14	90	1.5	80	3	—	3	—	—	—	—	—	0.8	80
2N375	CL	pnp, AJ, ge	7	—	95	—	80	3	—	3	—	—	—	—	—	1.0	MO
2N378	TS	pnp, AJ, ge	7	50	100	1.2	20	5	30	0.5	—	—	—	—	—	—	—
2N379	CL	pnp, AJ, ge	7	5	85	0.3	80	3	—	5	—	—	—	—	—	1	15
2N380	TS	pnp, AJ, ge	7	50	100	0.8	30	5	—	0.5	—	—	—	—	—	—	50
2N458	TI	pnp, AJ, ge	7	50	95	0.72	80	5	—	1	—	—	12	12.5	—	0.24	30
2N459	TS	pnp, AJ, ge	7	50	100	0.8	60	5	—	0.5	—	—	—	—	—	—	30
2N1011	DE	pnp, AJ, ge	7	70	100	0.1	80	5	—	100	—	—	5	2	—	0.3	—
2N456A	DE	pnp, AJ, ge	10	94	100	1.2	40	7	—	0.065	—	—	10	5	—	—	TI
2N457A	DE	pnp, AJ, ge	10	94	100	1.2	60	0.065	—	0.065	—	—	10	5	—	—	TI
2N458A	DE	pnp, AJ, ge	10	94	100	1.2	80	7	—	0.065	—	—	10	5	—	—	TI
2N1038	TI	pnp, AJ, ge	10	20	100	0.27	40	3	33	50	—	—	—	—	—	—	—
2N1039	TI	pnp, AJ, ge	10	20	100	0.27	60	3	33	50	—	—	—	—	—	—	—
2N1040	TI	pnp, AJ, ge	10	20	100	0.27	30	3	33	50	—	—	—	—	—	—	—
2N1358	DE	pnp, AJ, ge	10	150	100	2	80	15	—	0.1	—	40	15	5	0.3	—	—
2N1412	DE	pnp, AJ, ge	10	150	100	2	100	15	—	100	—	40	15	5	0.3	—	—
2N1970	DE	pnp, AJ, ge	10	150	100	2	100	15	—	0.1	—	—	10	5	—	—	—
2N387	PH	pnp, AJ, ge	12	12.5	100	0.5	80	3	—	1.0	33	5	—	—	—	0.35	—
2N386	PH	pnp, AJ, ge	14	12.5	100	0.5	60	3	—	0.1	33	5	—	—	—	—	—
2N1046	TI	pnp, AD, ge	15	150	100	2	100	10	40	10	—	—	—	—	—	—	—
2N1046A	TI	pnp, AD, ge	15	150	100	2	130	10	20	10	—	—	—	—	—	—	—
2N1046B	TI	pnp, AD, ge	15	150	100	2	130	10	10	10	—	—	—	—	—	—	—
2N1609	DE	pnp, AJ, ge	17	7.5	100	0.1	80	1.5	—	10	—	0.4w	3	1	0.3	—	—
2N1610	DE	pnp, AJ, ge	17	7.5	100	0.1	80	1.5	—	10	—	0.4w	3	1	0.3	—	—
2N1611	DE	pnp, AJ, ge	17	7.5	100	0.1	60	1.5	—	10	—	0.4w	3	1	0.3	—	—
2N1612	DE	pnp, AJ, ge	17	7.5	100	0.1	60	1.5	—	10	—	0.4w	3	1	0.3	—	—
2N1971	DE	pnp, AJ, ge	25	50	100	0.7	80	4	—	0.02	—	—	5	2	—	—	—
2N1015	WH	pnp, F, si	25	150	150	1.4	30	7.5	8	10	—	—	5	1	1.5	8	SE
2N1015A	WH	pnp, F, si	25	150	150	1.4	60	7.5	8	10	—	—	5	1	1.5	8	SE
2N1015B	WH	pnp, F, si	25	150	150	1.4	100	7.5	8	10	—	—	5	1	1.5	8	SE
2N1015C	WH	pnp, F, si	25	150	150	1.4	150	7.5	8	10	—	—	5	1	1.5	8	SE
2N1015D	WH	pnp, F, si	25	150	150	1.4	200	7.5	8	10	—	—	5	1	1.5	8	SE
2N1016	WH	pnp, F, si	25	150	150	1.4	30	7.5	8	10	—	—	5	1	2.5	8	SE
2N1016A	WH	pnp, F, si	25	150	150	1.4	60	7.5	8	10	—	—	5	1	2.5	8	SE
2N1016B	WH	pnp, F, si	25	150	150	1.4	100	7.5	8	10	—	—	5	1	2.5	8	SE
2N1016C	WH	pnp, F, si	25	150	158	1.4	150	7.5	8	10	—	—	5	1	2.5	8	SE
2N1016D	WH	pnp, F, si	25	150	150	1.4	200	7.5	8	10	—	—	5	1	2.5	8	SE
2N1667	AMP	pnp, PADT, ge	200	30	90	—	—	6	90	0.1	—	—	—	—	—	—	—
2N1668	AMP	pnp, PADT, ge	200	30	90	—	—	6	50	0.1	—	—	—	—	—	—	—
2N1669	AMP	pnp, PADT, ge	200	30	90	—	—	6	70	0.1	—	—	—	—	—	—	—
OC28	AMP	pnp, PADT, ge	200	13	90	—	80	6	32	<100	—	—	—	—	—	—	—
OC29	AMP	pnp, PADT, ge	200	13	90	—	60	6	90	<100	—	—	—	—	—	—	—
OC35	AMP	pnp, PADT, ge	200	13	90	—	60	6	50	<100	—	—	—	—	—	—	—
OC36	AMP	pnp, PADT, ge	200	13	90	—	80	6	70	<100	—	—	—	—	—	—	—
2N418	BE	pnp, AJ, ge	400	60	100	1.2	100	4	60	1.0	—	—	—	—	—	0.5	—
2N420	BE	pnp, AJ, ge	400	60	100	1.2	65	4	60	1.0	—	—	15	—	—	1.7	—
2N420A	BE	pnp, AJ, ge	400	60	100	1.2	90	15	60	1.0	—	—	—	—	—	0.5	—
2N637	BE	pnp, AJ, ge	400	60	100	1.2	60	6	45	1.0	—	—	—	—	—	0.7	—

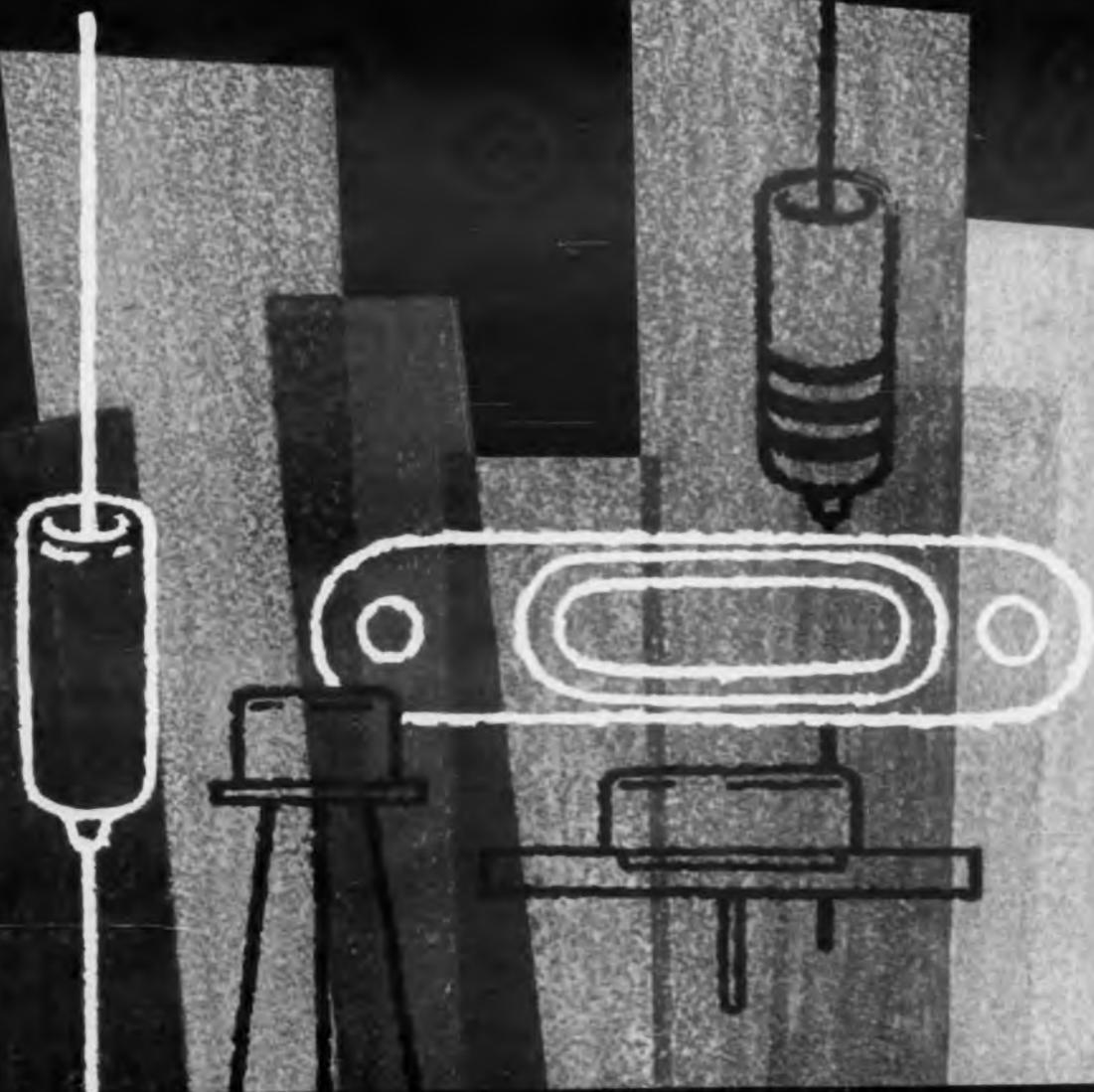
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ELECTRONIC DESIGN • July 5, 1961

reliability  
in  
volume . . .

**CLEVITE TRANSISTOR**

WALTHAM, MASSACHUSETTS



# How to select power transistors

by RICHARD F. MOREY, JR.

Manager, Applications Engineering, Clevite Transistor  
Division of Clevite Corporation

*A basic understanding of the interrelationship of transistor design parameters facilitates selection of the most advantageous unit for a given application.*

Transistor characteristics depend upon each other. Consequently, a design change in the manufacture of a transistor directly affects a number of its electrical characteristics.

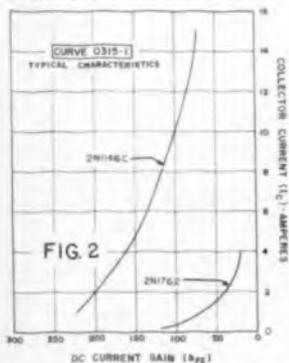
As a guide to users of power transistors, several of the important design elements and the electrical characteristics they influence have been summarized in chart form (fig. 1).

The curves (figs. 2-5), show typical characteristics for two power transistors of quite different design. Clevite's 2N1762, for example, is a 3 ampere unit having the following design parameters: Small junction area; high resistivity germanium; moderate germanium lifetime; average wafer thickness and no emitter doping.

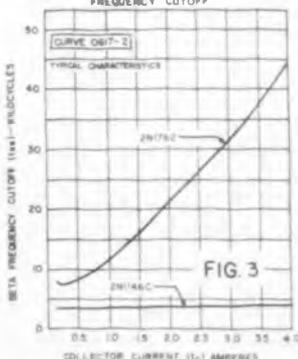
In contrast, Clevite's 2N1146C is a 15 ampere power transistor which has several quite different parameters based upon a higher current and power requirement; large junction area several times the size of the 3 ampere unit; identical base width and resistivity but longer germanium lifetime and thicker wafer plus aluminum doping to increase emitter efficiency.

Working with the chart in figure 1 and the table, figure 6, we see that the comparative design elements of

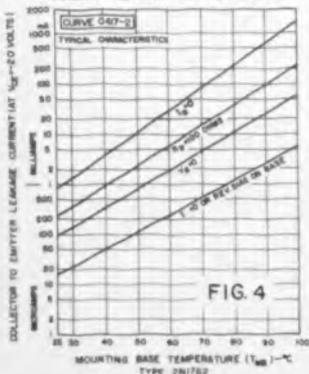
CURRENT GAIN VS COLLECTOR CURRENT



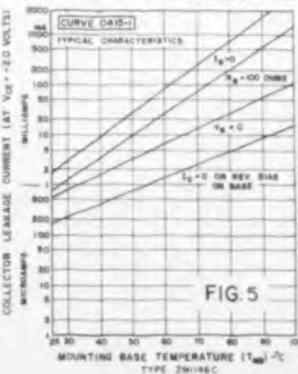
LARGE SIGNAL COMMON EMITTER FREQUENCY CUTOFF



LEAKAGE CURRENT VS TEMPERATURE



LEAKAGE CURRENT VS TEMPERATURE



### Effect of Transistor Design on Characteristics

DESIGN PARAMETER	Addition of Emitter Doping	Increase in Wafer Thickness	Reduction in GE material lifetime	Increase in GE material resistivity	Reduction in Base Width	Increase in Junction Area
THERMAL RESISTANCE $R_{\theta}$	—	—	—	—	—	decrease
COLLECTOR LEAKAGE CURRENT $I_{CBO}$	—	decrease	increase	increase	—	increase
COLLECTOR BASE VOLTAGE $V_{CB}$	—	—	—	increase	—	decrease slightly
COLLECTOR EMITTER VOLTAGE $V_{CE}$	decrease	—	increase	increase	decrease	decrease slightly
D.C. CURRENT GAIN $h_{FE}$	increase	—	decrease	—	increase	—
LINEARITY OF $h_{FE}$	better	—	—	—	—	better
SATURATION VOLTAGE $V_{CE(SAT)}$	decrease	decrease	increase	increase	decrease	decrease
BETA CUTOFF FREQUENCY $f_{\beta}$	decrease	—	increase	—	increase	decrease
PUNCH THROUGH VOLTAGE $V_{PT}$	—	—	—	decrease	decrease	—
SECONDARY BREAKDOWN CURRENT $I_{SM}$	increase	increase	—	decrease	—	increase

Figure 1.

- the two transistors result in the 15 ampere unit exhibiting:
- lower thermal resistance and higher leakage currents because of its large junction area.
  - slightly lower collector to base voltage.
  - higher gain because of the emitter doping and higher lifetime.
  - very linear current gain out to high currents because of its large area and special emitter doping.
  - lower collector to emitter breakdown voltages because of its higher gain and lower collector to base voltage.
  - much lower saturation voltage and base input voltage because of its high gain and thicker wafer and larger area.
  - low common emitter frequency response because of its high gain and large area.

### Comparison of Characteristics — Two different designs

Characteristic	2N1762	2N1146C	Units
	Typical Value 3 Amp. Device	Typical Value 15 Amp. Device	
Thermal Resistance	1.4	0.5	°C/watt
$I_{CBO}$ at 100V at 85°C	3	15	mA
$I_{CBO}$ at 100V at 25°C	1	4	mA
$BV_{CBO}$	130	120	Volts
$V_{CEO(max)}$	70	50	Volts
Current Gain at $I_C = 1$ Amp.	60	220	
Current Gain at $I_C = 5$ Amps.	15	140	
Current Gain at $I_C = 15$ Amps.	—	75	
Saturation Voltage at 3 Amps.	0.3	0.2	Volts
Saturation Voltage at 15 Amps.	—	0.4	Volts
Saturation Resistance	100	26	Milliohms
Frequency Cutoff at 1 Amp.	18	4	kc.

Figure 6

In order for circuit designers and users of power transistors to obtain the best combination of electrical characteristics, the requirements for the application must be well known and be matched to the transistors available on the market. Therefore, an elementary knowledge of the existing relationships between transistor characteristics is a useful design tool. A tabular summary of characteristics for Clevite's complete line of power transistors is available. Ask for Bulletin 61-A.



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## DATA CHART

### Abbreviation of Terms

AJ	Alloy Junction
DD	Double Diffused
DG	Grown Diffused
DJ	Diffused Junction
DM	Diffused Mesa
DP	Diffused Planar
Dr	Drift
Ep	Epitaxial
FA	Fused Alloy
FJ	Fused Junction
GD	Grown Diffused
Ge	Germanium
GJ	Grown Junction
GR	Grown Rate
MB	Meltback
MD	MADT
Ms	Mesa
RG	Rate Grown
Si	Silicon
SBT	Surface Barrier
$C_{ce}$	= Collector-to-emitter capacitance measured across the output terminals with the input ac open-circuited.
$f_{ce}$	= Frequency at which the magnitude of the forward-current transfer ratio (small-signal) is 0.707 of its low-frequency value.
$f_1$	= Frequency at which common emitter gain is unity.
$h_{fe}$	= Common emitter-small signal forward current transfer ratio.
$h_{FE}$	= Common emitter-static value of short-circuited forward current ratio.
$I_{ce}$	= Collector current when collector junction is reverse-biased and emitter is dc open-circuited.

If you would like an additional copy of the Transistor Data Chart Section circle 251 on the Reader-Service Card (Quantity prices on request)



# TRANSISTORS - 1961

## High Level (continued)

Type No.	Mfg.	Type	f <sub>α</sub>	Max. Ratings				Characteristics				Switching				Remarks	
				V <sub>c</sub> (w)	I <sub>c</sub>	P <sub>w/c</sub>	V <sub>ce</sub>	I <sub>ca</sub>	h <sub>fe</sub>	I <sub>co</sub> ma	Pow. Gain db	Pow. out w	Rise Time μsec	Stor Time μsec	Sat. Volt		Leak Out
2N637A	BE	npn,AJ,ge	400	60	100	1.2	90	6	45	1.0	-	-	-	-	0.7	-	-
2N637B	BE	npn,AJ,ge	400	60	100	1.2	100	6	45	1.0	-	-	-	-	0.7	-	CL
2N638	BE	npn,AJ,ge	400	60	100	1.2	60	6	30	1.0	-	-	-	-	0.7	-	-
2N638A	BE	npn,AJ,ge	400	60	100	1.2	90	6	30	1.0	-	-	-	-	0.7	-	-
2N638B	BE	npn,AJ,ge	400	60	100	1.2	100	6	30	1.0	-	-	-	-	0.7	-	-
2N675	PH	npn,AJ,ge	400	1	85	16.7	75	2	40	100	-	-	-	-	0.35	-	Infinite heat sink
2N456	TI	npn,AJ,ge	430	50	100	0.67	40	5	30-90	0.2	-	-	-	-	12	12.5	30 RCA
2N457	TI	npn,AJ,ge	430	50	100	0.67	60	5	30-90	0.6	-	-	-	-	12	12.5	30 RCA
2N671	PH	npn,AJ,ge	700	1	85	0.017	40	2	100	20	-	-	-	-	-	-	Infinite heat sink
STC1103	STC	npn,DJ,si	1mc	85	200	0.425	60	6	25-75	0.025	-	-	-	-	-	-	-
STC1104	STC	npn,DJ,si	1mc	85	200	0.425	100	6	25-75	0.025	-	-	-	-	-	-	-
2N673	PH	npn,AJ,ge	1.1mc	0.3	85	5	75	2	160	40	-	-	-	-	0.5	0.4	0.2
2N424A	STC	npn,DM,si	2mc	85	200	0.4	60	3	12-60	10	-	-	-	-	-	-	Infinite heat sink
2N1701	STC	npn,DM,si	2mc	25	200	0.125	60	2.5	20-80	0.1	-	-	-	-	-	-	SE
2N1702	STC	npn,DM,si	2mc	75	200	0.375	60	5	15-60	0.2	-	-	-	-	-	-	-
2N1768	STC	npn,DM,si	2	40	200	0.2	80	3	35-100	.015	-	-	-	-	-	-	-
2N1769	STC	npn,DM,si	2	40	200	0.2	100	3	35-100	.015	-	-	-	-	-	-	-
2N1620	STC	npn,DM,si	2mc	85	200	0.425	100	5	15-75	1	-	-	-	-	-	-	-
2N551	TR	npn,DJ,si	3mc	3	200	0.5	60	-	20-80	1.2	-	-	-	-	1.2	0.3	0.9
2N552	TR	npn,DJ,si	3mc	3	200	0.5	30	-	20-80	1.2	-	-	-	-	1.2	0.3	0.9
2N1055	TR	npn,DJ,si	3	3	200	0.045	100	-	20-80	0.001	-	-	-	-	-	-	-
2N547	TR	npn,DJ,si	4mc	5	200	0.5	60	-	20-80	1.2	-	-	-	-	0.7	0.2	3.0
2N548	TR	npn,DJ,si	4mc	5	200	0.5	30	-	20-80	0.5	-	-	-	-	0.7	0.2	2.0
2N549	TR	npn,DJ,si	4mc	5	200	0.5	60	-	20-80	0.5	-	-	-	-	0.7	0.2	1.5
2N550	TR	npn,DJ,si	4mc	5	200	0.5	30	-	20-80	0.5	-	-	-	-	0.7	0.2	1.5
2N1117	TR	npn,DJ,si	4mc	5	200	0.5	60	-	40	0.04	-	-	-	-	0.7	0.2	1.5
2N1116	TR	npn,DJ,si	6mc	5	200	0.5	60	-	40	1.2	-	-	-	-	0.7	0.2	3.0
2N1173	WE	npn,AJ,ge	6mc	-	100	3.33	35	0.2	80	0.004	-	-	-	-	-	-	-
ST402	TR	npn,DJ,si	6mc	50	200	0.33	60	3	30	20	-	-	-	-	0.25	0.5	6
ST403	TR	npn,DJ,si	6mc	50	200	0.33	45	3	30	20	-	-	-	-	0.25	0.5	5
2N1174	WE	npn,AJ,ge	7mc	-	100	3.33	35	0.2	85	0.005	-	-	-	-	-	-	-
2N545	TR	npn,DJ,si	8mc	5	200	0.5	60	-	15	1.2	-	-	-	-	0.3	0.15	3.0
2N546	TR	npn,DJ,si	8mc	5	200	0.5	30	-	15	0.5	-	-	-	-	0.3	-0.15	2.0
2N1052	TR	npn,DJ,si	8mc	5	200	.045	60	-	15	0.001	-	-	-	-	-	-	-
2N1212	TR	npn,DJ,si	10mc	85	200	0.27	60	3000	12-60	1000	-	-	-	-	-	-	3.5
2N1054	TR	npn,DJ,si	12mc	5	200	.045	125	-	20-80	.0004	-	-	-	-	-	-	-
2N1208	TR	npn,DJ,si	12mc	85	200	0.27	60	5	15	1.0	-	-	-	-	0.25	-	3
2N1209	TR	npn,DJ,si	12mc	85	200	0.27	45	5	20	2.0	-	-	-	-	0.25	-	3
2N1250	TR	npn,DJ,si	12mc	85	200	0.27	60	5	15	1.0	-	-	-	-	0.25	-	3
ST401	TR	npn,DJ,si	12mc	85	200	0.27	45	5	20	2.0	-	-	-	-	0.25	-	3
2N1072	WE	npn,DD,si	30mc	12	150	65	75	1	13	0.1	-	-	-	-	0.05	0.05	-
2N1041	TI	npn,AJ,ge	33	20	100	0.27	100	3	33	50	-	-	-	-	-	-	-
RT497M	RH	npn,DD,si	50	3	175	0.02	60	0.5	20	-	-	-	-	-	-	-	-
RT498M	RH	npn,DD,si	50	3	175	0.02	100	0.5	20	-	-	-	-	-	-	-	-
2N912	FA	npn,DP,si	60P	1.8	200	0.01	80	-	30	0.005 μA	-	-	-	-	-	-	-
2N1975	FA	npn,DP,si	60P	3	200	0.017	80	-	30	0.005 μA	-	-	-	-	-	-	-
2N1978	FA	npn,DP,si	60P	30	200	0.17	40	-	40	0.001 μA	-	-	-	-	-	-	-
2N1985	FA	npn,DM,si	60P	2	150	0.0016	35	-	30	-	-	-	-	-	-	-	-
2N1989	FA	npn,DM,si	60P	2	150	0.0016	60	-	40	-	-	-	-	-	-	-	-
RT656M	RH	npn,DD,si	60	3	175	0.02	60	0.5	60	-	-	-	-	-	-	-	-
RT657M	RH	npn,DD,si	60	3	175	0.02	100	0.5	60	-	-	-	-	-	-	-	-
RT5202	RH	npn,DD,si	60	5	175	0.033	175	0.5	50	0.001	-	-	-	-	-	-	-
RT5230	RH	npn,DD,si	60	2	175	0.013	30	0.5	50	-	-	-	-	-	-	-	-
2N721	FA	npn,DP,si	70P	1.5	175	0.01	50	-	35	0.0 μA	-	-	-	-	-	-	-
2N1131	FA	npn,DP,si	70P	2	175	13.3	50	-	35	0.01	-	-	-	-	-	-	-
2N1987	FA	npn,DM,si	70P	2	150	0.0016	40	-	50	-	-	-	-	-	-	-	-
2N696	FA	npn,DP,si	80(T)	2	175	13.3	40	-	40	-	-	-	-	-	0.08	-	0.03
2N698	FA	npn,DP,si	80(T)	2	175	13.3	80	-	30	0.01	-	-	-	-	0.08	-	-
2N717	FA	npn,DP,si	80(T)	1.5	175	10	80	-	30	0.01	-	-	-	-	0.08	-	-
2N719	FA	npn,DP,si	80(T)	1.5	175	10	80	-	30	0.01	-	-	-	-	0.08	-	-
2N1252	FA	npn,DP,si	80(T)	2	175	13.3	20	-	35	0.1	-	-	-	-	0.08	0.05	-
2N719A	FA	npn,DP,si	80P	1.8	200	0.01	80	-	45	0.0004 μA	-	-	-	-	-	-	-
2N870	FA	npn,DP,si	80P	1.8	200	0.01	80	-	80	0.0004 μA	-	-	-	-	-	-	-
2N911	FA	npn,DP,si	80P	1.8	200	0.01	80	-	70	.0005 μA	-	-	-	-	-	-	-
2N1613	FA	npn,DP,si	80P	3	200	17.2	50	-	80	0.0004 μA	17	-	-	-	0.08	-	-
2N1889	FA	npn,DP,si	80P	3	200	0.017	80	-	80	0.0004 μA	-	-	-	-	-	-	-
2N1893	FA	npn,DP,si	80P	3	200	0.017	100	-	80	0.0004 μA	-	-	-	-	-	-	-
2N1974	FA	npn,DP,si	80P	3	200	0.017	80	-	70	0.005 μA	-	-	-	-	-	-	-
2N1984	FA	npn,DM,si	80P	2	150	0.0016	35	-	70	-	-	-	-	-	-	-	-
2N1991	FA	npn,DM,si	80P	1	175	0.0057	20	-	45	0.005 μA	-	-	-	-	-	-	-
RT482	RH	npn,DD,si	80	2	175	0.0134	20	0.5	50	0.02	-	-	-	-	-	-	-
RT483	RH	npn,DD,si	80	2	175	0.0134	40	0.5	40	0.02	-	-	-	-	-	-	-
RT484	RH	npn,DD,si	80	2	175	0.0134	40	0.5	70	0.02	-	-	-	-	-	-	-
RT696M	RH	npn,DD,si	80	3	175	0.02	60	0.5	40	0.003	-	-	-	-	-	-	-

## High Level

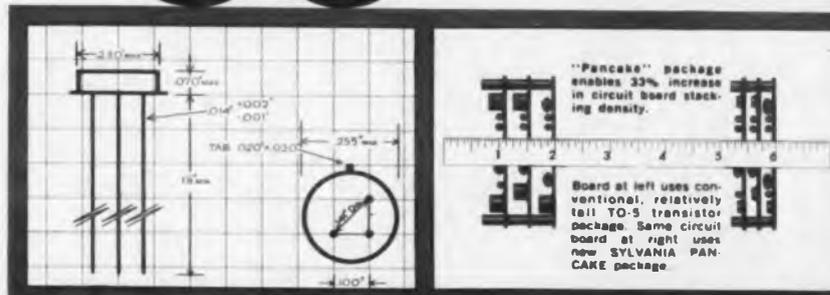
Type No.	Mfg.	Type	Max. Ratings				Remarks	
			I <sub>ca</sub>	V <sub>c</sub> (w)	T <sub>j</sub> c	V <sub>ce</sub>		
RT696M	RH	npn,DD,si	80	3	175	0.02	120	0.5
RT5151	RH	npn,DD,si	80	2	175	0.013	45	0.5
RT5152	RH	npn,DD,si	80	2	175	0.013	45	0.5
RT5203	RH	npn,DD,si	80	2	175	0.013	40	0.5
RT5204	RH	npn,DD,si	80	2	175	0.013	30	0.5
RT5212	RH	npn,DD,si	80	2	175	0.013	60	0.5
2N722	FA	npn,DP,si	90P	1.5	175	0.01	50	-
2N1988	FA	npn,DM,si	90P	2	150	0.0016	60	-
2N697	FA	npn,DP,si	100(T)	2	175	13.3	40	-
2N699	FA	npn,DP,si	100(T)	2	175	13.3	80	-
2N718	FA	npn,DP,si	100(T)	1.5	175	10	40	-
2N718A	FA	npn,DP,si	100P	1.8	200	0.01	50	-
2N720	FA	npn,DP,si	100(T)	1.5	175	10	80	-
2N720A	FA	npn,DP,si	100P	1.8	200	0.01	100	-
2N730	TI	npn,MS,si	100mc	1.5	175	0.01	60	-
2N731	TI	npn,MS,si	100mc	1.5	175	0.01	60	-
2N871	FA	npn,DP,si	100P	1.8	200	0.01	80	-
2N909	FA	npn,DM,si	100P	1.5	175	0.01	30	-
2N910	FA	npn,DP,si	100P	1.8	200	0.01	80	-
2N1060	WE	npn,MS,si	100mc	-	150	2	40	0.05
2N1132	FA	npn,DP,si	100(T)	2	175	13.3	50	-
2N1253	FA	npn,DP,si	100(T)	2	175	13.3	20	-
2N1420	FA	npn,DP,si	100P	2	175	0.013	30	-
2N1444	WE	npn,DM,si	100mc	-	150	4	60	0.25
2N1711	FA	npn,DP,si	100P	3	200	0.017	50	-
2N1890	FA	npn,DP,si	100P	3	200	0.017	80	-

## DATA CHART

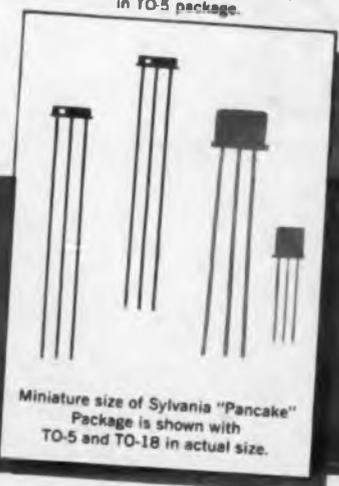
(concluded)

Characteristics				Switching				Remarks
$h_{fe}$	$I_{co}$ ma	Power Gain db	Power Out w	Rise Time $\mu$ sec	Stor. Time $\mu$ sec	Sat. Volt	Leak Out	
40	0.01	-	-	-	-	-	-	Microbloc
60	-	-	-	-	-	-	-	-
60	-	-	-	-	-	-	-	-
70	-	-	-	-	-	-	-	-
70	-	-	-	-	-	-	-	-
50	0.01 $\mu$ a	-	-	-	-	-	-	††
70	-	-	-	-	-	-	-	††
75	-	18	0.08	0.03	-	-	-	††
65	0.01	-	-	0.08	-	-	-	SSD, SY, NA, GI, TI, IND, PSI, HO, RH, TR
75	0.01	-	-	0.08	-	-	-	NA, TR, SSD, GI, PSI, TI, RH
80	0.0004 $\mu$ a	-	-	0.08	-	-	-	††
65	0.01	-	-	0.08	-	-	-	††
80	0.0004 $\mu$ a	-	-	0.08	-	-	-	††
30	0.01	-	-	0.11	0.14	0.9	-	††
60	0.01	-	-	0.11	0.14	0.9	-	††
130	0.0004	-	-	-	-	-	-	††
150	0.01 $\mu$ a	-	-	-	-	-	-	††
100	0.005 $\mu$ a	-	-	-	-	-	-	††
40	0.001 $\mu$ a	-	-	-	-	-	-	††
50	0.01	-	-	0.08	-	-	-	HU, TI, TR
45	0.01	-	-	0.08	0.05	-	-	TR, IND, GI, PSI, TI, RH
130	0.01	-	-	-	-	-	-	††
25	0.002 $\mu$ a	-	-	-	-	-	-	††
130	0.0004 $\mu$ a	-	-	-	-	-	-	††
130	0.0004	-	-	-	-	-	-	††
150	0.01 $\mu$ a	-	-	-	-	-	-	††
100	0.005 $\mu$ a	-	-	-	-	-	-	††
140	-	-	-	-	-	-	-	††
120	-	-	-	-	-	-	-	††
40	0.003	-	-	-	-	-	-	Microbloc
40	0.001	-	-	-	-	-	-	Microbloc
70	0.003	-	-	-	-	-	-	Microbloc
70	0.001	-	-	-	-	-	-	Microbloc
65	0.01	-	-	-	-	-	-	Microbloc
45	0.001	-	-	-	-	-	-	Microbloc
40	0.1	-	-	0.01	0.15	1.3	-	-
60	0.1	-	-	0.1	0.2	1.3	-	-
40	0.1	-	-	0.1	0.15	1.3	-	-
60	0.1	-	-	0.1	0.2	1.3	-	-
175	0.003	-	-	-	-	-	-	Microbloc
45	0.0004 $\mu$ a	-	-	-	-	-	-	††
30	10	7	1	0.06	0.1	0.8	-	Power gain F=70mcRH
10	0.05	10	1	0.032	0.1	-	-	-
60	10	7	1	0.042	0.17	0.8	-	RH
6.5	0.003	-	-	0.04	0.17	-	-	-
50	0.0004 $\mu$ a	-	-	-	-	-	-	††, GI
70	0.0003	-	-	-	-	-	-	††
80	0.0003 $\mu$ a	-	-	-	-	-	-	††
50	0.0004	-	-	-	-	-	-	††, Epitaxial
-	2	-	-	-	-	-	-	BE, 2N639A
12	10	-	-	-	-	-	-	-
12	10	-	-	-	-	-	-	-
30	10	-	-	-	-	-	-	-
30	10	-	-	-	-	-	-	-
40	-	-	-	-	-	-	-	-
50	-	-	-	-	-	-	-	-

# 85%\* smaller lighter



\*compared with electrical counterparts in TO-5 package.



Miniature size of Sylvania "Pancake" Package is shown with TO-5 and TO-18 in actual size.

## SYLVANIA PANCAKE TRANSISTORS

Increased packaging density! Mil-min .100" lead-to-lead spacing!

Now available in • Epitaxial Germanium Mesa • Epitaxial Silicon Mesa  
Germanium Alloy-Junction • Germanium Drift-Field

.100" lead-to-lead spacing for automatic and direct insertion in Mil-standard 275A printed circuit without reforming leads • mechanically indexed for positive and permanent lead identification • eliminate solder bridging problems • .070" max case height • .255" max case diameter • power dissipation in free air: 300 mw for Mesa, 100 mw for Alloy and Drift-Field units • max. junction temperature: 100°C for Germanium and 175°C for Silicon • meet all environmental tests in accordance with Mil-S-19500B • hermetic seal reliability (leak rate lower than  $1 \times 10^{-11}$  cc sec. verified by Radiflo equipment) • withstand 200 p.s.i.g. pressure.

Sylvania originated the "Pancake" package to provide a practicable solution to a vital engineering challenge—end-product miniaturization with high operational reliability. The tabulation of 15 types is a clear indicator of the industry's acceptance of the "Pancake" package.

If you are working with microminiaturization to improve "payload factors" or to enable "redundancy for reliability," call in your Sylvania Sales Engineer now, to help you determine the best device for your specific requirements. He or your Sylvania franchised Semiconductor Distributor can provide you with "Pancake" transistors—fast! For tech data on specific types, write Semiconductor Division, Sylvania Electric Products Inc., Dept. 187, Woburn, Mass.

"Pancake" types now available for space-saving circuitry

Sylvania "Pancake" Transistors		Electrically Similar Type
<b>GERMANIUM ALLOY-JUNCTION</b>		
2N1684	PNP	(TO-5 Package) 2N404
2N1685	NPN	2N388
2N1779	NPN	2N977
2N1780	NPN	2N385
2N1781	NPN	2N1005
2N1782	PNP	2N396
2N1783	PNP	2N414
2N1784	PNP	2N428
<b>GERMANIUM EPITAXIAL MESA</b>		
2N1960	PNP	(TO-18 Package) 2N781
2N1961	PNP	2N782
<b>SILICON EPITAXIAL MESA</b>		
2N1962	NPN	(TO-18 Package) 2N783
2N1963	NPN	2N784
2N1964	NPN	(TO-5 Package) 2N1958
2N1965	NPN	2N1959
<b>DRIFT-FIELD</b>		
2N1699	PNP	(TO-33 Package) 2N1225

# SYLVANIA

SUBSIDIARY OF

## GENERAL TELEPHONE & ELECTRONICS



CIRCLE 58 ON READER-SERVICE CARD

See Transistor Data Chart  
around and circle 251.

ELECTRONIC DESIGN • July 5, 1961

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# TRANSISTORS - 1961

## Low Level

Type No.	Mfg.	Type	f <sub>oe</sub>	Maximum Ratings				Characteristics				Switching				Remarks	
				V <sub>c</sub> (mv)	T <sub>j</sub> (c)	mm/c	V <sub>c</sub> v	I <sub>c</sub> ma	h <sub>FE</sub>	I <sub>co</sub> μA	C <sub>coe</sub> μμf	Rise Time	Stor Time	Sat Volt	Leak Cur		
2N327	CT	pnp, AJ, si	0.2	250	160	3	40	50	15	.005	70	-	-	-	-	-	-
2N1034	RA	pnp, FA, si	0.2	250	160	-	40	50	15	5	70	-	-	-	-	-	SSD, NA
2N1275	RA	pnp, FA, si	0.2	250	160	.54	80	100	15	.005	60	-	-	-	-	-	-
2N1037	RA	pnp, FA, ge	0.25	250	160	-	35	50	30	5	70	-	-	-	-	-	SSD, NA
2N328	CT	pnp, AJ, si	0.3	250	160	3	35	50	28	.005	70	-	-	-	-	-	-
2N1035	RA	pnp, FA, si	0.3	250	160	-	35	50	30	5	70	-	-	-	-	-	SSD, NA
2N1036	RA	pnp, FA, si	0.4	250	160	-	30	50	60	5	70	-	-	-	-	-	SSD, NA
2N1640	CT	pnp, AJ, si	0.4	250	160	2	20	50	11	.001	50	-	-	-	-	-	-
C101	CT	pnp, AJ, si	0.4	250	160	2	20	50	11	5	50	-	-	-	-	-	-
C301	CT	pnp, AJ, si	0.4	250	160	2	70	50	4	5	50	-	-	-	-	-	-
2N329	CT	pnp, AJ, si	0.5	250	160	3	30	50	60	.005	70	-	-	-	-	-	-
2N329A	RA	pnp, FA, si	0.5	385	160	-	30	50	60	.005	70	-	-	-	-	-	-
2N1057	GE	pnp, AJ, ge	0.5	240	100	4	45	300	-	300	40	-	-	-	0.08	58	-
2N327A	WT	pnp, AJ, si	0.7	-	200	3	.3	200	15	100	70	-	-	-	-	-	RA
2N670	PH	pnp, AJ, ge	0.7	300	85	5.0	40	2a	200	20	-	-	-	-	0.3	-	Pulse Amp.
2N1234	HU	pnp, AJ, si	0.8	400	160	3	110	100	21	10	95	-	-	-	-	-	TO-5 Package
2N1244	HU	pnp, AJ, si	0.8	1000	160	7.4	110	200	20	10	95	-	-	-	-	-	Coaxial package
2N1641	CT	pnp, AJ, si	0.8	250	160	2	10	50	15	.001	50	-	-	-	-	-	-
C102	CT	pnp, AJ, si	0.8	250	160	2	15	50	12	5	50	-	-	-	-	-	-
C302	CT	pnp, AJ, si	0.8	250	160	2	8	50	12	.2	50	-	-	-	-	-	-
2N327A	HU	pnp, AJ, si	1.0	385	160	3	50	100	14	10	95	-	-	-	-	-	RA, SSD
2N328A	HU	pnp, AJ, si	1.0	385	160	3	50	100	25	10	95	-	-	-	-	-	WT, RA, SSD, JA
2N329A	HU	pnp, AJ, si	1.0	385	160	3	50	100	50	10	95	-	-	-	-	-	WT, RA, SSD, NA
2N331	RCA	pnp, AJ, ge	1.0	200	85	3	30	200	-	16	-	-	-	-	-	-	BE, US, MO
2N1056	GE	pnp, AJ, ge	1.0	240	100	4	50	300	25	25	40	-	-	-	0.09	32	Neon indicator
2N674	PH	pnp, AJ, ge	1.1	300	85	5.0	75	2a	-	40	-	-	-	-	0.35	-	-
2N1228	HU	pnp, AJ, si	1.2	400	160	3	15	100	20	10	95	-	-	-	-	-	WT
2N1229	HU	pnp, AJ, si	1.2	400	160	3	15	100	36	10	95	-	-	-	-	-	WT, NA
2N1230	HU	pnp, F, si	1.2	250	200	-	35	500	14	50	100	-	-	-	-	-	WT, NA
2N1231	HU	pnp, F, si	1.2	250	200	-	35	500	24	50	100	-	-	-	-	-	WT, NA
2N1232	HU	pnp, F, si	1.2	250	200	-	65	500	14	50	100	-	-	-	-	-	WT, NA
2N1233	HU	pnp, F, si	1.2	250	200	-	65	500	24	50	100	-	-	-	-	-	WT, NA
2N1234	HU	pnp, F, si	1.2	250	200	-	110	500	14	50	100	-	-	-	-	-	WT, NA
2N1238	HU	pnp, AJ, si	1.2	1w	160	7.4	15	200	20	10	95	-	-	-	-	-	Coaxial package
2N1239	HU	pnp, AJ, si	1.2	1w	160	7.4	15	200	36	10	95	-	-	-	-	-	Coaxial package
2N1239	HU	pnp, AJ, si	1.2	1w	160	-	15	-	28-65	.1	-	-	-	-	-	-	-
2N1240	HU	pnp, AJ, si	1.2	1000	160	7.4	35	200	20	10	95	-	-	-	-	-	Coaxial package
2N1241	HU	pnp, AJ, si	1.2	1000	160	7.4	35	200	36	10	95	-	-	-	-	-	Coaxial package
2N1242	HU	pnp, AJ, si	1.2	1w	160	7.4	65	200	20	10	95	-	-	-	-	-	Coaxial package
2N1243	HU	pnp, AJ, si	1.2	1w	160	7.4	65	200	36	10	95	-	-	-	-	-	Coaxial package
2N1642	CT	pnp, AJ, si	1.2	250	160	2	6	50	23	.005	-	-	-	-	-	-	-
C103	CT	pnp, AJ, si	1.2	250	160	2	10	50	23	5	-	-	-	-	-	-	Field effect
C106	CT	pnp, AJ, si	1.2	250	160	2	10	50	50	50	-	-	-	-	-	-	Field effect
2N312	SY	npn, AJ, ge	1.5	100	85	1.66	15	200	-	15	-	1.5	2	0.075	50	-	-
2N519	IND	pnp, AJ, ge	1.5	150	85	2.5	15	200	25	7	14	-	-	-	-	-	US, KF
2N519A	IND	pnp, AJ, ge	1.5	150	85	2.5	25	200	25	1	14	1.3	0.7	-	35	-	US
B1154	BE	pnp, AJ, ge	1.5	400	100	.15	40	300	-	10	20	1.5	-	25	-	-	-
B1154A	BE	pnp, AJ, ge	1.5	400	100	.15	60	300	-	15	20	1.5	-	25	-	-	-
2N328A	SSD	pnp, FA, si	2	385	160	2.85	40	50	14	5	70	-	-	-	-	-	-
2N536	PH	pnp, AJ, ge	2.0	50	85	0.83	20	30	-	4.0	-	-	-	0.07	150	-	-
2N679	SY	npn, AJ, ge	2	150	85	2.5	20	200	-	25	-	5	5	0.3	20	-	-
2N1125	PH	pnp, AJ, ge	2	300	85	5.0	40	250	-	10	-	-	-	0.15	50	-	-
2N1220	SSD	pnp, AJ, si	2	150	150	1.2	25	-	9	0.1	-	-	-	-	-	-	10
2N1223	SSD	pnp, AJ, si	2	150	150	1.2	40	-	6	0.1	-	-	-	-	-	-	-
2N1446	IND	pnp, AJ, ge	2	200	85	3.33	45	400	30	5	-	-	-	-	-	-	-
OC80	AMP	pnp, PAOT, ge 2	550	75	-	32	600	85	10	-	-	-	-	-	-	-	-
2N438	SY	npn, AJ, ge	2.5	100	85	1.6	30	-	20	10	-	0.7	-	-	-	-	0.5
2N817	RA	npn, AJ, ge	2.5	75	85	1.25	30	400	20	10	20	-	-	-	-	-	Submin
2N818	RA	npn, AJ, ge	2.5	75	85	1.25	30	400	20	10	20	-	-	-	-	-	Submin
2N356	SY	npn, AJ, ge	3	100	85	1.6	20	500	-	25	-	1.0	0.3	0.6	-	-	GI
2N356A	GI	npn, AJ, ge	3	150	100	2	30	500	60	3	14	1.5	0.3	0.18	35	-	SY
2N520	KF	pnp, AJ, ge	3	150	100	2	20	-	20(min)	25	-	-	-	-	-	-	-
2N801	RA	pnp, AJ, ge	3	75	85	1.25	30	400	30	4	20	-	-	-	-	-	Submin
2N802	RA	pnp, AJ, ge	3	75	85	1.25	30	400	30	4	20	-	-	-	-	-	Submin
2N1447	IND	pnp, AJ, ge	3	200	85	3.33	45	400	45	5	-	-	-	-	-	-	-
2N1353	IND	pnp, AJ, ge	3.5	200	85	3.33	15	200	70	2.5	12	.6	4	0.1	-	-	-
2N305A	SY	npn, AJ, ge	4	150	100	2	40	200	30-110	40	-	-	-	-	-	-	GI
2N404A	RCA	pnp, AJ, ge	4	150	100	-	40	150	30	5	20	-	-	-	-	-	GI IND, TS
2N425	SY	pnp, AJ, GE	4	150	85	2.5	20	400	-	2.0	14	1.0	0.3	0.2	30	-	RA, INOTS, US, KF, GI
2N799	RA	pnp, AJ, ge	4	75	85	1.25	25	150	30	5	20	-	-	-	-	-	Submin
2N800	RA	pnp, AJ, ge	4	75	85	1.25	25	150	20	5	20	-	-	-	-	-	Submin
2N824	RA	npn, AJ, ge	4	75	85	1.25	25	100	40	5	20	-	-	-	-	-	Submin
2N1027	SSD	pnp, AJ, si	4	150	150	1.2	15	100	18	25	-	-	-	-	-	-	NA, SSD
2N1028	SSD	pnp, AJ, si	4	150	150	1.1	10	100	9	25	7	-	-	-	0.15	-	NA

# DATA CHART

## Low Level (continued)

Type No.	Mfg.	Type	f <sub>ao</sub>	Maximum Ratings				Characteristics				Switching				Remarks	
				V <sub>c</sub> (mv)	T <sub>j</sub> (c)	mm/c	V <sub>c</sub> v	I <sub>c</sub> ma	h <sub>FE</sub>	I <sub>co</sub> μA	C <sub>coe</sub> μF	Rise Time	Stor Time	Sat Volt	Leak Cur		
2N1448	IND	pn-p, AJ, ge	4	200	85	3.33	45	400	65	5	-	-	-	-	-	-	-
2N1605A	SY	npn, AJ, ge	4	200	100	2.6	40	200	40	10	20	-	-	-	-	-	-
2N1780	SY	npn, AJ, ge	4	100	100	1.3	25	100	30-110	10	20	-	-	-	-	-	-
2N1781	SY	npn, AJ, ge	4	100	100	1.3	25	100	40	5	20	-	-	-	-	-	-
2N2000	TI	pn-p, AJ, ge	4	300	100	4	50	750	8	30	-	-	-	-	-	-	-
CK25	RA	pn-p, FA, ge	4	80	85	-	20	400	-	2	14	0.5	0.3	0.25	30	-	-
2N395	GE	pn-p, AJ, ge	4.5	200	100	3.3	15	200	-	6	12	0.55	0.5	0.1	20	-	TI, KF
2N520	IND	pn-p, AJ, ge	4.5	150	85	2.5	15	200	40	1	14	-	-	-	-	-	US
2N520A	IND	pn-p, AJ, ge	4.5	150	85	2.5	25	200	100	1	14	0.9	0.7	-	75	-	US
2N1302	TI	npn, AJ, ge	4.5	150	85	2.5	25	300	-	5	11	.70	.50	.1v	-	-	TO-5, SY, GI
2N1303	TI	pn-p, AJ, ge	4.5	150	85	2.5	30	300	-	3	16	.40	.90	.1v	-	-	GI, KF
2N1354	IND	pn-p, AJ, ge	4.5	200	85	3.33	30	200	70	2.5	12	.55	.5	0.1	-	-	-
2N1169	SY	npn, AJ, ge	4.5	120	85	2	25	400	20	50	20	-	-	-	-	-	RCA
2N1170	SY	npn, AJ, ge	4.5	120	85	2	25	400	20	50	20	-	-	-	-	-	RCA
2N123	SY	pn-p, AJ, ge	5	100	85	1.66	15	125	30-150	10	6	-	-	-	0.2	-	(max)
2N315	GI	pn-p, AJ, ge	5	100	85	2	20	500	-	1	14	1.0	0.2	0.12	20	-	KF, IND, US
2N315A	GI	pn-p, AJ, ge	5	150	100	2	30	500	70	1	14	0.9	0.4	0.12	35	-	IND, US, KF
2N396A	SY	pn-p, AJ, ge	5	150	100	2	30	200	30-150	6	-	-	-	-	-	-	TS, KF, GE, GI
2N414	SY	pn-p, AJ, ge	5	150	85	2.5	30	200	30-90	5	-	-	-	-	-	-	KF, GI
2N439	SY	npn, AJ, ge	5	100	85	1.66	20	-	-	10	-	0.5	0.7	0.25	30	-	-
2N450	GE	pn-p, AJ, ge	5	150	85	2.5	12	125	-	6	20	-	-	-	0.2	30	-
2N576	SY	npn, AJ, ge	5	200	100	2.6	20	400	-	20	-	2	1	0.4	40	-	-
2N578	RCA	pn-p, AJ, ge	5	120	71	-	20	400	15	3	-	0.85	0.33	0.2	15	-	TS, IND, US, KF, GI
2N585	RCA	npn, AJ, ge	5	120	71	-	25	200	40	3	-	0.35	0.25	0.1	40	-	SY, GI
2N658	RA	pn-p, FA, ge	5	150	85	-	16	1a	-	2.5	12	-	-	0.25	50	-	KF
2N803	RA	pn-p, AJ, ge	5	75	85	1.25	30	400	40	4	20	-	-	-	-	-	Submin
2N804	RA	pn-p, AJ, ge	5	75	85	1.25	30	400	40	4	20	-	-	-	-	-	Submin
2N815	RA	npn, AJ, ge	5	75	85	1.25	25	200	60	10	20	-	-	-	-	-	Submin
2N816	RA	npn, AJ, ge	5	75	85	1.25	25	200	60	10	20	-	-	-	-	-	Submin
2N819	RA	npn, AJ, ge	5	75	85	1.25	30	400	30	10	20	-	-	-	-	-	Submin
2N820	RA	npn, AJ, ge	5	75	85	1.25	30	400	30	10	20	-	-	-	-	-	Submin
2N825	RA	pn-p, AJ, ge	5	75	85	1.25	30	200	30	6	20	-	-	-	-	-	Submin
2N826	RA	pn-p, AJ, ge	5	75	85	1.25	30	200	30	6	20	-	-	-	-	-	Submin
2N1012	GI	npn, AJ, ge	5	150	100	2	40	-	-	5	10	0.1	0.1	0.1	50	-	-
2N1123	PH	pn-p, AJ, ge	5	150	100	10	45	500	3.5	10	15	-	-	0.085	70	-	-
2N1219	SSD	pn-p, AJ, si	5	250	175	1.7	25	100	-	.001	15	-	-	-	-	-	-
2N1348	IND	pn-p, AJ, ge	5	200	85	3.33	40	400	95	5	12	-	-	-	-	-	-
2N1449	IND	pn-p, AJ, ge	5	200	85	3.33	45	400	80	5	-	-	-	-	-	-	-
2N1994	TI	npn, AJ, ge	5	150	85	2.5	30	300	-	5	11	1.1	1.5	-	-	-	-
GT1658	GI	npn, AJ, ge	5	150	100	2	30	-	50	3	10	-	-	-	-	-	-
KGS1005	KF	pn-p, AJ, ge	5	200	85	5.2	30	400	40	12	-	-	-	-	-	-	-
2N377	SY	npn, AJ, ge	6	150	100	2	20	200	-	10	-	2.5	0.7	-	40	-	GE, GI
2N357	SY	npn, AJ, ge	6	100	85	1.6	15	500	-	25	-	1.2	.7	.20	30	-	GI
2N357A	GI	npn, AJ, ge	6	150	100	2	30	500	90	3	14	0.5	0.5	0.18	40	-	SY
2N426	SY	pn-p, AJ, ge	6	150	85	2.5	20	400	-	2	14	1.0	0.3	0.22	40	-	RA, TR, TS, GI, US, TI, KF
2N789	RA	npn, DB, si	6	-	-	1.4	45	25	15	.002	5	-	-	-	-	-	-
2N902	RA	npn, DB, si	6	-	-	-	45	25	15	.002	5	-	-	-	-	-	-
2N1319	RCA	pn-p, AJ, ge	6	120	71	-	20	400	30	2.5	20	-	-	-	-	-	-
2N1343	IND	pn-p, AJ, ge	6	150	85	2.5	20	400	40	3	12	1.0	-	-	-	-	-
2N1997	TI	npn, AJ, ge	6	250	100	3.3	45	-	4	15	-	-	-	-	-	-	-
CK26	RA	pn-p, FA, ge	6	80	85	-	18	400	-	2	14	0.5	0.3	0.25	40	-	-
2N100	SY	npn, AJ, ge	7	150	100	2	40	-	25(min)	15	-	-	-	-	-	-	-
2N1090	RCA	npn, AJ, ge	7	120	85	-	25	400	50	4	-	0.25	0.20	-	50	-	GI
2N1114	SY	npn, AJ, ge	7	150	100	2	15	200	-	30	-	-	-	-	-	-	-
2N1995	TI	npn, AJ, ge	7	150	85	2.5	25	300	-	5	11	-	-	-	-	-	-
GT123	GI	pn-p, AJ, ge	7	150	150	2	25	-	40	3	15	0.9	0.5	0.1	90	-	SY
2N123	GE	pn-p, AJ, si	8	150	85	2.5	15	125	0.987	6	15	0.45	0.90	0.15	65	-	SY
2N388	GI	npn, AJ, ge	8	150	100	2	25	500	-	5	10	0.6	0.4	-	120	-	SY, GE, RA
2N396	GE	pn-p, AJ, ge	8	200	100	3.3	20	200	-	6	12	0.4	0.6	0.08	30	-	TI, GI, SY, TS
2N576A	SY	npn, AJ, ge	8	200	100	2.6	40	400	-	40	-	2	1	0.4	40	-	-
2N579	RCA	pn-p, AJ, ge	8	120	71	-	20	400	30	3	-	0.36	0.33	0.2	30	-	IND, US, TS, KF, GI
2N581	RCA	pn-p, AJ, ge	8	150	85	-	18	100	30	3	12	0.20	0.20	0.35	30	-	US, IND, GI, KF
2N583	RCA	pn-p, AJ, ge	8	120	85	-	18	100	30	3	12	0.20	0.20	0.35	30	-	-
2N598	PH	pn-p, AJ, ge	8	250	100	3.3	35	500	-	3	15	-	-	0.085	85	-	-
2N662	RA	pn-p, FA, ge	8	150	85	-	11	1a	-	2.5	12	-	-	0.25	60	-	KF
2N714	RCA	pn-p, AJ, ge	8	150	85	-	30	200	80	2	11	-	-	-	-	-	-
2N790	RA	npn, DB, si	8	-	-	1.4	45	25	30	.002	8	-	-	-	-	-	-
2N792	RA	npn, DB, si	8	-	-	1.4	45	25	60	.002	5	-	-	-	-	-	-
2N903	RA	npn, DB, si	8	-	-	-	45	25	30	.002	20	-	-	-	-	-	-
2N905	RA	npn, DB, si	8	-	-	-	45	25	80	.002	20	-	-	-	-	-	-
2N1280	IND	pn-p, AJ, ge	8	200	85	3.33	16	400	60	5	10	.10	-	-	-	-	-
2N1284	IND	pn-p, AJ, ge	8	150	85	2.5	20	400	90	2	15	.45	.9	.15	-	-	-
2N1304	TI	npn, AJ, ge	8	150	85	2.5	25	300	110	5	16	.45	.50	.1v	-	-	TO-5, GI, SY, GE



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CIRCLE 60 ON READER-SERVICE CARD

TRANSISTORS—1961

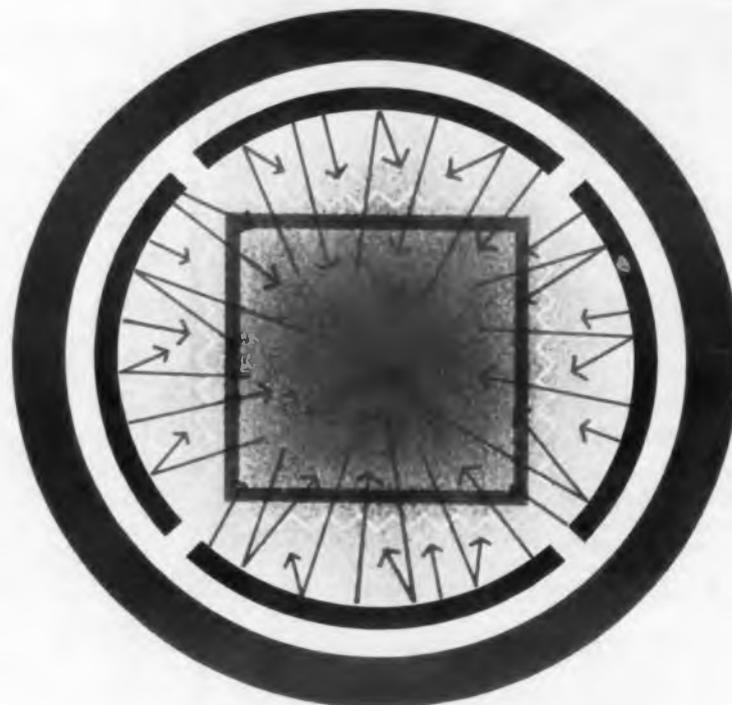
Low Level

Type No.	Mfg.	Type	f <sub>oe</sub>	Maximum Ratings				
				W <sub>c</sub> (mw)	T <sub>j</sub> (c)	μw/c	V <sub>c</sub> v	I <sub>c</sub> ma
2N1305	TI	npn,AJ,ge	8	150	85	2.5	30	100
2N1347	IND	npn,AJ,ge	8	150	85	2.5	20	200
2N1350	IND	npn,AJ,ge	8	200	85	3.33	50	100
2N1351	IND	npn,AJ,ge	8	200	85	3.33	40	100
2N1355	IND	npn,AJ,ge	8	200	85	3.33	30	200
2N1356	IND	npn,AJ,ge	8	200	100	2.66	30	200
2N1686	SY	npn,AJ,ge	8	100	100	1.3	25	200
2N2901	TI	npn,AJ,ge	8	300	100	4	30	750
2N167	GE	npn,GJ,ge	9	65	85	1.1	30	75
2N358	GI	npn,AJ,ge	9	100	85	2	20	500
2N358A	SY	npn,AJ,ge	9	150	100	2	30	500
2N394	GE	npn,AJ,ge	9	150	85	2.5	10	200
2N823	RA	npn,AJ,ge	9	75	85	1.25	25	100
2N1190	GE	npn,RG,ge	9	65	85	1.1	25	75
OC141	AMP	npn,PADT,gi	9	100	75	—	20	250
2N440	SY	npn,AJ,ge	10	100	85	1.66	15	—
2N510	GE	npn,AJ,ge	10	150	85	2.5	12	125
2N521	IND	npn,AJ,ge	10	150	85	2.5	15	200
2N521A	IND	npn,AJ,ge	10	150	85	2.5	25	200
2N600	PH	npn,AJ,ge	10	750	100	10	35	500
2N659	RA	npn,FA,ge	10	150	85	—	14	La
2N745	RA	npn,MS,si	10	150	175	0.75	45	50
2N805	RA	npn,AJ,ge	10	75	85	1.25	30	400
2N806	RA	npn,AJ,ge	10	75	85	1.25	30	400
2N821	RA	npn,AJ,ge	10	75	85	1.25	30	400
2N822	RA	npn,AJ,ge	10	75	85	1.25	30	400
2N1281	IND	npn,AJ,ge	10	200	85	3.33	16	400
2N1349	IND	npn,AJ,ge	10	200	85	3.33	40	400
2N1996	TI	npn,AJ,ge	10	150	85	2.5	20	300
2N1998	TI	npn,AJ,ge	10	250	100	3.3	35	400
2N427	GI	npn,AJ,ge	11	150	100	2	30	—
2N791	RA	npn,DB,si	11	—	—	1.4	45	25
2N904	RA	npn,DB,si	11	—	—	—	45	25
CK27	RA	npn,FA,ge	11	80	85	—	15	400
2N316	GI	npn,AJ,ge	12	100	85	2	20	500
2N316A	GI	npn,AJ,ge	12	150	100	2	30	500
2N397	GE	npn,AJ,ge	12	200	100	3.3	15	200
2N404	RCA	npn,AJ,ge	12	120	85	—	25	100
2N635	GE	npn,AJ,ge	12	150	85	2.5	20	300
2N1306	TI	npn,AJ,ge	12	150	85	2.5	25	300
2N1307	TI	npn,AJ,ge	12	150	85	2.5	30	300
2N1313	IND	npn,AJ,ge	12	175	85	—	30	400
2N1344	IND	npn,AJ,ge	12	150	85	2.5	15	400
2N1345	IND	npn,AJ,ge	12	150	85	2.5	10	400
2N1346	IND	npn,AJ,ge	12	150	85	2.5	12	400
2N1357	IND	npn,AJ,ge	12	200	85	3.33	30	200
2N269	RCA	npn,AJ,ge	13	120	85	—	25	100
2N793	RA	npn,DB,si	13	—	—	1.4	45	25
2N906	RA	npn,DB,si	13	—	—	—	45	25
2N1091	RCA	npn,AJ,ge	13	120	85	—	25	400
2N582	SY	npn,AJ,ge	14	120	71	2.6	25	100
2N807	RA	npn,AJ,ge	14	75	85	1.25	25	100
2N808	RA	npn,AJ,ge	14	75	85	1.25	25	100
2N858	PH	npn,SP,si	14	150	140	1.3	40	50
2N859	PH	npn,SP,si	14	150	140	1.3	40	50
2N860	PH	npn,SA,si	14	150	140	1.3	25	50
2N862	PH	npn,SP,si	14	150	140	1.3	15	50
2N580	RCA	npn,AJ,ge	15	120	71	—	20	400
2N636A	SY	npn,AJ,ge	15	150	100	2	25	300
2N660	RA	npn,FA,ge	15	150	85	—	11	1a
2N1282	IND	npn,AJ,ge	15	200	85	3.33	16	400
2N1316	IND	npn,AJ,ge	15	200	85	3.33	30	400
2N1317	IND	npn,AJ,ge	15	200	85	3.33	20	400
2N1310	IND	npn,AJ,ge	15	200	85	3.33	10	400
2N1999	TI	npn,AJ,ge	15	250	100	3.33	30	400
2N599	PH	npn,AJ,ge	16	250	100	3.3	30	500
2N601	PH	npn,AJ,ge	16	750	100	10.0	30	500
2N428	GI	npn,AJ,ge	17	150	100	2	30	—
2N636	GE	npn,AJ,ge	17	150	85	2.5	20	300
CK28	RA	npn,FA,ge	17	80	85	—	12	400
2N522	IND	npn,AJ,ge	18	150	85	2.5	15	200
2N522A	IND	npn,AJ,ge	18	150	85	2.5	25	200
2N582	RCA	npn,AJ,ge	18	120	85	—	25	100
2N584	RCA	npn,AJ,ge	18	120	85	—	25	100

## DATA CHART

(continued)

Characteristics			Switching			Leak Cur	Remarks	Type No.
$V_{FE}$ hFE	$I_{CO}$ $\mu a$	$C_{COM}$ $\mu\mu f$	Rise Time	Star Time	Sat Volt			
100	3	11	.28	.80	.1v	--	TO-5, KF, GI	2N1305
80	2.5	12	--	--	--	--		2N1347
95	10	12	--	--	--	--		2N1350
65	5	12	--	--	--	--		2N1351
80	2.5	12	.4	.6	0.08	--		2N1355
80	2.5	12	.4	.6	0.08	--		2N1356
40	10	20	--	--	--	--		2N1685
5	5	30	--	--	--	--		2N2001
0.085	1.5	2.5	0.4	0.7	0.35	30	USAF2N167-ML	2N167
60	3	14	0.4	0.5	0.18	30	SY	2N358
25-75	5	14	--	--	--	--	GI	2N358A
40	6	12	--	--	0.04	70	KF,	2N394
40	5	20	--	--	--	--		2N823
150	1.5	2.5	0.4	0.7	0.35	30		2N1198
150	0.8	--	--	--	--	--		OC141
--	10	--	0.3	0.7	0.25	40	GI	2N440
70	6	12	0.8	0.9	0.15	60		2N518
70	1	14	--	--	--	--	US, KF	2N521
150	1	14	0.2	0.5	--	135	US, KF	2N521A
--	10	15	--	--	0.085	90	EM	2N600
--	2.5	12	--	--	0.25	70	KF, GI	2N659
22	10	3	--	--	--	--		2N745
60	4	20	--	--	--	--	Submin	2N805
60	4	20	--	--	--	--	Submin	2N806
40	10	20	--	--	--	--	Submin	2N821
40	10	20	--	--	--	--	Submin	2N822
90	5	10	.9	--	--	--		2N1281
110	5	12	--	--	--	--		2N1349
--	5	11	--	--	--	--		2N1996
--	4	15	--	--	--	--		2N1998
--	2	14	0.43	0.3	0.105	55	KF, TS, TI, MO IND, RA, US	2N427
60	.002	5	--	--	--	--		2N791
60	.002	20	--	--	--	--		2N904
--	2	14	0.4	0.3	0.25	55		CK27
--	1	14	0.4	0.4	0.14	30		2N316
130	1	14	0.4	0.4	0.14	35	IND, US, KF	2N316A
--	6	12	0.3	0.7	0.07	40	TI, KF	2N397
--	5	--	0.17	0.20	0.12	--	US, GE, RA, GI, SY, KF	2N404
--	5	--	--	--	--	25		2N635
110	5	16	.22	.50	.1v	--	TO-5, GI, SY, GE	2N1306
110	3	11	.20	.80	.1v	--	TO-5, GI, KF	2N1307
80	--	14	--	--	--	--		2N1313
90	5	12	0.7	0.3	--	--		2N1344
60	3	14	.3	.4	--	--		2N1345
25	2.5	14	.3	.4	.10	--		2N1346
85	2.5	12	.3	.7	0.07	--		2N1357
40	2	--	0.17	0.20	0.12	--		2N269
50	.002	5	--	--	--	--		2N793
50	.002	20	--	--	--	--		2N906
70	4	--	0.20	0.17	--	70	GI	2N1091
40	5	--	--	--	--	--	KF, RCA	2N582
40	5	20	--	--	--	--	Submin	2N807
40	5	20	--	--	--	--	Submin	2N808
33	.1	5	--	--	--	--		2N858
65	.1	5	--	--	--	--		2N859
33	.1	5	--	--	--	--		2N860
33	.1	5	--	--	--	--		2N862
45	3	--	0.16	0.29	0.2	45	GI, IND, US, TS, KF	2N580
0-300	6	20	--	--	--	--		2N636A
--	2.5	12	--	--	0.25	90	KF	2N660
00	5	10	.8	--	--	--		2N1282
00	2	14	--	--	--	--	KF	2N1316
95	3	14	--	--	--	--	KF	2N1317
85	4	14	--	--	--	--		2N1318
--	4	15	--	--	--	--		2N1999
--	3.5	15	--	--	0.085	125		2N599
--	3.5	15	--	--	--	125		2N601
--	2	14	0.43	0.3	0.22	80	SY, MO, RA, IND, US, TS, TI, KF, GE	2N42F
--	5	--	--	--	--	35		2N636
20	2.0	14	0.4	0.3	0.25	80		CK28
00	1	14	--	--	--	--	US, KF	2N522
00	1	14	0.2	0.5	--	175	US, KF	2N522A
80	5	--	0.15	0.17	0.2	60	TS, GI, IND, SY, KF	2N582
80	2	12	0.15	0.17	0.2	60	US	2N584



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Plus or minus 3°C.

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500°C in 23 minutes.

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1°C Thermocouple INSIDE the work zone.

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\*Terminology recommended by Standards Committee of American Vacuum Society

CIRCLE 61 ON READER-SERVICE CARD



## Abbreviation of Terms

<b>AJ</b>	Alloy Junction
<b>DD</b>	Double Diffused
<b>DG</b>	Grown Diffused
<b>DJ</b>	Diffused Junction
<b>DM</b>	Diffused Mesa
<b>DP</b>	Diffused Planar
<b>Dr</b>	Drift
<b>Ep</b>	Epitaxial
<b>FA</b>	Fused Alloy
<b>FJ</b>	Fused Junction
<b>GD</b>	Grown Diffused
<b>Ge</b>	Germanium
<b>GJ</b>	Grown Junction
<b>GR</b>	Grown Rate
<b>MB</b>	Meltback
<b>MD</b>	MADT
<b>Ms</b>	Mesa
<b>RG</b>	Rate Grown
<b>Si</b>	Silicon
<b>SBT</b>	Surface Barrier
<b>C<sub>oe</sub></b>	= Collector-to-emitter capacitance measured across the output terminals with the input ac open-circuited.
<b>f<sub>αe</sub></b>	= Frequency at which the magnitude of the forward-current transfer ratio (small-signal) is 0.707 of its low-frequency value.
<b>f<sub>i</sub></b>	= Frequency at which common emitter gain is unity.
<b>h<sub>fe</sub></b>	= Common emitter-small signal forward current transfer ratio.
<b>h<sub>FE</sub></b>	= Common emitter-static value of short-circuited forward current ratio.
<b>I<sub>co</sub></b>	= Collector current when collector junction is reverse-biased and emitter is dc open-circuited.

For an additional copy of the Transistor Data Chart turn the Reader-Service Card and circle 251.

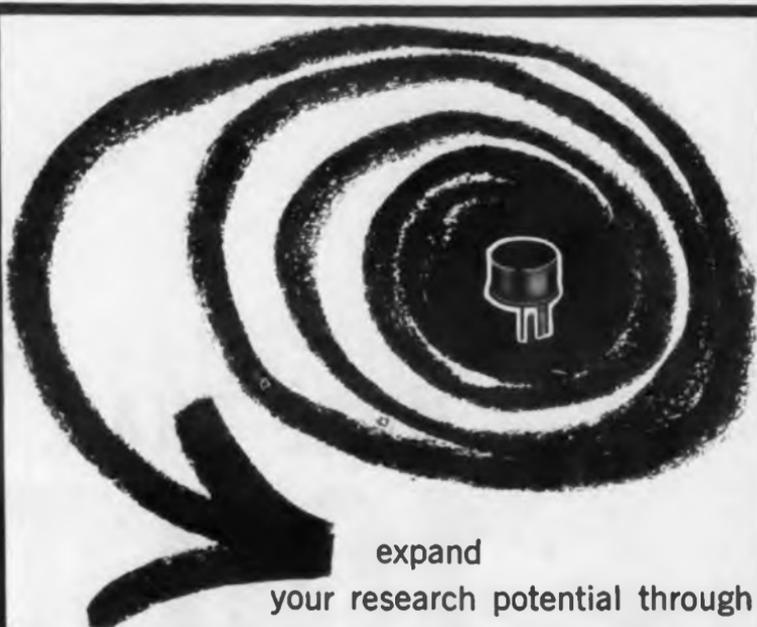
# DATA CHART

## Low Level (continued)

Type No.	Mfg.	Type	Maximum Ratings					Characteristics			Switching				Remarks		
			f <sub>ao</sub>	W <sub>c</sub> (mw)	T <sub>j</sub> (c)	mw/c	V <sub>c</sub> v	I <sub>c</sub> ma	h <sub>FE</sub> h <sub>FE</sub>	I <sub>co</sub> μa	C <sub>coe</sub> μf	Rise Time	Stor Time	Sat Volt		Leak Cur	
2N1308	TI	npn,AJ,ge	18	150	85	2.5	25	300	200	5	15	-	-	-	-	TO-5,SY,GE	
2N1309	TI	pnp,AJ,ge	18	150	85	2.5	30	300	210	3	11	-	-	-	-	TO-5, KF, GI	
2N317	GI	pnp,AJ,ge	20	100	85	2	30	500	-	1	14	0.3	0.4	0.18	30	US, IND, KF	
2N317A	GI	pnp,AJ,ge	20	150	100	2	30	500	180	1	14	0.3	0.4	0.18	40	IND, US, KF	
2N337	TI	npn,GD,si	20	125	150	.001	45	20	19	1	-	0.05	0.02	1.5	35	TR, RA, GE	
2N417	IND	pnp,AJ,ge	20	200	85	3	30	200	140	2	12	-	-	-	-	KF	
2N661	RA	pnp,FA,ge	20	150	85	-	9	1a	-	2.5	12	-	-	0.25	120	KF	
2N746	RA	npn,MS,si	20	150	175	0.75	45	50	45	10	3	-	-	-	-	-	
2N1008	BE	pnp,AJ,ge	20	400	85	6.6	20	300	100	10	-	-	-	-	0.25	-	
2N1008A	BE	pnp,AJ,ge	20	400	85	6.6	40	300	100	10	-	-	-	-	0.25	-	
2N1008B	BE	pnp,AJ,ge	20	400	85	6.6	60	300	100	10	-	-	-	-	0.25	-	
2N1017	RA	pnp,FA,ge	20	150	85	-	10	400	-	2	12	0.25	-	-	0.25	100	US, KF
CK419	RA	npn,FA,si	20	385	160	-	40	50	15	005	35	-	-	-	-	-	
CK420	RA	npn,FA,si	20	385	160	-	35	50	30	005	-	-	-	-	-	-	
CK421	RA	npn,FA,si	20	385	160	-	30	50	60	005	20	-	-	-	-	-	
CK474	RA	npn,DB,si	20	250	180	1.9	40	50	15	005	20	-	-	-	-	-	
CK475	RA	npn,DB,si	20	250	180	1.9	35	50	30	005	20	-	-	-	-	-	
CK476	RA	npn,DB,si	20	250	180	1.9	30	50	60	005	20	-	-	-	-	-	
CK477	RA	npn,DB,si	20	250	180	1.9	30	50	65	005	20	-	-	-	-	-	
2N861	PH	pnp,SP,si	22	150	140	1.3	25	50	65	0.1	5	-	-	-	-	-	
2N863	PH	pnp,SP,si	22	150	140	1.3	15	50	65	.1	5	-	-	-	-	-	
2N864	PH	pnp,SP,si	22	150	140	1.3	6	50	65	.1	-	-	-	-	-	-	
2N523	IND	pnp,AJ,ge	24	150	85	2.5	15	200	200	1	14	-	-	-	-	US, KF	
2N523A	IND	pnp,AJ,ge	24	150	85	2.5	20	200	300	1	14	0.1	0.4	-	200	US, KF	
2N747	RA	npn,MS,si	25	150	175	0.75	25	50	30	10	6	-	-	-	-	-	
2N748	RA	npn,MS,si	25	150	175	0.75	30	50	10	6	-	-	-	-	-	-	
2N1386	RA	npn,MS,si	25	300	175	0.5	25	50	30	10	6	-	-	-	-	-	
2N1387	RA	npn,MS,si	25	300	175	0.5	30	50	20	10	6	-	-	-	-	-	
2N1205	TR	npn,GR,si	27	150	150	-	20	-	6	50	3.0	-	-	-	-	30	
2N338	TI	npn,GD,si	30	125	150	.001	45	20	39	1	-	0.06	0.02	1.5	75	TR, RA, NA, GE	
2N643	RCA	pnp,DR,ge	30*	120	71	-	30	100	45	3	2	0.03	0.006	-	45	*gain bandwidth product	
2N907	RA	npn,DB,si	30	-	-	-	45	25	35	.002	20	-	-	-	-	-	
KGS1004	KF	pnp,AJ,ge	32	200	85	3	10	400	120	12	-	-	-	-	-	-	
2N842	TR	npn,GJ,si	44	300	175	-	45	25	20	0.1	6	-	-	-	-	-	
TMT842	TR	npn,DJ,si	44	150	175	-	45	25	20	1	6	-	-	-	-	-	
2N908	RA	npn,DB,si	45*	-	-	-	45	25	75	.002	20	-	-	-	-	-	
2N644	RCA	pnp,DR,ge	50*	120	71	-	30	100	45	3	2	0.015	0.004	-	45	*gain bandwidth product	
ST3030	TR	npn,DJ,si	50	100	150	0.8	15	-	-	50	4	.04	.07	40	-	-	
2N865	PH	pnp,SP,si	52	150	140	1.3	10	50	150	.1	5	-	-	-	-	-	
2N1254	HU	pnp,MS,si	55	250	160	1.8	15	-	25	30	8	-	0.15	0.15	0.28	TO-5 package	
2N1256	HU	pnp,MS,si	55	250	160	1.8	30	-	25	30	8	-	-	-	-	TO-5 package	
2N1258	HU	pnp,MS,si	55	250	160	1.8	50	-	25	30	8	-	-	-	-	TO-5 package	
2N1779	SY	npn,AJ,ge	60	100	100	1.3	25	100	25	10	10	-	-	-	-	-	
2N843	TR	npn,DJ,si	64	300	175	-	45	25	40	.1	6	-	-	-	-	-	
TMT843	TR	npn,DJ,si	64	150	175	-	45	25	40	.1	6	-	-	-	-	-	
2N560	WE	npn,DD,si	70	600	150	.25	60	100	20	.1	8	.06	.05	-	-	US, MI, Lonly, NA	
2N645	RCA	pnp,Dr,ge	70	120	85	-	30	100	45	3	2	0.01	0.002	-	45	*gain bandwidth product	
OC46	AMP	pnp,PA,DT,ge	73	83	75	-	20	125	<80	<3	-	-	-	-	-	-	
OC139	AMP	npn,PA,DT,ge	73.5	100	75	-	20	250	45	0.8	-	-	-	-	-	-	
OC140	AMP	npn,PA,DT,ge	74.5	100	75	-	20	250	75	0.8	-	-	-	-	-	-	
2N1255	HU	pnp,MS,si	75	250	160	1.8	15	-	55	30	8	-	-	-	-	TO-5 Package	
2N1257	HU	pnp,MS,si	75	250	160	1.8	30	-	55	30	8	-	-	-	-	TO-5 Package	
2N1259	HU	pnp,MS,si	75	250	160	1.8	50	-	55	30	8	-	-	-	-	TO-5 Package	
OC47	AMP	pnp,PA,DT,ge	75.5	83	75	-	20	125	<200	<3	-	-	-	-	-	-	
2N706	FA	npn,OP,si	80(ft)	1w	175	6.7	20	-	45	.005	5	.02	-	-	-	GI, TR, SSD, SY, NA, RH, IND, TI, RCA	
2N702	TI	npn,DJ,si	100	150	175	.002	20	50	15-45	5	-	-	-	.6	-	FA, NA	
2N1507	TR	npn,DD,si	120	1w	175	13.2	60	500	200	.003	20	80	600	.07	-	TI	
2N1139	TR	npn,GR,si	150	500	175	-	15	25	20	.25	8	12	10	0.7	5	-	
2N501	PH	pnp,MD,ge	175	60	100	0.8	15	50	-	1.0	1.75	0.013	0.007	0.08	35	SPR, GI	
2N501A	PH	pnp,MD,ge	175	175	60	0.8	15	50	-	-1.0	1.1	0.013	0.007	1.0	35	SPR, GI	
2N705	TI	pnp,AJ,ge	300	300	100	4	15	50	6	.3	5	0.03	0.075	0.2	40	MO, SY, GE, RA	
2N710	TI	pnp,MS,ge	300	100	300	4	15	50	6	.3	5	.06	.075	80	SY, MO, RCA, GE, RA		
2N711	TI	pnp,MS,ge	300	300	100	4	12	50	6	0.3	5	.07	0.1	90	MO, SY, RCA, GE, RA		
2N707A	MO	npn,DM,si	350	1w	175	6.7	70	-	30	.01	4	-	-	-	-	Epitaxial	
2N706A	MO	npn,DM,si	400	1w	175	6.7	25	-	4	.005	4.5	.018	.016	-	-	(Epitaxial MO) SY, TI (PSI, HU, NA, GI)	
2N706B	MO	npn,DM,si	400	1w	175	6.7	25	-	4	.005	4.5	.018	.016	-	-	(MO, Epitaxial) SY, PSI (NA, HU, GI)	
2N753	MO	npn,DM,si	400	1w	175	6.7	25	-	4	.005	4.5	.018	.019	-	-	(MO, Epitaxial) HU, SY (NA)	

## Low Level (concluded)

Type No.	Mfg.	Type	f <sub>oe</sub>	Maximum Ratings				Characteristics				Switching				Remarks
				W <sub>c</sub> (mw)	T <sub>j</sub> (c)	mw/c	V <sub>c</sub> v	I <sub>c</sub> ma	h <sub>FE</sub>	I <sub>co</sub> μA	C <sub>co</sub> μμf	Rise Time	Stor Time	Sat Volt	Leak Cur	
2N828	MO	npn, DM, si	400	500	175	4	15	200	4	.4	3.5	-	-	-	-	Epitaxial, SY
NS345	NA	npn, DM, si	400	500	175	2.8	30	80-200	-	5	-	-	-	-		
2N799A	PH	npn, MD, ge	450	60	100	.8	15	50	1	1.9	-	-	-	-		
2N84CA	PH	npn, MD, ge	450	60	100	.8	15	50	1	1.9	-	-	-	-		
2N834	MO	npn, DM, si	500	1w	175	6.7	40	200	5	.01	2.8	.015	.016	-	-	Epitaxial, SY
2N559	WE	npn, DG, ge	750	150	100	.5	15	50	25	5	-	.002	.003	-	US, MIL only	
2N1385	TI	npn, MS, ge	750	750	100	8	25	100	30	5	1.3	.001	.002	4	-	TO-5, non saturated
2N917	FA	npn, DP, si	800*	300	200	1.71	20	-	50	0.6	-	-	-	-	-	TT
2N167A	GE	npn, AJ, ge	-	65	85	-	30	75	30	0.6	-	-	-	-	-	
2N240	PH	npn, SB, ge	-	25	85	0.5	6	15	30	0.5	4	-	-	0.04	20	SPR
2N335B	GE	npn, GJ, si	-	500	175	-	60	25	52	1	-	-	-	-	-	
2N336A	GE	npn, GJ, si	-	500	175	-	45	25	75	1	11	-	-	-	-	
2N377A	SY	npn, AJ, ge	-	150	100	2	40	200	20-60	40	-	-	-	-	-	GI
2N388A	SY	npn, AJ, ge	-	150	100	2	25	200	60-180	40	-	-	-	-	-	
2N398	RCA	npn, AJ, ge	-	50	55	-	105	100	60	6	-	-	-	-	-	GI
2N399A	GE	npn, AJ, ge	-	150	100	-	15	200	70	2	-	-	-	0.3	60	
2N438A	SY	npn, AJ, ge	-	150	85	2.5	25	200	15(min)	10	-	0.7	-	-	-	
2N439A	SY	npn, AJ, ge	-	150	85	2.5	25	200	30(min)	10	-	0.5	-	-	-	
2N440A	SY	npn, AJ, ge	-	200	85	3.3	25	200	40	10	-	0.3	-	-	-	
2N496	PH	npn, SB, si	-	150	140	1.3	10	50	5.0	1	6	-	-	0.08	16	I <sub>s</sub> = 3.5 ns max I <sub>s</sub> = 2.0 ns max
2N556	SY	npn, AJ, ge	-	100	85	1.66	20	200	-	25	-	3.5	2	0.5	55	
2N557	SY	npn, AJ, ge	-	100	85	1.66	15	200	-	15	-	6.5	2.5	0.5	20	I <sub>s</sub> = 2.0 ns max
2N558	SY	npn, AJ, ge	-	100	85	1.66	15	200	-	15	-	3.5	2	0.75	20	
2N586	RCA	npn, AJ, ge	-	250	85	-	45	250	55	8	-	-	-	0.25	55	
2N587	SY	npn, AJ, ge	-	150	85	2.5	40	200	20	10	30	-	-	-	20	70
2N597	PH	npn, AJ, ge	-	250	100	3.3	45	400	-	5	15	-	-	0.085		
2N634A	GE	npn, AJ, ge	-	150	85	-	20	300	55	6	-	-	-	-	-	
2N635A	GE	npn, AJ, ge	-	150	85	-	85	20	300	100	6	-	-	-	-	
2N636A	GE	npn, AJ, ge	-	150	85	-	15	300	190	6	-	-	-	-	-	
2N707	FA	npn, DP, si	-	1w	175	6.7	28	-	12	.005	5	.02	-	-	-	(Epitaxial, MD), GI GE
2N725	SY	npn, DM, ge	-	150	100	2	15	50	20	3	-	0.1	-	-	-	
2N770	PH	npn, SA, si	-	150	150	1.2	20	100	5.5	.02	1.3	-	-	-	-	
2N771	PH	npn, SA, si	-	150	150	1.2	20	100	7.5	.7	1.3	-	-	-	-	
2N772	PH	npn, SA, si	-	150	150	1.2	25	100	5.5	.5	1.3	-	-	-	-	
2N794	RCA	npn, DM, ge	-	150	85	2.5	13	100	50	1	8	-	-	-	-	
2N795	RCA	npn, DM, ge	-	150	85	2.5	13	100	50	1	8	-	-	-	-	
2N1119	PH	npn, SAT, si	-	150	140	1.3	10	50	5.0	.001	6.0	-	-	-	-	
2N1122	PH	npn, MA, ge	-	25	85	0.63	12	50	8	5.0	6.0	-	-	0.1	25	SPR, GI
2N1122A	PH	npn, MA, ge	-	25	85	0.63	15	50	8	5.0	6.0	-	-	0.1	25	
2N1175	GE	npn, AJ, ge	-	200	85	-	25	200	80	6	-	-	-	-	-	
2N1175A	GE	npn, AJ, ge	-	200	85	-	25	200	80	6	-	-	-	-	-	
2N1213	RCA	npn, MESA, ge	-	75	85	-	25	100	-	3	-	.015	.05	-	-	
2N1214	RCA	npn, MESA, ge	-	75	85	-	25	100	-	3	-	.015	.05	-	-	
2N1215	RCA	npn, MESA, ge	-	75	85	-	25	100	-	3	-	.015	.05	-	-	
2N1216	RCA	npn, MESA, ge	-	75	85	-	25	100	-	3	-	.015	.05	-	-	
2N1217	GE	npn, AJ, ge	-	75	85	-	20	25	40	.6	-	-	-	-	-	
2N1277	GE	npn, GJ, si	-	150	150	-	30	25	20	.001	-	-	-	-	-	
2N1278	GE	npn, GJ, si	-	150	150	-	30	25	33	.001	-	-	-	-	-	
2N1279	GE	npn, GJ, si	-	150	150	-	30	25	80	.001	-	-	-	-	-	
2N1288	GE	npn, BG, ge	-	75	85	-	10	50	50	2	-	-	-	-	-	
2N1289	GE	npn, MB, ge	-	75	85	-	15	100	50	2	-	-	-	-	-	
2N1299	SY	npn, AJ, ge	-	150	100	2	40	200	35-110	0.1	-	-	-	-	-	
2N1300	RCA	npn, DM, ge	-	150	85	2.5	13	100	50	1	8	-	-	-	-	
2N1301	RCA	npn, DM, ge	-	150	85	2.5	13	100	50	1	8	-	-	-	-	
2N1304	RCA	npn, DR, ge	-	240	85	4	30	500	50	4	-	-	-	-	-	
2N1404	TI	npn, AJ, ge	-	150	85	2.5	25	300	-	3	16	-	-	-	-	
2N1413	GE	npn, AJ, ge	-	200	85	-	25	200	36	8	-	-	-	-	-	
2N1414	GE	npn, AJ, ge	-	200	85	-	25	200	52	8	-	-	-	-	-	
2N1450	RCA	npn, DR, ge	-	120	85	-	30	100	20	10	-	-	-	-	-	
2N1473	SY	npn, AJ, ge	-	200	75	4	40	400	25-80	100	-	-	-	-	-	
2N1495	PH	npn, MD, ge	-	25	85	0.63	28	50	35	1	25	-	0.12	-	-	
2N1614	GE	npn, AJ, ge	-	240	85	-	40	300	32	25	-	-	-	-	-	
2N1663	PH	npn, SA, si	-	150	150	1.2	20	100	7.5	1.5	-	-	-	-	-	
2N1683	RCA	npn, DM, ge	-	150	85	2.5	13	100	75	1	8	-	-	-	-	
2N1694	GE	npn, AJ, ge	-	75	85	-	20	25	30	0.6	-	-	-	-	-	
2N1754	PH	npn, MD, ge	-	50	85	.83	13	100	-	1	1.5	-	-	-	-	
2N1808	TI	npn, AJ, ge	-	150	85	2.5	25	300	-	5	11	-	-	-	-	
2N1954	RA	npn, AJ, ge	-	375	100	0.2	60	1a	90	10	-	-	-	-	-	
2N1955	RA	npn, AJ, ge	-	375	100	0.2	60	1a	100	10	-	-	-	-	-	
2N1956	RA	npn, AJ, ge	-	375	100	0.2	60	1a	90	-	-	-	-	-	-	
2N1957	RA	npn, AJ, ge	-	375	100	0.2	60	1a	90	10	-	-	-	-	-	
2N2002	NA	npn, AJ, si	-	250	175	1.67	30	100	-	.001	8	-	-	-	-	
2N2003	NA	npn, AJ, si	-	250	175	1.67	30	100	-	.001	8	-	-	-	-	
2N2004	NA	npn, AJ, si	-	250	175	1.67	50	100	-	.003	8	-	-	-	-	
2N2005	NA	npn, AJ, si	-	250	175	1.67	50	100	-	.0015	8	-	-	-	-	
2N2006	NA	npn, AJ, si	-	250	175	1.67	60	100	-	.002	8	-	-	-	-	
2N2007	NA	npn, AJ, si	-	250	175	1.67	60	100	-	.005	8	-	-	-	-	



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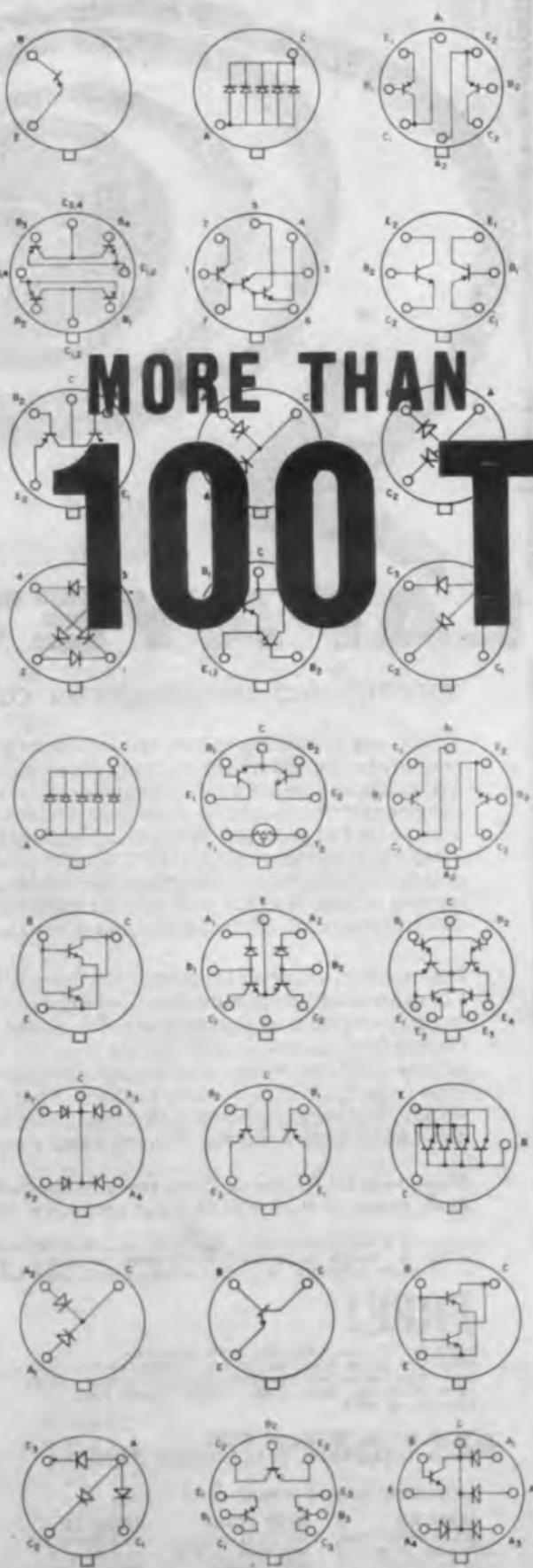
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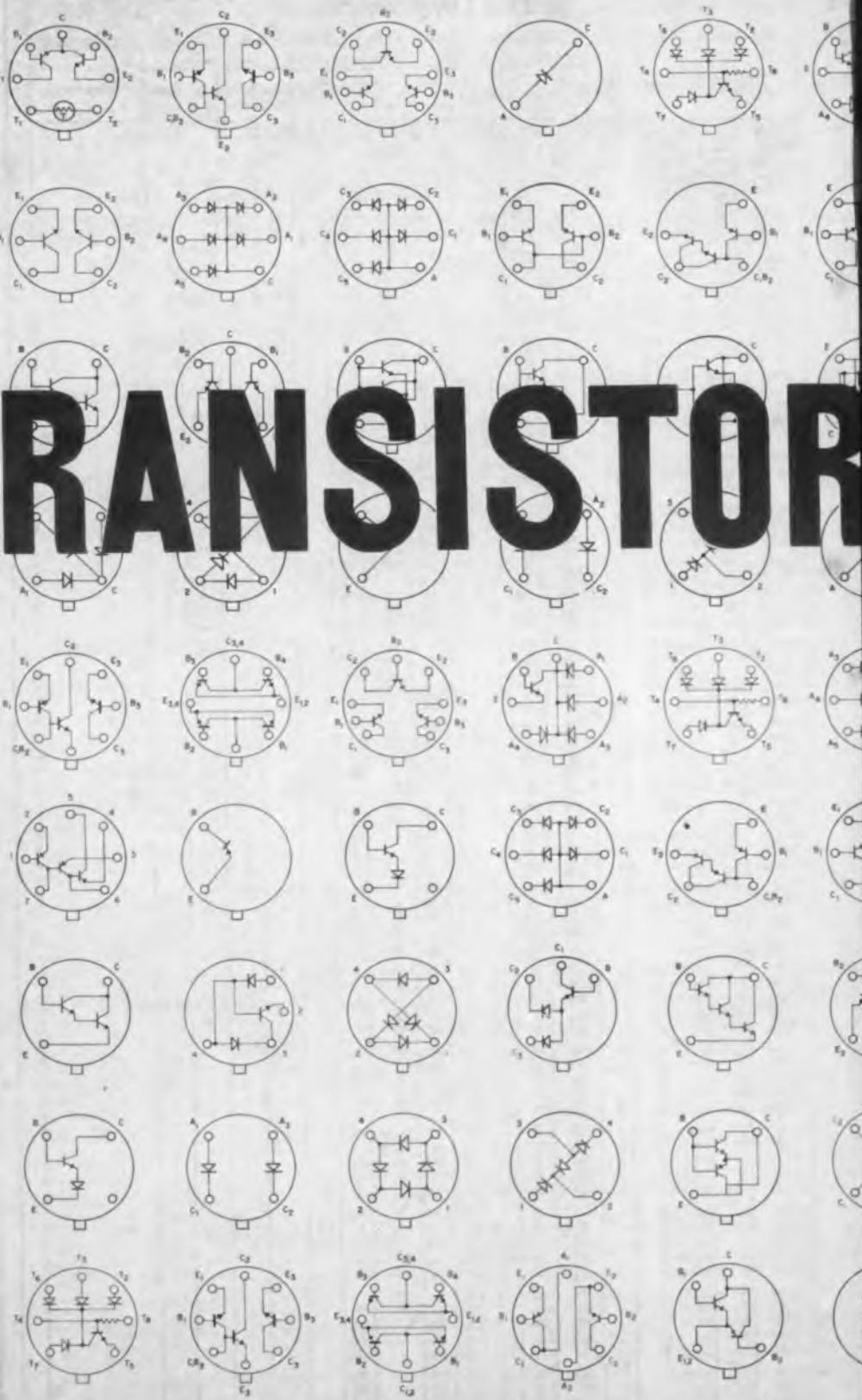
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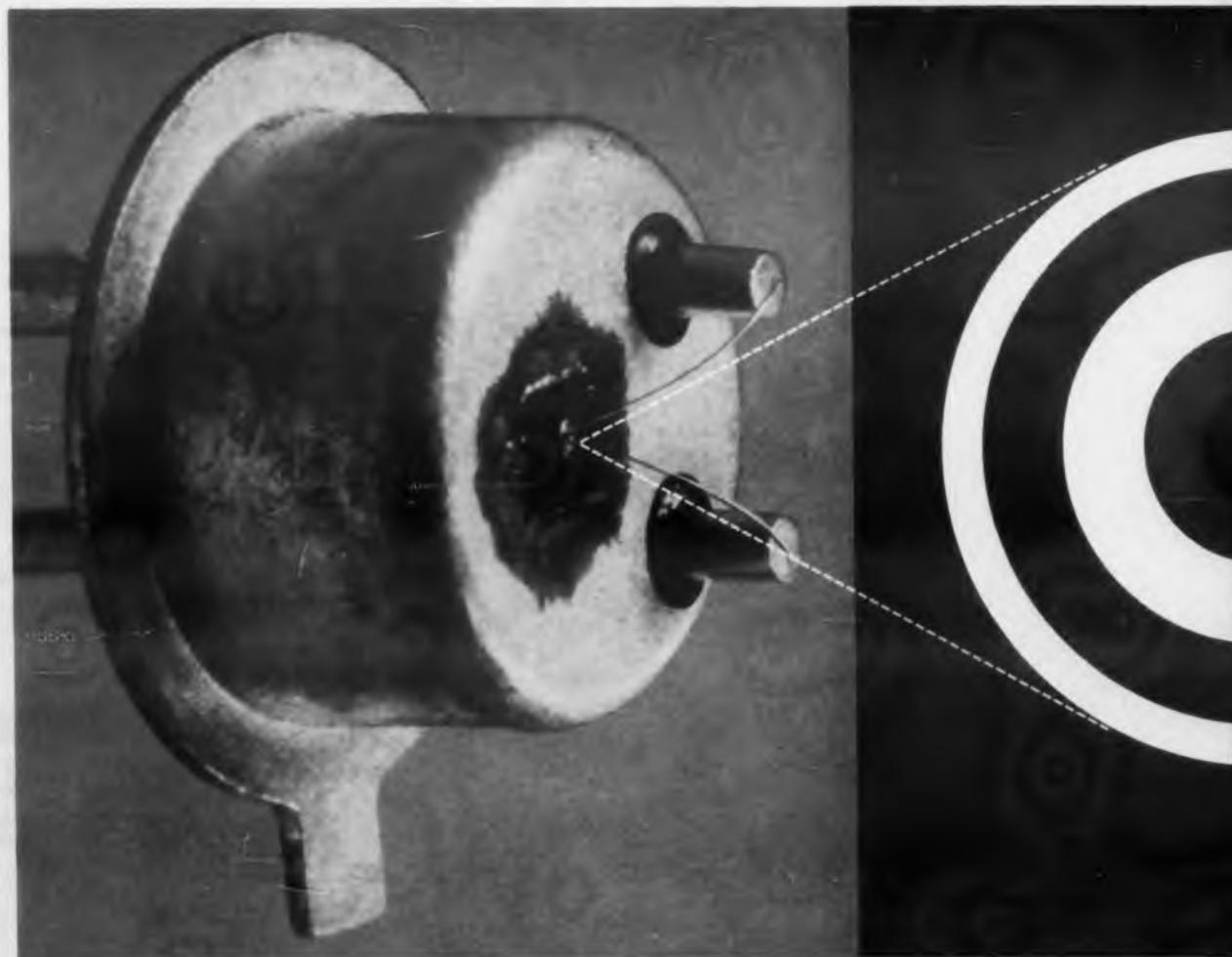
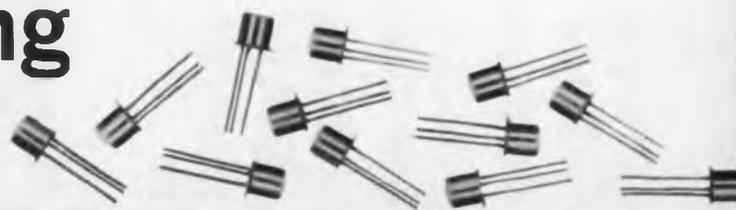
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2N120	A	2N269	LL	2N358A	LL
2N122	P	2N270	LL	2N359	A
2N123	LL	2N274	HF	2N360	A
2N128	HF	2N277	P	2N362	A
2N129	A	2N278	P	2N363	A
2N139	HF	2N279	P	2N368	A
2N140	HF	2N280	A	2N369	A
2N144/13	A	2N281	A	2N370	HF
2N155	P	2N284	A	2N371	HF
2N157	P	2N284A	A	2N372	HF
2N157A	P	2N285	A	2N373	HF
2N158	P	2N285A	P	2N374	HF
2N158A	P	2N291	A	2N375	HL
2N160	A	2N292	HF	2N376	P
2N160A	A	2N293	HF	2N376A	P
2N161	A	2N296	P	2N377	LL, HF
2N161A	A	2N297	HL	2N377A	LL
2N163	A	2N297A	P, HL	2N378	HL
2N163A	A	2N298	P, HL	2N378A	LL
2N168	HF	2N301	P	2N379	HL
2N168A	HF	2N301A	P	2N380	HL
2N169	HF	2N306	A	2N381	HL
2N169A	HF	2N307	P	2N382	A
2N173	P	2N307A	P	2N383	A
2N174	P	2N311	LL	2N384	HF
2N174A	P	2N312	HF	2N385	HF
2N175	A	2N315	LL	2N385A	LL
2N176	P	2N315A	LL	2N386	HL
2N178	P	2N316	LL	2N387	HL
2N185	A	2N316A	LL	2N388	LL, HF
2N186A	A	2N317	LL	2N389	P
2N187A	A	2N317A	LL	2N392	P
2N188A	A	2N319	A	2N393	HF
2N189	A	2N320	A	2N394	LL
2N190	A	2N321	A	2N395	LL, HF
2N191	A	2N322	A	2N396	HF
2N192	A	2N323	A	2N396A	LL
2N193	HF	2N324	A	2N397	LL, HF
2N194	HF	2N326	P	2N398	LL
2N194A	HF	2N327	LL	2N398A	A
2N207	A	2N327A	LL	2N399	P
2N207A	A	2N328	LL	2N400	P
2N207B	A	2N328A	LL	2N400A	LL
2N211	HF	2N329	LL	2N401	P
2N212	HF	2N330	A	2N404	LL
2N213	A	2N330A	A	2N404A	LL
2N213A	A	2N331	A	2N405	A
2N214	A	2N332	A	2N406	A
2N215	A	2N332A	A	2N407	A
2N217	A	2N333	A	2N408	A
2N218	HF	2N333A	A	2N409	HF
2N219	HF	2N334	A	2N410	HF
2N220	A	2N334A	A	2N411	HF
2N223	A	2N335	A	2N412	HF
2N224	A	2N335A	A	2N413	HF
2N226	A	2N335B	LL	2N413A	HF
2N228	A	2N336	A	2N414	LL, HF
2N229	A	2N336A	A	2N414A	HF
2N231	HF	2N337	LL	2N414B	HF
2N232	HF	2N338	LL	2N415	HF
2N233	HF	2N338A	LL	2N416	HF
2N233A	HF	2N339	P	2N417	LL, HF
2N234A	P	2N339A	LL	2N418	HL
2N235A	P	2N340	P	2N419	P
2N235B	P	2N340A	P	2N420	HL
2N236A	P	2N341	P, A	2N420A	HL
2N236B	P	2N341A	P	2N422	A
2N238	A	2N342	P	2N424	P
2N240	LL	2N342A	P	2N424A	HL
2N241	A	2N343	P	2N425	LL

# Introducing... concentric geometry A significant improvement in NPN diffused silicon mesa fast-switching transistors



Hughes Semiconductor Division offers immediate delivery of a whole family of exceptionally fast-switching NPN silicon mesa transistors. These devices incorporate a new design feature that increases both performance and reliability.

We call it concentric geometry—with a continuous surrounding base contact. It provides extremely low base spreading resistance  $r_b'$ . This results in a faster switch and a much improved amplifier.

This new design also greatly simplifies transistor construction assuring uniform quality and high reliability.

Hughes NPN silicon mesa transistors also provide other important advantages—controlled gain bands, low storage time, high  $f_t$ , low collector saturation voltage.

Here are some typical values for these high-performance transistors: 2N706...  $I_{CBO} = 20 \mu A$ ; 2N706A...  $V_{CE} = 0.3V$ ,  $t_s = 15 \text{ nsec.}$ ; 2N706B...  $r_b' = 15 \text{ ohm}$ ,  $t_s = 15 \text{ nsec.}$ ; 2N707...  $r_b' C_c = 60 \text{ psec}$ ,  $f_{max} = 400 \text{ mc}$ ; 2N753...  $V_{CE} = 0.3V$ ,  $t_s = 20 \text{ nsec.}$

To get complete information on these high performance NPN transistors—or Hughes extensive PNP line—contact your nearest Hughes Semiconductor Sales Office or Hughes Authorized Distributor. Or write Hughes Semiconductor Division, Marketing Department, Newport Beach, California. For export, write Hughes International, Culver City, California.

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HUGHES AIRCRAFT COMPANY  
SEMICONDUCTOR DIVISION

Type	Breakdown Voltages ( $I_C = 100 \mu A$ )			$V_{CE}$		$I_{CBO}$ ( $\mu A$ )	Max. Switching Time (nsec.)	Max. $I_{CBO}$ ( $\mu A$ )	Max. $I_{CM}$ ( $\mu A$ )	$V_{CE}$ $I_{CBO}$ ( $\mu A$ )	$V_{CE}$ $I_{CM}$ ( $\mu A$ )	$V_{CE}$ $I_{CBO}$ ( $\mu A$ )	$V_{CE}$ $I_{CM}$ ( $\mu A$ )	$r_b'$
	$V_{CBO}$ (V)	$V_{EBO}$ (V)	$V_{CEO}$ (V)	Min.	Max.									
2N706	25	3	—	20	20	—	—	60	0.5	5	0.6	—	0.9	—
2N706A	25	5	15	20	20	60	200	40	75	25	0.5	5	0.6	0.7
2N706B	25	5	15	20	20	60	200	40	75	25	0.5	5	0.4	0.7
2N753	25	5	15	20	40	120	200	40	75	35	0.5	5	0.6	0.7
2N707	56	4	—	25	9	—	—	—	5.0	10	0.6	—	0.9	—

Standard TO-18 Case; 1 Watt dissipation @ 25°C case temperature

2N426	LL	2N526	A	2N643	LL
2N427	LL	2N527	A	2N644	LL
2N428	LL	2N528	HF	2N645	LL
2N438	LL, HF	2N529	A	2N647	A
2N438A	HF	2N530	A	2N649	A
2N439	LL, HF	2N531	A	2N650	A
2N439A	HF	2N532	A	2N650A	A
2N440	LL, HF	2N533	A	2N651	A
2N440A	HF	2N534	A	2N651A	A
2N441	P	2N535	A	2N652A	A
2N442	P	2N535A	A	2N652	A
2N443	P	2N535B	A	2N653	A
2N444	HF	2N536	LL	2N654	A
2N444A	HF	2N537	HF	2N655	A
2N445	HF	2N538	P	2N656	P, HF
2N445A	HF	2N539	P	2N656A	HL
2N446	HF	2N540	P	2N657	P, HF
2N446A	HF	2N541	HF	2N657A	HL
2N447	HF	2N542	HF	2N658	LL
2N447A	HF	2N542A	HF	2N659	LL
2N448	HF	2N543	HF	2N660	LL
2N449	HF	2N543A	A	2N661	LL
2N450	LL	2N544	HF	2N662	LL
2N456	HL	2N545	HL	2N665	P
2N456A	HL	2N546	HL	2N669	P
2N457	HL	2N547	HL	2N670	LL
2N457A	HL	2N548	HL	2N671	HL
2N458	HL	2N549	HL	2N673	HL
2N458A	HL	2N550	HL	2N674	LL
2N459	HL	2N551	HL	2N675	HL
2N460	A	2N552	HL	2N677	P
2N461	A	2N553	P	2N677A	P
2N463	P	2N554	P	2N677B	P
2N464	A	2N555	P	2N677C	P
2N465	A	2N556	LL	2N678	P
2N466	SPA	2N557	LL	2N678A	P
2N467	A	2N558	LL	2N678B	P
2N469A	SP	2N559	LL	2N678C	P
2N470	A	2N560	LL	2N679	LL
2N471	A	2N561	P	2N695	HF
2N471A	HF	2N564	A	2N696	HF, HL
2N472	A	2N566	A	2N697	HF, HL
2N472A	A, HF	2N568	A	2N698	HF, HL
2N473	HF	2N570	A	2N699	HF, HL
2N474	HF	2N572	A	2N700	HF
2N474A	HF	2N574	P	2N700A	HF
2N475	HF	2N575	P	2N702	LL
2N475A	A	2N575A	P	2N705	LL
2N476	HF	2N576	LL	2N706	LL, HF
2N477	HF	2N576A	LL	2N706A	LL
2N478	HF	2N578	LL	2N706B	LL
2N479	HF	2N579	LL	2N706C	HF
2N479A	HF	2N580	LL	2N707A	LL
2N480	HF	2N581	LL, HF	2N707	LL
2N480A	A	2N582	LL, HF	2N708	HL
2N481	HF	2N583	LL	2N710	LL, HF
2N482	HF	2N584	LL	2N711	LL
2N484	HF	2N585	LL	2N714	LL
2N485	HF	2N586	LL	2N715	HF
2N486	HF	2N587	LL	2N716	HF
2N495	HF	2N588	HF	2N717	HL
2N496	HF	2N591	A	2N718	HL
2N496A	SP	2N592	A	2N718A	HL
2N497	P, HF	2N593	A	2N719A	HL
2N497A	HL	2N594	A	2N719	HL
2N498	P, HF	2N595	A	2N720	HL
2N498A	HL	2N596	A	2N721	HL
2N499	HF	2N597	LL	2N722	HL
2N500	P	2N598	LL	2N725	LL
2N501	LL	2N599	LL	2N726	A
2N501A	LL	2N600	LL	2N728	HF
2N502	HF	2N601	LL	2N729	HF
2N502A	HF	2N602	HF	2N730	HL
2N503	HF	2N603	HF	2N731	HL
2N504	HF	2N604	HF	2N734	A
2N508	A	2N609	A	2N735	A
2N511	P	2N610	A	2N736	A
2N511A	P	2N618	HL	2N738	A
2N511B	P	2N624	HF	2N739	A
2N512	P	2N627	P	2N740	A
2N512A	P	2N628	P	2N741	HF
2N512B	P	2N629	P	2N741A	HF
2N513	P	2N630	P	2N742	A
2N513A	P	2N631	A	2N743	HF
2N513B	P	2N632	A	2N744	HF
2N514	P	2N633	A	2N745	LL
2N514A	P	2N634	HF	2N746	LL
2N514B	P	2N634A	LL	2N747	LL
2N515	HF	2N635	LL, HF	2N748	LL
2N516	HF	2N635A	LL	2N749	HF
2N517	HF	2N636A	LL	2N750	HF
2N518	LL	2N636	HF	2N751	HF
2N519	LL, HF	2N637	HL	2N753	LL, HF
2N519A	HF	2N637A	HL	2N754	HF
2N520	LL	2N637B	HL	2N755	HF
2N520A	LL, HF	2N638	HL	2N756A	A
2N521	LL	2N638A	HL	2N757A	A
2N521A	LL	2N638B	HL	2N757B	A
2N522	LL	2N639	P	2N758A	A
2N522A	LL, HF	2N639A	P	2N759	A
2N523	LL	2N639B	P	2N759A	A
2N523A	P, HF	2N640	HF	2N760	A
2N524	A	2N641	HF	2N760A	A
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2N844	HF	2N1023	HF
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2N907	LL	2N1039	HL
2N908	LL	2N1040	HL
2N909	HL	2N1041	HL



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2N1055	HL	2N1163A	P
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2N1125	LL	2N1211	P
2N1128	A	2N1212	HL
2N1129	A	2N1213	LL
2N1130	A	2N1214	LL
2N1131	HL	2N1215	LL
2N1132	HL	2N1216	LL
2N1136	P	2N1217	LL
2N1136A	P	2N1218	P
2N1136B	P	2N1220	LL
2N1137	P	2N1221	LL
2N1137A	P	2N1222	LL
2N1137B	P	2N1223	LL
2N1138	P	2N1224	HL
2N1138A	P	2N1225	HF
2N1138B	P	2N1226	HF
2N1139	LL	2N1228	LL
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2N1147B	P	2N1243	LL

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## NS381-4 SERIES NPN HI-SPEED SWITCHING TRANSISTORS

... with low saturation voltages, high breakdown voltages, and low output capacities.

PARAMETER	CONDITIONS	NS381	NS382	NS383	NS384
Min. BV <sub>CEO</sub>	(I <sub>CE</sub> = 10mA)	20v	20v	12v	12v
Min. BV <sub>CER</sub>	(I <sub>CE</sub> = 10mA, R <sub>BE</sub> = 10Ω)	25v	25v	15v	15v
Min. BV <sub>EBO</sub>	(I <sub>EB</sub> = 10μA, I <sub>C</sub> = 0)	5v	5v	5v	5v
h <sub>FE</sub>	(I <sub>C</sub> = 3mA, V <sub>CE</sub> = .4v)	20-60	40-120	20-60	40-120
Max. V <sub>CE</sub>	(I <sub>C</sub> = 3mA, I <sub>B</sub> = .3mA)	.25v	.25v	.15v	.15v
Max. t <sub>ON</sub>	(I <sub>B1</sub> = 3mA, I <sub>B2</sub> = 1mA, V <sub>CC</sub> = 3v, R <sub>L</sub> = 270Ω)	15nsec	15nsec	15nsec	15nsec
Max. t <sub>OFF</sub>	(I <sub>B1</sub> = 3mA, I <sub>B2</sub> = 1mA, V <sub>CC</sub> = 3v, R <sub>L</sub> = 270Ω)	25nsec	25nsec	25nsec	25nsec
Max. t <sub>s</sub>	(I <sub>B1</sub> = I <sub>B2</sub> = I <sub>C</sub> = 10mA, V <sub>CC</sub> = 10v, R <sub>L</sub> = 1k)	15nsec	15nsec	12nsec	12nsec

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TRANSISTORS - 1961

### Cross Index (continued)

2N1244	LL	2N1337	HF	2N1442	A	2N1539	P	
2N1247	A	2N1339	P, HF	2N1444	HL	2N1539A	P	
2N1248	A	2N1340	P, HF	2N1446	A, LL	2N1540	P	
2N1250	HL	2N1341	P, HF	2N1447	A, LL	2N1540A	P	
2N1251	A	2N1344	LL	2N1448	A, LL	2N1541	P	
2N1252		2N1345	LL	2N1449	A, LL	2N1541A	P	
	HF, HL	2N1346	LL	2N1450	HF	2N1542	P	
2N1253		2N1347	LL	2N1451	A	2N1542A	P	
	HF, HL	2N1348	LL	2N1452	A	2N1543	P	
2N1254	LL	2N1349	LL	2N1453	P	2N1544	P	
2N1255	LL	2N1350	LL	2N1454	P	2N1544A	P	
2N1256	LL	2N1351	LL	2N1455	P	2N1545	P	
2N1257	LL	2N1352	A	2N1456	P	2N1545A	P	
2N1258	LL	2N1353	LL	2N1457	P	2N1546	P	
2N1259	LL	2N1354	LL	2N1458	P	2N1546A	P	
2N1261	P	2N1355	LL	2N1461	P	2N1547	P	
2N1262	P	2N1356	LL	2N1462	P	2N1547A	P	
2N1263	P	2N1357	LL	2N1463	P	2N1548	P	
2N1264	P	2N1358	HL	2N1464	P	2N1549	P	
2N1265	HF	2N1359	P	2N1465	P	2N1549A	P	
2N1266	A	2N1360	P	2N1466	P	2N1550	P	
2N1267	HF	2N1362	P	2N1469	HF	2N1550A	P	
2N1268	HF	2N1363	P	2N1470	P	2N1551	P	
2N1269	HF	2N1364	P	2N1471	A	2N1551A	P	
2N1270	HF	2N1365	P	2N1473	LL	2N1552	P	
2N1271	HF	2N1370	A	2N1474	A	2N1552A	P	
2N1272	HF	2N1371	A	2N1474A	A	2N1553	P	
2N1273	A	2N1372	A	2N1475	A	2N1553A	P	
2N1274	A	2N1373	A	2N1476	A	2N1554	P	
2N1275	LL	2N1374	A	2N1477	A	2N1554A	P	
2N1277	LL	2N1375	A	2N1479	P	2N1555	P	
2N1278	LL	2N1376	A	2N1480	P	2N1555A	P	
2N1279	LL	2N1377	A	2N1481	P	2N1556	P	
2N1280	LL	2N1378	A	2N1482	P	2N1556A	P	
2N1281	LL	2N1379	A	2N1483	P	2N1557	P	
2N1282	LL	2N1380	A	2N1484	P	2N1557A	P	
2N1284	LL	2N1381	A	2N1485	P	2N1558	P	
2N1288	LL	2N1382	A	2N1486	P	2N1558A	P	
2N1289	LL	2N1383	A	2N1487	P	2N1559	P	
2N1291	P	2N1384	LL	2N1488	P	2N1559A	P	
2N1292	P	2N1386	LL	2N1489	P	2N1560	P	
2N1293	P	2N1387	LL	2N1490	P	2N1560A	P	
2N1294	P	2N1388	HF	2N1491	HF	2N1561	P, HF	
2N1295	P	2N1389	HF	2N1492	HF	2N1562	P, HF	
2N1296	P	2N1390	HF	2N1493	HF	2N1564	A	
2N1297	P	2N1392	SP	2N1494	HF	2N1565	A	
2N1298	P	2N1393	SP	2N1499	LL	2N1566	P	
2N1299	LL	2N1394	SP	2N1501	P	2N1572	A	
2N1300	LL	2N1395	HF	2N1502	P	2N1573	A	
2N1301	LL	2N1396	HF	2N1504	P	2N1574	A	
2N1303	LL	2N1397	HF	2N1505	P, HF	2N1605	LL	
2N1304	LL	2N1398	HF	2N1506	P, HF	2N1605A	LL	
2N1305	LL	2N1399	HF	2N1507	HF	2N1609	HL	
2N1306	LL	2N1400	HF	2N1515	HF	2N1610	HL	
2N1307	LL	2N1401	HF	2N1515/	HF	2N1611	HL	
2N1308	LL	2N1401A	OC169	2N1516	HF	2N1612	HL	
2N1309	LL	2N1402	HF	2N1516	HF	2N1613	HL	
2N1310	A, SP	2N1405	HF	2N1517	LL		HF, HL	
2N1311	A, SP	2N1406	HF	2N1517A	HF	2N1614	LL	
2N1312	A, SP	2N1407	HF	2N1518	HL	2N1616	P	
2N1313	A	2N1408	HF	2N1519	HL	2N1617	P	
2N1314	A	2N1409	SP	2N1520	HL	2N1618	P	
	1314/		HF, HL	2N1521	HL	2N1619	P	
	OC26	P	2N1409A	HL	2N1522	HL	2N1620	HL
2N1315	A	2N1410		2N1523	HL	2N1623	A	
2N1316	LL		HF, HL	2N1524	HF	2N1631	HF	
2N1317	LL	2N1410A	HL	2N1525	HF	2N1632	HF	
2N1318	LL	2N1411A	HF	2N1526	HF	2N1633	HF	
2N1319	LL	2N1412	HL	2N1527	HF	2N1634	HF	
2N1320	P	2N1413	LL	2N1529	P	2N1635	HF	
2N1321	P	2N1414	LL	2N1530	P	2N1636	HF	
2N1322	P	2N1415	LL	2N1530A	P	2N1637	HF	
2N1323	P	2N1417	HF	2N1531	P	2N1638	HF	
2N1324	P	2N1418	HF	2N1531A	P	2N1639	HF	
2N1325	P	2N1420	LL, HF	2N1532	P	2N1640	HL	
2N1326	P	2N1425	HF	2N1532A	P	2N1641	LL	
2N1327	P	2N1426	HF	2N1533	P	2N1642	LL	
2N1328	P	2N1428	HF	2N1534	P	2N1645	HF	
2N1329	P	2N1429	HF	2N1534A	P	2N1646	HF	
2N1330	P	2N1431	A	2N1535	P	2N1647	P	
2N1331	P	2N1432	A	2N1535A	P	2N1648	P	
2N1332	P	2N1437	P	2N1536	P	2N1649	P	
2N1333	P	2N1438	P	2N1536A	P	2N1650	P	
2N1334	P, LL	2N1439	P	2N1537	P	2N1651	P	
2N1335	P, HF	2N1440	A	2N1537A	P	2N1652	P	
2N1336	P, HF	2N1441	A	2N1538	P	2N1653	P	

2N1654	A	2N1899	P, HF	C652	SP	OC53	A
2N1655	A	2N1900	P, HF	C653	SP	OC54	A
2N1656	A	2N1901	P, HF	CF45017	HL	OC55	A
2N1657	P	2N1905	P	CK4	A	OC56	A
2N1658	P	2N1906	P	CK4A	A	OC57	A
2N1659	P	2N1917	A	CK13	HF	OC58	A
2N1660	P	2N1918	A	CK14	HF	OC59	A
2N1661	P	2N1919	A	CK16	HF	OC60	A
2N1662	P	2N1920	A	CK17	HF	OC74	A
2N1663	LL	2N1921	A	CK17A	A	OC79	A
2N1665	HF	2N1922	A	CK22	A	OC80	LL
2N1667	HL	2N1924	A	CK22A	A	OC139	LL
2N1668	HL	2N1925	A	CK22B	A	OC140	LL
2N1669	HL	2N1926	A	CK22C	A	OC141	LL
2N1670	A	2N1936	P	CK25	LL	OC170	HF
2N1672	A	2N1937	P	CK25A	A	OC171	HF
2N1676	HF	2N1944	A	CK26	LL	OC200	A
2N1677	HF	2N1945	A	CK26A	A	OC201	A
2N1678	A	2N1946	A	CK27	LL	OC270	A
2N1681	HF	2N1947	A	CK27A	A	PADT20	HF
2N1683	LL	2N1948	A	CK28	LL	PADT21	HF
2N1684	HF	2N1949	A	CK28A	A	PADT22	HF
2N1692	P	2N1950	A	CK64	A	PADT23	HF
2N1693	P	2N1951	A	CK64A	A	PADT24	HF
2N1701	HL	2N1952	A	CK64B	A	PADT25	HF
2N1702	HL	2N1954	LL	CK64C	A	PADT26	HF
2N1705	A	2N1955	LL	CK65A	A	PADT27	HF
2N1706	A	2N1956	LL	CK65B	A	PADT28	HF
2N1707	A	2N1957	LL	CK65C	A	PADT29	HF
2N1709	P, HF	2N1958	HF	CK66	A	PADT30	HF
2N1710	P, HF	2N1959	HF	CK66B	A	PADT31	HF
2N1711	HL	2N1960	HF	CK66C	A	PADT40	LL
2N1714	P	2N1961	HF	CK67	A	PADT50	HL
2N1715	P	2N1962	HF	CK67A	A	PADT51	LL
2N1716	P	2N1963	HF	CK67B	A	PADT60	SP
2N1717	P	2N1964	HF	CK67C	A	PT600	HF
2N1718	P	2N1965	HF	CK261	A	PT601	HF
2N1719	P	2N1969	HF	CK262	A	PT850	HF
2N1720	P	2N1970	HL	CK419	LL	PT850A	HF
2N1721	P	2N1971	HL	CK420	LL	PT900	P
2N1722	P	2N1972	HL	CK421	LL	RT409	HL
2N1723	P	2N1973	HL	CK474	LL	RT482	HL
2N1724	P	2N1974	HL	CK475	LL	RT483	HL
2N1726	HF	2N1975	HL	CK476	LL	RT484	HL
2N1727	HF	2N1978	HL	CK477	LL	RT497M	HL
2N1728	HF	2N1983	HL	CDT1310	P	RT498M	HL
2N1730	A	2N1984	HL	CDT1311	P	RT656M	HL
2N1731	A	2N1985	HL	CDT1312	P	RT657M	HL
2N1742	HF	2N1986	HL	CDT1313	P	RT696M	HL
2N1743	HF	2N1987	HL	CDT1319	P	RT696AM	HL
2N1744	HF	2N1988	HL	CDT1320	P	RT697M	HL
2N1745	HF	2N1989	HL	CDT1321	P	RT697AM	HL
2N1746	HF	2N1990	HL	CDT1322	P	RT698M	HL
2N1747	HF	2N1991	HL	CST1739	P	RT699M	HL
2N1748	HF	2N1994	LL	CST1740	P	RT1420M	HL
2N1749	HF	2N1995	LL	CST1741	P	RT1613M	HL
2N1750	HF	2N1996	LL	CST1742	P	RT5151	HL
2N1752	HF	2N1997	LL	CST1743	P	RT5152	HL
2N1754	LL	2N1998	LL	CST1744	P	RT5202	HL
2N1755	P	2N1999	LL	CST1745	P	RT5203	HL
2N1756	P	2N2000	LL	CST1746	P	RT5204	HL
2N1757	P	2N2001	LL	CTP1104	P	RT5212	HL
2N1758	P	2N2002	LL	CTP1105	P	RT5230	HL
2N1759	P	2N2003	LL	CTP1108	P	SO-1	HF
2N1760	P	2N2004	LL	CTP1109	P	SO-2	HF
2N1768	HL	2N2005	LL	CTP1500	P	SO-3	HF
2N1769	HL	2N2006	LL	CTP1503	P	ST15	HF
2N1779	LL	2N2007	LL	CTP1504	P	ST35	HF
2N1780	LL	2N2018	P	CTP1508	P	ST45	HF
2N1781	LL	2N2019	P	CTP1544	P	ST401	HL
2N1782	HF	2N2020	P	CTP1552	P	ST440	P
2N1783	HF	2N2021	P	CTP1553	P	ST450	P
2N1784	HF	3N34	HF	CTP1728	P	ST4201	P
2N1785	HF	3N35	HF	GK13A	HF	ST4203	P
2N1786	HF	3N36	HF	GK16A	HF	ST4204	P
2N1787	HF	3N37	HF	GT74	A	STC1103	HL
2N1788	HF	3N45	P	GT81	A	STC1104	HL
2N1789	HF	3N46	P	GT109	A	TMT839	HF
2N1790	HF	3N47	P	GT123	LL	TMT840	HF
2N1837	HF	3N48	P	GT1200	SP	TMT841	HF
2N1837A	HF	3N49	P	GT1624	SP	TMT842	HF
2N1838	HF	3N50	P	KGS1004	LL	TMT843	HF, LL
2N1838A	HF	3N51	P	KGS1005	LL	TMT843	HF, LL
2N1839	HF	3N52	P	LT11	P	WX115UA	P
2N1839A	HF	3N54	P	LT12	P	WX115UB	P
2N1840	HF	B177	P	LT13	P	WX115UC	P
2N1840A	HF	B178	P	LT14	P	WX115UD	P
2N1841	P	B179	P	LT15	P	WX115WA	P
2N1864	HF	B1085	HL	MA-1	HF	WX115WB	P
2N1865	HF	B1154	LL	MA-2	HF	WX115WC	P
2N1866	HF	B1154A	LL	NS345	LL	WX115WD	P
2N1867	HF	C101	LL	OC22	HL	WX115XA	P
2N1868	HF	C102	LL	OC23	HL	WX115XB	P
2N1886	P	C103	LL	OC24	HL	WX115XC	P
2N1889	HL	C106	LL	OC28	HL	WX115XD	P
2N1890	HL	C301	LL	OC29	HL	WX118UA	P
2N1893	HL	C302	LL	OC30	P	WX118UB	P
2N1894	P	C611	SP	OC35	HL	WX118UC	P
2N1895	P	C612	SP	OC36	HL	WX118XA	P
2N1896	P	C613	SP	OC44	HF	WX118XB	P
2N1897	P	C614	SP	OC45	HF	WX118XC	P
2N1898	P	C650	SP	OC46	LL		
2N1899	P	C651	SP	OC47	LL		



**There's a Better Way...** to cool a transistor. The fish don't like this sort of briny nonsense, either. The one on the left is a rare species known as *Pisces Lingua*, or underwater talking fish. He's telling the rest of his buddies that some irate electronics engineer probably gave this transistor the deep six because of thermal runaway. Or maybe its derating curve was all wet. The other fish are mute on the matter. They could inform *Pisces Lingua* that the Birtcher Corporation makes a semiconductor heat radiator that would not only cool the transistor, but boost its efficiency 25% to 27%. But they refrain from comment because there's a hungry gleam in his eye. If this makes you hungry to do business with me, write today for my catalog and other stuff. Don't ask me to send you any fish. But I'll send you an Honorary Membership Certificate to my Society. Write to: Charles F. Booher, Secretary, *There's a Better Way Society of America, Inc., The Birtcher Corporation* / Industrial Division, 745 S. Monterey Pass Rd., Monterey Park, California; phone ANgelus 8-8584, TWX LA 2177.



*Cool!*  
Write for my  
non-fishy Transistor  
Radiator Catalog



**B** Sizes available for just about every commonly used transistor. So yours are different? Maybe I'll provide a radiator anyway — no hooks.

CIRCLE 67 ON READER-SERVICE CARD



# Transistor Data Sheets— What They Mean and How to Use Them Properly

ELECTRONIC DESIGN's *Ninth Annual Transistor Data Chart* (p 33) contains 1714 transistor types with abbreviated specifications. For complete details on the various transistor parameters and explanation of the test conditions used, reference to manufacturers' data sheets is necessary. Thus, the *Transistor Data Chart* is intended to guide the design engineer to several types; the specific selections is then based on complete device characteristics and price as obtained from the manufacturer. The relationship which exists between published characteristics and design requirements is discussed and a useful circuit design check list is included.

Mitchell Baker, Jordan V. Sukert  
Motorola Semiconductor Div., Inc.  
Phoenix, Ariz.

**A** WELL-PREPARED transistor data sheet, properly interpreted by a circuit design engineer, is an extremely useful design aid. To meet the present demands for circuit and systems reliability, an understanding of transistor specifications and their relationship to design requirements is a valuable design asset.

## Basic Structure of a Transistor Data Sheet

A modern, well-prepared data sheet should provide the design engineer with all the necessary information for selecting a transistor capable of performing a particular job. To accomplish this, the data sheet is normally divided into six general sections. A description of the device is given first, followed by sections on absolute ratings, electrical and thermal characteristics, mechanical data and applications information.

The description of the device usually gives the broad general application which permits the designer to classify transistors ac-

ording to his specific requirements. Thus, a typical power transistor description might indicate whether the unit was designed for audio work or switching applications. In addition, the power and/or current rating is specified, the polarity (pnp or npn) is given, and the type of material is indicated. At a glance, therefore, the engineer can determine if a particular transistor or group of transistors is suitable for using in a particular purpose.

From this point, however, the selection of a specific transistor for a particular project becomes more involved. The unit must be considered in terms of its various electrical ratings and characteristics to make sure that it fits the application from every conceivable standpoint. In addition, the engineer is responsible for selecting the least expensive transistor.

## Distinction Between Ratings and Characteristics

A rating is defined as a limiting value assigned by the manufacturer which, if exceeded, may result in permanent damage to the device. On the other hand, a characteristic is a measurable property of the device under specific operating conditions for

which the transistor will provide satisfactory and reliable performance.

Absolute Maximum Ratings are those ratings beyond which degradation regarding the life and reliability of a transistor may be expected. These ratings are based on internal physical construction, semiconductor material and manufacturing processes. Because these are "ratings", most data sheets will not indicate test conditions under which these "ratings" are specified. Therefore, "ratings" are the extreme capabilities of a transistor and are not intended to be used as design conditions.

For example, under absolute maximum ratings, the letter *B* placed before a characteristic symbol usually means breakdown. Therefore,  $BV_{CBO}$ ,  $BV_{CEO}$ ,  $BV_{CER}$ ,  $BV_{CER}$ , and  $BV_{EBO}$  represent the breakdown ratings of the device; when these ratings are exceeded, an avalanche or breakdown condition may take place and destroy a transistor. Breakdown is dependent upon temperature and an

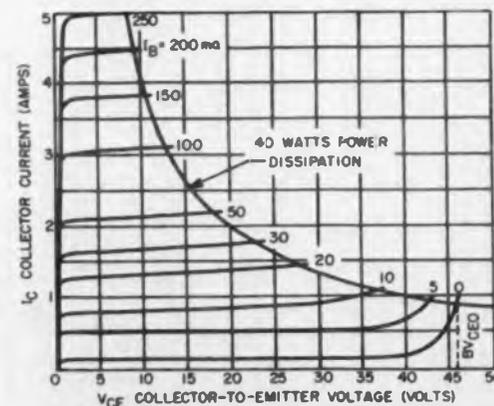


Fig. 1. Typical output characteristics of a Motorola 2N1530 power transistor.

If you would like an additional copy of the Transistor Data Chart Section circle 251 on the Reader-Service Card.

arbitrary voltage and current condition, the combination of which can trigger the avalanche effect.

As a practical example, the graph in Fig. 1 illustrates the typical output characteristics of a 2N1530 power transistor. The absolute maximum voltage  $BV_{CEO}$  is shown as being 45 v, the absolute maximum current is shown as 5 amp.

With an absolute maximum power rating of 90 w (as shown on the data sheet for this particular transistor), it is now possible for the design engineer to calculate and plot a maximum voltage-current relationship which must not be exceeded.

Thermal characteristics, listed with the absolute maximum ratings, are expressed in degrees C per watt and define the dissipation capability of the transistor regarding the junction temperature in relation to the transistor case temperature.

### Electrical Characteristics Indicate Design Centers

Whereas the absolute maximum specifications provide the limits beyond which reliable operation cannot be obtained, this section of the data sheet contains the device design centers. When discussing any specific characteristics, the test conditions must be defined in order to achieve a common understanding between the user and the manufacturer of the transistor. Almost every parameter listed on a data sheet is subject to variation among manufacturers due to these test conditions. Motorola data sheets covering the power transistor series from 2N1539 through 2N1548 will be used to discuss each parameter in order. (See Fig. 2).

**Collector-Base Leakage Currents:**  $I_{CBO}$  is a term initially used to signify the quality of a transistor. Actually, three very definite  $I_{CBO}$ 's are of importance to the designer. The first is the reading taken at some low collector-base voltage, in this case, 2 v, with a maximum value of  $I_{CBO}$  indicated at this voltage. This value, for all practical purposes, represents the thermal component of the collector current which cannot be reduced by further decrease of  $V_{CB}$ . As the ambient temperature increases, the leakage current increases. Using the arbitrary rule that the thermal component of current will double for every 10 C, the design engineer can pinpoint the temperature component of the leakage current.

**Collector-Base Voltage Characteristics:** The second component of  $I_{CBO}$  which is important in high-temperature usage is the current due to the collector-base voltage with the emitter

### ELECTRICAL CHARACTERISTICS, GENERAL (At 25°C Case Temperature unless otherwise specified)

Parameter	Symbol	Min	Typ	Max	Unit
Collector-Base Cutoff Current $V_{CB} = -25V$ , 2N1539, 2N1544 $V_{CB} = -40V$ , 2N1540, 2N1545 $V_{CB} = -55V$ , 2N1541, 2N1546 $V_{CB} = -65V$ , 2N1542, 2N1547 $V_{CB} = -80V$ , 2N1543, 2N1548	$I_{CBO}$	—	—	2.0	mA
Collector-Base Cutoff Current $V_{CB} = -2V$ (all types)	$I_{CBO}$	—	—	200	$\mu A$
Collector-Base Cutoff Current at $T_c = +90^\circ C$ at $V_{CB} = \frac{1}{2} BV_{CB}$ rating	$I_{CBO}$	—	—	20	mA
Emitter-Base Cutoff Current $V_{EB} = 12V$ (all types)	$I_{EBO}$	—	—	0.5	mA
Collector-Emitter Breakdown Voltage $I_c = 500mA$ , $V_{EB} = 0$	$BV_{CE}$	30	—	—	volts
2N1539, 2N1544		45	—	—	
2N1540, 2N1545		60	—	—	
2N1541, 2N1546		75	—	—	
2N1542, 2N1547		90	—	—	
2N1543, 2N1548		—	—	—	
Collector-Emitter Leakage Current $V_{BE} = 1.0V$ $V_{CE} = 40$ , 2N1539, 2N1544 $V_{CE} = 60$ , 2N1540, 2N1545 $V_{CE} = 80$ , 2N1541, 2N1546 $V_{CE} = 100$ , 2N1542, 2N1547 $V_{CE} = 120$ , 2N1543, 2N1548	$I_{CE}$	—	—	20	mA
Collector-Emitter Breakdown Voltage $I_c = 500mA$ , $I_B = 0$	$BV_{CEU}$	20	—	—	volts
2N1539, 2N1544		30	—	—	
2N1540, 2N1545		40	—	—	
2N1541, 2N1546		50	—	—	
2N1542, 2N1547		60	—	—	
2N1543, 2N1548		—	—	—	
Collector-Base Breakdown Voltage $I_c = 20mA$	$BV_{CBO}$	40	—	—	volts
2N1539, 2N1544		60	—	—	
2N1540, 2N1545		80	—	—	
2N1541, 2N1546		100	—	—	
2N1542, 2N1547		120	—	—	
2N1543, 2N1548		—	—	—	

### ELECTRICAL CHARACTERISTICS, COMMON EMITTER (At 25°C Case Temperature unless otherwise specified)

Current Gain $V_{CE} = -2V$ , $I_c = 3A$ 2N1539, 2N1540, 2N1541, 2N1542, 2N1543 2N1544, 2N1545, 2N1546, 2N1547, 2N1548	$h_{FE}$	50 75	—	100 150	—
Base-Emitter Drive Voltage $I_c = 3A$ , $I_B = 300mA$ 2N1539, 2N1540, 2N1541, 2N1542, 2N1543 2N1544, 2N1545, 2N1546, 2N1547, 2N1548	$V_{BE}$	—	—	0.7 0.5	volts
Collector Saturation Voltage $I_c = 3A$ , $I_B = 300mA$ 2N1539, 2N1540, 2N1541, 2N1542, 2N1543 2N1544, 2N1545, 2N1546, 2N1547, 2N1548	$V_{CE(sat)}$	—	0.2 0.1	0.6 0.3	volts
Frequency Cutoff $V_{CE} = -2V$ , $I_c = 3A$ 2N1539, 2N1540, 2N1541, 2N1542, 2N1543 2N1544, 2N1545, 2N1546, 2N1547, 2N1548	$f_{\beta}$	—	4 4	—	kc
Switching Characteristics $I_c = 3A$ Delay + Rise Time 2N1539, 2N1540, 2N1541, 2N1542, 2N1543 2N1544, 2N1545, 2N1546, 2N1547, 2N1548 Storage Time 2N1539, 2N1540, 2N1541, 2N1542, 2N1543 2N1544, 2N1545, 2N1546, 2N1547, 2N1548 Fall Time 2N1539, 2N1540, 2N1541, 2N1542, 2N1543 2N1544, 2N1545, 2N1546, 2N1547, 2N1548	$t_d + t_r$  $t_s$  $t_f$	— — — —	5 5 3 3 5 8	— — — —	$\mu sec$  $\mu sec$  $\mu sec$
Transconductance $V_{CE} = -2V$ , $I_c = 3A$ 2N1539, 2N1540, 2N1541, 2N1542, 2N1543 2N1544, 2N1545, 2N1546, 2N1547, 2N1548	$g_m$	3.0 5.0	6.0 7.5	— —	mhos

Fig. 2. Electrical characteristics contained in a transistor data sheet.

open. The data sheet indicates that  $V_{CB}$  at 25 v on the 2N1539 power transistor produces a maximum leakage of 2 ma. This voltage component is not temperature sensitive. Therefore, the design engineer wishing to determine his leakage value at some higher temperature (e.g.  $T_j = 75^\circ C$ ), can safely assume that the maximum increase in the thermal component of leakage current will be 32 times 200  $\mu A$  (using the "doubling-every-10 C" rule). Adding to this the 2-ma

voltage component results in a value of 8.4 ma maximum leakage at 75 C with 25 v across the transistor. All future references to temperature will refer to the transistor case temperature and not the ambient temperature.

**High-Temperature Collector-Base Leakage Currents:** Since there are many voltages and many applications to be considered, it is difficult for any manufacturer to specify leakage under all voltages at all tempera-



## TRANSISTORS - 1961

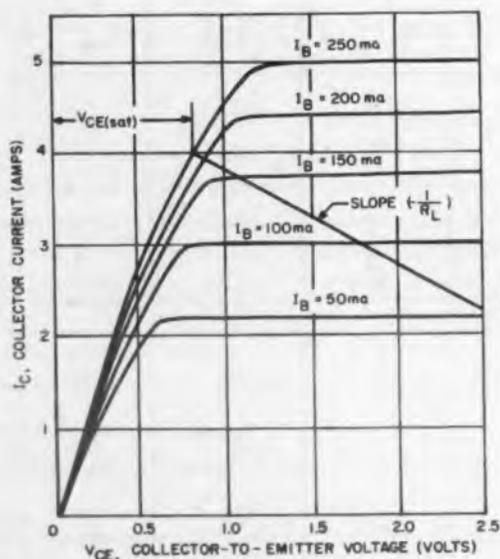


Fig. 5. Output characteristics of the 2N351A with the saturation region indicated.

tures hence, the third  $I_{CBO}$ . Motorola specifies a guaranteed maximum leakage at 90 C at a voltage level well within reliable usage of any given transistor. The selection of the one-half collector-emitter breakdown voltage ( $BV_{CES}$ ) rating for the high temperature test is an arbitrary one but is established at a point where the manufacturer knows the device will be in a reliable operating area.

**Emitter-Base Cut-Off Current ( $I_{EBO}$ ):** One of the least used parameters on a data sheet is  $I_{EBO}$ . It is well to know the  $I_{EBO}$  limit of any given junction within a transistor; therefore this limit is shown at a region where most design will be taking place. The emitter-base diode breakdown voltage rating is indicated by the  $BV_{EBO}$  listed under the absolute maximum ratings.

**Collector-Emitter Leakage Current ( $I_{CEX}$ ):** The X in this symbol means that there is

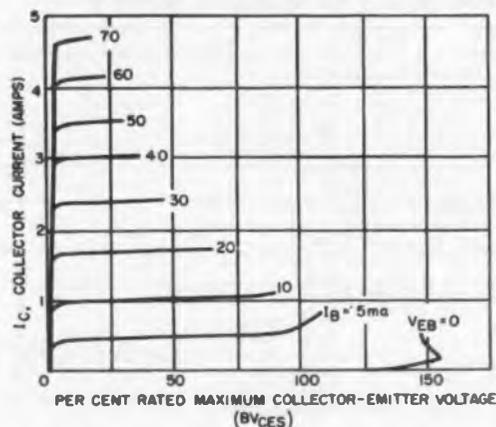


Fig. 3. Collector characteristics of a power transistor in a common emitter connection.

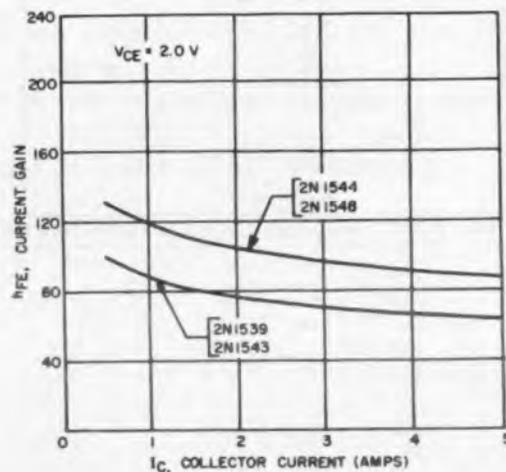


Fig. 4. The current gain,  $h_{FE}$  of alloy transistors decreases with increased collector current.

some known back-bias voltage applied to the base-emitter diode. For each transistor, this back-bias must be specified as a test condition for any given  $I_{CEX}$  or  $BV_{CEX}$  rating. This rating is very useful in designing power converters where one transistor is conducting while the other transistor is back-biased in the off condition waiting for transformer action to turn it back on. It is more convenient to apply a given voltage and guarantee that the current will not be above a certain maximum value than to apply a test current and see if the voltage will be above a certain minimum value. The latter test could be related to a second breakdown type of relationship. On many diodes, applying a given test current could show a voltage rating of many volts above the manufacturer's listed rating. The collector-emitter could, for example, possibly with-

stand 150 to 200 v; however, power dissipation could be exceeded.

**Collector-Emitter Breakdown ( $BV_{CES}$ ):** The most important rating that the engineer can consider when selecting the transistor for his circuit is  $BV_{CES}$ , see Fig. 3.

Almost all power transistor applications require source voltages, collector-to-emitter, thus  $V_{CE}$  ratings must be equal to or larger than the source voltage; inductive loads will make this requirement higher. For the design engineer, a useful rating would be  $BV_{CER}$  which falls between  $BV_{CES}$  and  $BV_{CEO}$  in alloy transistors. On many test conditions, high dissipation can be experienced with the combination of test voltage and test current. Therefore, many tests are specified as sweep tests or pulse tests where the duty cycle is low enough that the maximum junction temperature is not exceeded. These tests should be performed with the transistor mounted on an adequate heat sink.

**Collector-Emitter Breakdown Voltage with the Base Open ( $BV_{CEO}$ ):** This test is related to  $I_{CBO}$  and the gain characteristic  $h_{FE}$ . With the base open, a condition can be reached where  $h_{FE}$  will multiply the  $I_{CBO}$  at a given voltage and start an avalanche condition as the junction temperature rises due to self-heating. This can quickly reach breakdown conditions if not carefully tested by the sweep method.

A possible cause of transistor failure is lack of  $BV_{CEO}$ , especially at high voltages; this condition is often encountered in application such as series-regulated power supplies and power amplifiers. In switching circuits, this condition can exist when the transistor is switched from on to off, thus passing a region where the base has infinite resistance or is essentially open.

**Collector-Base Breakdown Voltage ( $BV_{CBO}$ ):** This rating will show the limitation of the collector-base junction, but is a rating which is only occasionally used in actual circuit considerations. Many engineers make the error of selecting a transistor based on this parameter putting themselves into a high-priced, low-availability category, when actually the true ratings could have been defined by  $BV_{CER}$ . Circuits should be carefully analyzed to determine if  $BV_{CBO}$  or some collector-to-emitter rating is the controlling factor under the worst conditions.

**Current Gain ( $h_{FE}$ ):** This is the most arbitrary of all test conditions listed on a data sheet. For alloy transistors, current-gain is a function of collector current and in most

cases will decrease when  $I_c$  increases, see Fig. 4.

It is best to design around data sheet limits. However, circuit requirements could dictate current gain spreads. Under these circumstances, it would be beneficial for the design engineer to work closely with the manufacturer to obtain a special device. This parameter is one that will vary to some degree with life, and is therefore used as an end-of-life characteristic.

**Base to Emitter Voltage ( $V_{BE}$ ):** This parameter denotes the input voltage at the specified test condition, required in the design of power converters and switching circuits. The test for this parameter is usually performed with the transistor in saturation. **Saturation Voltage ( $V_{CE sat}$ ):** Saturation voltage  $V_{CE sat}$  (Fig. 5) is the minimum voltage necessary to maintain normal transistor action at a particular collector current. At collector voltages lower than  $V_{CE sat}$ , the base-collector diode is forward biased and the current-voltage relationship changes abruptly. Thus, the saturation voltage is the minimum collector-emitter voltage required to maintain full conduction when enough base drive is supplied; further applications of base drive will reduce  $V_{CE sat}$ . Since the  $V_{CE sat}-I_c$  curve is almost a straight line, some transistor manufacturers list the characteristic as saturation resistance ( $V_{CE sat}$ ).

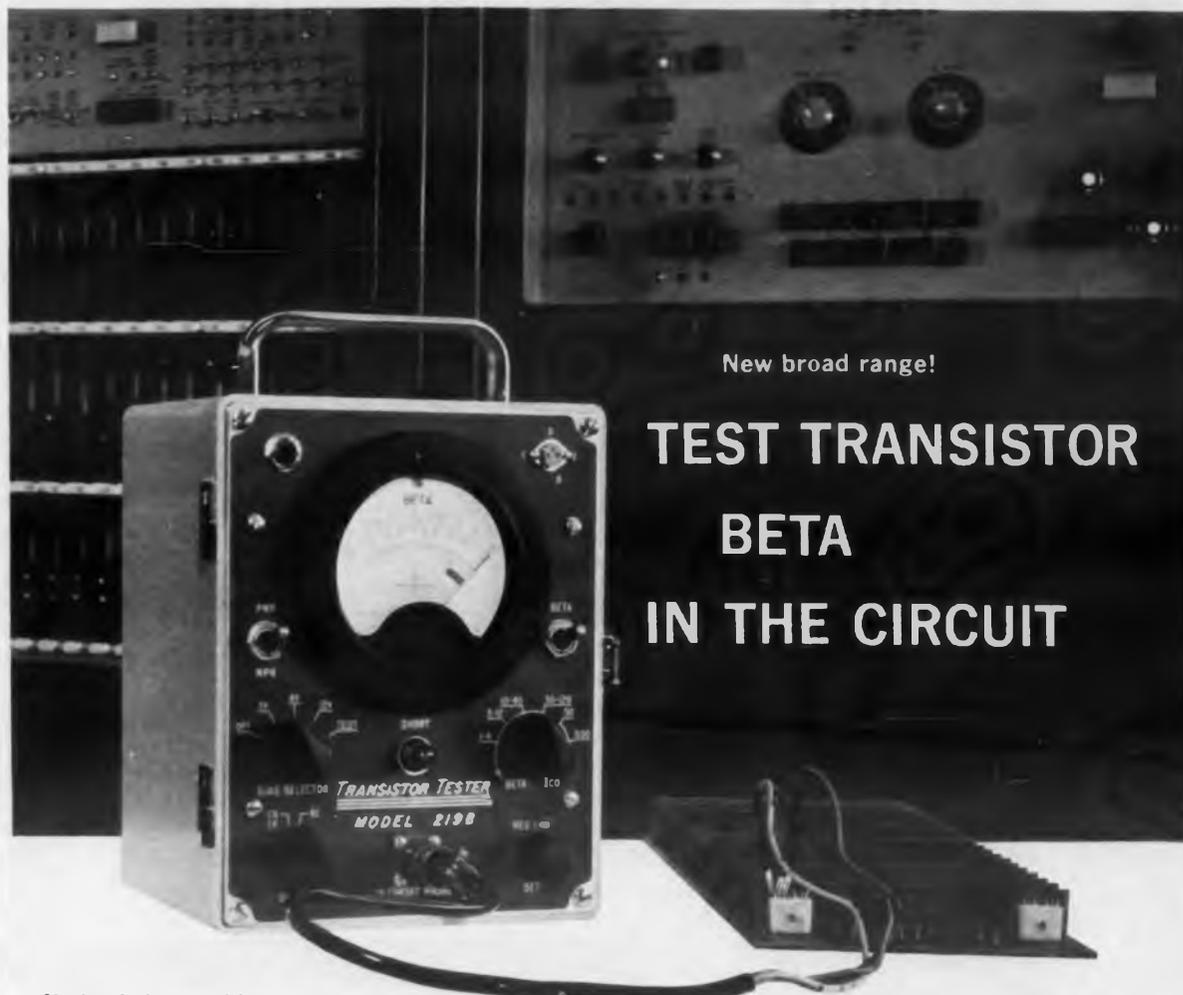
Transistor efficiency in converters is a function of switching speed and power dissipated in the fully-on condition. A very low saturation voltage is extremely desirable and is a function of the collector current and base current drive. Saturation voltage rises with an increase in collector current and is inversely related to the gain ( $h_{FE}$ ) of the transistor.

**Common Emitter-Cut-Off Frequency ( $f_{ce}$ ):** Current gain frequency cut-off ( $f_{ce}$ ) for the common emitter configuration, (also called the beta cut-off frequency) is the frequency where the small-signal, forward-current gain is 0.707 of the current gain value at a given reference frequency. The common base frequency cut-off  $F_{cb}$ , (generally not specified for power transistors) is approximately equal to  $h_{FE}$  times  $F_{ce}$ .

#### Power Transistor Circuit Design Check List

Without going into details of the external circuit requirements, the following questions should be considered during selection of a proper power transistor.

(continued on p 80)



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	*Beta readings to 300 may be approximated.

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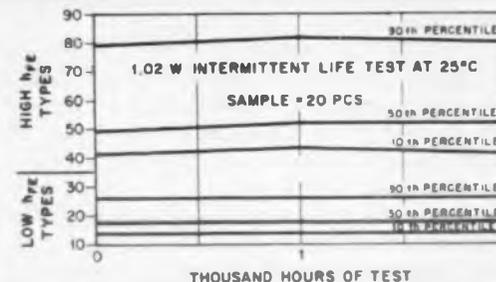
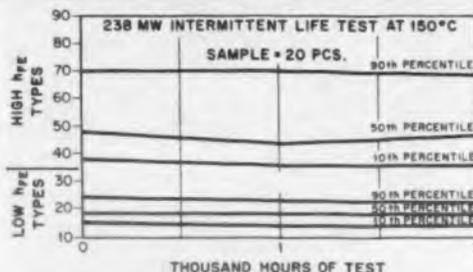
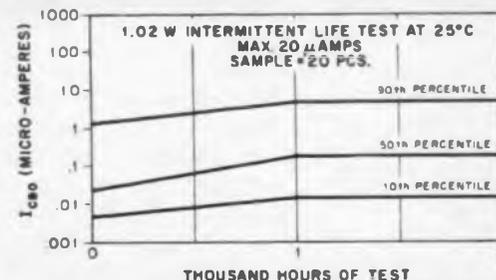
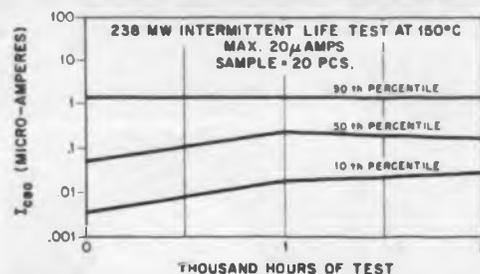
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## Absolute Maximum Ratings (25°C)

Collector to Base	2N497A	2N498A	2N456A	2N457A	volts
V <sub>CB0</sub>	60	100	60	100	volts
Collector to Emitter	60	100	60	100	volts
V <sub>CE0</sub>	60	100	60	100	volts
Emitter to Base	8	8	8	8	volts

Temperatures	T <sub>STG</sub>	Operating Junction	T <sub>J</sub>
Storage	-65 to 200°C		
Operating Junction		-65 to 200°C	

Total Dissipation  
Free Air @ 25°C - 1 watt\*  
Case Temperature @ 25°C - 5 watts\*\*  
\*Derate 5.72 mw/°C increase in ambient temperature above 25°C  
\*\*Derate 28.6 mw/°C increase in case temperature above 25°C

## Electrical Characteristics (25°C) unless otherwise specified

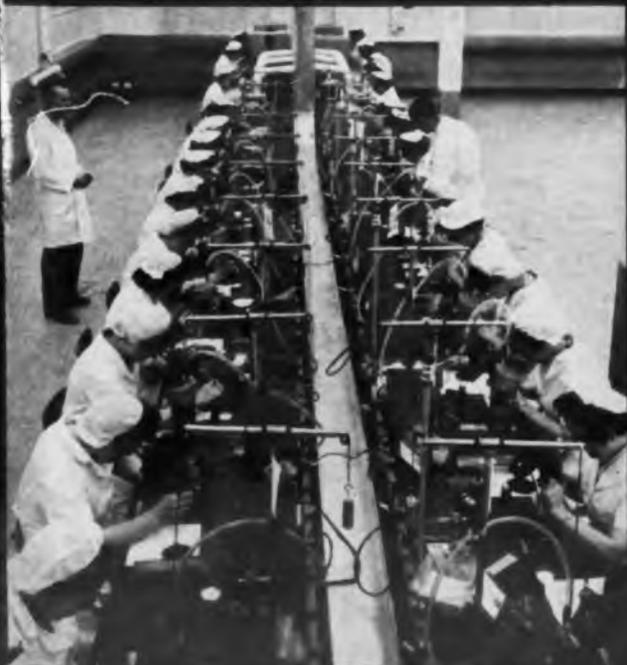
### D-C Characteristics

	2N497A		2N498A		2N456A		2N457A		
	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	
Collector to Base Voltage (I <sub>C</sub> = 100 $\mu$ a, I <sub>B</sub> = 0)	60		100		60		100		volts
Collector to Emitter Voltage (I <sub>C</sub> = 250 $\mu$ a)	60		100		60		100		volts
Collector to Emitter Voltage (I <sub>C</sub> = 16 ma)	60				60				volts
Collector to Emitter Voltage (I <sub>C</sub> = 10 ma)			100				100		volts
Emitter to Base Voltage (I <sub>E</sub> = 250 $\mu$ a, I <sub>C</sub> = 0)	8		8		8		8		volts
Forward Current Transfer Ratio* (I <sub>C</sub> = 200 ma, V <sub>CE</sub> = 10V)	12	36	12	36	30	90	30	90	
Base Input Resistance* (I <sub>B</sub> = 8 ma, V <sub>CE</sub> = 10V)		200		200		200		200	ohms
Saturation Resistance* (I <sub>B</sub> = 40 ma, I <sub>C</sub> = 200 ma)		10		10		10		10	ohms
Cutoff Characteristics									
Collector Current (I <sub>B</sub> = 0, V <sub>CE</sub> = 30V)		10		10		10		10	$\mu$ a
Collector Current (High Temperature) (I <sub>B</sub> = 0, V <sub>CE</sub> = 30V, T <sub>A</sub> = 150°C)		250		250		250		250	$\mu$ a

\*Pulse Test: 300  $\mu$ sec. 2% Duty Cycle

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## TRANSISTORS - 1961

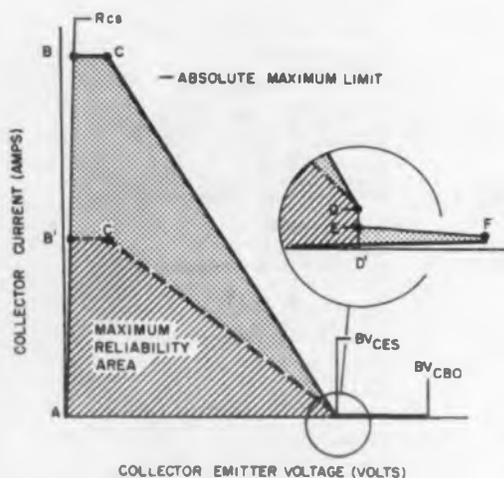


Fig. 6. The reliable area of collector operation is contained within the shaded region shown.

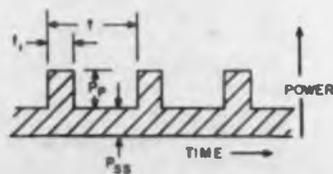
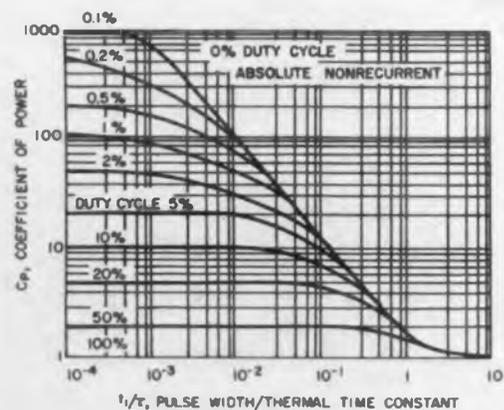


Fig. 7. Curves used in determining peak power of a power transistor.

1. What will the maximum load current requirement be?
2. What is the output voltage desired and what are the low and high line values of the source or input voltage?
3. What driving power is available? This factor is needed to determine the dc current gain required for the maximum and minimum load currents.
4. What type of heat sink will be available?
5. What will the ambient temperature excursions be?
6. Are there any frequency requirements such as a response to a step function?
7. What are the cost limitations and availability requirements when considering large scale production?

In referring to the above questions, perhaps the most critical point is the collector-emitter voltage requirement for the specific design conditions. Knowing the voltage extremes and the maximum load current, the power dissipation must be considered in relationship to the heat sink available. With this knowledge, a search is then made for the thermal resistance or power dissipation capability of a suitable device. At this point, a decision might be required necessitating parallel operation for excessive load current requirements or series operation for high-voltage applications.<sup>2</sup> Series or parallel operation is well worth considering because of the lower price and better availability of less-specialized types. If heat sink considerations limit single power transistor dissipation capability, series operation may be attractive. For a given heat sink size and a stated maximum dissipation, the individual junction temperature rise for two transistors in series will be one-half the rise of a single unit. The same advantage is offered with parallel operation.

Assume a condition of 80 C case temperature and power dissipation sufficient to raise the junction temperature of a single unit to 105 C. This would indicate a power dissipation of approximately 30 w if the thermal resistance junction to case was 0.8 C per watt. This 30 w would be divided between two transistors if series operation was used therefore dissipating 15 w per unit or a junction temperature rise of 12.5 C per transistor. The junction temperature will now be 92.5 C for both devices instead of the single unit at 105 C.

### Checkout for Reliable Circuit Design

A design is not complete until an examination is made of the reliability of the circuit.

It is of utmost importance to examine the safe area of operation and the load line characteristic of each power transistor used in any equipment.

Definite areas of reliable operation can be predicted in devices such as germanium pnp power transistors. In Fig. 6, the region indicated as "maximum reliability" denotes safe operation with little chance of device burnout. The cross-hatched area is a derated zone of operation which may be considered safe for momentary excursions but may result in a collector-to-emitter short. To evaluate line or load surges which instantaneously place the transistor into higher dissipation, a set of curves based upon the thermal time constant, pulse width, and duty-cycle is included on the data sheet as shown in Fig. 7. **Determination of Peak Power:** The peak allowable power is; from Fig. 7,

$$P_p = \frac{(T_j - T_A - \theta_{JA} P_{ss})}{\theta_{JC} \left( \frac{1}{C_p} \right) + \theta_{CA} (t_1/t)}$$

$C_p$  is a coefficient of power as obtained from the data chart.  $T_j$  is junction temperature in C;  $T_A$  is ambient temperature in C;  $\theta_{JC} + \theta_{CA}$ ;  $t_1$  is pulse width;  $t$  is the pulse period;  $(t_1/t)$  is the duty cycle;  $P_{ss}$  is a constant power dissipation and  $P_p$  is the additional allowable pulse power dissipation above the amount of  $P_{ss}$ .

The above equation applies when a heat sink is used which has thermal capacity much larger than the transistors' thermal capacity.

The chart in Fig. 7a is normalized with respect to the thermal time constant, which is on the order of 50 msec for these power transistors. Consider a typical example as follows:

$$P_{ss} = 10 \text{ w} \quad T_A = 40 \text{ C}$$

$$\text{Pulse width } (t_1) = 1 \text{ msec}$$

$$\text{Duty Cycle} = 20\%$$

$$\theta_{CA} = 3 \text{ C/w}$$

$$\theta_{JC} = 0.8 \text{ C/w} \quad T_{j \text{ max}} = 100 \text{ C}$$

Solution: Enter the graph at  $t_1/\tau = 1 \text{ msec}/50 \text{ msec}$ , and duty cycle 20%. Find  $C_p = 5$ . Solve equation

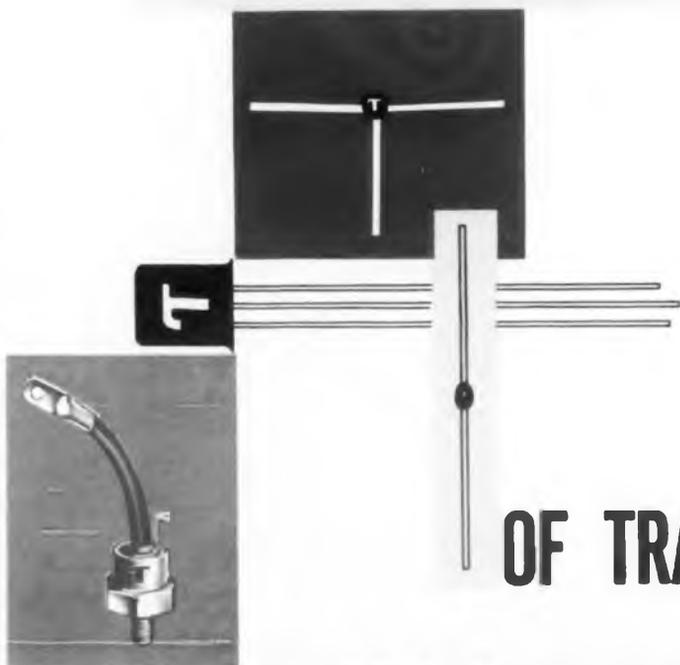
$$P_p = \frac{100 - 40 - (3 + 0.8) 10}{0.8 + 3 \times 0.2} \times 0.2$$

$P_p = 29 \text{ w}$  in addition to the steady 10 w resulting in 39 w peak. ■ ■

### Reference

1. "How to Design Economical High-Voltage Circuits", Motorola Semiconductor Products, Inc., Phoenix, Ariz.
2. Motorola Power Transistor Handbook, First Edition, pp. 33-34.

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Type	Minimum Peak Reverse Voltage and Minimum Forward Breakover Voltage (volts)	Maximum Average Forward Current (amps)		Package Configuration	Package
		at 25° C case	at 100° case		
TCR1020	100.	20.	10.	1 1/8" hex	B
TCR2020	200.	20.	10.	1 1/8" hex	B
TCR3020 TCR4020	300.	20.	10.	1 1/8" hex	B
TCR1010	100.	10.	5.0	1 1/8" hex	B
TCR2010	200.	10.	5.0	1 1/8" hex	B
TCR3010	300.	10.	5.0	1 1/8" hex	B
TCR4010	400.	10.	5.0	1 1/8" hex	B

CONTINUED INSIDE

# Transistron

## SILICON CONTROLLED RECTIFIERS - closely controlled electrical characteristics plus a high degree of mechanical ruggedness



**1/8", 1/4", 3/8" HEX PACKAGES  
(B, C, D)**

Transitron's Silicon Controlled Rectifiers are PNP high power bistable controlled switching devices. They are analogous to a thyatron or ignitron, with far smaller triggering requirements and microsecond switching. The low conduction drop permits current ratings up to 20 amperes and provides high efficiency with low cooling requirements. Also, blocking voltages up to 500 volts permit the smallest packaging yet made possible for high power control. Operation at 125 C is permissible with derating.



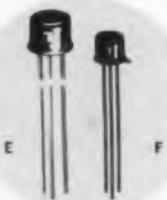
**TO-5 PACKAGE (E)**

The TO-5 package configuration also has a low conduction drop which permits operations from 25 ma to 1 ampere (types 2N1595 - 2N1599) and 5 ma to 1 ampere (Types TCR 251 - TCR 4001). Operating and storage temperature range is from -65 C to 150 C. Typical turn-on time is 0.2 to 0.3 microseconds; turn-off time is 1.0 to 1.2 microseconds.

**TO-18 PACKAGE (F)**

Transitron's Silicon Controlled Switch is also a PNP bistable unit featuring high gate sensitivity and low holding currents for low level switching from 1 ma to 200 ma. Further, these units are particularly useful in controlled rectifier trigger circuits as these switches offer precise and consistent control of the firing angle. Typical turn-on time is 0.2 microseconds; turn-off time, 1.0 microseconds.

For information on Transitron's complete line of Controlled Rectifiers and Controlled Switches check 155 Reader Service Card, or write for Bulletin TE-1356.



### SILICON CONTROLLED RECTIFIERS

Type	Minimum Peak Reverse Voltage and Minimum Forward Breakover Voltage (volts)	Maximum Average Forward Current (amps) at 25°C case at 100° case		Package Configuration	Package
2N683	100.	16.	8.	1/8" hex	C
2N685	200.	16.	8.	1/8" hex	C
2N687	300.	16.	8.	1/8" hex	C
2N688	400.	16.	8.	1/8" hex	C
2N689	500.	16.	8.	1/8" hex	C
2N1844	100.	10.	4.*	1/8" hex	C
2N1846	200.	10.	4.*	1/8" hex	C
2N1848	300.	10.	4.*	1/8" hex	C
2N1849	400.	10.	4.*	1/8" hex	C
2N1850	500.	10.	4.*	1/8" hex	C
TCR1005	100.	5.0	3.0	1/8" hex	D
TCR2005	200.	5.0	3.0	1/8" hex	D
TCR3005	300.	5.0	3.0	1/8" hex	D
TCR4005	400.	5.0	3.0	1/8" hex	D
2N1600	50.	3.0	3.0*	1/8" hex	D
2N1601	100	3.0	3.0*	1/8" hex	D
2N1602	200.	3.0	3.0*	1/8" hex	D
2N1603	300	3.0	3.0*	1/8" hex	D
2N1604	400.	3.0	3.0*	1/8" hex	D
2N1772A	100.	4.7	3.	1/8" hex	D
2N1774A	200	4.7	3.	1/8" hex	D
2N1776A	300	4.7	3.	1/8" hex	D
2N1777A	400	4.7	3.	1/8" hex	D
2N1772	100	4.7	3.	1/8" hex	D
2N1774	200.	4.7	3.	1/8" hex	D
2N1776	300.	4.7	3.	1/8" hex	D
2N1777	400.	4.7	3.	1/8" hex	D
2N1595	50.	0.6**	1.0*	TO-5	E
2N1596	100.	0.6**	1.0*	TO-5	E
2N1597	200.	0.6**	1.0*	TO-5	E
2N1598	300.	0.6**	1.0*	TO-5	E
2N1599	400.	0.6**	1.0*	TO-5	E
2N2011 (TCR1001)	100.	0.6**	1.0*	TO-5	E
2N2012 (TCR2001)	200.	0.6**	1.0*	TO-5	E
2N2013 (TCR3001)	300.	0.6**	1.0*	TO-5	E
2N2014 (TCR4001)	400.	0.6**	1.0*	TO-5	E

### SILICON CONTROLLED SWITCHES

2N948 (TSW31S)	30.	0.2**	0.2†	TO-18	F
2N949 (TSW61S)	60.	0.2**	0.2†	TO-18	F
2N950 (TSW101S)	100.	0.2**	0.2†	TO-18	F
2N951 (TSW201S)	200.	0.2**	0.2†	TO-18	F

\*At 80°C case

\*\*At 25°C ambient

†At 75° ambient

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## SILICON DIODES - advanced techniques insure long-term mechanical and electrical stability

### COMPUTER TYPES

Type	Maximum Inverse Operating Voltage (volts)	Maximum Average Forward Current @ 25°C (mA)	Maximum Recovery Time (μsec)	Maximum Capacitance at 0 Volts (μμf)	Package
1N914*	75.	75.	4.	4.	A
1N916*	75.	75.	4.	2.	A

\*Also available in micro package

### MICRO ZENER DIODES (SPECIFICATIONS AT 25°C)

Type	Nominal* Voltage (volts)	Test Current (mA)	Maximum Dynamic Resistance (ohms)	Maximum Inverse Current @ $E_b = -1$ Volt (μA)	Typical Forward Voltage @ 5.0 mA (volts)	Package
TMD-01	5.1	5	15	1.0	0.75	B
TMD-02	5.6	5	15	1.0	0.75	B
TMD-03	6.2	5	15	1.0	0.75	B
TMD-04	6.8	5	15	1.0	0.75	B
TMD-05	7.5	5	15	0.1	0.75	B
TMD-06	8.2	5	15	0.1	0.75	B
TMD-07	9.1	5	15	0.1	0.75	B
TMD-08	10.0	5	15	0.1	0.75	B
TMD-09	11.0	5	20	0.1	0.75	B
TMD-10	12.0	5	20	0.1	0.75	B

\*Voltage Tolerance ±10%. For ±5% Voltage Tolerance use "A" suffix (i.e. TMD-01A).

### FAST SWITCHING

Type	Maximum Inverse Operating Voltage (volts)	Maximum Average Forward Current @ 25°C (mA)	Maximum Recovery Time (μsec)	Package
TMD24	50.	50.	0.3	B
TMD25	100.	50.	0.3	B
TMD27	200.	50.	0.3	B

### VERY FAST SWITCHING

TMD50	60.	20.	.004	B
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### NEW! COMPUTER TYPE DIODES AVAILABLE IN MICRO PACKAGE

TMD54 (1N914)	75.	75.	.004	B
TMD56 (1N916)	75.	75.	.004	B

### HIGH CONDUCTANCE TYPES

Type	Maximum Inverse Operating Voltage (volts)	Maximum Average Forward Current @ 25°C (mA)	Maximum Inverse Current @ 25°C (μA @ volts)	Package
TMD-41	50.	75.	0.25 @ 50	B
TMD-42	100.	75.	0.25 @ 100	B
TMD-45	200.	75.	0.25 @ 200	B

### MICRO-STABISTORS

Type	Forward Voltage @ 1 mA DC (volts)	Maximum Forward Voltage @ 20 mA DC (volts)	Maximum Dynamic Resistance @ 1 mA @ 1 KC (ohms)	Maximum Inverse Current @ -2 volts DC (μA)	Package
TMD20	0.64 ± 10%	0.85	60	0.5	B
TMD40	0.55 ± 10%	0.85	60	0.5	B

### 1N914 AND 1N916 COMPUTER TYPE SILICON DIODES

Transitron now offers the industry superior reliability in diffused silicon computer diodes. Low capacitance and milli-micro-second switching are combined with low inverse currents, high breakdown voltages and good forward switching characteristics. A double plug package insures added strength and strain relief at both ends.

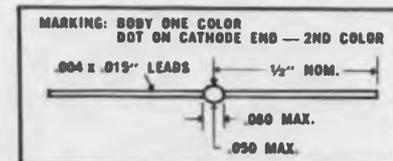
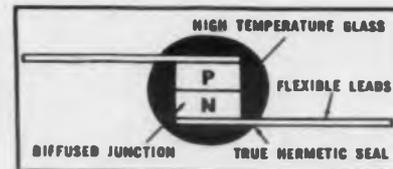
The 1N914 and 1N916 will find applications wherever fast switching and high reliability diodes are required.

For Complete Information on Transitron's Computer Type Silicon Diodes, check 156 Reader Service Card, or write for Bulletin TE-1350G

### SILICON MICRO DIODES WITH A TRUE HERMETIC SEAL!

With the introduction of all-glass packaging, Transitron now has been able to achieve TRUE hermetic sealing for its entire line of silicon microdiodes! . . . All units are completely compatible with present circuitry . . . All provide the same excellent performance as larger Transitron devices in 1/8th to 1/20th the space. Glass is melted around the silicon body that forms the working part of the device. Absolute hermetic sealing makes this the most reliable and efficient micro-regulator ever developed — ideal for voltage regulating and reference service wherever space and weight economies are required.

For Complete Information on these Transitron Micro Zener Diodes, check 157 Reader Service Card



SEE TRANSITRON'S COMPLETE LINE OF SEMICONDUCTORS AT WESCON BOOTHS 3502-3504

## SILICON T... superior b... extended



Transitron, pioneer... of the indu... ductors now offers

- PNP 2N1131
- 2N1132
- NPN 2N696
- 2N697
- 2N698
- 2N699
- 2N1252
- 2N1253
- 2N706
- 2N1420

Type	Maximum Collector Voltage $V_{cb}$ (volts)
2N1131	40
2N1132	40
2N696	60
2N697	60
2N698	100
2N699	100
2N1252	30
2N1253	30
2N706	25
2N1420	60

For Complete Inform... 158 Reader Service

MINUTEMAN T... and Titan High... improvements h... semiconductor l... improved: Low... Power NPN Si... mediate Power... These types ar... Transitron Distr...

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## PN TRANSISTORS - with or beta linearity permit ded operating range



pioneering developer of silicon transistors and pro-  
the industry's broadest line of high-quality semicon-  
w offers these popular types.

- 2N1131** (multi-purpose medium power)
- 2N1132** Write for Bulletin TE-1354-1131
- 2N696** (multi-purpose medium power)
- 2N697** Write for Bulletin TE-1354-696
- 2N698** (high voltage medium power)
- 2N699** Write for Bulletin TE-1354-698
- 2N1252** (low storage time medium power)
- 2N1253** Write for Bulletin TE-1354-1252
- 2N706** (high speed logic transistor, small signal)
- Write for Bulletin TE-1353-706
- 2N1420** (multi purpose medium power)
- Write for Bulletin TE-1354-1420

### SILICON TRANSISTORS

Maximum Collector Voltage $V_{cb}$ (volts)	Minimum DC Common Emitter Current Gain, $\beta$ :	Typical Collector Saturation Voltage (volts @ mA)	Typical Cut-off Frequency (Mc)	Maximum Power Dissipation @ 100° C Case (watts)
40	15 @ 150mA	1.0 @ 150	50	1
40	30 @ 150mA	1.0 @ 150	60	1
60	20 @ 150mA	0.8 @ 150	80	1
60	40 @ 150mA	0.8 @ 150	100	1
100	20 @ 150mA	3. @ 150	80	1
100	40 @ 150mA	3. @ 150	100	1
30	15 @ 150mA	0.8 @ 150	90	1
30	30 @ 150mA	0.8 @ 150	110	1
25	20 @ 10mA	0.3 @ 10	400	0.5
60	100 @ 150mA	0.7 @ 150	100	1

ate Information on these Transitron Silicon Transistors check  
r Service Card, or write for Bulletins indicated.

**MAN TYPES** — As a result of the Minuteman  
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n Distributor.

## LIBRARY OF APPLICATIONS INFORMATION

Transitron now has available additional litera-  
ture covering circuit design, operation, and  
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- **THE BIASING of Silicon Controlled Rectifiers and Switches (AN-1356B-7B)**
- **THE TUNNEL DIODE CIRCUIT DESIGN HANDBOOK (AN-1359A)**
- **THE SILICON CONTROLLED RECTIFIER — Theory of Operation • Application Notes • Circuits (AN-1356A)**
- **THE BINISTOR — Circuit Design Information and Application Notes (AN-1360A)**
- **THE TRANSWITCH — Circuit Design Information and Application Notes (AN-1357A)**

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*"25 Tips on How to Buy Semiconductors"*  
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Write directly to Transitron Electronic Corpora-  
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tact your nearest Transitron Industrial Distributor  
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## APPLICATION ASSISTANCE

If you would like application assistance on  
immediate projects in the selection of

- MICRO-COMPONENTS
- CONTROLLED RECTIFIERS
- SILICON TRANSISTORS
- SILICON DIODES
- OTHER TRANSITRON TYPES

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tion outlining your requirements.

## WANT MORE INFORMATION?

If you would like to have more complete infor-  
mation on any of the new Transitron semicon-  
ductor types shown on these pages, please  
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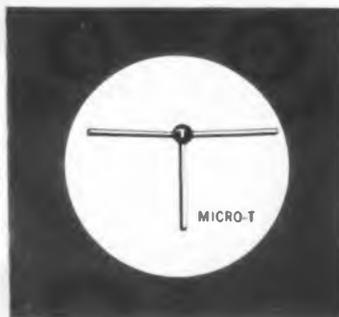
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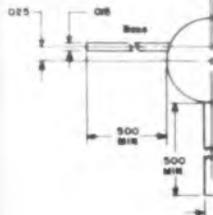
# Transitron M Micro



**TRUE HERMETIC  
ASSURES RELIABILITY  
UNDER A WIDE RANGE OF  
OPERATING CONDITIONS**

Development of the MICRO-T transistor in an hermetical package represents a major step forward with conventional "metal can" glass packaging embodies a hermetic seal between leads; substantially increased; possible.

For Complete Information, check Bulletins PB-78, PB-79.



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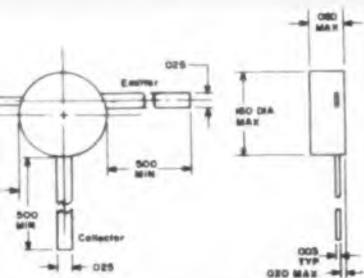
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# Micro-T - the first silicon diffused mesa micro-Transistor in an all glass package!

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RELIABLE PERFORMANCE  
WIDE RANGE OF  
OPERATING CONDITIONS**

MICRO-T — first silicon diffused mesa micro-  
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sentative in microminiaturization. As compared  
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stantially improved as the possibility of leakage is sharply reduced.

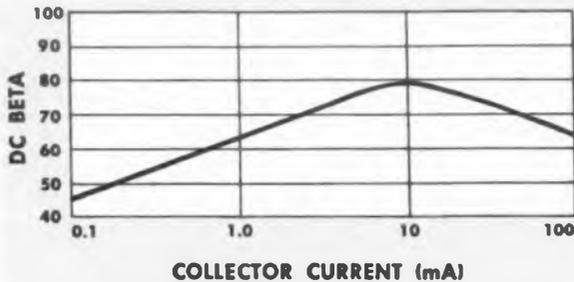
For more information, check 159 Reader Service Card or write for



## MICRO-TRANSISTORS

AMPLIFIER TYPES					
Type	Maximum Collector Voltage (Volts)	Minimum AC Beta (h <sub>ie</sub> )	Typical Gain-Bandwidth Product (Mc)	Maximum Collector Leakage Current at 25° C (μA)	Maximum Power Dissipation at 25° C Ambient (mW)
TMT 839	45	20	45	1	150
TMT 840	45	40	45	1	150
TMT 841	45	80	65	1	150
SWITCHING TYPES					
Type	Maximum Collector Voltage (Volts)	Minimum DC Beta (h <sub>FE</sub> )	Typical Gain-Bandwidth Product (Mc)	Maximum Saturation Resistance (Ohms)	Maximum Power Dissipation at 25° C Ambient (mW)
TMT 842	45	20	45	120	150
TMT 843	45	45	65	120	150

## TYPICAL DC BETA VS. COLLECTOR CURRENT FOR THE TMT841



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## Updated Transistor List Contains Many Improved Types

Over 600 new types are included in this year's Transistor Data Chart. A high percentage of last year's types are upgraded in electrical characteristics such as power dissipation and cut-off frequency. Improvements in transistor fabrication techniques have resulted in the availability of high-power, high-frequency devices plus fast-switching epitaxial transistors.

The increasing quantity of types, of course, presents a growing problem to the design engineer in search of a particular one. Less than two dozen former types were abandoned. The addition of types bearing new JEDEC numbers, with marginal improvements (if any) over existing types, adds to the selection problem.

ELECTRONIC DESIGN's organization of its Transistor Data Chart into basic types and its listing of types by the increasing value of a key characteristic make selection as straight-forward as possible.

If you would like a free reprint of this section, turn to the Reader-Service Card and circle 251.

### July 19—Case for Switching Speed

Due to space limitations, we were forced to postpone publication of a provocative argument posed by Charles Askanas, Engineering Project Manager at Lumatron Electronics. Titled "Optimum Test Limit for Transistor Switching-Circuit Measurements," the article offers a justification for the use of 20 and 80 per cent test points rather than 10 and 90 per cent points, presently used to characterize switching devices. Be sure to read the analysis in the July 19 issue; your comments on the validity of the argument are invited.

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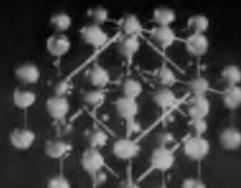
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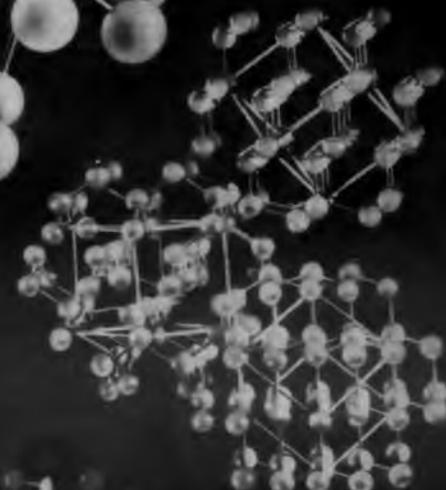


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RESEARCH and PRODUCTION FOR BETTER SOLID-STATE MATERIALS



# Latest Listings of Military Approved Transistors

*To encourage the use of improved transistor types in the design of new military equipment, MIL-STD-701A has been updated, with Department of Defense approval, by MIL-STD-701B. New types have been added, some older types have been dropped and several "guidance" types have been added to the "preferred" category. MIL-STD-701B types are grouped in a convenient application chart shown in Table 1. A list of the DOD, as well as single-service types with specification numbers and issue dates is in Table 2.*

Table 1

			Germanium		Silicon		
			PNP	NPN	PNP	NPN	
Low power	Audio (< 300 mw)	Preferred	2N526 2N652A			2N335	
		Guidance	2N467 2N220		2N1026A		
	Medium frequency (3 to 30 mc)	Preferred				2N338	
		Guidance	2N1309	2N1308	2N1118		
	High frequency (> 30 mc)	Preferred					
		Guidance	2N384 2N700A 2N1142			3N35 2N1613	
Switching	Low speed (> 5 μsec total time)	Preferred			2N329A		
		Guidance	2N398 2N404 2N428 2N396A	2N358A			
	Medium speed (1 to 5 μsec)	Preferred		2N388			
		Guidance	2N599	2N1310	2N491 2N1119	2N337	
	Fast speed (< 1 μsec)	Preferred	2N705			2N697 2N706	
		Guidance	2N559 2N1500 2N695 2N1195		2N1132	2N560	
						2N1893	
		Bilateral switch (medium speed)	Preferred				
	Power	300 mw to 3 w	Preferred	2N1039 2N1041		2N1234	2N341
			Guidance	2N539			2N498 2N657 2N1485
3 to 30 w		Preferred	2N1184B 2N297A 2N1358	2N326			
		Guidance					
> 30 w		Preferred					
		Guidance	2N1120 2N1165 2N1046			2N389 2N424 2N1050 2N1016B	

Table 2

Type	Specification	Date
2N43A	MIL-T-19500/18(USAF)	Amend 2. 10 November 1958
2N44A	MIL-T-19500/6(USAF)	Amend 1. 10 April 1958
2N78A	MIL-S-19500/90(USAF)	23 May 1960
2N117	MIL-T-19500/35(NAVY)	15 March 1958
2N118	MIL-T-19500/35(NAVY)	15 March 1958
2N119	MIL-T-19500/35(NAVY)	15 March 1958
2N118	MIL-T-19500/2(JAN)	12 December 1957
2N123	MIL-T-19500/30(USAF)	4 February 1959
2N128	MIL-T-19500/9A(JAN)	12 June 1959
2N129	MIL-T-19500/8(SigC)	21 July 1958
2N144	MIL-T-19500/29(USAF)	Dropped
2N158	MIL-S-19500/24A(JAN)	27 November 1959
2N167A	MIL-S-19500/11A(USAF)	23 May 1960
2N173	MIL-T-19500/12(NAVY)	Dropped
2N174	MIL-T-19500/13A(JAN)	8 January 1958
2N200	MIL-T-19500/5	Dropped
2N220	MIL-T-19500/1	14 June 1957
2N240	MIL-S-19500/25A(JAN)	5 November 1959
2N243	MIL-T-19500/34(USAF)	Dropped
2N244	MIL-T-19500/34(USAF)	Dropped
2N245	MIL-T-19500/14(USAF)	Dropped
2N246	MIL-T-19500/15(USAF)	Dropped
2N274	MIL-T-19500/26(SigC)	3 October 1957
2N297A	MIL-T-19500/36A(SigC)	17 November 1958
2N299	MIL-T-19500/39(SigC)	Dropped
2N300	MIL-T-19500/55(SigC)	21 July 1958
2N325	MIL-S-19500/40(JAN)	29 February 1960
2N326	MIL-S-19500/40(JAN)	29 February 1960
2N328A	MIL-S-19500/110(SigC)	Amend 1. 13 May 1960
2N329A	MIL-S-19500/111(SigC)	Amend 1. 13 May 1960
2N331	MIL-T-19500/4A	16 January 1958
2N332	MIL-T-19500/37A(NAVY)	18 June 1959
2N333	MIL-T-19500/37A(NAVY)	18 June 1959
2N334	MIL-T-19500/37A(NAVY)	18 June 1959
2N335	MIL-T-19500/37A(NAVY)	18 June 1959
2N337	MIL-S-19500/69C(NAVY)	14 October 1960
2N338	MIL-S-19500/69C(NAVY)	14 October 1960
2N342	MIL-S-19500/16B(JAN)	24 February 1960
2N343	MIL-S-19500/16B(JAN)	24 February 1960
2N358A	MIL-S-19500/63B(JAN)	23 May 1960
2N384	MIL-S-19500/27A(JAN)	20 January 1960
2N388	MIL-T-19500/65(NAVY)	20 March 1959
2N393	MIL-S-19500/77A(SigC)	30 October 1959
2N396A	MIL-S-19500/64A(NAVY)	27 October 1959
2N404	MIL-T-19500/20(USAF)	Amend 2. 3 March 1959
2N416	MIL-T-19500/56A(SigC)	3 February 1959
2N417	MIL-T-19500/57A(SigC)	3 February 1959
2N422	MIL-T-19500/66A(NAVY)	26 June 1959
2N425	MIL-T-19500/41A(SigC)	26 January 1959
2N426	MIL-T-19500/42A(SigC)	26 January 1959
2N427	MIL-T-19500/43A(SigC)	26 January 1959
2N428	MIL-S-19500/44B(SigC)	
2N431	MIL-T-19500/21(USAF)	Amend 1. 10 April 1958
2N432	MIL-T-19500/22(USAF)	Amend 1. 10 April 1958
2N433	MIL-T-19500/23(USAF)	Amend 1. 10 April 1958
2N461	MIL-T-19500/45(USAF)	7 July 1958
2N463	MIL-T-19500/70(NAVY)	14 May 1959
2N464	MIL-T-19500/49B(SigC)	3 February 1959
2N465	MIL-T-19500/50A(SigC)	3 February 1959
2N466	MIL-S-19500/51B(SigC)	17 August 1960
2N467	MIL-T-19500/52B(SigC)	3 February 1959
2N489	MIL-T-19500/75(USAF)	1 July 1959
2N490	MIL-T-19500/75(USAF)	1 July 1959
2N491	MIL-T-19500/75(USAF)	1 July 1959
2N492	MIL-T-19500/75(USAF)	1 July 1959
2N493	MIL-T-19500/75(USAF)	1 July 1959
2N494	MIL-T-19500/75(USAF)	1 July 1959
2N495	MIL-T-19500/54A(SigC)	13 August 1959
2N496	MIL-S-19500/85(SigC)	Amend 1. 22 March 1960
2N497	MIL-T-19500/74(NAVY)	30 June 1959
2N498		
2N499	MIL-T-19500/72A(SigC)	4 January 1960
2N501A	MIL-T-19500/62(SigC)	5 December 1953
2N502A	MIL-S-19500/112(SigC)	4 April 1960
2N526	MIL-S-19500/60C(JAN)	29 July 1960
2N537	MIL-S-19500/100(SigC)	30 November 1959
2N539	MIL-T-19500/38(NAVY)	28 May 1958
2N545	MIL-S-19500/84(NAVY)	24 February 1960
2N559	MIL-S-19500/152(SigC)	7 December 1960
2N560	MIL-S-19500/73A(JAN)	29 July 1960
2N574	MIL-T-19500/46(SigC)	22 May 1960

Type	Specification	Date
2N575	MIL T-19500/47(SigC)	22 May 1960
2N599	MIL S 19500/66(NAVY)	25 January 1961
2N624	MIL T-19500/82(SigC)	10 August 1959
2N656	MIL T-19500/74(NAVY)	30 June 1959
2N657	MIL T 19500/74(NAVY)	30 June 1959
2N665	MIL S-19500/58B(JAN)	12 July 1960
2N681	MIL S-19500/108(NAVY) Controlled Rectifiers	22 March 1960
2N682	MIL S-19500/108(NAVY) Controlled Rectifiers	22 March 1960
2N683	MIL S-19500/108(NAVY) Controlled Rectifiers	22 March 1960
2N684	MIL S-19500/108(NAVY) Controlled Rectifiers	22 March 1960
2N685	MIL S 19500/108(NAVY) Controlled Rectifiers	22 March 1960
2N686	MIL S 19500/108(NAVY) Controlled Rectifiers	22 March 1960
2N687	MIL S 19500/108(NAVY) Controlled Rectifiers	22 March 1960
2N688	MIL S-19500/108(NAVY) Controlled Rectifiers	22 March 1960
2N694	MIL S 19500/160(SigC)	9 December 1960
2N695	MIL S-19500/135(NAVY)	17 October 1960
2N696	MIL S 19500/99A(SigC)	1 April 1960
2N697	MIL S 19500/99A(SigC)	1 April 1960
2N700A	MIL S 19500/123(SigC)	1 July 1960
2N702	MIL S 19500/153(SigC)	7 December 1960
2N703	MIL S 19500/153(SigC)	7 December 1960
2N705	MIL S 19500/86(NAVY)	6 June 1960
2N706	MIL S 19500/120(SigC)	2 June 1960
2N716	MIL S 19500/154(SigC)	7 December 1960
2N1000	MIL T-19500/79(SigC)	22 June 1959
2N1001	MIL S 19500/81(SigC)	17 June 1959
2N1002	MIL S 19500/83(SigC)	10 August 1959
2N1011	MIL T 19500/67(SigC)	22 January 1959
2N1025	MIL S 19500/78A(SigC)	7 December 1959
2N1026	MIL S 19500/78A(SigC)	7 December 1959
2N1026A	MIL S 19500/78A(SigC)	7 December 1959
2N1039	MIL S 19500/89(NAVY)	21 July 1960
2N1041	MIL S 19500/89(NAVY)	21 July 1960
2N1042	MIL S 19500/137(SigC)	8 September 1960
2N1043	MIL S 19500/137(SigC)	8 September 1960
2N1044	MIL S 19500/137(SigC)	8 September 1960
2N1045	MIL S 19500/137(SigC)	8 September 1960
2N1046	MIL S 19500/88(NAVY)	21 July 1960
2N1072	MIL S 19500/163(SigC)	5 January 1961
2N1082	MIL S 19500/103(SigC)	18 December 1959
2N1094	MIL S 19500/161(SigC)	9 December 1960
2N1118	MIL S 19500/138(SigC)	9 September 1960
2N1119	MIL S 19500/139(SigC)	9 September 1960
2N1120	MIL T 19500/68(SigC)	10 February 1960
2N1142	MIL S 19500/87(NAVY)	15 August 1960
2N1158A	MIL S 19500/113(SigC)	4 April 1960
2N1183	MIL S 19500/143(SigC)	10 October 1950
2N1183A	MIL S 19500/143(SigC)	10 October 1950
2N1183B	MIL S 19500/143(SigC)	10 October 1950
2N1184	MIL S 19500/143(SigC)	10 October 1950
2N1184A	MIL S 19500/143(SigC)	10 October 1950
2N1184B	MIL S 19500/143(SigC)	10 October 1950
2N1195	MIL S 19500/71B(JAN)	29 July 1960
2N1196	MIL S 19500/164(SigC)	6 January 1961
2N1197	MIL S 19500/165(SigC)	6 January 1961
2N1199A	MIL S 19500/131(SigC)	25 July 1960
2N1200	MIL S 19500/105(SigC)	28 December 1959
2N1201	MIL S 19500/101(SigC)	30 November 1960
2N1302	MIL S 19500/126(NAVY)	14 October 1960
2N1303	MIL S 19500/126(NAVY)	14 October 1960
2N1304	MIL S 19500/126(NAVY)	14 October 1960
2N1305	MIL S 19500/126(NAVY)	14 October 1960
2N1306	MIL S 19500/126(NAVY)	14 October 1960
2N1307	MIL S 19500/126(NAVY)	14 October 1960
2N1308	MIL S 19500/126(NAVY)	14 October 1960
2N1309	MIL S 19500/126(NAVY)	14 October 1960
2N1310	MIL S 19500/136(NAVY)	6 December 1960
2N1358	MIL S 19500/122(SigC)	20 June 1960
2N1411	MIL S 19500/133(SigC)	3 August 1960
2N1412	MIL S 19500/76(NAVY)	4 February 1960
2N1500	MIL S 19500/125(SigC)	11 July 1960
3M35	MIL S 19500/80A(SigC)	30 October 1959

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# Transient Control Device Protects Rectifiers From Surge Overloads

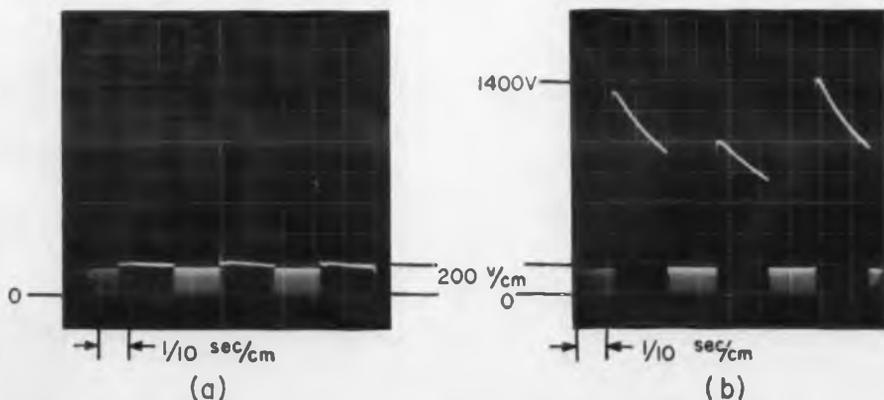


**H**IGH-VOLTAGE transients, appearing across power supplies when an inductive load is suddenly turned off, can be effectively reduced by a newly developed gas-tube device. Conventional means to avoid rectifier burnout include the use of relatively expensive, high piv diodes or Zener devices.

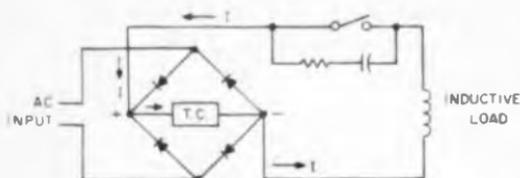
## Low Cost Diodes Can Be Used With Transient Protector

Low cost, 200-v piv rectifiers can be used with transient control, de-

veloped by Ledex, Inc., Dayton, Ohio. Transient peaks as high as 1,400 v have been applied to rectifier and bridge arrangements using the transient control with no rectifier failures resulting. See Fig. 1. The heart of the device consists of a gas tube which ionizes at a critical voltage (200 v in present units) thus creating a low-impedance shunt for excessively large pulses. For most power-supply applications, the 200-v ionization potential is adequate; higher voltage ratings and low-



**Fig. 1.** Oscilloscope trace across inductive load at output of a bridge rectifier. In (a) is shown a 1,400-v pulse (200-v/division) appearing across the dc output while (b) shows the clipping action achieved by addition of the transient control.



**Fig. 2.** Basic rectifier bridge circuit showing current flow resulting from suddenly opening the inductive load circuit.

er voltage ratings can be supplied on a custom basis if required.

**Device Protects Against Line As Well As Load Surges**

In the full-wave bridge circuit shown in Fig. 2, current  $I$  would flow as indicated from an inductive load when the switch is opened. Without the transient control, a high-voltage pulse would appear across the four diodes and breakdown is possible; should one diode become shorted, the diode on the adjacent leg of the bridge would be destroyed in a short time.

Should a transient occur at the ac input, the transient control permits current flow through the low impedance or conducting diodes rather than through the high-impedance bridge arms. Thus, positive or negative spikes are clipped at the 200-v level.

In addition to the transient control, Ledex is packaging a protected bridge rectifier, incorporating four rectifiers plus a built-in control rated as follows: 115 v ac input, 100 v dc output, maximum surge 50 amp for 8 msec.

Transient controls, part A-46800-001 are packed 10 to a carton; prices per carton are \$20.50 for one carton, \$18.50 ea for 2-9 cartons and \$16.00 ea for 10-49 cartons. The protected bridge rectifier, part A-46501-001, is \$8.15 ea in 1-9 quantities, \$7.40 ea in 10-24 lots and \$6.80 ea in 25-99 quantities. A value analysis kit RTC, containing one protected bridge rectifier and one transient control, is available at \$11.00 ea.

For further information on these devices, turn to the Reader-Service Card and circle 252.

75  
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6

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## J-SERIES

(Polar Type)

**.0047 to 330  
MICROFARADS**

Temperature Range:  
- 55 to +125° C

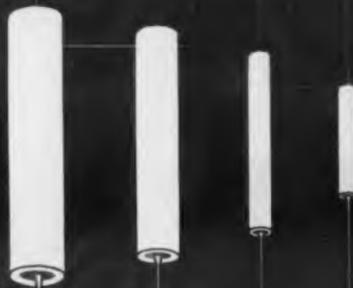


## N-SERIES

(Non-Polar Type)

**.0024 to 160  
MICROFARADS**

Temperature Range:  
- 55 to +105° C



### J-Series meets or exceeds MIL-C-26655A

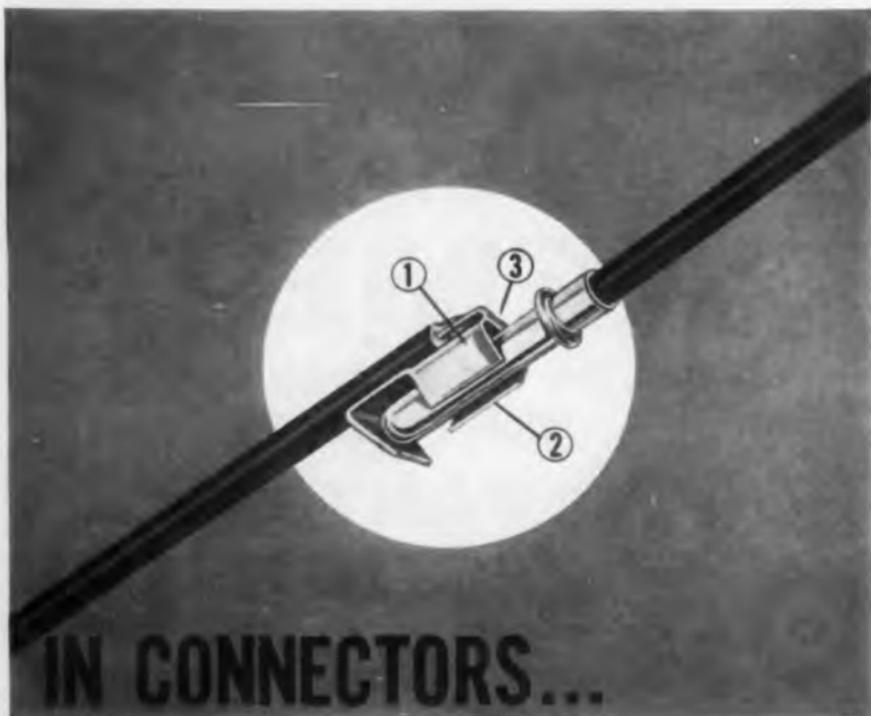
KEMET offers you the only full line of high-voltage solid tantalum capacitors for a multitude of military/industrial applications. J-Series and N-Series are available in working voltages of 75, 60, 50, 35, 20, 15, 10, and 6—in standard E.I.A. values with  $\pm 5\%$ ,  $\pm 10\%$ , and  $\pm 20\%$  tolerances. Low leakage characteristics are excellent. Four J-Series case sizes conform to MIL-C-26655A—with or without insulating sleeve. Leads are solderable and weldable. All KEMET types have passed approved environmental tests. Whatever your solid tantalum capacitor needs, meet them with KEMET's complete line! Kemet Company, Division of Union Carbide Corporation, 11901 Madison Avenue, Cleveland 1, Ohio.

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**3** positive contact surfaces on each Alden top-connected contact give you:

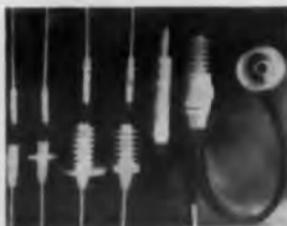
- More reliable electrical contact
- More secure mechanical grip
- Minimum electrical resistance

Each lead has individual strain relief because wire is doubled back through contact tab. Punch press contact design permits rapid heat transfer — eliminates unreliable cold solder joints as in screw machine contacts. Danger of insulation pull back is eliminated by bringing wire insulation right into molded clip pocket.

These unique Alden molding techniques in connector design drastically reduce the number of parts required and make possible multi-contact connectors of amazing basic simplicity and reliability.

Resilient Alden contacts can be included in any type of molded insulation for any combination of contacts. Hundreds of standard off-the-shelf designs are quickly available — with or without leads — or as part of unit-molded cables.

Our Customer Department will work closely with you on any connecting or cabling problems. A letter with description or sketch will enable us to provide recommendations or samples at once.



**New, flameproof, high voltage connectors** now available in high-density, flame-retardant polyethylene. Light, compact connectors for applications up to 30 KVDC and up to 250° F without distortion.



**First major advance in connector reliability since potting** offers fool-proof, tamper-proof connections for trouble-free operation. Alden "IMI" connectors and cables (wires, contacts, or other inserts) are integrally molded in a single hot shot of insulation so that material forming the connectors and covering the wires forms a single continuous, bonded insulation.



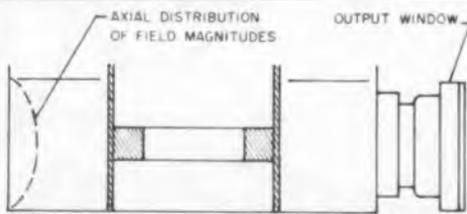
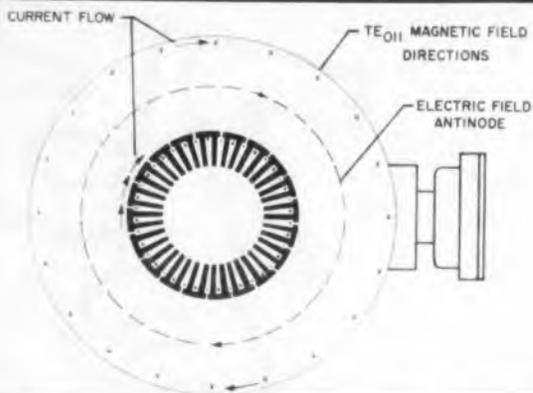
**Standard assembled connectors** in non-interchangeable layouts with from 2 to 11 contacts; miniature connectors, plain or shielded, for carrying power or signal; miniature plugs and sockets; signal connectors; and CRT connectors are all available for fast delivery.

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PRODUCTS COMPANY

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## Coaxial Cavity Increases Magnetron Frequency Stability

**T**HE USE of the coaxial cavity principle in magnetron design results in 5 to 10 times better frequency stability. Model SFD-303 magnetron, designed for X-band use, operates at 50 per cent efficiency, delivers minimum peak power of 1 megawatt and an average power of 1 kw. Its light weight of 45 lb makes it ideal for long-range airborne radar systems. Greater frequency stabilization makes steady state operation possible at the optimum impedance point.

The SFD-303 coaxial magnetron, manufactured by SFD Laboratories, 800 Rahway Ave., Union, N. J., employs a new concept in anode design which results in the significant improvements in frequency stability. Typically, side-lobe ratios are greater than 10 db, missing pulses less than 0.2 per cent and pulling factor is less than 6 mc at the megawatt level. At 2- $\mu$ sec pulse lengths, the rf band-width is less than 0.7 mc.

The principle on which the model

303 is based allows for high-frequency magnetrons to be built with large interaction areas so that the power dissipated per unit area of the anode and cathode is very low. Normally, when such large interaction areas are used, serious problems of mode control exist. Control of the mode in which oscillations begin is lost as the voltage pulse rises on the magnetron.

The approach which has heretofore been taken to the problem of mode control consists in designing the multi-cavity anode circuit to produce a relatively large frequency separation between the desired, or pi-mode, and its adjacent neighbors. Both strapped and rising-sun structures are based upon this philosophy. These techniques insure mode stability once the proper mode has been established, but do not insure its build-up in the presence of competing modes whose starting voltages fall in the same general range. To overcome the ease of starting such an unloaded mode the practice has

been to introduce some asymmetry into the anode block to orient both components of the doublet equally to the output slot.

In the coaxial structure, the design insures correctly phased rf currents at the normally short-circuited ends of the resonators.

The figure shown illustrates the main features of the anode. Alternate resonators are cut through to the coaxial cavity which is dimensioned to resonate in the circular electric ( $TE_{011}$ ) mode. The circumferential currents associated with this mode have the same phase at all points around the periphery of the cylinders. Since the resonators present a low impedance at their back ends, they are well matched to the impedance of the coaxial cavity as seen from the inner cylinder wall cut through positions.

Operation of the large cavity in the  $TE_{011}$  mode insures currents and voltages of the same phase in alternate resonators. Mutual flux linkage between adjacent resonators is relied upon to excite the other half of the resonators with equal, but oppositely phased, currents giving rise to a pure pi-mode.

The higher  $Q_0$  achieved by removing the straps in the resonator assembly yields higher efficiency in addition to greater frequency stability. It also raises the impedance of the anode so that less stored energy, accompanied by reduced power loss, is required to produce the same electric field in the interaction space.

In a conventional magnetron the anode surface can be increased only by increasing the anode height. This results in a long magnet with large magnet weight. With the new design the anode surface can be increased by increasing the number of resonators rather than increasing their height. This allows an extra degree of design freedom which results in weight reduction.

Model SFD-303 is available 120 days after receipt of order, with price dependent on quantity and delivery date.

For further information on this magnetron turn to the Reader-Service Card and Circle 253.

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MODEL 866B



A Compact-Versatile

## POWER SUPPLY

Constant Voltage / Constant Current Operation

• Auto-Series & Auto-Parallel Operation

### SPECIFICATIONS

Output: 0-40 Volts, 0-0.5 Amps D.C.

Load Regulation:

Constant Voltage: 0.01% or 4 mv.

Constant Current: 0.05% or 250  $\mu$ a.

Line Regulation:

Constant Voltage: 0.01% or 4 mv.

Constant Current: 0.05% or 250  $\mu$ a.

Ripple and Noise:

Constant Voltage: 200  $\mu$ v.

Constant Current: 200  $\mu$ a.

Transient Recovery Time: 50  $\mu$ sec.

Size: 5 $\frac{1}{8}$ " H X 7 $\frac{1}{4}$ " W X 8 $\frac{1}{2}$ " D

Price: **\$169.00**

OTHER PRECISE, VERSATILE AND COMPACT POWER SUPPLIES INCLUDE:

Model	E Out	I Out	Bench Model	Rack Model	Continuously Variable	Special Comments	Price
S20A	0-36	0-25		X	Yes	High Efficiency	\$575.00
8000-2	0-36	0-1.5	X	X	Yes	Dual Output	580.00
8000-2	0-36	0-2.5	X	X	Yes	Low Cost Medium Current Supply	339.00
802B	0-36	0-1.5		X	Yes	Dual Output Remote Sensing	580.00
806AM	0-20	0-2.0		X	Yes	Remote Sensing Remote Programming	350.00
808A	0-36	0-5		X	Yes	Constant Voltage / Constant Current	475.00
810B	0-60	0-7.5		X	Yes	Constant Voltage / Constant Current	795.00
812C	0-32	0-10		X	No	Remote Sensing	550.00
814A	0-36	0-25		X	Yes	Constant Voltage / Constant Current	775.00
855B	0-18	0-1.5	X	X	Yes	Constant Voltage / Constant Current	169.00
880	0-100	0-1.0	X	X	Yes	Wide Voltage Span	375.00
881A	0-100	0-1.0		X	Yes	Constant Voltage / Constant Current	475.00
888A	0-300	0-0.6		X	Yes	Remote Programming	495.00

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# NEW PRODUCTS

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## System Records 1,200 Bits Per In.

256

High-density recording system PHD-1200 can reliably read and write digital tapes at 1,200 bits per in., 100 ips. Transient error rates are fewer than one bit in  $10^8$  and permanent error rates are less than one bit in  $10^{10}$ . More than 20,000 passes of the same tape can be made without losing information or increasing transient dropout rate. System includes a digital magnetic tape transport, a dual read/write head assembly, read/write amplifiers, de-skewing buffer, manual control unit, and power supplies, cabled and mounted in a rack cabinet.

Potter Instrument Co., Inc., Dept. ED, Sunnyside Blvd., Plainview, N. Y.

P&A: \$29,500, evaluation sample; 4 months.



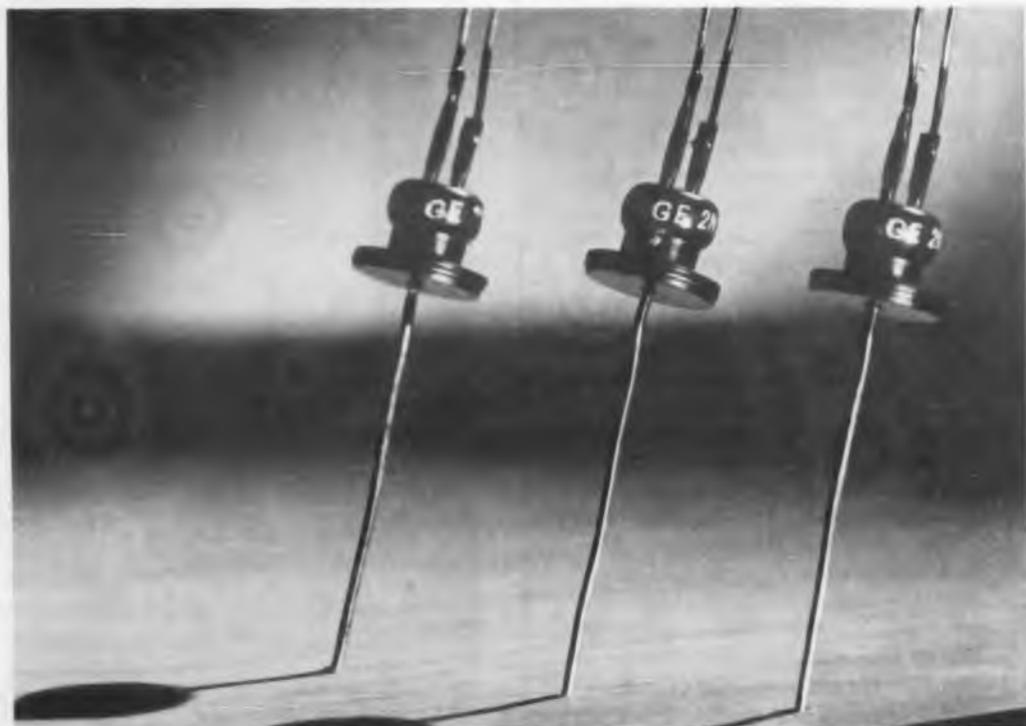
## Line Voltage Regulator Provides 100-Db Isolation

255

Solid state ac line regulator series 700 provides 0.1% regulation and 100-db line isolation. Harmonic attenuation and transient rejection are 40 db. Input harmonics of 10% max are reduced to less than 0.25% in the output. Power rating is 1 kva. Response time is 100  $\mu$ sec. Bench and rack models are made for use at 50, 60, and 400 cps. Both 115 and 230 v units are available.

Stevens-Evens, Inc., Dept. ED, 3801 Hicoek St., San Diego, Calif.

P&A: \$1,200 to \$1,500; 45 to 60 days.



## Silicon Controlled Rectifiers In Studless Housing

257

Housed in a double-ended, studless package, silicon controlled rectifiers 2N1929 through 2N1935, handle up to 1.1 amp without heat sinks. Piv ratings range from 25 to 300 v; operating temperature range is  $-65$  to  $+125$  C. Maximum leakage current ranges from 4.0 to 0.9 ma.

General Electric Co., Rectifier Components Dept., Dept. ED, W. Genesee St., Auburn, N. Y.

P&A: 2N1933, \$10 OEM; stock.



### PNPN Device Has Alloyed Junction

258

The Dynaquad is a germanium, three-terminal, pnpn structure packaged in a standard TO-5 case. Alloyed junction design is used for economy and reliability. The device has a rise time of 0.1  $\mu$ sec, and provides an output voltage swing of 35 v. Applications include driver, flip-flop, counter, shift register and other logic circuits. Types 2N1966 through 2N1968 are in production.

Tung-Sol Electric Inc., Dept. ED, 1 Sumner Ave., Newark 4, N. J.

**P&A:** From \$3.10; immediate.



### Voltage-Controlled Subcarrier Oscillator

259

Transistorized subcarrier oscillator type 516/2, operating on IRIG channels 1 to 18 and A to E, measures 3/4 x 3/4 x 1-1/4 in. Input is 0 to 5 v or  $\pm 2.5$  v. Input impedance is 300 K min, linearity  $\pm 0.5\%$  of bandwidth. Output is 1 v rms nominal. Unit requires 28 v unregulated dc at 10 ma, and weighs 1.6 oz. Shock, acceleration and vibration tests are met.

Telemetering Corp. of America, Dept. ED, 8345 Hayvenhurst Ave., Sepulveda, Calif.

**P&A:** On request.



# JFD

## MINIATURE METALIZED INDUCTORS MAKE THE DIFFERENCE!

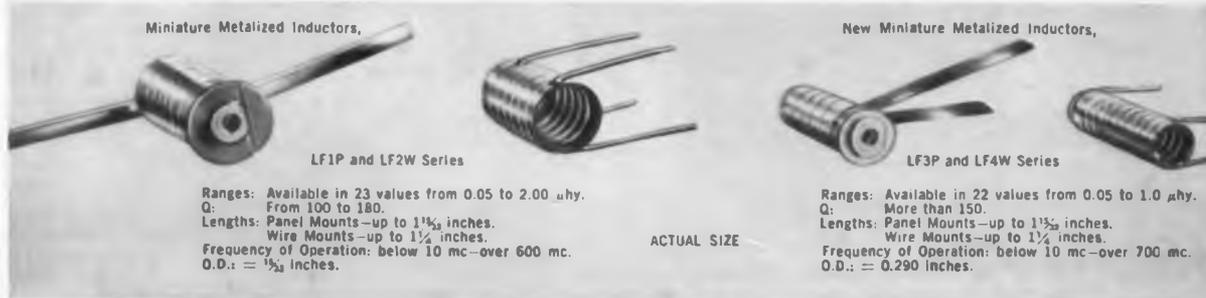
JFD Metalized Inductors provide outstanding electrical performance under severe environmental conditions - - in a small package.

Utilizing a silver film fired permanently to a high dielectric constant glass, they offer the ultimate in inductor simplicity and stability. This inherently rugged construction results in extraordinary reliability under extremely severe environments - - especially those of shock, vibration, temperature and altitude.

The inductance, types of windings, size, distributed capacitance, Q and other parameters of JFD Metalized Inductors can be designed to meet your specific needs. Why don't you write for bulletin 223 and see the difference they can make in your circuitry?

### Features

1. Rugged construction affords unusually high stability under conditions of severe shock and vibration.
2. Use of glass dielectric assures low temperature coefficient of inductance and operation without derating over extremely severe environmental conditions.
3. Low distributed capacity.
4. Special alloy plating protects metal parts from corrosion.
5. A high Q over a broad frequency range.
6. Silver plated copper leads.
7. Available in panel mount and printed circuit mount types.
8. JFD Variable Inductors can also be supplied to order. Write for questionnaire or contact the JFD sales office or representative nearest you.



Miniature Metalized Inductors,

LF1P and LF2W Series

Ranges: Available in 23 values from 0.05 to 2.00  $\mu$ hy.  
Q: From 100 to 180.  
Lengths: Panel Mounts—up to 1 1/8 inches.  
Wire Mounts—up to 1 1/2 inches.  
Frequency of Operation: below 10 mc—over 600 mc.  
O.D.: = 1/8 inches.

New Miniature Metalized Inductors,

LF3P and LF4W Series

Ranges: Available in 22 values from 0.05 to 1.0  $\mu$ hy.  
Q: More than 150.  
Lengths: Panel Mounts—up to 1 1/8 inches.  
Wire Mounts—up to 1 1/2 inches.  
Frequency of Operation: below 10 mc—over 700 mc.  
O.D.: = 0.290 inches.

ACTUAL SIZE

# JFD

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Components Division • 6101 16th Avenue, Brooklyn, New York • Phone DEwey 1-1000 • TWX-NY25040

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Phone: SPring 4-4761

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FIXED AND VARIABLE, DISTRIBUTED AND LUMPED CONSTANT DELAY LINES • PULSE FORMING NETWORKS

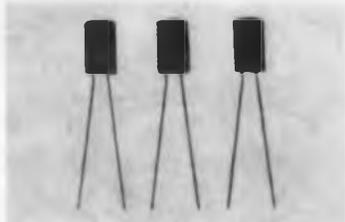
BE SURE TO VISIT JFD BOOTH No. 621 AT THE 1961 WESCON SHOW, AUGUST 22-25.

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## NEW PRODUCTS

### Carbon Film Resistor

670



Designed for printed circuits, carbon film resistor EC 25 is 1/4 in. in diameter by 13/32 in. long and mounts vertically. Rating is 1/4 w at 70 C derated to 0 at 150 C. Resistances range from 5 ohms to 500 K with a tolerance of 1%.

Mepco, Inc., Dept. ED, 37 Abbett Ave., Morristown, N. J.

### Electron Beam Systems

673



Guns, controls, and power supplies are available in ratings from 3 kw at 10 kv to 9 kw at 30 kv. Systems of the LB-100 series are complete, and provide magnetic deflection of beam over 3 in. square area, pulsing, regulation, and variable focus and focal length. Temperatures above 6,200 are readily attained.

GVC Electron Heating Corp., Dept. ED, 81 Hicks Ave., Medford 55, Mass.

### Instrument Switch

676



With up to six banks. Instrument switch type PW is available in 1-, 2-, 3- and 4-pole types and assemblies up to six banks. Maximum number of positions is 29 in one-pole versions, six in the four-pole version. Voltage rating is 250 v ac or dc, current rating 0.5 amp.

Interlab, Inc., Dept. ED, 116 Kraft Ave., Bronxville, N. Y.

Price: \$6.96 to \$41.72.

### Alternators

411



Semiconductor voltage regulation, holding the output to  $\pm 2\%$  from 1,000 to 12,000 rpm, is provided by these alternators. Two types are offered: 15 v dc, 1,000 w; 100 v dc, 1,500 w. Construction features radially oriented ceramic magnets in the rotor.

Syncro Corp., Dept. ED, Oxford, Mich.

### Transistor Testers

544

Automatic multi-parameter tester type 4 is one of a group of go no-go and absolute readout transistor testers. With automatic sorting and classification, it tests breakdown voltage, lower limiting voltage, dc pulse current gain, saturation voltage, and reverse current.

Fairchild Semiconductor Corp., Dept. ED, 545 Whisman Road, Mountain View, Calif.

P&A: \$22,000; 90 to 120 days.

### Frequency Standard

551

Stable to 1 part in  $10^{11}$  for one month, the Rubidium frequency standard is suitable for applications in the hf electromagnetic spectrum in communications, navigation and computational systems of aircraft and missiles. It weighs about 20 lb.

FMA, Inc., Dept. ED, 142 Nevada St., El Segundo, Calif.

### Servo Motor

412



Designed for missile use, this 6-pole, 400-cps, size 15 servo motor offers the following characteristics: theoretical acceleration at stall, 22,700 radians per sec<sup>2</sup>; minimum power output, 1.151 w; input power at stall, 6.1 w; motor dampening, 130 dyne-cm per sec.

Wright Machinery Co., Div. of Sperry Rand Corp., Dept. ED, Durham, N. C.

### Balancing Computer

675



Cuts balancing time 80%. Used with a vibration analyzer, this computer determines location and amount of compensating weight to be added or removed. Used in single and two-plane balancing operations for both in-place or production balancing of rotating parts, the instrument saves up to 80% time.

International Research & Development Corp., Dept. ED, Worthington, Ohio.

### Autotransformers

672



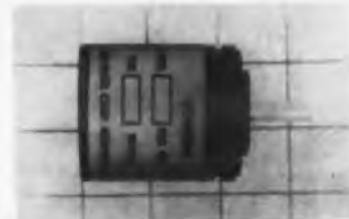
Handle 30 amp. Series W Variac autotransformers type W30, rated for 30 amp, provide continuous control of ac voltage from 0 v to 17% above line voltage. Available for 120- or 240-v, 50- to 60-cps operation, units withstand momentary overload of 1,000%. Type W30M is fully enclosed.

General Radio Co., Dept. ED, West Concord, Mass.

Price: W30, \$75; W30M, \$97.

### Gear Heads

688



Precision gear heads and speed reducers are available in size 5 to 18 servo mounts. Units have Class 2 gearing, with ABEC Class 1.5 bearings. End play and radial play are low; backlash is 30 min maximum. Housing is anodized aluminum alloy.

Elm Instrument Corp., Dept. ED, 30 Chasner St., Hempstead, L. I., N. Y.



Accuracy is 0.01% for voltage and resistance measurements or 0.2% for ac measurements to 1,000 v and for 10 ohms to 10 meg. Model 600 voltohmmeters are five-digit precision differential instruments with in-line display readout. Reference voltage is provided by Zener diode supply stable to 0.001% for a 10% line change.

Auto-Data, Dept. ED, 943 Turquoise, San Diego, Calif.  
**P&A:** \$1,885 to \$3,450; 30 to 45 days.

**Silicon Diodes**

Diffused-junction silicon diodes in 53 types have high inverse voltages, high forward conductance, low leakage current, and high rectification efficiency. Operating from -65 to +175 C, the medium current rectifiers are welded and hermetically sealed in a glass and metal case.

Raytheon Co., Semiconductor Div., Dept. ED, 215 First Ave., Needham, Mass.

**P&A:** \$0.43 to \$3 ea, 100 to 999; immediate.

**Glass Diodes**



Mesa diffused junction glass diodes 3G05 through 3G30 have rating ranging from 50 to 300 v. Forward conductance to 300 ma, voltage drop of 0.9 v at 25 C, and low leakage characteristics are other features. Temperature range is -55 to +150 C.

International Rectifier Corp., Dept. ED, 1521 E. Grand Ave., El Segundo, Calif.

**P&A:** \$1.07 to \$2.80 ea, 1 to 99; stock.

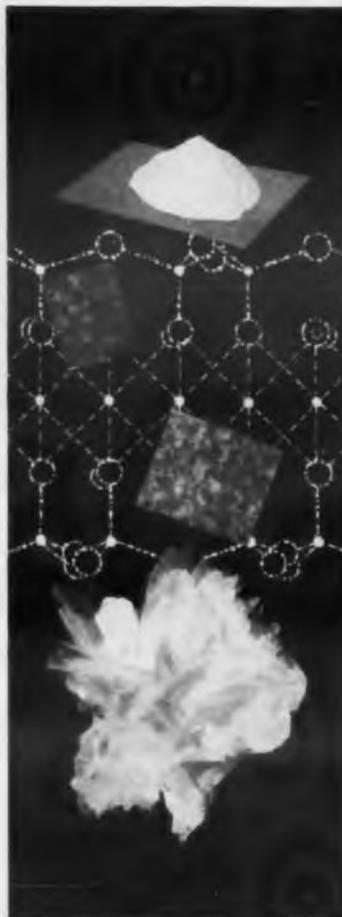
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For the most critical design applications...

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**SYNTHAMICA®** synthetic mica: a fusion of silica, alumina, magnesia, and alkali fluorides... chemically pure, offering a wide range of superior properties for the most demanding dielectric applications.



**SUPRAMICA®** ceramoplastics: exclusive formulations of synthetic mica and special electrical-grade glasses. **Now — SUPRAMICA 620™** ceramoplastic for true high-temperature hermetic seals (helium leakage less than  $2 \times 10^{-10}$  after severe environmental tests).

**MYCALEX®** glass-bonded mica: quality natural mica and electrical-grade glasses. Offer high dielectric strength, high arc resistance, high-temperature capabilities.

Both formulations offer total dimensional stability in precision-molded and precision-fabricated grades.



**MYCALEX** tube and transistor sockets: a line of precision-molded, glass-bonded mica and ceramoplastics for UHF, VHF, and similar high-reliability applications.



**MYCALEX** commutation switches and plates: high-reliability, miniaturized electromechanical devices for missiles, multiplexing, telemetering, timing, time-division and control switching. Now up to 540 contacts on a 3" O.D. plate!

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World's largest manufacturer of ceramoplastics, glass-bonded mica and synthetic mica products





Progress In Hydrogen Thyratrons

# 55 x 10<sup>9</sup>

## ANODE DISSIPATION FACTOR



### G-E Power Tube Department Products Also Include:

- Ignitrons
- Traveling-wave tubes
- Magnetrons
- Metal-ceramic tetrodes
- High-power duplexers
- High-power waveguide filters
- Klystrons
- Thermionic converters

## Highest Registered Rating Now Available from G.E. In an Air-cooled Tube

The latest addition to General Electric's expanding line of hydrogen thyratrons is now available for pulse applications such as radar modulators and linear accelerators. Developed under U. S. Army Signal Corps contract, the GL-7890 achieves an anode dissipation factor of  $55 \times 10^9$  and has a peak anode voltage rating of 40 kv. The tube can now be operated water-cooled or air-cooled at full ratings.

### COMING: INCREASED CURRENT AND VOLTAGE CAPACITY

Now in the late stages of development, the Z-5212 will further increase voltage and current-carrying capacity in hydrogen thyratrons. Peak anode voltage rating for this tube will be 50 kv with an average current rating of 8 amp. General Electric's Power Tube Department will welcome your requests for technical data on the Z-5212.

### TEMPERATURE INDICATING DEVICE ON GL-7390A

The first high-power ceramic-metal hydrogen thyatron, General Electric's GL-7390, is now being built to MIL specifications. A modified version of this tube, the GL-7390A, is equipped with an integral anode temperature indicator for convenient readings. Both the GL-7390 and the GL-7390A have ratings of 33-kv peak anode voltage and 4-amp average current.



GL-7390A

### HYDROGEN THYRATRON BULLETIN AVAILABLE

For a comprehensive analysis of the theory and application of hydrogen thyratrons, write to the Power Tube Department, General Electric Company, Schenectady, N. Y. Ask for Bulletin PT-49. To order, or obtain more information on hydrogen thyratrons, contact your nearest Power Tube sales office. Phone numbers are listed below.

265-09-9545-8481-36



POWER TUBE DEPARTMENT

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TELEPHONE TODAY—Syracuse, OL 2-5102 . . . Clifton, N. J., GR 3-6307  
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Los Angeles, GR 9-7765.

## NEW PRODUCTS

Storage Tube

591



Double-ended scan converter readout storage tube type K2070 provides resolution in excess of 1,000 lines at 50% modulation. Simultaneous or sequential reading and writing is possible; retention, erasure, and decay rate are controlled.

Electronic Tube Sales Dept., Allen B. Dumont Laboratories, Div. of Fairchild Camera and Instrument Corp., Dept. ED, 750 Bloomfield Ave., Clifton, N. J.

Multiplier-Modulator

583



Miniature analog multiplier-modulator model 100 provides 2% accuracy in case size of 1 x 1-1/2 x 3 in. Inputs are dc to 20 kc,  $\pm 1.5$  v, output 100 to 20,000 cps, zero to 1.4 v rms. Distortion is less than 1%; response time as a modulator is less than 1 msec.

Transmagnetics Inc., Dept. ED, 40-66 Lawrence St., Flushing 54, N. Y.

Ratio Computer

586



Output is 1 ma or 10 mv suitable for driving pen writing or strip-chart recorders. Model 557-2B ratio computer accepts two independent dc signals as low as 10 mv. Accuracy of computed ratio is 1%. Uses include measurement of ratios from strain-gage type transducers, thermocouples, resistance bulbs.

Magnetic Instruments Co., Inc., Dept. ED, Thornwood, N. Y.

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## Variable Inductors

493



Encapsulated variable inductors, with single or bifilar windings, meet MIL-C-15305. Coils are tuned by a powdered iron core. Inductance variation is  $\pm 20\%$  from nominal, with temperature coefficient of  $-50$  to  $+100$  ppm per deg C. Distributed capacity is 1.5 pf max.

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

## Angle Repeater

497



Accurate within 6 min. Panel-mounted model PPR-20 displays the angular position of remote unit to within 6 min of arc. Range is 0 to 360 deg, slewing rate 180 deg per sec. Unit has solid-state construction and rapid response. Panel size is 1-3/4 in. OD by 1-1/2 in. long.

Theta Instrument Corp., Dept. ED, 520 Victor St., Saddle Brook, N. J.

P&A: \$1,500; 3 weeks.

## Vane-Axial Blower

575



Delivers 140 cfm of air against a static pressure of 5 in. of water at 25,000 ft. Sea level output is 77 cfm against 5 in. of water. No pressure-sensing or speed-regulating switches are needed in the system. Motor is wound for 200 v ac, 400 cps, three phase.

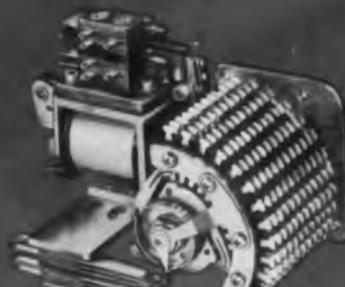
Globe Industries, Inc., Dept. ED, 1784 Stanley Ave., Dayton 4, Ohio.

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## SPRING-DRIVEN



**TYPE 210**  
Up to twelve 10-point levels  
or four 30-point levels



**TYPE 211**  
Up to twelve 11-point levels  
or four 33-point levels



**TYPE 212**  
Up to sixteen 20-point levels  
or twelve 30-point levels



**TYPE 213**  
Up to sixteen 20-point levels  
or twelve 30-point levels

## CAM-OPERATED



**TYPE 200**  
Up to eight cams with 30, 32  
or 36 tooth ratchets

## DIRECT-DRIVE



Up to three 40-point levels

# Let Clare put the exactly right stepping switch in your design

Designers who count on CLARE stepping switches as components for complex counting, totalizing and sequence-control equipment know that from the wide CLARE line they can select the exact switch their application requires. If necessary, CLARE engineering will provide special switch designs.

CLARE stepping switches are available as spring-driven, cam-operated or direct-drive switches with capacities from 10 to 52 points. All may be hermetically sealed in nitrogen or oil, or provided with dust covers.

All CLARE stepping switches are well known for their long life, high capacity and minimum maintenance through millions of precise stepping operations. For complete information write for Catalog 202.



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C. P. Clare Canada Ltd., 840 Caledonia Road,  
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FOR—

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- Stable insulation resistance
- Good arc resistance
- Strength and stability
- Low moisture absorption

\*diallyl phthalate



## C. P. CLARE & CO.

Relays and related  
control components

## NEW PRODUCTS

### Pressure Transducer

609



High-range absolute pressure transducer 737 meets government specs in miniature size. Ranges from 0 to 4,000 up to 0 to 10,000 psi are made, with resolution to 0.2%, resistances 1 K to 10 K  $\pm 5\%$ .

Bourns, Inc., Dept. ED, 6135 Magnolia Ave., Riverside, Calif.

### Shaft Extensions

533



Available in 1/8, 3/16, and 1/4 in. shaft sizes, these precision shaft extensions have male and female ends in the same or any combination of these sizes. Length of extension is 1-5/8 in. Diameters are concentric to 0.0005 in.

PIC Design Corp., Dept. ED, 477 Atlantic Ave., East Rockaway, L. I., N. Y.  
P&A: \$15 to 75.00; from stock.

### Wide Band-Pass Filters

537



Types NB-1 and NB-1B are four-crystal networks contained in a hermetically sealed package less than 1 cu-in. and 2.5 cu-in. respectively. The center frequency of both types is 10.7 mc  $\pm 3$  kc with a 6 db bandwidth of 200 kc + 10 kc, -0 kc and an ultimate rejection of 100 db min. Singly they provide a 60 to 6 db bandwidth ratio of 2.25 to 1.

Midland Manufacturing Co., Dept. ED, 3155 Fiberglas Road, Kansas City 15, Kan.  
Availability: From stock.



### LEADERSHIP IN DESIGN AND MANUFACTURE OF SLIP RING ASSEMBLIES

Complete facilities, metallurgical and engineering services are available for design and manufacture of slip ring assemblies to critical specifications, ranging in diameter from 1" to 48" and larger—for General Purpose, Radio Frequency and Video Ring Circuits, High Speed Instrumentation, High Voltage Ring Circuits and Power Pulse Slip Rings. A slip ring data file is available—write for your copy.

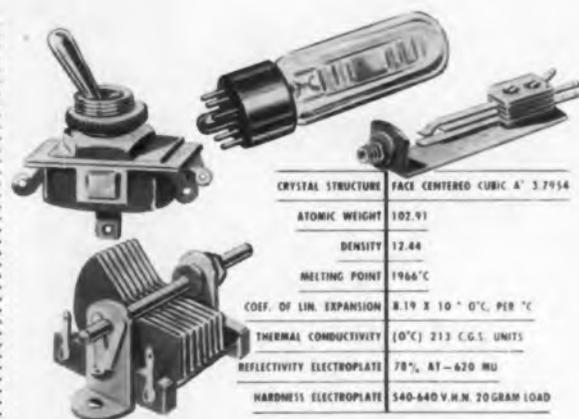
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CRYSTAL STRUCTURE	FACE CENTERED CUBIC A' 3.7954
ATOMIC WEIGHT	102.91
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MELTING POINT	1966°C
COEF. OF LIN. EXPANSION	8.19 X 10 <sup>-6</sup> °C. PER °C
THERMAL CONDUCTIVITY (0°C)	213 C.G.S. UNITS
REFLECTIVITY ELECTROPLATE	78%, AT-620 MU
HARDNESS ELECTROPLATE	540-640 V.H.N. 20 GRAM LOAD

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Rhodium plating offers outstanding protection against surface corrosion under all atmospheric conditions. Used in electrical and electronic applications, it improves efficiency whenever a low-resistance, long-wearing, oxide-free component is required . . . assures low noise level for moving components . . . provides positive action for components subject to long periods of inactivity . . . eliminates partial rectification and unwanted signals by keeping components oxide-free. Send for complete technical data.

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### SIMPLIFIED SILVER PLATING FOR ELECTRICAL AND ELECTRONIC COMPONENTS

The simplest, most efficient process for protecting electrical, electronic and lamp components with mirror-bright silver plating in flash to heavy deposits. Silva-Brite is a crystal-clear solution—work is visible during plating process. Plating is quick, easy, non-critical with results assured at current densities from 10 to 40 amps psf—and little or no polishing required. Normal room temperature operation minimizes fumes and bath decomposition. Write for complete information on Silva-Brite and application procedure.

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ELECTRONIC DESIGN • July 5, 1961



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Precious metal contacts in pure or alloyed forms of silver, platinum, palladium and gold provide unmatched resistance to atmospheric corrosion, deformation, arc erosion, binding and metal transfer. Baker high-reliability precious metal contacts are supplied as wire, rod, sheet and in a complete line of fabricated forms. Facilities are also available for manufacture to your specifications.

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### FINE WIRE, THIN FOILS, RIBBON AND TUBING IN NOBLE METALS AND THEIR ALLOYS

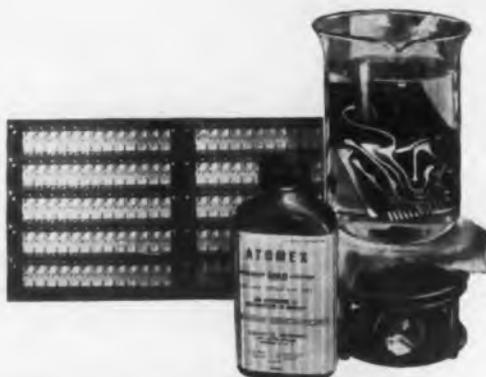
**WIRES:** Bare drawn wire of ductile materials down to .004"—High temperature thermocouple wires—High temperature furnace windings—Potentiometer and Resistance wires—Platinum clad tungsten wire.

**FOILS:** In platinum, palladium and gold down to .0001"—in iridium and rhodium as thin as .001".

**TUBING:** Seamless in platinum, palladium, gold and their alloys. Sizes from .018" with .004" wall up to 1½" with .042" wall. • Available in standard or to specification.

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Use Atomex gold immersion solution for more permanent, less expensive coating of printed circuits, metalized plastics, etc. with complete assurance of tarnish resistance and electrical resistivity. In a simplified immersion process, 24K gold is deposited by ionic displacement in a thin, dense, uniform protective layer. • Atomex is the first practical gold immersion solution containing no free cyanide. It eliminates need for costly analytical controls. Write for technical data.

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 Fine Wire, Thin Foils, Ribbons & Tubing

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CITY..... ZONE..... STATE.....

### Torque Motor

536



Providing 6 lb of linear force from a few watts of power, the firm's model 11 torque motor operates in high humidity and temperature. Unit can operate while immersed in fluids, resists shock to 67 g, and operates from -66 to +400 F. Device weighs 12 oz and meets MIL specs.

Midwestern Instruments, Inc., Dept. ED, P. O. Box 7509, Tulsa 18, Okla.

### Potentiometer Tester

534



Plots results on X-Y recorder. This potentiometer tester, type 2398, supplies necessary signals to plot resistance vs shaft rotation on an X-Y recorder. It operates in two ranges, from 1 ohm to 1 meg and from 10 ohms to 10 meg, and provides 120 db resistance measurement capability.

F. L. Moseley Co., Dept. ED, 409 N. Fair Oaks Ave., Pasadena, Calif.

### Ceramic Bases

539



For mounting components. Alumina ceramic bases are said to be extremely rugged, useful at temperatures as high as 1,000 C. Parts are custom fabricated. Complete subassemblies with metalized ceramic bases brazed into metal parts are available.

Metalizing Industries, Inc., Dept. ED, 338 Hudson St., Hackensack, N. J.

Are there limits to Centralab

## Rotary Switch Design?

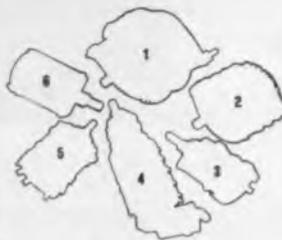


Of course—but they are much broader than you might think. The illustrated units are just a few of the difficult and unusual switches that CENTRALAB has been called upon to design.

What kind of special switch do you need? CENTRALAB engineers can modify an existing type, or design an entirely new switch to solve your problems.

For immediate attention, write directly to CENTRALAB'S Switch Sales Manager, outlining your problem.

1. Switches 36 circuits progressively in missile check-out application. Used with stepping relay in limited equipment area. Glass silicone insulation.
2. Sub-miniature 24 position switch provides 50% space reduction over conventional switch construction. Has rugged, accurate indexing for long life. Glass epoxy insulation.
3. Low voltage switch with auxiliary high voltage snap action switch which breaks heavy load to rotary switch during switch cycle. Has guarded detent.
4. 5 pole, 9 position low voltage switch with locking action make and break on integral snap action switch. Snap action switch breaks load to rotary switch during switch cycle.
5. Dual concentric switch in which inner shaft operates rotors of all 3 sections while outer shaft operates rotor on front section independently. Used in aerial photography equipment.
6. 3 pole, 18 position unit with 6 positions on each section. Has high torque for positive positioning of contacts. Glass epoxy insulation. Used in ground support equipment.



# Centralab

THE ELECTRONICS DIVISION OF GLOBE-UNION INC.  
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In Canada: Centralab Canada Ltd., P.O. Box 400, Ajax, Ontario

P-6131

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## NEW PRODUCTS

### Component Holders

540



**Shock and vibration resistant.** Shock tests in excess of 200 g resulted in no visible shifting of components. Peak acceleration at 500 cps vibration is 200 g; and at 2,000 cps, 90 g; 487 designs are available.

Masterite Industries, Dept. ED, 851 W. Olive St., Inglewood, Calif.

**Availability:** from stock.

### Curve Follower

590



**Function generator** converts manual set-point control to automatic program control. The Data-Trak curve follower can drive ganged pots to provide up to 12 control signals. Dust-tight case is 19 in. wide.

Research, Inc., Dept. ED, Box 6164, Minneapolis 24, Minn.

### Proportional Solenoid

535



**Occupying less than 1-1/2 cu in.,** and weighing less than 4-1/2 oz, this proportional solenoid, model 15, provides relatively small, high-force displacements proportional to input signals. Unit operates in temperatures to 400 F, is submersible in fluid or gas, and can be mounted to provide force in any direction.

Midwestern Instruments, Inc., Dept. ED, P. O. Box 7509, Tulsa 18, Okla.

## Oscilloscope

584



Sensitivity is  $50 \mu\text{v}$  per cm; low noise level permits resolution of signals down to  $10 \mu\text{v}$ . Model 403-B commercial oscilloscope permits display of nonamplified outputs from strain gages, pressure pickups, accelerometers and other transducers. Its 21 sweeps range from  $1 \mu\text{sec}$  to 5 sec per cm.

Allen B. Du Mont Laboratories, Dept. ED, 750 Bloomfield Ave., Clifton, N. J.

## Current Recorder

704



Five-ampere current recorder has better than 2% over-all accuracy, and a frequency response of 25 to 500 cps. Safe working voltage is 750 v rms, input resistance is 0.02 ohm. At standard chart speed of 1 in. per hr. paper supply lasts 31 days.

Rustrak Instrument Co., Dept. ED, 130 Silver St., Manchester, N. H.

Price: \$105.

## Volt-Ohm-Milliammeter

585



Models 267 and 268 are designed for general laboratory work and production line testing. Sensitivity is 5,000 ohms per volt for both models. Microampere ranges are 0 to 50 for model 267 and 0 to 60 for model 268.

Simpson Electric Co., Dept. ED, 5200 W. Kinzie St., Chicago 44, Ill.

Availability: Immediate from distributors.

## High-Performance Commercial Potentiometer—Under \$1

NUMBER 16—NEW PRODUCT SERIES

Now—solve the quality-price dilemma with Bourns E-Z Trim® commercial potentiometers. These subminiature thoroughbreds are direct descendants of the time-proven Trimpot® potentiometer, and their performance shows it. They stand up to steady-state humidity and fully satisfy the requirements for such demanding applications as industrial controls.

Settings you make with E-Z Trim units are pinpoint-sharp, thanks to the superior angular resolution afforded by the 15-turn shaft. They stay that way, too, because the shaft is self-locking. Adjustments are fast and simple—an ordinary screwdriver does the job.

Take your choice of wirewound or Resiston® carbon units. Wirewound Model 3067 handles a hefty  $\frac{1}{2}$  watt at room temperature, is available with resistances of 100 ohms to 20K. Carbon Model 3068 offers resistances of 20K to 1 Meg. Both units have either printed circuit pins or solder lug terminals.

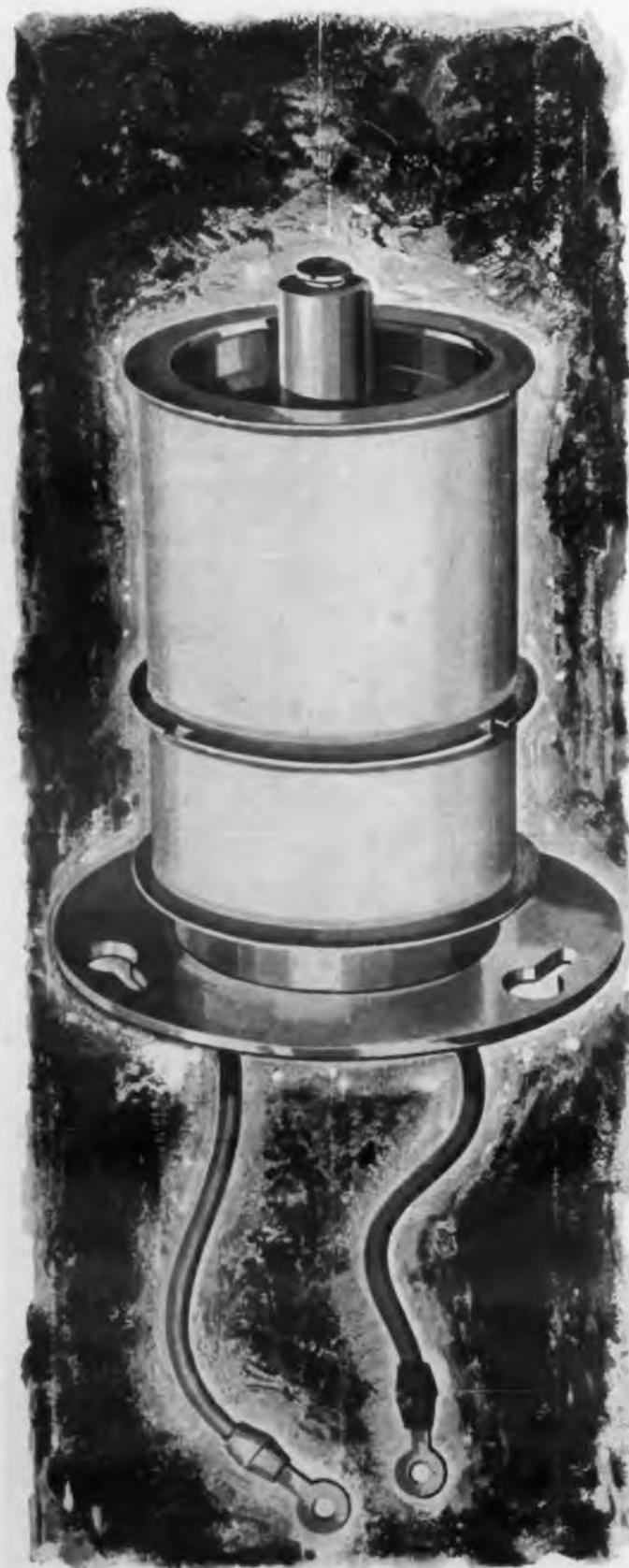
Order in production quantities of 1000 or more, and these exceptional potentiometers are yours for under \$1 each. Tell us you're in a hurry, and you'll have them within 48 hours—they're on the shelf from coast to coast. Write now for complete data and list of stocking distributors.



BOURNS, INC. TRIMPOT DIVISION  
8135 MAGNOLA AVE. RIVERSIDE, CALIF.  
PHONE: OVERLAND 4-1400 - TWX: 822222  
CABLE: BOURNEINC

Manufacturer: Trimpot® potentiometers; transducers for position, pressure, acceleration. Plants: Riverside, California; Ames, Iowa; and Toronto, Canada

CIRCLE 84 ON READER-SERVICE CARD



### 8036 SMALL, RUGGED CERAMIC HYDROGEN THYRATRON SAVES VALUABLE SPACE

Tung-Sol leads the way with a ceramic Hydrogen Thyatron that fills an important design need. An electrical equivalent of the popular Tung-Sol 5949A — only one third tube volume is required by this new member of the family.

Tung-Sol ceramic Hydrogen Thyatron 8036 has rugged environmental ratings. It is designed for flange mounting with flexible connectors to achieve a solid mounting with loss-free terminations. Grid connection is made to the flange through the grid ring clamp.

For full technical data, consult your Tung-Sol representative or write: Tung-Sol Electric Inc., Newark 4, N.J. TWX: NK193.



#### HYDROGEN THYRATRON 6587A

6587A, a glass thyatron, is a direct plug-in replacement for Tung-Sol 5C22. Valuable inches of overall height are saved by means of the ring-disk type of construction, which also provides the advantages of external (cool) anode and lower lead inductance. It is rated for higher voltages with higher currents than prototype tubes. Grid connection can be made through the grid ring or through the tube base pin. An internally-connected hydrogen reservoir promotes long life.

	8036	6587A	5C22
Overall height, Max	3.75"	6.	8.75
Peak forward voltage	25. KV	18.	16.
Peak current	500. Amps	365.	325.
Peak Pulse Power (Delivered to the load)	6.25Mw	3.25	2.6

TECHNICAL ASSISTANCE IS AVAILABLE THROUGH: Atlanta, Ga.; Columbus, Ohio; Culver City, Calif.; Dallas, Tex.; Denver, Colo.; Detroit, Mich.; Irvington, N. J.; Melrose Park, Ill.; Newark, N. J.; Philadelphia, Pa.; Seattle, Wash. In Canada: Abbey Electronics, Toronto, Ont.

 **TUNG-SOL**

## NEW PRODUCTS

### Time-Delay Relay

592



Solid-state time-delay relay SI-01-TD, weighing less than 3 oz, has no moving parts. Supply voltage is 18 to 30 v dc; delay is  $30 \pm 6$  sec. Equivalent contact rating is 40 v, 10 ma. Operating temperature range is  $-55$  to  $+125$  C.

Espey Manufacturing & Electronics Corp., Saratoga Industries Div., Dept. ED, Saratoga Springs, N. Y.

### Oven Assembly

547

Three-vacuum oven assembly model 8435 is for bake-out of semiconductors and other devices at 200 or 300 C. A single pump evaluates to  $1 \times 10^{-3}$  mm Hg. Control is sensitive to within  $\pm 1/2$  C. Each oven has individual controls. Work chamber is 18 x 18 x 18 in.

Electric Hotpack Co., Inc., Dept. ED, Cottman Ave. at Melrose St., Philadelphia 35, Pa.

### Navigation Gyro

548

For missile applications and other high performance uses, type C70 2527-001 floated-rate integrating gyro has an angular momentum of inertia of 500,000 gm-cm<sup>2</sup> per sec. Vertical drift is 0.003 and azimuth drift is 0.015 deg per hr, short term.

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

### Pulse Counter

543



Differential pulse counter F 160 has separate coils for addition and subtraction. Simultaneous add and subtract commands are accepted without error. Count rate is 25 per sec max. Front plate size of the five-digit counter is 2 x 3-3/4 in.

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

P&A: \$62.50; stock.

CIRCLE 85 ON READER-SERVICE CARD

ELECTRONIC DESIGN • July 5, 1961



Miniature, low-pressure transducer, model L-96, has less than 1% error at vibration levels exceeding 35 g. Available in 0 to 10 to 0 to 350 psi absolute or gage pressure ranges. Performance is said to be unaffected by temperature variations. The unit weighs 4 oz and measures 1 in. in diameter and 2 in. long.

Servonic Instruments, Inc., Dept. ED, 1644 Whittier Ave., Costa Mesa, Calif.

### Medium-Power Relay 550

Rated at 15 amp, the GF series relay is for motor loads of up to 1/2 hp and can be used in a wide range of ac and dc applications. Contacts are spst to 4pdt. Standard relays with 1/4-in. diameter silver contacts are rated at 15 amp at 115 v ac or 28 v dc.

American Machine & Foundry Co., Potter & Brumfield Div., Dept. ED, Princeton, Ind.  
P&A: \$3.40 to \$7.10; from stock.

### Integrating Gyro 549

Floated-rate integrating gyro type C70 2516 010 is suitable for missiles. Angular momentum is 100,000 gm-cm<sup>2</sup> per sec; short term vertical drift is 0.02 deg per hr; short term azimuth drift is 0.03 deg per hr; mass unbalance shift is 0.5 deg per hr.

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

### Drive Regulators 588

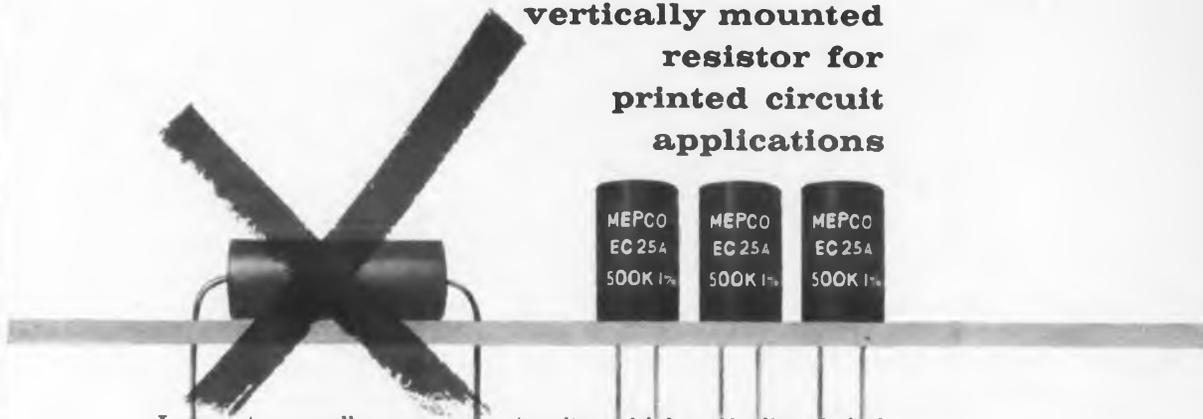


Variable-speed drive regulators and exciters use silicon controlled rectifiers and diodes to provide 0.1% regulation at base speed, with response times up to twice that of tube-type regulators. Drives range from 1 to 350 hp.

Reliance Electric & Engineering Co., Dept. ED, 24701 Euclid Ave., Cleveland 17, Ohio.

# NEW CARBON FILM RESISTORS

the first  
economical,  
space saving,  
vertically mounted  
resistor for  
printed circuit  
applications



Low cost — smaller space . . . two items high on the list of vital importance in solving today's tough design problems. MEPCO's new miniature 1/4 W Carbon Film resistors were specifically designed to break the cost and space barrier in printed circuit applications.

Having both leads extending from one end and available in three different lead spacing arrangements, these Carbon Film Resistors for vertical mounting offer advantages never before available.

Write or call today for samples and literature.

## SPECIFICATIONS

Power Rating	1/4 W at 70°C derated to 0 at 150°C	Length	1 3/4 ± 1/4
Max. Voltage	300 volts	Diameter	1/4 ± 1/4
Resistance Range	5 to 500 K	Leads	1" ± 1/4"
Tolerance	± 1%	Lead Spacing	A .125 ± .005
Temp. Coeff.	-200 PPM to 500 PPM		B .156 ± .005
Environmental Char.	MIL-R-10509C Char. B		C .200 ± .005

# MEPCO



Manufacturers of Precision Resistors

MEPCO, INC.  
Morristown, New Jersey

CIRCLE 86 ON READER-SERVICE CARD

# Resistance Values up to 100,000,000 Megohms



■ Model RX-1 Hi-Meg Resistor

*Victoreen Hi-Meg Resistors —  
Standard of the Industry  
for Over 18 Years*

*Available tolerances*

1% 2% 5% 10%

■ For longer life, Victoreen Hi-Meg Resistors are in a class by themselves, especially for all high-impedance, low-current applications. Hi-Meg Resistors have a carbon-coated glass rod element with silver-banded ends for best electrical contact . . . are vacuum sealed in a glass envelope treated with special silicone varnish that minimizes moisture effects. Always specify Victoreen Hi-Meg Resistors for the ultimate in long-term stability.

*Victoreen*

5806 HOUGH AVENUE • CLEVELAND 3, OHIO  
EXPORT: 240 WEST 17TH ST. • NEW YORK 17, NEW YORK  
CIRCLE 87 ON READER-SERVICE CARD

A-4135A

## NEW PRODUCTS

### Booster Amplifier

541



This dual-channel booster amplifier is able to drive both stators of a precision size 11, 400-cps resolver. Known as model 1012, the device has unity gain, an accuracy of 0.05%, and less than 5 min phase shift. The unit occupies 1 cu in., weighs 1 oz, and operates from  $-55$  to  $+125$  C. Different mounting configurations are available.

Melcor Electronics Corp., Dept. ED, 48 Toledo St., South Farmingdale, L. I., N. Y.

P&A: \$250-280 each; 30 days.

### Germanium Transistor

545

For critical computer switching applications. Type 3907/2N404 germanium transistor meets mechanical and environmental stability requirements of MIL-S-19500B. Specifications are: collector-to-base voltage,  $-25$  v max; collector-to-emitter voltage,  $-24$  v max with  $V_{EB}$  at  $-1$  v; operating ambient temperature,  $-65$  to  $+85$  C.

Radio Corporation of America, Dept. ED, Somerville, N. J.

Availability: Immediate.

### Magnetic-Tape Rewinder

581



Spools 10.5-in. reel in 90 sec. Average rewind speed is 500 ips. The TR-300 magnetic-tape rewriter has a universal hub variable from 3 to 3-3/4 in. which accepts NAB or IBM tape reels without adapters. Tape guides handle tapes 1/2 or 1 in. wide.

Electronic Engineering Co. of Calif., Automation Div., Dept. ED, 1601 E. Chestnut Ave., Santa Ana, Calif.

P&A: \$690; 6 weeks.



### Gamewell made a pot that will trip a microswitch

This  $7/8$ " , 100,000 ohm pot has a microswitch attached. The cam-shaped shaft can actuate the switch precisely at the chosen point

A simple solution — yes, but the answer to a special problem.

Gamewell's YES service — Your Engineered Specials service — is amazingly capable at designing simple answers to special pot problems. Why not put it to the test? Write for the facts.

\*your

Engineered

Specials service



BLISS

Gamewell®

THE GAMEWELL COMPANY, POTENTIOMETER DIVISION, 1421 CHESTNUT STREET, NEWTON UPPER FALLS 64, MASS. A SUBSIDIARY OF E. W. BLISS COMPANY.

CIRCLE 88 ON READER-SERVICE CARD

ELECTRONIC DESIGN • July 5, 1961

## Solenoid Valves

578



For up to 3,000-psi oil pressure, two-way solenoid valves are available in normally open and normally closed types. Both are pilot operated poppet valves in cartridge form and can adapt to any type of manifold or sub-plate. The poppet and plunger are the only moving parts.

Fluid Power Accessories, Inc.,  
Dept. ED, Box 64, Glenview, Ill.

## Plugs and Receptacles

572

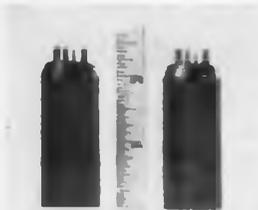


Phenolic molding compounds are used in the manufacture of these multiple plugs and receptacles, available in a variety of shapes and terminal arrangements. Applications include appliances, electronic equipment and other industries.

Hooker Chemical Corp., Durez  
Plastics Div., Dept. ED, Niagara  
Falls, N. Y.

## Multivibrators

571



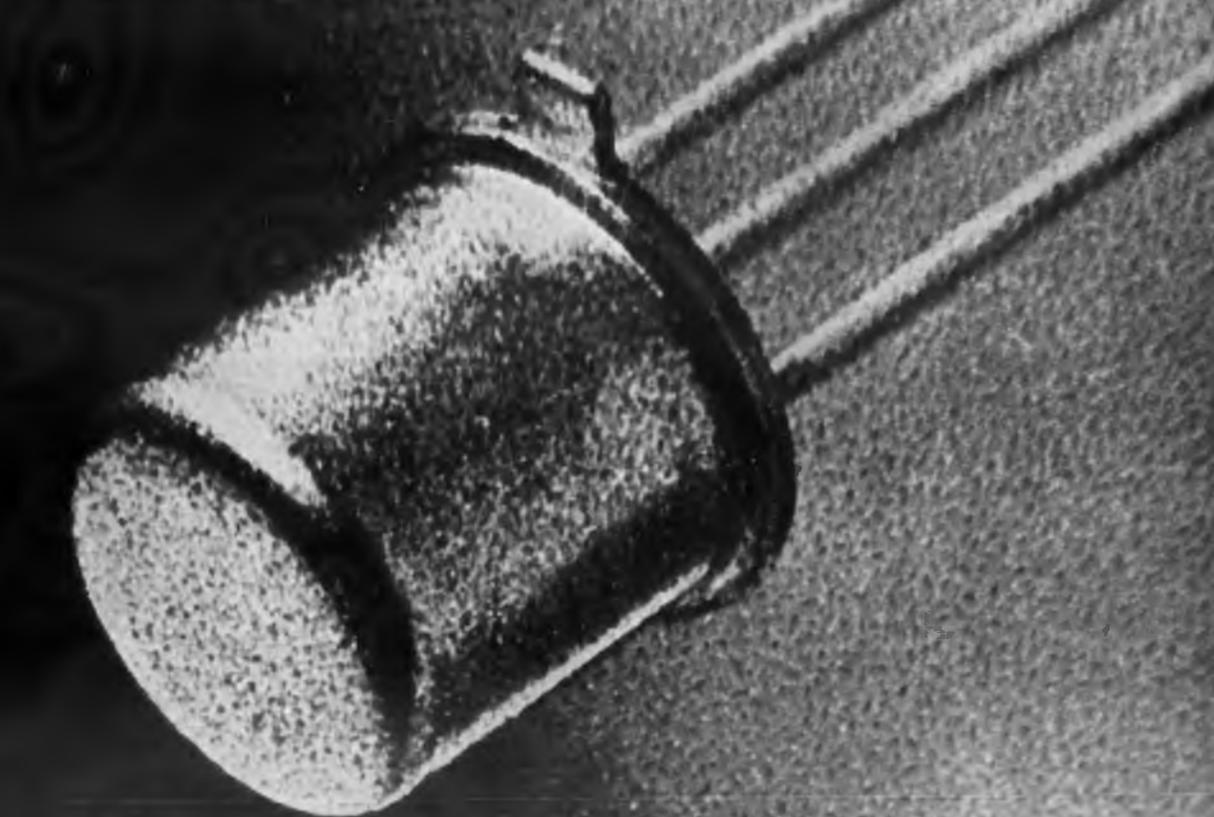
One-shot multivibrators are offered in two types: the T-166 contains a built-in noise rejection circuit and the T-167 is designed to have a pulse-width variation of 5% max from -45 to +65 C. A pulse width of 2  $\mu$ sec to 1 sec can be generated by either unit.

Engineered Electronics Co.,  
Dept. ED, 1441 E. Chestnut Ave.,  
Santa Ana, Calif.

P&A: \$38.40; \$44.50; 2 weeks.

CIRCLE 89 ON READER-SERVICE CARD ►

## General Instrument Planar Transistors



### At last! A truly passivated planar! New 2N708 silicon switch

For high speed logic switching with assured reliability, the General Instrument 2N708 npn silicon planar switch features the unique Molecular Shield™ surface-passivation process. ■ Here's a planar that is stable, reliable and uniform...lot by lot...with excellent gain characteristics as well as extremely low leakage current. Designed for switching applications, this type, as well as others in the popular 2N706 class, utilizes the latest planar techniques. ■ Extensive tests have proved that this type of transistor construction offers definite circuit advantages. Life tests, for example, indicate little degradation as a result of operation and storage at high temperatures. ■ The immediate availability of the 2N706 series in production quantities should be of interest to designers now using our silicon mesa transistors. The 2N708 is also available in limited quantities. For microtransistors, pancake-package transistors...for all your silicon planar and mesa transistors, call the sales office or franchised distributor nearest you. Or write for complete details to General Instrument Semiconductor Division, 65 Gouverneur St., Newark 4, N. J.

Abbreviated Specifications—General Instrument NPN Silicon Planar Transistors

Type	V <sub>CSO</sub>	V <sub>CER</sub>	$\beta_{FE}$	T <sub>s</sub>
2N706	25v	20v	20	60 nsec
2N706A	25v	20v	20	25 nsec
2N706B	25v	20v	20	25 nsec
2N708	40v	20v	30	25 nsec

**GENERAL INSTRUMENT SEMICONDUCTOR DIVISION**  
**GENERAL INSTRUMENT CORPORATION**

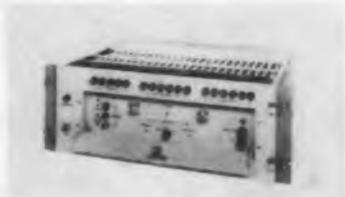


JEDEC TO 18 CASE ACTUAL SIZE

## NEW PRODUCTS

### Time-Code Generator

579



Any 17-bit time code containing three binary words for seconds, minutes or hours can be generated. Model 6202 time-code generator, for ground or airborne use, has a stability of  $10^7$  per day. One code format can be supplied as an amplitude-width-modulated code on a 1,000-cps sine wave and as a dc level shift.

Epsco-West, Dept. ED, 240 E. Palais Road, Anaheim, Calif.

### Five-Digit Voltmeter

705



Accuracy is 0.01%. This five-digit voltmeter has a range of  $\pm 0.0001$  to  $\pm 999.99$  v dc. Speed is 20 readings per sec avg; outputs are BCD and 10-line decimal; all switching is electronic; dimensions are 5-1/4 x 19 x 20 in.

Electro Instruments, Inc., Dept. ED, 8611 Balboa Ave., San Diego 11, Calif.

### Power Inductor

706



Variable power inductor is designed for complex load banks, accurate voltage control for tuning and phase-angle control circuits and breadboard filter circuits. It is available in two overlapping ranges from 10 to 40 and 40 to 160 mh. Dc resistance in either range is less than 5 ohms with dc and rms current of 0.5 amp max.

Servomechanisms/Inc., Dept. ED, 200 N. Aviation Blvd., El Segundo, Calif.

## Design with MALLORY MERCURY BATTERIES for new sales appeal in your products



**PERSONAL RADIATION MONITOR**, developed at Oak Ridge National Laboratory, warns of radiation levels by flashing a neon lamp and sounding a tone in a hearing aid earphone. The transistorized circuit operates 24 hours a day for 30 days at a time, from power by a single Mallory TR-133R mercury battery.

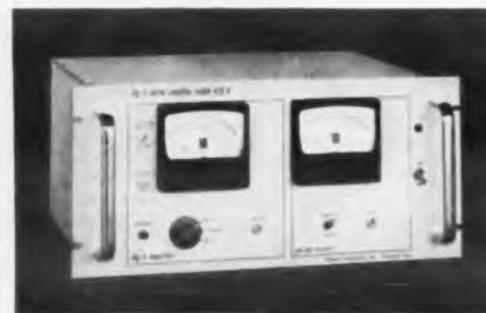
*Photo courtesy Oak Ridge National Laboratory  
Operated by Union Carbide Corporation  
For the U. S. Atomic Energy Commission*



**PORTABLE TRANSISTOR TEST SET** is made by Metronix, Inc., a subsidiary of Assembly Products, Inc. Used as the DC power source, Mallory Mercury Batteries assure stable voltage over long periods of time, are undamaged by momentary short circuits, and provide long shelf life.



**MICROMINIATURE TRANSMITTER**, used for monitoring tooth wear and pressures and for other biomedical applications, is made by Varo, Inc. Small enough to be fitted into a dental bridge, it transmits information over short distances to a pickup/preamp, utilizing an RM-312 Mallory Mercury Battery smaller than an aspirin tablet.



**A DUAL INSTRUMENT FOR REACTOR MONITORING**, the log n Period Amplifier made by Keithley Instruments, Inc. gives extremely accurate low-level DC measurements. The constant voltage source used for calibrating this sensitive instrument is a Mallory Mercury Battery . . . chosen for its steady voltage and an accuracy within  $\pm 1/2\%$ . Stable, long-lived Mallory Mercury Batteries are used as the power supply for several other Keithley instruments.

CIRCLE 90 ON READER-SERVICE CARD

Miniaturize your new product . . . make it more portable . . . give it extra long service between battery changes . . . with Mallory Mercury Batteries. Pioneered by Mallory, these unusual batteries last 3 to 7 times longer than conventional batteries, depending on drain. They provide the highest watt-hours per pound of any commercially available primary battery. Sizes smaller than an aspirin tablet deliver ample energy for many miniature circuits.

Mallory Mercury Batteries have the unique characteristic of staying at constant voltage throughout their long life. This property is ideal for transistor circuitry . . . also proves useful in applying these cells as a highly stable source of voltage for reference or calibration. Voltage of cells coming from production varies no more than a few millivolts.

As for shelf life, we've tested mercury batteries held in storage for over six years: capacity loss was minimum. Steel case construction with molded grommet seal makes them free from leakage.

Choose from a broad line of standard single or multiple voltage cells . . . or let us develop a custom power pack for you. Write us for consultation and engineering data.

Mallory Battery Co., North Tarrytown, N. Y.  
a division of P. R. Mallory & Co. Inc.



In Canada: Mallory Battery Company of Canada Limited,  
Toronto 4, Ontario  
In Europe: Mallory Batteries, Ltd., Dagenham, England

## Servo Amplifiers

582



**Have no moving parts.** Six types of Power-Max integral horsepower, position servo amplifiers are available. Positioning accuracy is typically better than 0.3%. Dc inputs include analog programmer output, positioning potentiometers, selector switch and fixed-resistor networks, electromagnetic flow-meters and static switching circuits.

Electromotion Co., Dept. ED, 4254 Glencoe Ave., Venice, Calif.  
**Availability:** stock.

## Resistor Networks

589

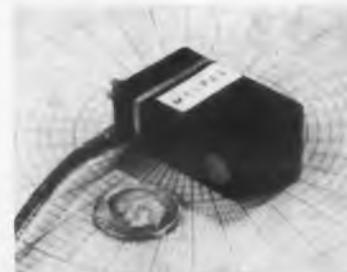


**Lug-type resistor networks** are made in lengths to 6 in., with up to 13 resistors. Values can be matched to 0.005%; individual tolerances are 0.01%. Values range from 1 ohm to 2 meg, with ratings to 3 w and 1 kv.

Reon Resistor Corp., Dept. ED, 155 Saw Mill River Road, Yonkers, N. Y.

## Photoelectric Reader

671



**Sorts by color.** Photoelectric reader model 150 provides a resistance range of about 25 K to 250 K from white to black surfaces at a distance of 1/8 in. from the lens. Volume is 2/3 cu in. Range is flush to 1-1/2 in.; weight is 1 oz.

Melpar, Inc., Dept. ED, 3000 Arlington Blvd., Falls Church, Va.

From Blueprint  
To Plastic Product  
**CONSOLIDATED**



At Consolidated, we take the designer's concept and turn it into exciting, satisfying reality.

Consolidated has always handled the tough jobs—the special jobs that “couldn’t be made from plastics.” And today at Consolidated we’re still pioneering—still finding new, better ways to work with newer, better materials.

Most of America's blue chip companies are on the honor roll of Consolidated customers. How About You?

FOR THREE QUARTERS  
OF A CENTURY  
YOUR BLUEPRINT  
IN PLASTICS



**CONSOLIDATED**

MOLDED PRODUCTS CORPORATION  
610 THREEP STREET, SCRANTON 5, PA.

Send for your free copy of the new 20-page Facilities Report

CIRCLE 91 ON READER-SERVICE CARD

## NEW PRODUCTS

### Vertical Sensing Element

580



Two-axis, proportionally damped, bubble-type A1800-01A-A vertical sensing element drives gyro torque motors. Vertical accuracy is  $\pm 15$  min of arc, repeatability is 5 min and tilt angle is 0.75 deg nominal at full-scale output.

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

### Power Supply Cabinet

542



Shock and vibration, category D per MIL-E-4970A, are withstood by this power supply cabinet. Designated model 2C, the cabinet is weather-proof and suitable for outdoor use. The cabinet is offered on nine of the firm's standard power supply models providing dc currents up to 1,500 amp from 15 to 135 v.

Christie Electric Corp., Dept. ED, 3410 W. 67th St., Los Angeles 43, Calif.

### Bellows Couplings

674



Allow 5-deg misalignment. Solid, split-hub, and combination miniature bellows couplings transmit 200 oz-in. max torque. The phosphor bronze units have zero backlash, permit 5-deg max misalignment, and 3,000 rpm max speed. Surface is palladium flash-plated.

FAE Instrument Corp., Dept. ED, 16 Norden Lane, Huntington Station, L. I., N. Y.

*when  
conditions  
are  
critical...*



*the choice is  
atlee  
transistor  
clips*



#### HERE'S WHY . . .

**HOLDING POWER** — atlee clips are specially contoured to flex under tension. Their grip actually increases as shock and vibration increases. **PROVEN RESULTS** — no visible shifting or twisting — no lead-breaking resonance — holding power unchanged by heat or constant use.



**COOLING EFFICIENCY** — atlee clips, acting as heat sinks, approach within 10% of "infinity". **PROVEN RESULTS** — operation of transistor at maximum ratings without life shortage.



**ELECTRICAL INSULATION** — atlee clips are available with Dalcoat B coating, an enamel combining twice the dielectric strength of Teflon with equal heat conductivity of mica. **PROVEN RESULTS** — proper electrical insulation from chassis and proper thermal behavior.



**SEND FOR TRANSISTOR APPLICATION TABLE** — A comprehensive listing of atlee clips for specific transistor application.



atlee corporation

atlab



DIVISION

47 PROSPECT STREET, WOBURN, MASS

CIRCLE 92 ON READER-SERVICE CARD  
ELECTRONIC DESIGN • July 5, 1961

## AC Power Supply

514



This variable-voltage power supply has an output from 0 to 140 v ac with regulation of  $\pm 6\%$  at 75 w. Maximum no-load output is 142 v rms. Front panel meter reads 0 to 150 v with 1% full scale accuracy. Unit measures 9-3/8 x 4-7/8 x 5-1/2 in.

Lafayette Radio Corp., Dept. ED, 165-08 Liberty Ave., Jamaica 33, N. Y.

Price: \$19.75.

## Miniature Pentode

521

Improved linear deflection is featured in the 6HB6, a T6-1/2 miniature pentode. Designed for receiver applications, the tube has a transconductance of 25,000  $\mu$ mhos.

Raytheon Co., Industrial Components Div., Dept. ED, 55 Chapel St., Newton 58, Mass.

P&A: \$0.72 ea, 100 or more; immediate.

## Recycling Timer

516



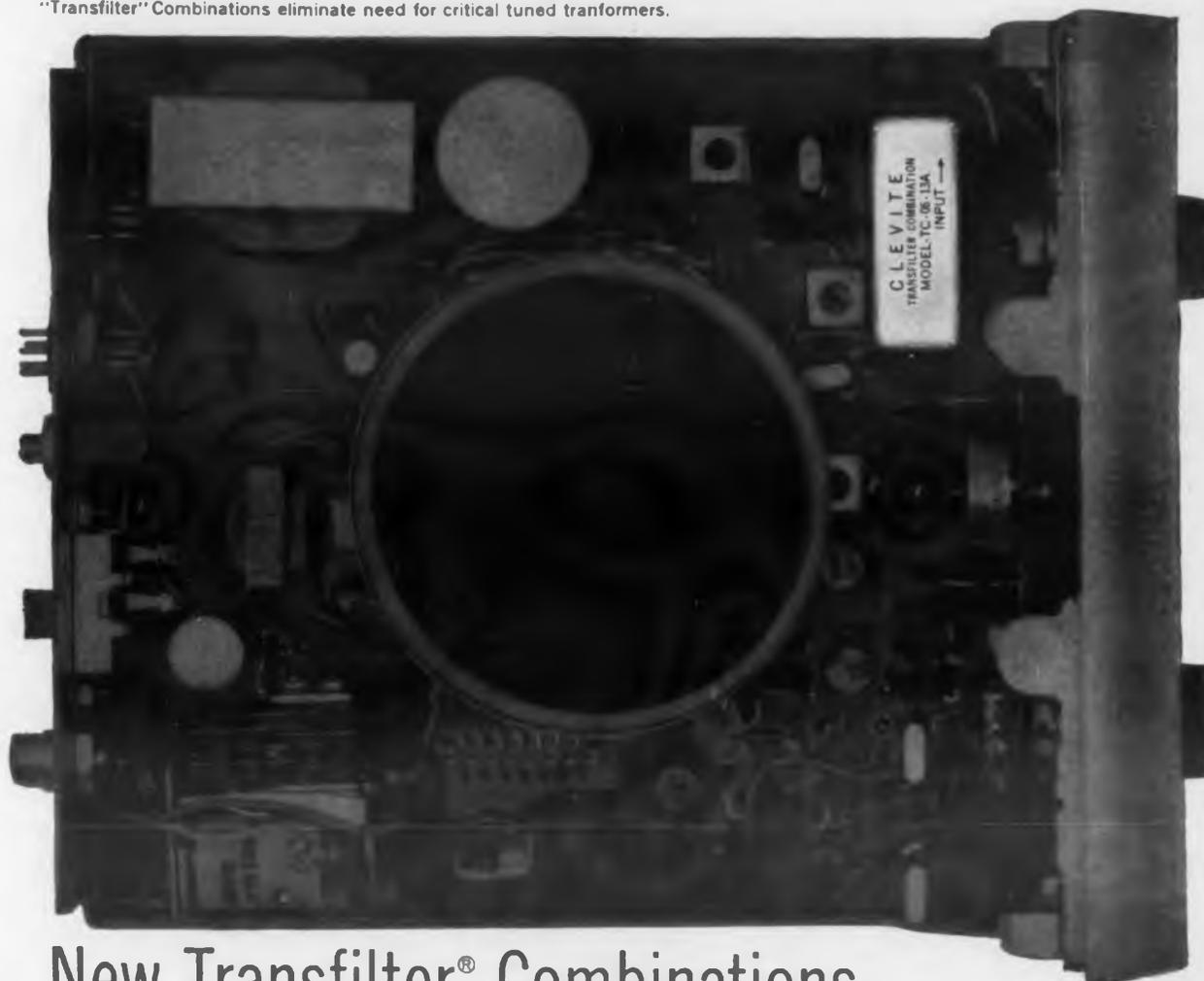
This compact recycling timer, designated series Dual-Trol, produces a series of on-off electrical pulses. It consists of two timing modules, one for the on and the other for the off signal, which can be adjusted to vary the timing interval. Ten replaceable modules are available with timing ranges from 6 sec to 3 hr. Units are rated at 10 amp and measure 7-1/2 x 5-1/8 x 5-9/16 in.

Industrial Timer Corp., Dept. ED, 1407 McCarter Highway, Newark 4, N. J.

P&A: \$77.50; six to eight weeks.

CIRCLE 93 ON READER-SERVICE CARD

Compact chassis of Osborne 300 CBT Citizens Band Transceiver.  
"Transfilter" Combinations eliminate need for critical tuned transformers.



## New Transfilter® Combinations

### Greater selectivity in a miniature package

... and increased stability at a decreased cost. Further, magnetic shielding can be eliminated as well as the necessity for factory and field alignment. That's why CLEVITE'S ceramic i-f filters are rapidly replacing conventional components in today's mobile or high quality commercial receivers. Basic component of these rugged fixed-tuned devices is the CLEVITE piezoelectric "Transfilter" developed especially for great stability of resonant frequency with respect to time and temperature. Cascading and coupling these resonators provide excellent selectivity at desired bandwidths. Size, 1 1/2" x 3/4" x 2.0" high; Center Frequency, 455 kc; Shape Factor (60/6db), 3:1 to 6:1; Bandwidth, 4 to 20 kc; Insertion Loss, 6 to 12 db max. (depending on bandwidth); Impedance, 2700 ohms in and out; Temperature Range, -20°C to +90°C. Call, write or wire for complete details.



## CLEVITE ELECTRONIC COMPONENTS

232 Forbes Road, Bedford, Ohio / Division of CLEVITE Corporation

## NEW PRODUCTS

### Angular Accelerometers

466



Resolution is 0.01% of full scale. The AA series angular accelerometers for sensing roll, pitch and yaw cover from 0.5 to 500 radians per sec<sup>2</sup> in five models. They can be used with carrier amplifiers or 400-cps power systems and are suitable for missile instrumentation and control.

Dynamic Measurements Co., Dept. ED, 106 Terwood Road, Willow Grove, Pa.

### Image Orthicon

428

With rugged construction as well as high sensitivity, type G1-7409 image orthicon is designed for military applications such as in missiles, satellites, fire control and drone guidance.

General Electric Co., Cathode Ray Tube Dept., Dept. ED, Syracuse, N. Y.

### Infrared Bolometer

426

Mosaic infrared bolometer permits imaging or photographing extensive areas at one time through the use of passive heat emission. A complete image can be provided in a fraction of a second.

Barnes Engineering Co., Dept. ED, 40 Commercial Road, Stamford, Conn.

### Program Drill

465



Drills up to 200 holes in any pattern through a load of one or more printed-circuit boards, up to 8 x 12 in. Model 120 automatic program drill, having a repeat accuracy of 0.002 in., is a high-speed electric drill with a pneumatically operated spindle and movable work table controlled by paired stop-pins set in a revolving control disk.

Develop-Amatic Engineering, Dept. ED, 923 Industrial Ave., Palo Alto, Calif.

## SILICONE NEWS from Dow Corning

# Engineer for Value



## New Dielectric Gel Assures Protection Plus Easy Repairs

If value engineering is important to you, so is Dielectric Gel. This new "see-through" potting material offers all the advantages of other materials plus visual inspection and instrument testing . . . plus easy repair . . . plus fool-proof repotting.

A water white, medium viscosity liquid, Dielectric Gel readily surrounds components. It cures in place, forming a resilient mass with outstanding dielectric properties, good thermal stability and moisture resistance. No significant stresses are developed during or after cure. Serviceable from -60 to 200 C, Dielectric Gel protects potted components and circuits from

shock and vibration, other environmental extremes . . . is excellent for filling and impregnating capacitors, magnetic amplifiers, similar components and devices.

Circuits and components potted in Dielectric Gel can be checked both visually and by instrument. When probes are removed, Dielectric Gel heals itself. To replace a defective part you simply cut away the Dielectric Gel with a knife or scissors, replace the defective component and pour fresh Gel around the part. Result: Original high quality protection!

CIRCLE 800 ON READER SERVICE CARD

For 12-page manual, "Silicones for the Electronic Engineer", Write Dept. 4019a.

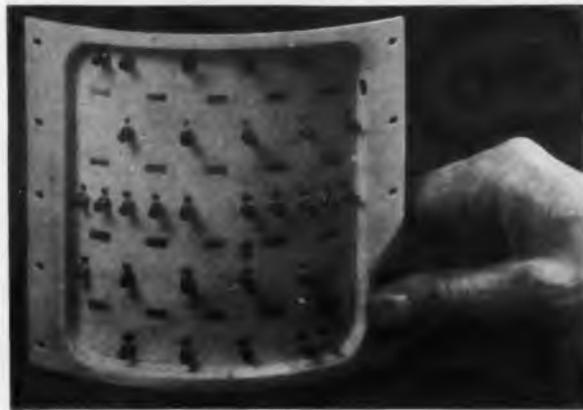


## Dow Corning

# ...Specify Silicones

## No Heat-loosened Terminals Here

Repeated soldering does not loosen terminals mounted on silicone-glass laminate made with Dow Corning resins. Lightweight and rugged, silicone-glass laminates provide greater strength at elevated temperatures than many metals . . . keep their excellent dielectric properties despite storage, environmental aging, rapidly changing ambients, vibratory shock and high humidity. These are the reasons why Lear, Inc., Grand Rapids, Michigan selected silicone-glass laminate for the capacitor mounting board in their Stable Platform Model 2013J.



CIRCLE 801 ON READER SERVICE CARD

## Easy Way to Repair Encapsulations

It's easy to replace defective parts encapsulated in Silastic® RTV, the fluid silicone rubber that cures without heat. First, you cut a slit in the Silastic RTV jacket; second, replace the component; third, patch the cut by pouring fresh Silastic RTV over the repair . . . there's no measurable loss in dielectric properties or physical strength. Encapsulation with Silastic RTV offers these advantages, too: resistance to moisture, fungus, corrosive atmospheres, corona and ozone, excellent dielectric properties, good heat dissipation and an operating temperature range of -60 to 250 C. Silastic RTV assures top value protection.



CIRCLE 802 ON READER SERVICE CARD

## Heat-sink Sealant Ups Performance

When transistors and diodes are mounted with Dow Corning compound as the heat-sink sealant, heat dissipation improves up to 50%. That's because this grease-like silicone compound doesn't dry out, harden, melt or lose its initial properties from -70 to 200 C . . . even after long time exposure. Dow Corning silicone compound has excellent thermal conductivity and increases the heat transfer between diode-and-washer and washer-and-chassis . . . improves device performance. Applied to lead terminals and connector pins after soldering, Dow Corning compound protects against corrosion, corona and shorts.



CIRCLE 803 ON READER SERVICE CARD

## Automatic Checkout Systems

451



Programed, digital automatic checkout systems provide quantitative, qualitative and go/no-go testing at all levels of maintenance and production. They direct input-output switching, select measurement scales and compare system responses to predefined limits. Magnetic or punch tape can be used.

Curtiss-Wright Corp., Electronics Div., Dept. ED, P. O. Box 10044, Albuquerque, N. M.

## Panel Meters

450



Accuracy is 2% of full scale for dc and rf rectifier and ac moving-iron type panel meters. The ac rectifier type has an accuracy of 3%. Series 201 and 301 are 2-1/2 and 3-1/2 in., round or rectangular. All types have three-year warranty.

Daystrom, Inc., Weston Instruments Div., Dept. ED, 614 Frelinghuysen Ave., Newark 12, N. J.

## Tape Transport

410



Messages of 10 sec to 3 min in length may be stored in the cartridge of the Repeater Reel magnetic-tape transport. Messages may be played over and over because the tape is spliced to form one continuous loop. Applications include monitoring and surveillance of mechanical and automatic operations.

Metric Processing Corp., Dept. ED, 143 Roseland Ave., Caldwell, N. J.

**CORPORATION** MIDLAND, MICHIGAN

branches: ATLANTA BOSTON CHICAGO CLEVELAND DALLAS LOS ANGELES NEW YORK WASHINGTON, D.C.  
CIRCLE 800, 801, 802, 803 ON READER-SERVICE CARD

ELECTRONIC DESIGN • July 5, 1961

107



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"Where More Electronic Executives Find Their Positions  
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CIRCLE 872 ON READER-SERVICE CARD

**Class 1, Nikrothal L  
Kanthal's Standard Nickel-based Alloy  
for resistors and potentiometers**

*Now better quality  
and at a lower price!*

Thanks to new aging equipment and more efficient processing, Kanthal now offers Class 1, Nikrothal L with a maximum temperature coefficient of resistance of  $\pm 5$  ppm per  $^{\circ}\text{C}$  from  $-50^{\circ}\text{C}$  to  $+150^{\circ}\text{C}$  (was 10 ppm) and at a five per cent reduction in bare wire price. Prices have been correspondingly lowered for insulated Class 1, Nikrothal L.

Don't forget Class 2, Nikrothal L, and Classes 1 and 2, Kanthal DR — no change in quality or price.

Write today for Kanthal's new  
Precision Resistance Alloys Bulletin  
describing physical properties,  
sizes, specifications, design and  
application considerations.



**THE KANTHAL CORPORATION**

8 Amelia Place, Stamford, Conn.  
Canadian Rep., Ferro Enamels, Ont., Canada

CIRCLE 96 ON READER-SERVICE CARD

## NEW PRODUCTS

High-Low Temperature Chamber 483



Range is  $-100^{\circ}\text{F}$  to  $+600^{\circ}\text{F}$ . Temperature can be lowered from  $70^{\circ}\text{F}$  to  $-100^{\circ}\text{F}$  in 5 min, and raised to  $600^{\circ}\text{F}$  in 45 min. Heating unit is electric resistance type, operating on 15 amp, 115 v ac. Refrigerant is liquid  $\text{CO}_2$ . Sealed construction is said to permit continuous operation at  $-100^{\circ}\text{F}$  without condensation. Unit measures  $21\frac{1}{2} \times 14 \times 18$  in. Test space measures  $9 \times 11 \times 10$  in.

Bemco, Inc., Dept. ED, 11631 Vanowen St., North Hollywood, Calif.

P&A: \$440.00 FOB North Hollywood; from stock.

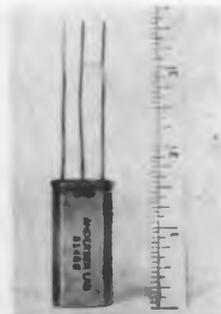
Controlled Switches 527

Fast recovery silicon controlled switches operate from 50 to 800 ma average, 10 amp peak. Complete recovery occurs in  $2 \mu\text{sec}$ ; rise time is  $0.1 \mu\text{sec}$ . Voltage ratings of the pnpn devices range from 30 to 200.

Solid State Products, Inc., Dept. ED, 1 Pingree St., Salem, Mass.

P&A: \$10 to \$29 ea, 100 to 999; stock.

Delay Lines 460



Lumped-constant electromagnetic delay lines are designed for microminiature circuit applications. Delay is  $0.35 \mu\text{sec} \pm 5\%$ ; risetime is  $0.03 \mu\text{sec}$  max; impedance is 1,500 ohms; temperature range is  $-55$  to  $+125^{\circ}\text{C}$ . Unit shown occupies  $0.3$  cu in. Requirements of MIL-STD-202-B are met.

Andersen Laboratories, Inc., Dept. ED, 501 New Park Ave., W. Hartford 10, Conn.

# **+500°F TO -100°F in SIX minutes**

With NEW  
**DELTA**  
TEMPERATURE  
CHAMBER



MODEL 1060F

Rapid temperature cycling without sacrificing precise control ( $\pm \frac{1}{2}^{\circ}\text{F}$ ) is achieved with the Delta 1060F temperature chamber.

This convenient bench model can make the complete cycle between  $-100^{\circ}\text{F}$  and  $+500^{\circ}\text{F}$  in less than twelve minutes.

An auxiliary timer Delta MR-1 is available for use in test work where automatic cycling is desired.

For further information on the 1060F and other Delta temperature chambers, contact your local Delta representative or write



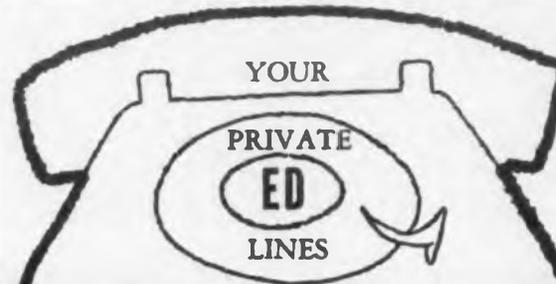
3163 Adams Ave.  
San Diego 16, Calif.

ATwater 3-3193

TWX: SD 6488U

Cable: DELTA

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When employment information is obtained through **ELECTRONIC DESIGN**, it's sent direct to your home, so that only you and one prospective employer at a time know about it. You can conduct your employment campaign privately—as it should be conducted.

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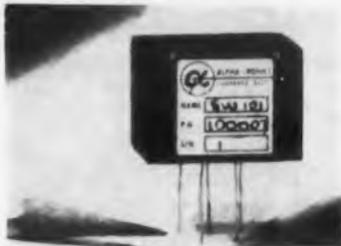
You can apply for many jobs simultaneously . . . only you will know how many.

Use the Career Inquiry Service Form, and the Reader Service Card when job hunting. They're your *private lines* to employment opportunities . . . another service for you from

**ELECTRONIC DESIGN.**

#### Low-Level Switch

482



Solid-state device is designed to switch input signals of up to 1 v with a resolution of  $5 \mu\text{v}$ . Designated type SW-101, the unit switches up to 1,000 times per sec. Switching transient is less than 4 mv; gating power is less than 2.5 mw, and error is less than  $50 \mu\text{v}$ . No external transformer is required. The unit occupies less than  $1/2$  cu in. and weighs 8 g.

Alpha-Tronics Corp., Dept. ED, 1033 Engracia, Torrance, Calif.

Availability: 30 days.

#### Multicoder

432

For all IRIG channels with sampling rates for PDM systems. Transducer-source resistances up to 5 meg may be used. Other features of the multicoder are: input of 28 v at 1-1/4 w, input resistance greater than 100 meg at 70 C, input impedance at 1,000 cps of 150 K.

Applied Electronics Corp. of N. J., Dept. ED, 22 Center St., P. O. Box 43, Metuchen, N. J.

#### Absolute Pressure Transducer

485



Designed for use with corrosive media, the model 723 absolute pressure transducer is a bourdon-tube, potentiometer-type instrument with a stainless steel isolation bellows. Range is from 0 to 350, to 0 to 3,500 psia. Typical static error band is  $\pm 1\%$ . Resistance is 1 K to 10 K. Nominal resolution is 0.25 to 0.45%. Power rating is 1.5 w continuous at 165 F. Units are 1-3/8 in. in diameter and 3 in. long. Weight is 7 oz.

Bourns, Inc., Instrument Div., Dept. ED, 6135 Magnolia Ave., Riverside, Calif.

### SYLVANIA LIGHTING—DESIGNED FOR DESIGN ENGINEERS



## New Panelescent lamp by Sylvania

### puts a dramatic idea in appliance design

Now you can design exciting new sales appeal into almost any appliance with PANELESCENT<sup>®</sup> (electroluminescent) lamps.

For example, in the control panel of a room air conditioner. This startling new form of light glows beautifully in the dark, makes a control panel clearly visible in dim rooms or during the night.

Not a bulb, not a tube, but a sheet of metal with an electrified coating, the PANELESCENT lamp is virtually indestructible, gives off no heat, either.

Installation by mass assembly is simple. No sockets,

bulbs, fragile parts, or complicated assemblies. PANELESCENT lamps use a minute amount of current, glow for years without ever needing to be switched on or off.

See your Sylvania representative for more information about how PANELESCENT lamps can be used to improve a new product you're planning. Or write now to Special Products Division, Sylvania Electric Products Inc., 60 Boston St., Salem, Mass.

With 6000 different kinds of lamps

**SYLVANIA LIGHTS THE WAY**

# SYLVANIA

SUBSIDIARY OF

## GENERAL TELEPHONE & ELECTRONICS



CIRCLE 98 ON READER-SERVICE CARD

# NEW! Solid State time/delay/relays



...with traditional **AGASTAT**<sup>®</sup> reliability!

Now available . . . solid state time/delay/relays with the accuracy essential for critical missile and computer applications! These new AGASTAT relays are the result of over 25 years' time delay engineering and manufacturing experience . . . specialized experience which has made AGASTAT the standard of reliability throughout industry.

**Advanced design** combines specially selected semiconductors and other components in a "modular-sandwich" configuration. Result: the standard modules mean flexibility; uniformity; and rapid delivery of "custom" produced prototypes. The solid state AGASTAT is hermetically sealed . . . resistant to vibration and shock. Special circuitry protects against input polarity reversal, provides immunity to voltage transients and continuously modified inputs.

**What are your requirements?** These solid state relays are only 1-5/16" sq. . . available in six standard types, with delay on pull-in or drop-out; timing ranges from 0.01 sec. to 10 hours, fixed or adjustable. Operation—18-32 vdc; -55c to 125c; load capacity to 5 amperes. Write Dept. S1-47 for data sheet. Or ask for a quotation on your special application requirements.

**AGASTAT TIMING INSTRUMENTS**  
ELASTIC STOP NUT CORPORATION OF AMERICA  
ELIZABETH DIVISION • ELIZABETH, NEW JERSEY

IN CANADA: ESNA CANADA, LTD., 12 GOWER ST., TORONTO 16, ONTARIO, CANADA

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## NEW PRODUCTS

### Brakes and Clutches

486



Size 5 brakes and clutches have torque ratings of 6 oz-in. min engaged and 0.05 oz-in. max disengaged at 28 v dc. Brake torque is 2 oz-in. Units consume 1.16 w and have a 2.8 msec response time at 28 v. Minimum engagement voltage is 6 v dc. Designed for use in analog navigation computers, units weigh 0.97 oz and meet MIL specs.

Clifton Precision Products Co., Inc., Dept. ED, 5050 State Road, Drexel Hill, Pa.

*Availability: Off-shelf delivery.*

### Hermetic Sealing Glass

532

Precision electronic components can be hermetically sealed in this glass, Kovex 50. The glass is said to provide a matched seal with metal. Annealing point is 502 C; softening point, 700 C; thermal expansion coefficient,  $48 \times 10^{-7}$ ; density, 2.27; power factor, 0.25; dielectric constant, 4.98; loss factor, 1.24.

Mansol Ceramics Co., Dept. ED, Belleville, N. J.

### Static Relay

463



Sensitivity is  $0.5 \mu\text{w}$ . The ultRelay static relay with meter-movement sensitivity handles up to 750-w, 650-cps loads, and is virtually unaffected by shock and vibration. Power amplification ratios are 90 to 100 db. Operating temperature range is  $-40$  to  $+160$  F.

Airborne Accessories Corp., Industrionic Div., Dept. ED, 5456 W. Washington Blvd., Los Angeles 16, Calif.

*Price: \$85.*

# TECLITES

U. S. PAT. NO. 2,900,874



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It's a fact! Only a specially designed indicator can *exactly* meet the precise circuitry requirements of computers, data processing and control systems.

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Every TEC-LITE—a complex transistorized indicator or a simple lite—is manufactured under rigid quality assurance programs to surpass military and commercial quality standards.

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TRANSISTORIZED INDICATORS



### Transistor Electronics Corporation

3357 Republic Ave. • Minneapolis 26, Minn.  
TWX MP 331 • WE 9-6754

CIRCLE 100 ON READER-SERVICE CARD  
ELECTRONIC DESIGN • July 5, 1961



For TO-18 package. Heat sinks for mesa transistors in the TO-18 package use a threaded nut for secure contact with transistor weld flange. The two-piece, stud-mounted sinks are of aluminum having high thermal efficiency. No. 1107 is anodized, No. 1106 has caustic etch finish.

Thermolloy Co., Dept. ED, 2130 Irving Blvd., Dallas 8, Tex.

### Silicon Controlled Rectifiers

500

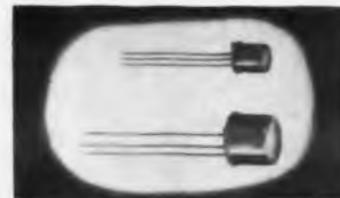


Rated at 25 amp at 100 C, diffused silicon controlled rectifiers of the TI-150 series are housed in stud package. Rated breakover voltages, both forward and reverse, are 50, 100, 200, 300, and 400 v respectively for the TI-150, 151, 152, 153, and 154.

Texas Instruments Inc., Dept. ED, P. O. Box 5012, Dallas 22, Tex. Availability: Immediate.

### Silicon Transistors

502



In TO-18 case, pnp alloy junction silicon transistors 2N935 through 2N946 are electrically equivalent to TO-5 types such as 2N1917 through 2N1922, 2N1025, and others. They are suited for switching, communications, and instrumentation uses.

Sperry Semiconductor Div., Sperry Rand Corp., Dept. ED, Norwalk, Conn.

CIRCLE 101 ON READER-SERVICE CARD >

# New Improved CBS PNP Power Transistors

2N538(A) • 2N539(A) • 2N540(A)

FEATURE MORE POWER,  
LESS WEIGHT, LESS SPACE

The CBS 2N538(A), 2N539(A) and 2N540(A) have a maximum dissipation of 30 watts at a base mounting temperature of 25 deg. Centigrade. Yet, each transistor weighs less than 5 grams and requires only 1/3 square inch of chassis space.

Compact and rugged, these hermetically-sealed CBS PNP Germanium Power Transistors are ideal for military and industrial power applications demanding high reliability. They are especially suited for servo motor controls, power amplifiers, converters, power supply regulators and low-speed power switches.

Note the major characteristics and advantages. Call or write today for complete technical data and delivery information from your local sales office or Manufacturer's Warehousing Distributor.

#### ELECTRICAL CHARACTERISTICS

Type	Max. VCBO	Min. VCE (d=1)	NPN (IC=2A, VCE=-2V)		VBE (IC=2A, VCE=-2V)		Cp (mhos) (IC=2A, VCE=-2V)	
			Min.	Max.	Min.	Max.	Min.	Max.
2N538	-80	-55	20	50	1.33	3.33		
2N538A	-80	-55	20	50	1.33	3.33	17.5	52
2N539	-80	-55	30	75	1.00	2.50		
2N539A	-80	-55	30	75	1.00	2.50	35	105
2N540	-80	-55	45	113	0.75	1.88		
2N540A	-80	-55	45	113	0.75	1.88	71	213

All types have: Max. collector current, 3.5 amps; junction temperature, -65 to +95°C; max. saturation voltage 0.6 volts (IC=2A, IB=200 mA). Minimum alpha cutoff frequency is 200 KC (IC=100 MA, VCE=-4 volts); max. thermal resistance, 2.2°C/W.



## semiconductors

More Reliable Products through Advanced Engineering

**CBS ELECTRONICS, Semiconductor Operations, Lowell, Massachusetts**

A Division of Columbia Broadcasting System, Inc. • Semiconductors • tubes • audio components • microelectronics

Sales Offices: Lowell, Mass., 900 Chelmsford St., GLenview 2-8961 • Newark, N. J., 231 Johnson Ave., TAIBert 4-2450  
Melrose Park, Ill., 1990 N. Mannheim Rd., ESTebrook 9-2100 • Los Angeles, Calif., 2120 S. Garfield Ave., RAYmond 3-9081  
Toronto, Ont., Canadian General Electric Co., Ltd., LEnnox 4-6311.



CBS PNP Power Transistors with an improved industrial male package offer:

- Single, sturdy 8-32 mounting stud
- Matched glass-to-metal seal for greater mechanical strength and resistance to thermal shock
- Rugged welded construction through the selection of matched materials having excellent welding properties
- Typical leakage three to five times lower than specification limits.
- High dissipation with minimum size
- High collector-to-base voltage
- High collector-emitter breakdown voltage
- Wide range of operating and storage temperatures



MODEL  
4005  
with



## CONSTANT VOLTAGE CONSTANT CURRENT PROGRAMMABLE CROSSOVER

\$143<sup>50</sup>

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FACTORY

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Available  
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Catalog

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**Power Designs inc.**

1700 SHAMES DRIVE  
WESTBURY, NEW YORK  
EDgewood 3-6200 (LD Area Code 516)  
CIRCLE 102 ON READER-SERVICE CARD

## FIELD PROVEN!

MODEL  
3240

WITH



**ROBOTEC**  
overload and  
short protection  
and



**HEATRAN**  
electronic  
dissipation  
control

\$349<sup>50</sup>

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SEMICONDUCTORIZED  
POWER SUPPLY

1-32 VOLTS  
0-4.0 AMP

High efficiency,  
stabilized solid state  
DC power supply with  
.05% regulation,  
.01 ohm source im-  
pedance, 50 microsec-  
ond response time, 55-  
440 cycle input.

IMMEDIATE DELIVERY

## NOW! CONTINUOUS PRODUCTION

permits a

PRICE  
REDUCTION  
\$229<sup>50</sup>

F.O.B. NEW YORK



SEMICONDUCTORIZED  
POWER SUPPLY

MODEL  
5015

1-50 V.D.C. • 0-1.5 AMP

WITH • .05% regulation—300  $\mu$ V ripple.

OVER  
10,000  
in  
use!

- ROBOTEC short circuit protection.
- HEATRAN electronic heat transfer.

IMMEDIATE DELIVERY

**Power Designs inc.**

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EDgewood 3-6200 (LD Area Code 516)  
CIRCLE 104 ON READER-SERVICE CARD

## NEW PRODUCTS

Bulkhead Connector

517



This compression-sealed unit has a normal leakage rate of less than  $10^{-7}$  cc per sec, with rates of  $10^{-9}$  cc per sec available on special order. Bodies and pins are fused with glass, meeting MIL-C-5015 specifications. Various contact arrangements with 12 to 32 pins are available. Unit mates with any standard MS socket.

Escon, Inc., 735 Branch Ave., Providence, R. I.

Module Cage

507

Instrumentation module cage holds up to 24 printed circuit cards, or up to 12 modules 1.375 in. wide. Standard 22-pin or 24-pin connectors mount at rear. Modules are available for strain gage, telemetry, and recorder uses.

Wiley Electronic Products Co., Dept. ED, 2045 W. Cheryl Drive, Phoenix, Ariz.

Connector Cables

506

Color-coded connector cables are made for interconnection of audio equipment. Plugs are provided. Basic colors of white, green, yellow, red and blue are available. Colored marking strips and color dots may be easily applied.

Zoron, Inc., Dept. ED, 612 W. Monroe St., Chicago, Ill.

Time Delay Relay

518



Of almost crystal can size, this time delay relay, Model M-100, has spdt output contacts rated at 0.25 amp. Input voltage is 24 to 32 v dc. Adjustable time ranges are from 5 msec to 30 sec,  $\pm 5\%$  under 10 sec and  $\pm 10\%$  over 10 sec. Units are hermetically sealed, rated at one million operations, and available in a variety of mounting styles.

Electronic Products Corp., Dept. ED, 4642 Belair Road, Baltimore 6, Md.

## CONTROL DATA

# 350

COMPUTERS

BUSINESS MACHINES

DATA REDUCTION

DATA PROCESSING

MACHINE CONTROL

INDUSTRIAL CONTROL

## High Speed Punched Paper Tape Reader



- Unsurpassed Reliability
- Advanced Mechanical Design
- 350 Char/Sec Read Rate
- Start-Stop or Continuous Mode
- 5, 7, or 8 Level Tape
- Tape Widths:  $1\frac{1}{16}$ ",  $\frac{7}{16}$ ",  $1$ "
- Instantaneous tape width selection
- Reads all punched tape  
Paper-Plastic  
Colored-Plain  
Oiled or Non-oiled
- Complete freedom from programming limitations

The Control Data Model 350 Paper Tape Reader employs the most advanced tape controls and reading techniques. Multi-colored tapes can be read interchangeably without the need of bias adjustments, and new specially designed light guides in the reading head eliminate dirt collecting holes. The precise control system eliminates troublesome resonances and provides complete freedom from programming limitations. These and other features combined with careful attention to details and quality, result in a paper tape reader which provides new high standards of reliability and versatility.

For complete specifications, prices and delivery write or call us directly or contact our nearest sales representatives.



## CONTROL DATA CORPORATION

### CEDAR ENGINEERING DIVISION

TWX-MP 974 • 5806 36th St. West • Minneapolis, Minn. • WEat 9-1687

CIRCLE 105 ON READER-SERVICE CARD

## Module Cooling Unit

520



Designed to cool digital modules, particularly the firm's S-PAC series, the model CU-30 cooling unit utilizes three axial-flow fan units mounted in parallel within the chassis. It has a removable dust filter. The airduct may be adjusted to draw air from either the front or rear of the cabinet. Unit measures 19 x 5 x 8 in.

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

P&A: \$127.00; delivery from stock.

## Differential Mv Commutator

459



Range is dc to 20 kc for the differential millivolt commutator, packaged for missile and ground support applications. Specifications include: power, 1 w at 28 v; input impedance, 100 K; sensitivity, 10 mv full-scale input; resolution, better than 20  $\mu$ v; linearity, better than 0.25%.

Applied Electronics Corp. of N. J., Dept. ED, 22 Center St., P. O. Box 43, Metuchen, N. J.

## Leak Detector

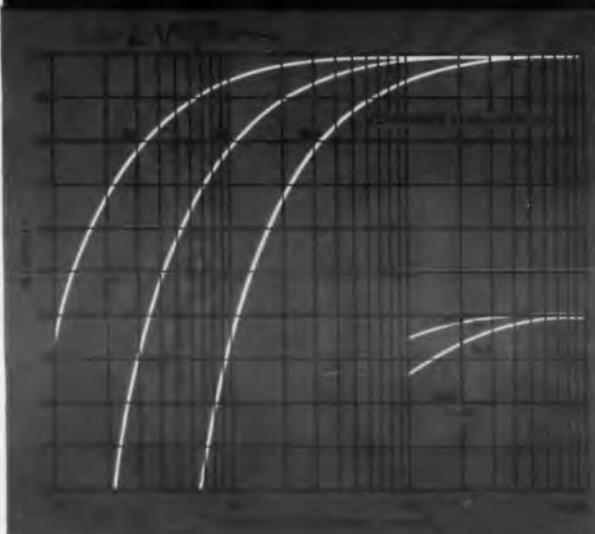
519



For testing hermetically sealed components. Leaks in the  $10^{-11}$  cc-per-sec range can be detected with the type 24-510 leak detector. Up to 10,000 transistors can be tested in each cycle, requiring less than an hour. Components are soaked in a nontoxic radioactive gas, are air washed, then are tested for traces of radioactivity.

Consolidated Electrodynamics Corp., Dept. ED, 360 Sierra Madre Villa, Pasadena, Calif.

# EVERYONE TALKS IN HERMETICALLY SEALED CONNECTORS BUT ONLY OFFERS STATISTICAL PROOF



The Cannon KPT Hermetic line is designed to, and far surpasses all requirements of MIL-C-26482...has proven statistically reliable in leakage tests 200 times as severe as that required by MIL-C-26482. Cannon offers you hermetic seals with a reliability coefficient of .999 at a confidence level of 95%. Our rigid manufacturing controls and continued testing guarantee reliability at no added cost—and, in many instances, at lower prices than ordinary hermetic seals. Available for off-the-shelf delivery from Cannon stocking points and CAPS Distributors throughout the United States. ● **LEAD-FREE COMPRESSION GLASS** ● **EXCEPTIONALLY LEGIBLE CONTACT IDENTIFICATION FOR FASTER**

**TERMINATING AND CHECKOUT** ● **RELIABILITY ASSURANCE SUBSTANTIALLY REDUCES THE NEED FOR USER'S VERIFICATION TESTING** ● These are only a few of the many reasons why you should consult the world's most experienced manufacturer of electrical connectors for your hermetic sealing needs. For immediate delivery and quotations write, phone, or wire Customer Services Manager, PHOENIX DIVISION, 2801 AIRLANE, PHOENIX, ARIZONA. Phone BRidge 5-4792. Test report and complete KPT Catalog available upon request from:

**CANNON**  
**PLUGS**

**CANNON ELECTRIC COMPANY**, 3208 Humboldt Street, Los Angeles 31, California.

CIRCLE 106 ON READER-SERVICE CARD

# AA

## in telemetry systems management

The ascendant position of Vitro Electronics in telemetry systems management and products stems from the facilities, experience, and talent it takes to produce *on time*. Vitro telemetry capability is demonstrated daily down the AMR and PMR ranges. Management versatility is reflected in our ground, mobile, shipboard, airborne, and space operations around the globe. ■ This specialty of Vitro's trusted electronic competence is founded on long and familiar experience in the functions of telemetry conception, design, engineering, procurement, production, testing, and installation. Where the utmost in exacting telemetry systems performance is demanded — Vitro is at work.

Outstanding opportunities for telemetry systems, RF and advanced development engineers.

**Vitro ELECTRONICS** A DIVISION OF VITRO CORPORATION OF AMERICA  
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CIRCLE 107 ON READER-SERVICE CARD

## NEW PRODUCTS

### Sea-Water Depth Transducer

456



Range is 350 to 1,000 psia for model 734 sea-water depth transducer. Other features include: resistances of 5 to 10 K  $\pm 5\%$ , resolution of as low as 0.15%; vibration limit of 35 g at 2,000 cps, static error band of  $\pm 0.5\%$ , dimensions of 2 in. in diameter by 1.44 in., and weight of 16 oz.

Bourns, Inc., Dept. ED, 6135 Magnolia Ave., Riverside, Calif.

### Appliance Wire

528

Teflon TFE and FEP insulation is 10 mils to 1/32 in. thick on appliance wire AWG 16 to 26. Temperature ratings are 105 to 200 C max. with voltage ratings to 600 v. Wire is U/L-approved.

Tensolite Insulated Wire Co., Inc., Dept. ED, W. Main St., Tarrytown, N. Y.

### Ultrasonic Delay Lines

531

Almost temperature-independent. These delay lines are manufactured of Code 8875 glass. This material has a nominal time delay temperature coefficient of zero  $\pm 0.75$  ppm per C. Attenuation coefficient is low enough to permit time delays of 350  $\mu$ sec or higher at frequencies below 10 mc.

Corning Glass Works, Dept. ED, Corning, N. Y.

### Frequency Standard

461



For 360 to 1,300 cps with accuracies of 0.002%. Type 27 frequency standard measures 11/16 in. in diameter and 2-15/16 in. long. It weighs 1-3/4 oz, requires 20 to 30 v dc at 5 ma and operates over a temperature range of -65 to +125 C. Vibration conditions of MIL-E-5272B Procedure II are met.

American Time Products, Div. of The Bulova Watch Co., Inc., Dept. ED, 61-20 Woodside Ave., Woodside 77, N. Y.

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## Potentiometer

457



Rated at 15 w at 25 C with maximum operating temperature of 265 C. Model 3030 wirewound potentiometer offers resistances of 10 ohms to 10 K and nominal resolution of as low as 0.6%. Weight is 0.9 oz; size is 1.07 x 0.52 x 1.27 in. Applications include in power supplies.

Bourns, Inc., Dept. ED, 6135 Magnolia Ave., Riverside, Calif.

Price: \$8 to \$10.

## Synchros

530

Bu/Weps specification MIL-S-20708A are met by this series of synchros over a temperature range of -55 to +85 C. The series is designed for use in fire control, radar, navigation, missile functions, and similar applications.

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

## Image Orthicon

433

For near infrared use, type Z5395 image orthicon is suitable for both military and industrial applications. It can be used to penetrate hazy atmospheres for mapping and surveillance, as well as in passive detection systems.

General Electric Co., Cathode Ray Tube Dept., Dept. ED, Syracuse, N. Y.

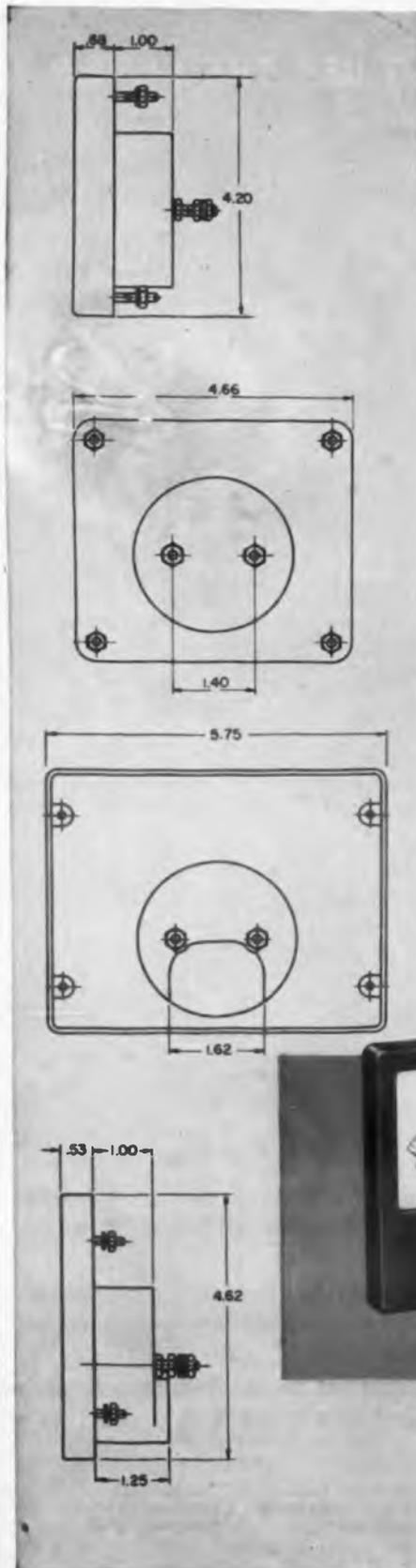
## Static Inverter

462



Rated at 175 va, model 143-101-171 static inverter has an output of 115 v ac, 400 cps, single phase from an input of 25 to 30 v dc. Output voltage and frequency are maintained within  $\pm 1\%$  from no load to full load; harmonic distortion is held to within 4%. Uses include missile and aircraft ground support equipment.

American Electronics, Inc., Precision Power Div., Dept. ED, 1598 E. Ross Ave., Fullerton, Calif.



## NEW WESTON PANEL METERS PROVIDE THREE IMPORTANT DESIGN ADVANTAGES...

- Exclusive magnetic shielding
- Sustained accuracy—up to  $\pm 0.5\%$
- Ranges tailored for special applications

Long-term accuracy and reliability are special features of Weston's new line of panel instruments. Accuracy—in Model 1761—is up to  $\pm 0.5\%$  of full scale deflection when supplied with knife edge pointer and mirror scale. Exclusive CORMAG<sup>®</sup> self-shielded mechanisms are used in both Models 1751 and 1761. The meters may be mounted on magnetic or non-magnetic panels without special adjustments... are immune to the effects of stray fields and nearby instruments. Housed in dust and moisture-resistant Bakelite cases with glass windows, they are supplied in a wide variety of standard ranges.

Special range meters with conventional magnetic construction are available where higher current sensitivity, lower resistance, special ballistic characteristics and controlled scale distribution are required.

Call your Weston representative for details, or write for Catalogs 01-109 and 01-110—which contain technical information on this new line of precision panel meters. Weston Instruments Division, Daystrom, Inc., Newark 12, New Jersey. International Sales Division, 100 Empire Street, Newark 12, New Jersey. In Canada: Daystrom Ltd., 840 Caledonia Rd., Toronto 19, Ontario.

Standard instruments: Black lance pointer, easy to read black markings on white dial, 100° arc. Model 1751—Size: Rectangular—4.66" x 4.20", 4" long scale. Accuracy:  $\pm 2\%$  full deflection as DC instrument. Model 1761—Size: Rectangular—5.75" x 4.62", 4.5" long scale. Both models available as: DC ammeters, milliammeters, microammeters, voltmeters (10001/volt).

**DAYSTROM, INCORPORATED**  
WESTON INSTRUMENTS DIVISION  
*Weston for Dependable Accuracy.*

CIRCLE 109 ON READER-SERVICE CARD

## NEW PRODUCTS

### Inductance Bridge

484



Designed for 400 to 20,000 cps operation, this inductance bridge is basically a calibrated variable frequency oscillator coupled to a modified Maxwell bridge. The bridge, model 63B, provides direct-reading calibration of both the inductance and resistance dials, with a resolution of 0.01%. Inductance range is  $0.02 \mu\text{h}$  to 1h; resistance range, 0.002 ohm to 110 K. Accuracy is about 0.25%.

Boonton Electronics Corp., Dept. ED, Morris Plains, N. J.

### Image Orthicon

430

With ultraviolet sensitivity, type GL 7969 image orthicon is suited for missile detection systems, spectrographic detection and medical instruments. Light-level capacity can be as low as  $10^{-9}$  ft-c. Resolution is high.

General Electric Co., Cathode Ray Tube Dept., Dept. ED, Syracuse, N. Y.

### Fast-Responding Pico-ammeter

431

For nuclear applications, this pico-ammeter has a dynamic range of  $10^{-12}$  to  $10^{-3}$  amp in 19 ranges and an accuracy of better than 3% of full scale at all outputs. Speed of response is less than 1 msec to 64% of final value at  $10^{-9}$  to  $10^{-3}$  amp.

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

### Variable Inductor

492



For low audio range. Miniature saturable-core reactor model EL-215 operates at 1 w from 30 to 450 cps min, and 250 to 3,750 cps max. Used to determine frequencies in filter and oscillator circuits, it is effective as a low-frequency sweeping device. The potted unit operates in temperatures from  $-55$  to  $+85$  C.

Vari-L Co., Inc., Dept. ED, 207 Greenwich Ave., Dept. ED, Stamford, Conn.

## HOW TO GET THE POWER TRANSISTORS YOU NEED?



**JUST ASK DELCO.** For even though our catalog lists only a handful of germanium power transistors, there is only a handful out of all those ever catalogued that we don't make. And those only because nobody ever asked for them.

We've made, by the millions, both large and small power transistors. Both diamond and round base. Both industrial and military types. And each in a wide variety of parameters that have proved themselves reliable in nearly every conceivable application.

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Detroit, Michigan  
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RELIABILITY

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RELIABILITY

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**Voltage Reference**

**491**



Solid-state, shielded voltage reference standards of series 220 provide 5.7, 8.5, or 10.5 v dc at 10 ma. Operating from 115 v, 60 cps line, regulation is  $\pm 0.001\%$  for  $\pm 10\%$  line variations. Capacitance from line to output is less than 1 pf.

Viking Industries, Inc., Dept. ED, 21343 Roscoe Blvd., Canoga Park, Calif.  
**P&A:** \$150; 3 weeks.

**Timing and Control Systems**

**434**

Programmed timing and control systems provide initiation and termination of various switching functions at preselected times. Programming is from punched tape, punched cards, magnetic tape, hard wire, patch panels or thumb-wheel switches. Digital design and modular construction are used.

Curtiss-Wright Corp., Electronics Div., Dept. ED, P. O. Box 10044, Albuquerque, N. M.

**Size 11 Resolvers**

**529**

Small, light weight size 11 resolves are intended for such applications as computation, angle data transmission and automatic control. Models CR4-0987-001 through CR4-0987-005, have a 0.1% function error,  $\pm 3$  min inter-axis error, and 0.1% transformation ratio unbalance.

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

**Submersible Pan-Tilt**

**489**



Operating to 1,000 ft depth, model 3003-2 submersible pan and tilt mechanism permits remotely controlled underwater positioning with 360 deg of pan and 90 deg of tilt. Remote read-out of pan and tilt position is available.

Ward Associates, Dept. ED, P. O. Box 9067, San Diego 9, Calif.

**P&A:** \$3,000; 60 days.



## **MICRO-MINIATURE RELAY STYLE 6A**

### **For Printed Circuits**

*Less Space*

*Lower Mounting Height*

*Terminals & Mounting  
Conform to 0.2" Grid Spacing*

For reliable switching of low-level as well as power loads. Style 6A will operate at coil power levels below most larger current-sensitive relays in its general class, yet easily switches load currents of 2 amps resistive and higher at 26.5 VDC or 115 VAC. Contact arrangement to DPDT.

Unique construction permits flexible wiring and a variety of schematics. Withstands 50 G shock and 20 G vibration to 2000 cycles.

Meets applicable portions of specifications MIL-R-5757D and MIL-R-25018 (USAF) Class B, Type II, Grade 3.

*Call Or Write For Additional Information*

# **PRICE ELECTRIC CORPORATION**

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CIRCLE 112 ON READER-SERVICE CARD

# RCA's GROWING **nuvistor** FAMILY



*in the  
palm of  
your hand...*

## NEW DESIGN CAPABILITY

New design capabilities unfold as RCA's amazing nuvistor tube family grows in number. You now have at your fingertips five commercial nuvistor types which permit you to nuvistorize your critical equipment designs for greater efficiency and extreme compactness.

**RCA-7587** general-purpose sharp-cutoff industrial tetrode

**RCA-7588** general-purpose medium-mu industrial triode

**RCA-7895** high-mu industrial triode ( $\mu=64$ )

**RCA-8CW4** TV and FM tuner triode

**RCA-2CW4** TV and FM tuner triode

*Design features responsible for the fast-growing popularity of nuvistor tubes include:*

- Low heater drain • Very high transconductance at low plate current and voltage • Exceptional mechanical ruggedness from ceramic-and-metal construction • Exceptional uniformity of characteristics from tube to tube • Operation at full ratings at any altitude • Extremely low interelectrode leakage • High sensitivity and stability • Very small size and light weight

*Nuvistorized circuits are currently in use or under development for:*

- Jet engine wave and vibration analyzers
  - Radar air traffic controllers
  - Sonar systems, sonobuoys
  - Electrometers and vacuum-tube voltmeters
  - Research satellite
  - Scintillation counters
  - FM tuners, VHF TV tuners
  - Pulse-width discriminators, frequency multipliers
  - IF amplifiers in airborne weather radars
  - Cascode amplifiers in radar beacon IF strips
- ...and literally scores of other applications.

Discover for yourself what nuvistor tubes can do in your own critical circuits. For information, contact your RCA Field Representative, or write: **Commercial Engineering, Section G-18-DE-1, RCA/Electron Tube Division, Harrison, New Jersey.**



**The Most Trusted Name in Electronics**  
RADIO CORPORATION OF AMERICA

RCA FIELD OFFICES... **EAST:** Newark 2, N. J., 744 Broad Street, HUmboldt 5-3900 • **MIDWEST:** Chicago 54, Ill., Suite 1154, Merchandise Mart Plaza, Whitehall 4-2900 • **WEST:** Los Angeles 22, Calif., 6801 E. Washington Blvd., RAymond 3-8361 • Burlingame, Calif., 1838 El Camino Real, OXford 7-1620

## NEW PRODUCTS

### Thermoelectric Generator

498



**Eight-watt thermoelectric power generator** is designed for operation of remote, unattended industrial field instrumentation. Fuel is natural gas, propane or butane. Rugged, reliable unit may be continually exposed to weather. Weight is 65 lb, width 12 in., height 17 in.

Texas Instruments Inc., Dept. ED, P. O. Box 6027, Houston 6, Tex.

### Ultrasonic Probe

512

**Operating to 100 kc**, with useful response to 1 mc, probe VP-10 provides an inexpensive means of measuring ultrasonic levels. The probe will stand a static pressure of 100 psi, and is unaffected by high temperatures. Output at cavitation is several volts, permitting use with simple equipment for waveform and level display.

Vibrasonics, Inc., Dept. ED, 10 High St., Boston, Mass.

### Low-Noise Preamplicifier

501



**For radiation detectors.** Pre-amplifier model 100A, featuring charge-sensitive feedback, is used with semiconductor radiation detectors. Charge sensitivity variation is less than 10% from 0 to 1,000 pf. Noise is equivalent to 600 electrons rms, rise time less than 0.1  $\mu$ sec.

Nuclear Industries, Inc., Dept. ED, 10 Holland Court, Valley Stream, N. Y.

**Price:** \$295.



This 100-w broadband amplifier can provide a cw signal from 200 kc to 275 mc. Input and output impedances of 50 and 90 ohms, respectively, are compatible with standard transmission lines and fittings. Broadband rf transformers for different impedance levels can be supplied. The cabinet measures 21 x 22 x 47 in., and has recessed casters.

Instruments for Industry, Inc., 101 New South Road, Hicksville, N. Y.

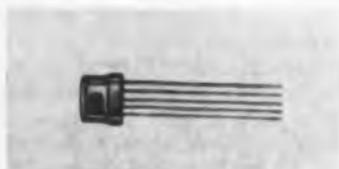
P&A: \$6,500; about 8 weeks.

Power Transistors 522

Silicon power transistors 2N2015 and 2N2016 have saturation resistance of 0.25 ohm max, power dissipation up to 150 w. Beta is 15 to 50 at 5 amp, 7.5 min at 10 amp. The devices operate at case temperatures from -65 to +200 C.

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

Silicon Chopper 503



One-gram silicon chopper operates from less than 1 mv to  $\pm 20$  v. Driving voltage is a square wave with amplitude of 5 to 25 v, peak to peak. Signal Current is 10 ma max, linearity less than  $\pm 0.5\%$  deviation from best straight line. Operating temperature is -55 to +150 C.

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

P&A: \$88; stock.

CIRCLE 114 ON READER-SERVICE CARD ▶

# INSTANT ENGINEERING DRAWINGS



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THE TERMS "FILMSORT" AND "THERMO-FAX" ARE REGISTERED TRADEMARKS OF  
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... WHERE RESEARCH IS THE KEY TO TOMORROW

## Furnace and Oven Users:

**Q.** Why did BTU Engineering Corporation switch to a stepless temperature control designed around the General Electric Silicon Controlled Rectifier?

**A.** "The General Electric SCR makes a better control at a lower price. It has all the advantages of the saturable core reactor with none of its limitations of range and power matching requirements, and all the latitude of a magnetic contactor without the see-saw effect, stickiness and noise."



Diffusion furnace used in semiconductor manufacturing, developed by BTU Engineering Corporation, Waltham, Mass. The Stepless Control designed around the General Electric SCR has no moving parts, does not deteriorate with age. It is also fail safe. In the absence of a signal it shuts off the power.

Advantages of the BTU Stepless Control include:

- No costly contactor failures.
- Reliability of a solid state rectifier as the heart of the system.
- It operates "full-on," "full-off" or any point in between with infinitesimally precise control.
- Nearly linear throughout range.
- No matching of imposed load to size of control unit required.

Now lower-priced than ever before, the SCR opens new areas for engineering development. Can you afford to wait any longer? Write today for application information. Rectifier Components Department, Section 23G7, General Electric Company, Auburn, New York.



**GENERAL  
ELECTRIC**

CIRCLE 195 ON READER-SERVICE CARD

## Light Flasher Users:

**Q.** Why does the Aero-Space Division of the Walter Kidde Co. use General Electric Silicon Controlled Rectifiers in their static light flashers?

**A.** "General Electric SCR's have made possible solid state circuits that optimize long, maintenance free life in our static flashers. They easily withstand the high inrush currents of incandescent lamp loads and the severe electrical and environmental conditions associated with commercial and military airborne equipment."



Solid state light flashers, developed by the Aero-Space Div. of the Walter Kidde Co., Belleville, N.J., eliminate all rotating elements, nothing to wear out. Another example of advanced equipment design made possible by the use of the General Electric SCR.

Advantages of the static light flasher include:

- Withstands inrush currents ten times normal.
- No arcing or corroding of points.
- No rotating elements.
- Reliability through long, maintenance free life.
- Smaller size, lighter weight.
- Lower total package cost.

Now lower-priced than ever before, the SCR opens new areas for engineering development. Can you afford to wait any longer? Write today for application information. Section 23G18, Rectifier Components Dept., General Electric Company, Auburn, N. Y.



**GENERAL  
ELECTRIC**

CIRCLE 196 ON READER-SERVICE CARD

## NEW PRODUCTS

### High-Power Transmitter

415



Output is 1 to 2 kw at 200 to 400 mc. Designed for missile and space applications, the transmitter withstands temperatures of 400 or 500 F as well as severe shock and vibration. The rf circuitry is broad-banded for operation over a 10-mc range around a selected nominal frequency.

Space Electronics Corp., Dept. ED, 930 Air Way, Glendale, Calif.

### Electroluminescent Panels

508

Metal, glass and plastic e-l panels are now available in quantity. Metal panels can be made up to 2 sq ft, glass panels 30 in. square; plastic panels are made in a wide variety of shapes and forms. Metal panel life is about 15,000 hours. Light output is about 10 ft-l at 600 v, 60 cps.

Westinghouse Electric Corp., Dept. ED, Box 2278, Pittsburgh 30, Pa.

### Temperature Chamber

427

Range is -100 to +350 F for the Mark II temperature chamber. Features include: internal working dimensions of 11 x 12 x 5 in., liquid carbon dioxide refrigeration, resistance element heater, aluminum liner and fan with external blower motor.

Associated Testing Laboratories, Inc., Dept. ED, Wayne, N. J.

Price: \$285.

### Decade Resistance

490



Five-dial decade resistance box has ranges from 0.0 to 9,999.9 to 999,990 ohms in steps of 0.1 to 10.0 ohms. Temperature coefficient is less than 0.002% per deg C. Current rating ranges from 10 ma to 0.5 amp.

Voltron Products, Inc., Dept. ED, 1020 S. Arroyo Parkway, Pasadena, Calif.

Price: \$115 to \$150.

## Super processing aids Tucor TR tubes' power-handling ability



One stage in Tucor's exclusive electronic ionization processing technique is illustrated in the high-power TR tube shown at the exhaust station. Model T48U15 is a quartz, folded-cylinder tube operating at UHF and L-band frequencies with a multi-megawatt power input. This tube was designed to provide short recovery time without the disadvantages of the contaminants usually added for this purpose that shorten tube life. The addition of a newly-developed uranium getter maintains purity of the gas fill indefinitely.

Following the duplexer stage in which such a tube would be used, a lower-powered post-TR tube circuit is usually required. Such tubes as the Tucor T48U9 and T48U10, which have been developed for this purpose as well as for use in medium-powered duplexers, provide lower leakage powers and long-life performance.

Why do Tucor tubes perform better? A combined microwave circuit and plasma physics design results in an optimum configuration and gas fill for any application.

Whether shelf items or custom designs for your specific application, Tucor tubes provide advantages in reliability. Why not investigate further by asking for our latest tube catalog?



**TUCOR  
INC.**

59 Danbury Road (Route 7), Wilton, Connecticut  
CIRCLE 197 ON READER-SERVICE CARD

ELECTRONIC DESIGN • July 5, 1961

## Trimmer Potentiometer

414



The 25-turn, 3/4-in. sq model 51 trimmer potentiometer is available in ranges from 50 ohms to 200 K. It dissipates 3 w without external heat sink or other hardware. Military specs for altitude, humidity and other environmental conditions are met. Weight is 5 g.

Spectrol Electronics Corp., Dept. ED, 1074 S. Del Mar Ave., San Gabriel, Calif.

## Camera Tube

429

With tri-alkali photocathode, type 7967 camera tube is claimed to provide 50 times more sensitivity than standard image orthicons. It operates with an illumination of up to  $10^{-6}$  ft-c. The magnesium-oxide semiconductive target has almost no lateral leakage. Resolution is better than 300 TV lines at low light levels or 1,200 lines at higher levels.

General Electric Co., Cathode Ray Tube Dept., Dept. ED, Syracuse, N. Y.

## Miniature Humistor

435

Over-all length is 1/4 in. and header diameter is 5/32 in. Model H-160-3 humistor detects and measures vapor or gases exhibiting an electric di-pole movement. Readout is through a megohmmeter or a megohm bridge. The device can be completely immersed in water and withstands temperatures from 0 to 100 C.

Conrad-Carson Electronics, Inc., Dept. ED, El Cajon, Calif.

P&A: \$10; from stock in small quantities.

## Remote Alarm

488



A solid-state remote alarm monitor, model 901, samples and encodes any number of data points and keys a single channel of any transmission medium. The signal is decoded and displayed at the receiver. Operation is continuous. Compact plug-in construction is employed, 17 points occupying a 3-1/2 x 5-3/16 x 6-15/16 in. package. Units resist moisture, fungus, and high temperature.

Compudyne Corp., Dept. ED, Hatboro, Pa.



The 6 most important things in your working life are your five skilled fingers and your A.W.FABER #9800SG LOCKTITE Tel-A-Grade Lead Holder.

LOCKTITE becomes a part of your creative process. The no-slip functional grip gives you smooth traction and practically banishes finger fatigue. Gun-rifled clutch holds the lead like the jaws of a bull dog. Unique indicator reveals the degree in use at a glance. Carries ironclad 2-year guarantee. A.W.FABER will replace the entire holder at no charge if any part wears out in normal

usage. Yes, you can buy cheaper lead holders, but can you afford to let pennies stand between you and your perfect working tools? Buy quality—buy LOCKTITE, call your dealer today.

Castell Drawing Leads #9030, are of the identical quality and grading as world-famous Castell wood pencil  
■ Usable in all standard holders, but a perfect mate for Locktite  
■ Draws perfectly on all surfaces, including Cronar and Mylar base films  
■ Available in all degrees from 7B to 10H, and in a kaleidoscope of colors ■



A.W.FABER-CASTELL  
Pencil Co., Inc., Newark 3, N. J.

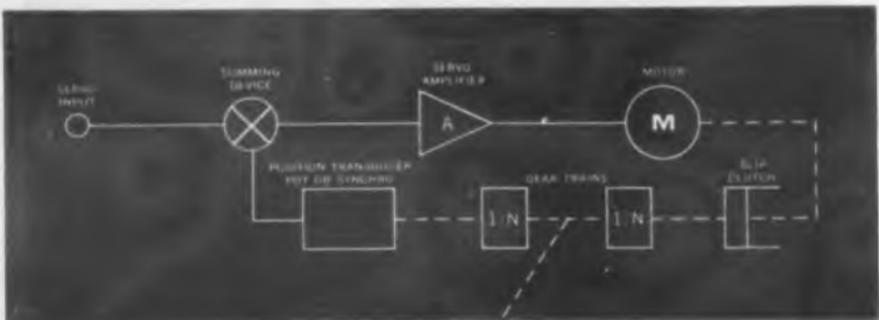
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200 years of uninterrupted  
manufacturing experience.



A.W.FABER-CASTELL DRAWING LEAD 9030

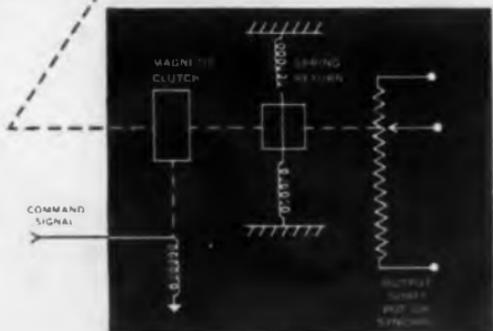
CIRCLE 116 ON READER-SERVICE CARD

**PROBLEM:** To provide an output Potentiometer-Transducer which can be readily engaged with a minimum angular error to a servomechanisms gear train when energized by an external command signal. The transducer must accurately return to a specified null position when the command signal is removed.



**A SOLUTION:**

Provide an electro-magnetic clutch, spring return mechanism and rotary potentiometer. Assemble these parts into the required package with the resultant difficulties brought about by the mounting and coupling problems with a consequent increase in cost.



**THE OPTIMUM SOLUTION:**

Technology Instrument Corporation's west coast engineering facilities developed and offer a unitized package consisting of an electro-magnetic clutch, spring return mechanism and rotary potentiometer as one compact assembly. The clutch will transmit high torque without slippage and has negligible angular engagement error. TIC's unique spring return mechanism will accurately return the output transducer to the desired null, yet requires low driving torque. TIC's unitized assembly replaces three (3) individual components with their inherent assembly difficulties.



**TIC**  
*unitized package*

**GENERAL INFORMATION:**

Shaft Position Transducers can be linear or nonlinear potentiometers, synchros, linear transformers or digitizers. Spring return mechanism can be supplied designed to return to any desired point. A built-in slip clutch can also be furnished if the input torque can exceed the rating of the clutch.

**TIC UNITIZED PACKAGE HAS MANY APPLICATIONS,**

**SUCH AS:** Auto pilots, altitude controllers, machine controllers, measurement and control problems, speed control, process control of temperature and flow, differential measurement, expanded scale servos, or any other problem requiring an output, commencing at some specified servo position determined by an external command signal.



**TECHNOLOGY INSTRUMENT CORPORATION**

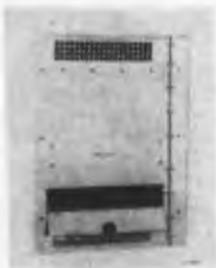
555 Main Street, Acton, Massachusetts • COLONIAL 3-7711

CIRCLE 117 ON READER-SERVICE CARD

## NEW PRODUCTS

### In-Wall Amplifier

418



For flush-mounting in frame or masonry walls, model 2030 in-wall amplifier requires a depth of 4 in. A 30-w, all-transistor unit, the amplifier includes a voltage-regulated power supply and has four microphone inputs. All 12 transistors are accessible through removable front plate.

Rauland-Borg Corp., Dept. ED, 3535 W. Addison St., Chicago 18, Ill.

### Storage Tube

510

Writing speed of 400,000 ips and a brightness in excess of 200 ft-l is obtained with a potential of 5 kv in the WL 7682 storage tube. One writing gun and one flood gun are used in the electrostatically focussed and deflected tube. Storage time is 30 sec to 30 min. Display area is 4 in. with an OD of 5-1/4 in. max.

Westinghouse Electronic Tube Div., Dept. ED, P. O. Box 284, Elmira, N. Y.

### Multichannel Digital System

487



Low-level data signals are displayed and recorded on paper tape by this multichannel digital system, model ER-3295. Consisting of five separate units, the instrument scans consecutively 98 three-wire inputs from various transducers. Resolution is  $\pm 1 \mu\text{v}$ . A digital voltmeter provides visual readout. A slave scanner can be added to increase input capacity.

Kin Tel Division, Cohu Electronics, Dept. ED, Box 623, San Diego, Calif.

P&A: About \$11,500, fob; San Diego; 90 days.

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a wide range of  
**STANDARD SIZES**



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beryllium copper  
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for: Transistor, Capacitor,  
Diode, Fuse and  
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B T I electronic clips are now stocked for prompt shipment in a complete range of standard sizes and designs. The use of beryllium copper and associated alloys insures positive spring contact pressure with exceedingly high electrical and thermal conductivity.

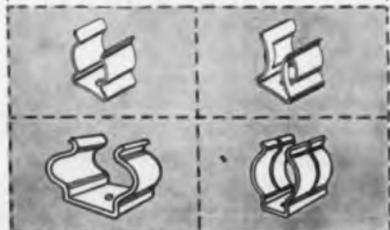
Write today for the new series of B T I bulletins showing standard sizes with specifications.

B T I also offers standard grounding strips and ring contacts for all electronic requirements.



**BRAUN TOOL & INSTRUMENT  
COMPANY, INC.**

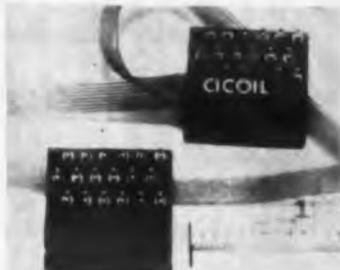
138 Fifth Ave., Hawthorne, N. J.



CIRCLE 118 ON READER-SERVICE CARD

## Terminal Boards

445



Microminiature series 251 terminal boards can be encapsulated with terminals wired to connector contacts or supplied with a cap to facilitate customer wiring prior to encapsulation. Floating-type connector contacts are polarized. For use with the firm's Super-Flex tapes, the boards are made for computer, radar and communications use.

Cicoil Corp., Dept. ED, 3833 Saticoy St., Van Nuys, Calif.

## Voltage Divider

511

Decade voltage divider has total resistance of 1 K, 10 K and 100 K. Linearity of the five-dial unit is 0.01%, temperature coefficient 0.001%. The Kelvin Varley circuit is used. Box measures 3-3/4 x 4 x 5 in. and weighs 1 lb.

Voltron Products, Inc., Dept. ED, 1020 S. Arroyo Parkway, Pasadena, Calif.

P&A: \$150; 30 days.

## DC Power Supply

449



Rated at 100 kv, 10 ma, continuous duty. Model 5492 power supply has a highly regulated output, automatic rate of voltage rise and is short-circuit proof. Provisions are made for remote control operation and remote metering. Plug-in shielded cable is used for connections.

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

CIRCLE 119 ON READER-SERVICE CARD

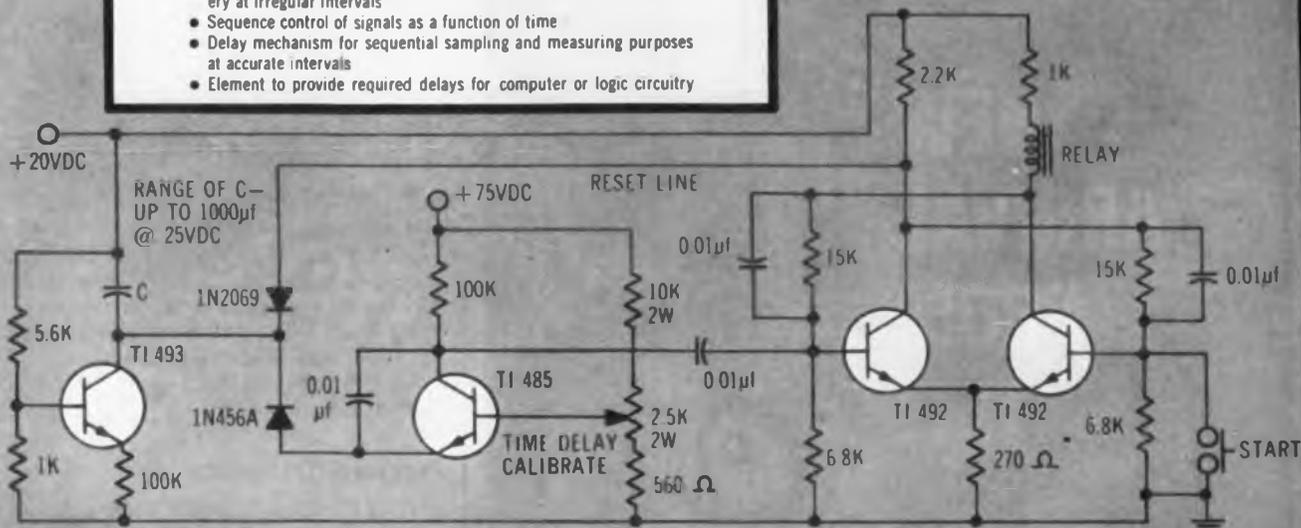
## Variable Delay Timing Circuit

### Typical Applications

- Safety device for sequential application of signals
- Warm-up delay mechanism for starting complex machinery
- Automatic on/off control to facilitate adjustment of process machinery at irregular intervals
- Sequence control of signals as a function of time
- Delay mechanism for sequential sampling and measuring purposes at accurate intervals
- Element to provide required delays for computer or logic circuitry

### Features

Time Delay From 25 milliseconds to 3 minutes  
Self Resetting or Externally Cycled  
Temperature Range  $-40^{\circ}\text{C}$  to  $+125^{\circ}\text{C}$   
ON/OFF Relay Actuator



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## With New TI Low-Cost Silicon Industrial Transistors...

You can assure your customers optimum circuit performance up to  $125^{\circ}\text{C}$  when you design-in new, low-cost TI silicon industrial transistors. Priced comparable to lower-temperature industrial devices, these new TI silicon industrial units provide the high performance your industrial designs require.

Get greater margins of operational safety by applying these new silicon industrial transistors to your process control, communication, aviation system, electronic instrumentation, and computer applications today.

CHARACTERISTICS					APPLICATIONS			
TYPE	MIN BV <sub>CEO</sub>	DC Beta Range	MAX I <sub>CEO</sub> @ 100°C	f <sub>αb</sub> (typ)	AMPLIFIER	SWITCHING	RELAY	OTHER
TI 480	50 v	9-36* @ 5 ma	50 μa @ 30 v	1 mc	TI 490			
TI 481	80 v	9-36* @ 5 ma	50 μa @ 30 v	1 mc	TI 481			
TI 482	20 v	>20 @ 30 & 150 ma	50 μa @ 10 v†	60 mc		TI 482	TI 482	
TI 483	40 v	20-60 @ 150 ma	50 μa @ 30 v†	60 mc		TI 483	TI 483	
TI 484	40 v	40-120 @ 150 ma	50 μa @ 30 v†	60 mc		TI 484	TI 484	
TI 485	20 v	15-60 @ 10 ma	20 μa @ 15 v†	200 mc				TI 485
TI 486	80 v	20-80 @ 200 ma	300 μa @ 60 v‡	15 mc		TI 486		
TI 487	80 v	20-80 @ 200 ma	300 μa @ 60 v‡	15 mc		TI 487		
TI 492	40 v	15-45* @ 1 ma	50 μa @ 30 v	8 mc				
TI 493	40 v	15-45 @ 10 ma	50 μa @ 20 v	20 mc	TI 492			
TI 494	40 v	40-125 @ 10 ma	50 μa @ 20 v	20 mc	TI 493			
TI 495	40 v	120-250 @ 10 ma	50 μa @ 20 v	20 mc	TI 494			
TI 496	40 v	>10 @ 3 ma	75 μa @ 40 v	1 mc	TI 495			
								TI 496

\*AC Beta †I<sub>CEO</sub> @ 125°C ‡I<sub>CEO</sub> @ 150°C †100 μa to 20 ma \*\*20 ma to 500 ma †BV<sub>CEX</sub> ® TRADEMARK OF BURROUGHS CORPORATION



SEMICONDUCTOR COMPONENTS  
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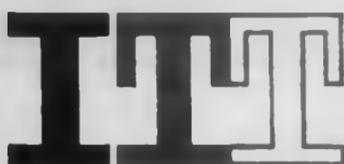
# NEW ARRIVAL FROM ITT!



AND, NO DIAPER NEEDED! ITT WET-ANODE TANTALUM CAPACITORS NOW AVAILABLE IN NEW SHAPE WITH POSITIVE WEDGE SEAL, RATINGS FROM 1.7 TO 560 MFD.

Proud product of a two-year design effort: a unique, positive mechanical seal permits straight-wall construction in this new line of ITT wet-anode tantalum capacitors. No flange. Your most advanced circuit designs gain new compactness, new simplicity — plus new reliability and performance from high-purity tantalum dielectric and ITT's total process control during manufacture. This new line meets all the requirements of MIL-C-3965B and is now available in ratings from 1.7 to 560 mfd. Specify H-type for temperatures to 85°C; L-type for temperatures to 125°C.

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Cleveland . . . . . GR 5-3000	New York . . . . . LO 5-1820
Dallas . . . . . EM 1-1765	Philadelphia . . . . . TR 8-3737
Dayton . . . . . BA 8-5493	Phoenix . . . . . WM 5-2471
Denver . . . . . KE 4-5001	Rochester . . . . . FI 2-1413
Detroit . . . . . TO 8-3322	San Francisco . . . . . Y0 7-5318
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Kansas City . . . . . JE 1-5236	St. Louis . . . . . EV 2-3508

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## NEW PRODUCTS

### High-Voltage Rectifiers

416



Ratings are to 50,000 piv and 1 amp dc per block for the SDI series double diffused silicon rectifier assemblies. They are designed in single wave: half wave, center tap or full wave; three phase: half wave, full wave or star; protective networks and tube replacements.

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

### Pressure Transducer

405



Potentiometer-type pressure transducer model 12112 is offered in ranges from 1 to 200 psia and psig. Typical resolution is 0.25% to 0.33%. Platinum-alloy winding element has resistance of 5 to 15 K. Repeatability, hysteresis and friction are under 0.5%. Applications include space and missile environments.

Princeton Machine and Development Co., Dept. ED, P. O. Box 187, Princeton Junction, N. J.

### Sound Meter

417



Range is 35 to -142 db; response is from 40 to 8,000 cps. Model 450 sound meter measures 2 x 3 x 6 in., weighs 2 lb and operates from a 22.5-v battery. It meets ASA Standard A, B and C weightings. The amplifier is stabilized against voltage and temperature changes.

H. H. Scott, Inc., Dept. ED, 111 Powdermill Road, Maynard, Mass.

Price: \$150.

# STANDING AT THE TOP WesTran TRANSISTORS

QUALITY - RELIABILITY



## WesTran PNP SILICON

### ALLOY JUNCTION TRANSISTORS

TYPES - 2N327A - 28A - 29A  
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ELECTRONIC DESIGN • July 5, 1961

### Power Switching Transistors 504

Capable of switching 400 w, these pnp switching transistors, types 2N637, 2N637A, 2N637B, 2N638, 2N638A, and 2N638B, are designed for high current operation in dc-dc converters and dc-ac inverters. The series has three different voltage breakdown ratings for use in both 12-v and 28-v supplies. Average power dissipation is 60 w max. Current gain is controlled, eliminating need for matching.

Bendix Corp., Dept. ED, Red Bank Div., Holmdel, N. J.

### Pressure Transducer 453



For missile applications. Type 4-328 pressure transducer operates from between 0 to 15 and 0 to 99 psia. Output is 50 mv; linearity and hysteresis are less than  $\pm 0.5\%$  of full range output. Thermal zero shift is within 0.005% per deg F. Weight is 5.5 oz.

Consolidated Electrodynamics Corp., Dept. ED, 360 Sierra Madre Villa, Pasadena, Calif.

### Smoothing Chokes 505

Designed for aircraft and missiles, these hermetically sealed smoothing chokes have inductances from 0.2 mh to 5.100 h, at dc currents from 6 ma to 25 amp. Units have straight-pin, hooked-pin, or flexible Teflon lead connectors, and may be mounted on chassis, printed-circuit board, or stacked. Dimensions range from 1.12 x 0.91 x 0.87 in. to 1.77 x 1.46 x 1.49 in. Weight is 1.2 to 8 oz.

Arnold Magnetics Corp., Dept. ED, 6050 W. Jefferson Blvd., Los Angeles 16, Calif.

P&A: \$5.00 to \$20.00; two weeks.

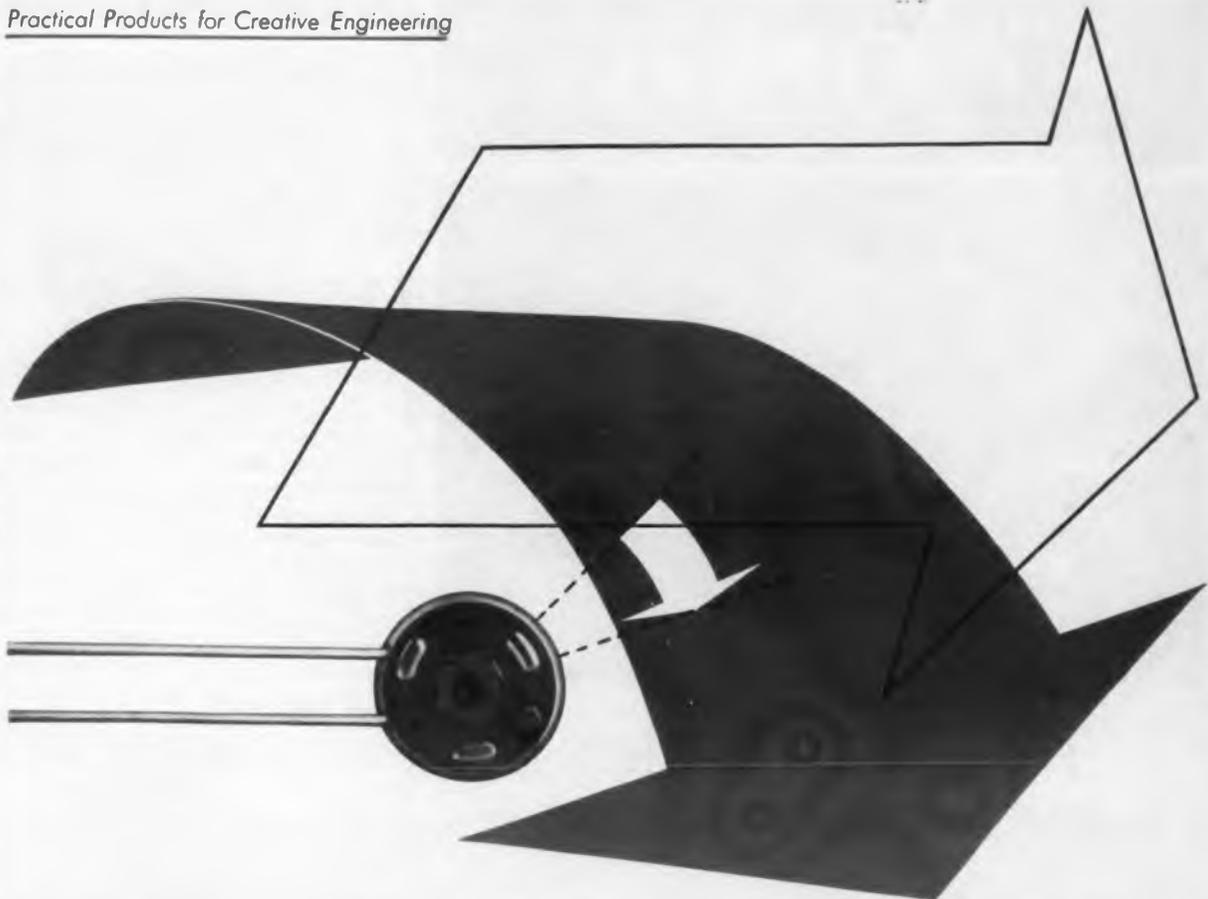
### Attenuators 446



Rated at 20 w audio, 5 w dc. These L and T pad attenuators measure less than 1-3/16 in. deep. Insulation used combines rapid heat transfer with high dielectric strength. Wiper contacts are rigidly attached to the shaft. A wide range of impedance ratings is furnished.

Centralab, Div. of Globe-Union Inc., Dept. ED, 900 E. Keefe Ave., Milwaukee 1, Wis.

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**OAK ROTARY SOLENOIDS** provide high torque at the start of their actuation stroke—where and when it's needed most. Ordinarily, magnetic attraction of the solenoid coil is greatest near the end of the stroke. Oak engineers have solved this by inclining the ball races at a steeper angle near the top—or start—of the race. This "downhill" action levels off near the end of the rotary stroke. Since torque is inversely proportional to the length of stroke, a 2E solenoid that pro-

vides 6.4 inch-ounces of starting torque at 45° would offer almost twice as much torque when designed for a 25° stroke. You can obtain Oak Solenoids for stepping angles of 25°, 35°, 45°, and 67.5°—in right—or left-hand rotation. Because Oak Solenoids are custom-made to meet specific actuation and torque requirements, you can outline your needs with your local Oak sales representative. If you prefer, send a sketch of your design to our Applications Engineering department.



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OAK ELECTRONICS CORPORATION, (Subsidiary) Culver City, California

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ENGINEERING

# REPORT

ON BENDIX COMPONENTS



## PRECISION SIZE 5 MOTORS NOW AVAILABLE FROM STOCK

Available for immediate delivery, these miniaturized Bendix® motors (type number CK 1066-40-A1) are designed for applications where space and weight requirements are at a minimum. So small that four can be packaged in a square inch, these motors are ideally suited for missile instrumentation and similar miniaturized applications. The motor has a tapered shaft; however, units may be obtained with other type shafts and with center tapped control windings.

### TYPICAL MOTOR CHARACTERISTICS

<b>Voltage</b>	
Fixed phase . . . . .	26 volts
Control phase . . . . .	26 volts
Frequency . . . . .	400 cycles
<b>Stall Current*</b>	
Fixed Phase . . . . .	100 ma
Control Phase . . . . .	100 ma
<b>Stall Impedance*</b>	
Fixed Phase . . . . .	$260 = 184.5 + j183.5$ ohms
Control Phase . . . . .	$260 = 184.5 + j183.5$ ohms
Stall Power Input* (Total) . . . . .	3.69 watts
Stall Torque . . . . .	0.138 oz.-in.
No Load Speed . . . . .	9900
Torque-to-Inertia Ratio . . . . .	44,400 rad/sec <sup>2</sup> (Stall Acceleration)
<b>Operating Temperature</b>	
Range . . . . .	-55°C. to +70°C.
Weight . . . . .	0.88 oz.
*With rated voltage applied to each phase.	

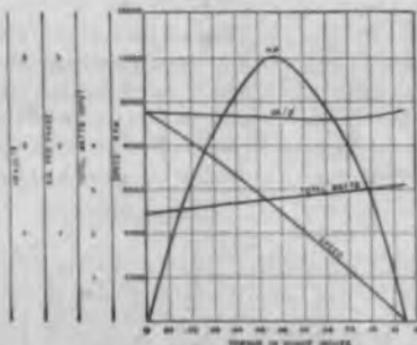
For information on these motors—  
or similar motors in sizes 8, 10, 11, 15,  
20, and 28—write:

**Eclipse-Pioneer Division**  
Teterboro, N. J.



District Offices: Burbank, and San Francisco, Calif.; Seattle, Wash.; Dayton, Ohio; and Washington, D. C.  
Expert Sales & Service: Bendix International, 205 E. 42nd St., New York 17, N. Y.

### AVERAGE PERFORMANCE CURVES

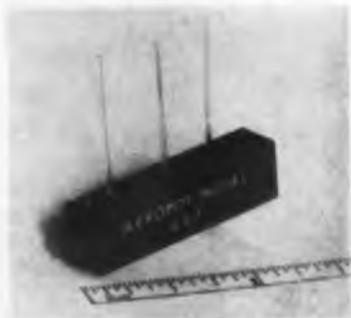


CIRCLE 123 ON READER-SERVICE CARD

## NEW PRODUCTS

### Trimmer Potentiometer

464



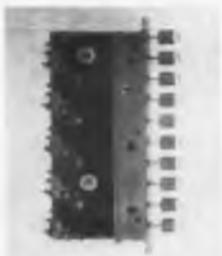
Range is 20 ohms to 100 K. Model 427 trimmer potentiometer is designed for etched circuit boards and has gold-plated copper leads of 0.1-in. spacing. Power dissipation is 1 w to 70 C; tolerances are  $\pm 10$  or  $\pm 5\%$ ; requirements of MIL-R-27208 are met.

Aero Electronics Corp., Dept. ED, 1745 W. 134th St., Gardena, Calif.

Availability: 1 to 2 weeks.

### Bar Switches

454



Parity-code bar switches, series DP and series OP, provide odd or even parity in the five-bit output. Conversion from octal or decimal digits to binary code is by means of binary-coded contact closures. Full 10-button decimal banks with 1-2-4-8 output contacts are offered in the DP series; seven-button banks with 1-2-4 contacts are offered in the OP series.

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

### Instrument Carrier

455



For submarine use, the V-Fin instrument carrier is for applications such as seismic investigation, echo sounding, pressure and tempera-

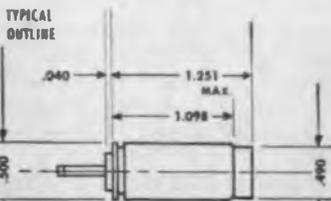
## REPORT

### AUTOSYN<sup>®</sup> SYNCHROS

Dependable in miniaturizing control circuitry



These Bendix<sup>®</sup> size 5 Autosyn synchros are well suited to the needs of missile instrumentation and similar applications requiring miniaturization and weight reduction. Typical characteristics are listed below. For additional information, including comprehensive data on transmitter, control transformer, and differential characteristics, write today.



#### TYPICAL CHARACTERISTICS

Operating temperature range... -55°C. to 95°C.  
 Rotor moment of inertia... 0.25 gm cm<sup>2</sup>  
 Weight... 0.8 oz.  
 Accuracy...  $\pm 15$  minutes

Available as transmitter, control transformer and differential.

Manufacturers of

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 RADAR DEVICES • INSTRUMENTATION  
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Eclipse-Pioneer Division



Teterboro, N. J.

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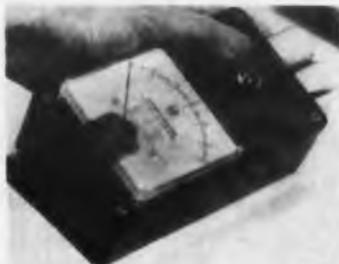
ELECTRONIC DESIGN • July 5, 1961

ture studies. It can be used in acoustic systems over the range of 10 to 6,000 cps. Hydrophone sensitivity is -88 db. Molded in Fiberglass, the unit weighs less than 14.5 lb and has an instrument compartment of 12 x 2-1/2 x 1-1/8 in.

Braincon Corp., Dept. ED, 312, Marion, Mass.

## Electronic Tachometer

406



Speeds to 12,000 rpm are calibrated accurately with this miniature electronic tachometer. A photoelectric cell responds to illumination changes and transmits a signal to a pulse-triggered computer which determines the rpm and displays the result on a direct-reading meter. Drills, presses, power drives, motors and other equipment can be checked. No external power source is needed.

Pioneer Electric & Research Corp., Dept. ED, 743 Circle Ave., Forest Park, Ill.

Price: \$95.

## Waveform Analyzers

452



With digital output, these waveform analyzers are capable of measuring amplitude rise-time, ring, decay time and sag. They are suitable for applications where large quantities of measurements are required such as in automatic checkout systems and production test systems.

Curtiss-Wright Corp., Electronics Div., Dept. ED, P. O. Box 10044, Albuquerque, N. M.

from under the seas... to the edges of space... and beyond



# VAP-AIR MERC THERMOSTATS

Vap-Air Mercs have many uses, widespread acceptance

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**Used for:**

Temperature control of electronic compartments, reference ovens, crystal ovens; nose-cone devices; gyroscopes; inertial guidance system; accelerometers; air compressors; turbines; cabins, cockpits, capsules; windshields; de-icing equipment; oil, fuel, hydraulic systems; for telemetering of temperatures; for control systems, and as warning devices in ground support vans and equipment; and many other uses.

have proved outstandingly accurate and dependable for the most critical thermal sensing and control applications in missiles, aircraft, ground support and undersea equipment.

The Army Ballistic Missile Agency has for two years accepted Merc thermostats as standard temperature control items on all their missiles.

Time after time, Vap-Air mercury tube thermostats have proved their exceptional ability to meet the most exacting specifications for thermal sensing and control. Small, lightweight, they are unaffected by altitude or moisture, can't arc or burn, can withstand 100-G shocks and 30-G vibration without loss of accuracy. They have fast response, close limit tolerances, wide operating ranges, and undeviating accuracy to provide millions of cycles of reliable operation. Mercs need only simple circuits, are adaptable to virtually any need.



3.75 INCHES LONG

DUCT-TYPE



2.52 INCHES LONG

SURFACE-TYPE



2 INCHES LONG

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Three standard groups: (1) Duct-type, for gas or fluid temperature, (2) Surface-type, for "area-contact" temperature sensing, (3) Well-type, for sensing case temperatures. Order direct from catalog. Complete, ready to mount. Meet military specification MIL-E-5272 A. Write for Bulletin No. 684.

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Please send information on Vap-Air Merc Thermostats

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**LOOK HERE FOR ANSWERS  
TO YOUR RELAY PROBLEMS**

**IT'S WHAT'S INSIDE THAT COUNTS  
IN TIME DELAY RELAYS**



Especially when milliseconds count! Note the printed circuit construction of Leach's optional output time delay relays. This economical line of off-the-shelf electronic units includes time delays on release and time delays on operate—in a timing range of 100 milliseconds to 60 seconds. These standard components are available with fixed or adjustable timing to meet your most critical requirements. And they're all 100% inspected during manufacture for highest reliability!

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Leach balanced-armature relays provide high resistance to shock (50 G's) and vibration (15 G's to 2000 cps). They meet or exceed MIL-R-25018, MIL-R-5757C and MIL-R-6106C. Choose from 4,000 variations of 20 basic types!



*Bulletin BA-859.*

**NOT A SQUARE IN THE WHOLE FAMILY!**



2 PDT, 3 AMP

4 PDT, 5 AMP

6 PDT, 5 AMP

2 PDT, 10 AMP

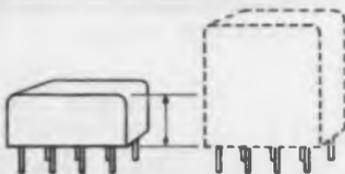
4 PDT, 10 AMP

When only a round can relay will fit your need, Leach offers this family group in contact configurations of 2, 4 and 6 PDT and in contact ratings ranging from dry circuit to 10 amps.

*Bulletin RC-800.*

**SUBMINIATURE  
CRYSTAL CANS, TOO!**

Want big performance, compact size? Get both in a wide range of standard relay configurations. Dual coils... balanced rotary armature for 2 amp, 2 PDT switching in aerospace and electronic applications. *Bulletin CC-M200 and M101.*



**WHAT'S HALF OF A  
SUBMINIATURE?**

Answer: The new Leach Half-Size Crystal Can Relay. Half the height of a subminiature but boasting the same base dimensions, the same performance! Amazing.

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**LOOK TO LEACH**

CIRCLE 126 ON READER-SERVICE CARD

## NEW PRODUCTS

### Power Supply

407



Regulation is  $\pm 0.1\%$  for line and  $\pm 0.4$  v for load. Model MTR28-10 power supply provides 24 to 32 v dc at 10 amp. Ripple is 2 mv. Features include a magnetic amplifier and a transistor series regulator. No tubes, vibrators or moving parts are used.

Perkin Electronics Corp., Dept. ED, 345 Kansas St., El Segundo, Calif.

### IF Preamplifiers

408



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MICROWAVES

## Research, Anyone?

A bad case of scientific heartburn was induced among diners at this year's PGMTT symposium banquet, when the after-dinner speaker reported some amazing tales of Soviet derring-do in microwaves. The speaker was actually a representative of the United States Information Agency playing the bogus role of a Russian scientist to perfection. To everyone's relief, he finally admitted that the Russians had not supported a 1-sq-km space platform with microwave power—not yet.

Meanwhile, back at the lab, ELECTRONIC DESIGN checked into U. S. progress in direct conversion of microwave power. Our status: a wealth of interesting proposals and some research effort—but possibly not enough. Two small projects, funded with less than \$200,000 are paying off. But they constitute the total American participation in direct conversion of microwave power. The details are in the article beginning on the opposite page. Any good ideas here that are not being exploited because of inadequate support by government and industry?

---

*Solid-state diodes and inverse magnetrons are being developed for direct conversion of microwave power. See*

### Direct Microwaves-to-Electricity, Power Seen Near ..... p 131

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*An integral antenna-parametric amplifier combination that reduces noise pickup and that can be electronically switched is described in*

### Designing the Parant ..... p 136

---

*For the latest thinking on the problem of defining noise, turn to*

### New Definitions of Receiver Noise Performance ..... p 142

---

*A coaxial cavity magnetron and an optical instrument for detection of waveguide arcing are featured in*

### Microwave Products ..... p 144

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## Direct Microwaves-to-Electricity Power Seen Near



**Manfred Meisels**  
Technical Editor

**O**FF-THE-SHELF hardware for direct conversion of microwaves into electrical power may be a reality within two years, according to scientists at the Wright Air Development Div., which is now sponsoring two research projects in this area.

Raytheon's Spencer Laboratory, Burlington, Mass., is investigating the inverse operation of magnetron-type tubes, while at Purdue University, West Lafayette, Ind., the emphasis is on inverse operation of klystrons, and both vacuum and semiconductor diodes. Efficiencies of 60 per cent are believed possible with the inverse magnetron and semiconductor diode approaches.

Power requirements for such converters are fairly modest—1 kw cw for the magnetron and perhaps 75 w for the semiconductor diodes. Proposed applications include powering electronic gear aboard satellites and transmitting power to unmanned equipment atop mountains and in other remote areas.

These applications and the proposed conversion methods differ markedly from those for the microwave powered helicopter (also a Raytheon project) in which heat exchangers and gas turbines would achieve power conversion. Power requirements here are measured in megawatts, though Raytheon is reportedly looking into thermionic and thermoelectric generators as an alternative to the mechanical conversion cycle. Regardless of the application and ultimate conversion scheme used, ultra-high-power microwave tubes such as Raytheon's Amplitron or General Electric's multiple-beam



**Inverse magnetron converter** developed by Raytheon. Left to right: cathode, anode-cavity structure, coaxial rf input and cover. Final version of this device may approach 60 per cent efficiency and generate up to 1 kw cw in the 1- to 2-Gc range. Wright Air Development Div. is presently emphasizing development of this type of microwave power converter over other possible inversely operated tubes. The weight of the final version, including magnet, will be approximately 35 lb.



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klystron and Orthotron would be employed at the transmitter.

The direct conversion methods now being actively studied fall into three categories.

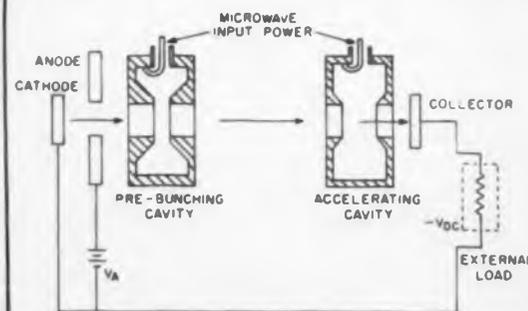
- Inverse operation of conventional microwave tubes
- Vacuum diodes
- Semiconductor diode arrays

Of these, inverse operation of microwave tubes appears most likely to yield moderate-order powers (approximately 1 kw) with acceptable efficiency. For low power, semiconductor diode arrays look promising. Light weight and small size would make them attractive for many satellite applications.

The inverse magnetron tube being developed by Raytheon as an outgrowth of earlier work with the backward-wave type Microfier has already shown efficiencies of 32 per cent. In tests at 1.28 Gc, pulsed outputs of 4 kw were obtained over a 0.1 per cent duty cycle. WADD scientists feel that cw operation at 60 per cent efficiency will eventually be obtained.

The tube consists of 30 radial vanes which form 29 anode cavities. Microwave fields applied to the tube accelerate the electrons from cathode to anode. Current is drawn to the anode when the rf interaction voltage exceeds the dc potential of the tube and Hartree threshold voltage.

Raytheon has built nine progressively improved tubes of this type for WADD. In its ultimate version, a 1-kw tube is expected to weigh about 35 lb, including the magnet. Continuous heating of the cathode would



**Inverse klystron** microwave power converter. Electron beam between cathode and collector is accelerated by microwave input. Efficiency is reduced by need to divert some of the input to the pre-bunching cavity. A separately heated cathode is required.

not be required as operation is sustained by secondary electron emission resulting from back bombardment.

Inverse operation of klystrons for direct conversion is also considered feasible. Recently initiated work at Purdue University has been confined to inverse operation of commercially available tubes. Preliminary tests at 3 Gc are inconclusive as the emphasis has been on gathering data for design of a special-purpose tube rather than on extracting power from a commercial version.

A proposed inverse klystron, illustrated here, has been theoretically analyzed by WADD with mixed conclusions. Such a unit could be designed for high powers and frequencies. However, a separate heater supply is necessary. Spreading of the electron beam and entrance angle, as well as the need to supply power to both cavities of the tube would result in low efficiency and degraded performance.

An inversely operated traveling-wave-tube converter has also been analyzed at WADD. The electron beam in this device would gain energy from the microwave field rather than surrendering it as is the case in normal twt operation. By gradually increasing phase velocity of the rf traveling wave to account for increasing beam velocity, the electrons can be accelerated while continuing to be phase locked with the traveling wave. This can be accomplished with a tapered helix of gradually increasing pitch.

Limitations of the inverse twt include need for a separate heater supply and limited power handling capability of the slow wave structure. Efficiency of such a device might approach 40 per cent.

#### Cyclotron and Plasma Converters Believed Theoretically Possible

A cyclotron resonance converter has also been analyzed at WADD. In the basic design, electrons emitted from a central anode are spiraled outward by the cyclotron action of the rf input and a suitably adjusted magnetic field. The electrons thus gain energy from the field and strike properly oriented collector plates. By placing the collectors at a low velocity point of the electron trajectory, efficiencies of up to 60 per cent could

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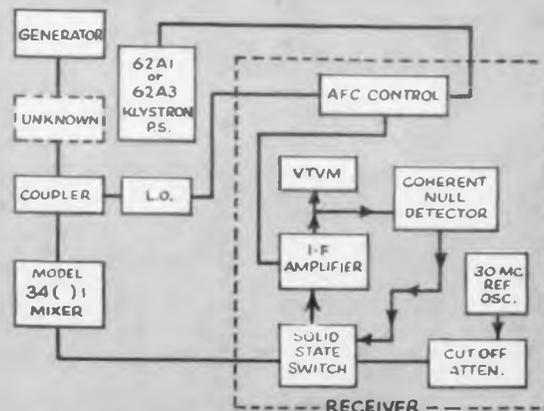
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4351	5.85-8.20	3, 10, 20	\$140
4351	8.20-10.00	3, 10, 20	\$120
4351	10.00-12.40	3, 10, 20	\$100
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4351	15.85-18.50	3, 10, 20	\$175
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MICROWAVES NEWS

result, as there would be little power dissipated via electron bombardment. Back bombardment of the cathode, however, could enable heaterless operation.

Prospects for plasma converters have also been analyzed by WADD. One approach would be to create a plasma by using the microwave input and then apply a magnetic gradient to cause ion and electron drift in opposite directions. The electrons would be connected to an external load and the positive ions used to bombard a cathode to cause electron emission.

While a plasma converter would be small and easy to fabricate, the wide distribution of electron energies in the plasma would probably result in efficiencies no greater than 25 per cent.

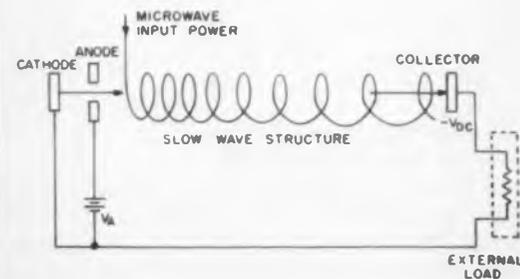
Having analyzed these approaches to medium-power direct conversion, WADD has settled on the inverse magnetron as the most feasible—at least for the immediate future.

#### Multiple-Diode Arrays In Development at Purdue

Equally imaginative designs for low-power converters have also been proposed. The obvious approach of vacuum diode rectification may prove useful despite electron transit time limitations. It has been shown that rectification can take place even when the cathode-to-anode spacing is equal to several hundred periods. Realistically, a spacing equal to a few periods could achieve

TYPICAL OPERATING PARAMETERS

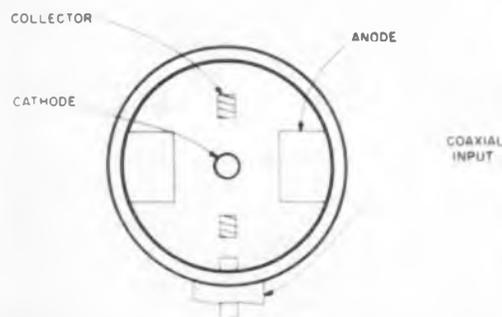
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ELECTRON TUBE AND DEVICE DIVISION



**Inverse traveling-wave-tube** microwave power converter. Electron beam is accelerated by absorbing energy from rf wave in the helix. The gradually increasing pitch of the helix keeps the traveling wave in phase with the accelerating electrons. A separate heater is required for the cathode.

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## MICROWAVES



**Proposed cyclotron resonance** microwave power converter. Rf input, in conjunction with magnetic field (perpendicular to plane of drawing), accelerates electrons to the collector plates. Studies indicate that the device could approach 60 per cent efficiency. Back bombardment of cathode would eliminate need for heater.

efficiencies of up to 25 per cent. In this mode of operation, out-of-phase electrons would absorb energy from the rf input and be returned to the cathode. The resulting secondary emission could allow heaterless operation of the diode.

Experiments at Purdue with lighthouse tubes operating as diodes have shown efficiencies of up to 20 per cent at 3 Gc. Maximum output was approximately 1 w.

Much higher efficiency and power output are anticipated for arrays of semiconductor diodes wired as full-wave rectifiers. The group at Purdue has operated arrays of 64 diodes placed directly in the waveguide. A 360-diode array employing 1N830 silicon point-contact diodes is now being assembled for testing. The diodes will be mounted in a flared section of 10-cm guide. Outputs of between 10 and 15 w at 2.5 Gc with perhaps 75 per cent efficiency are hoped for.

Future plans call for even larger arrays developing up to 100 w. These could be distributed among several parallel sections of guide joined by a magic T or similar device.

Theoretical studies of large junction diodes as possible microwave rectifiers are also under way. In addition, nonlinear effects in bulk semiconductor materials in strong rf fields have been noted at Purdue. It has been suggested that an understanding of these effects could lead to a rectifier consisting of a large semiconductor crystal properly oriented within a waveguide. ■ ■



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## Designing the "Parant"



Instead of worrying about noise temperature and noise pickup in antenna leads, authors Frost and Clark circumvented these problems by integrating the parametric amplifier within the antenna structure. The resulting parant, designed for Doppler tracking of satellites, eliminates open connecting lines between antenna and amplifier. Input to the parametric amplifier is applied directly from the signal-induced potentials at the ends of the antenna. Dipole parants have been built for 54-, 108-, and 220- mc operation. Etched circuit antennas for 500 mc and slotted antennas useful at 2 Gc are being designed.



Fig. 1. Half-wave dipole parant designed for 108-mc signal. Stripline section at center connects internal pickup loop to the coax connector. Square aluminum pipe is used for outer element of the antenna.

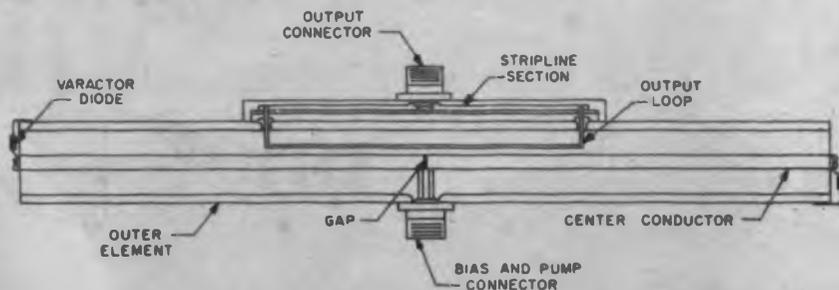


Fig. 2. Construction details of the half-wave parant. Two matched varactor diodes provide parametric amplification in conjunction with the coaxial cavity formed by the addition of the hollow center conductor. Higher order TEM modes provide resonant storage for the pump and idler frequencies.

Albert D. Frost, Ronald R. Clark

University of New Hampshire,  
Durham, N. H.

WHEN the need for low-noise reception warrants the use of parametric amplifiers, noise pickup in the leads between the antenna and receiver can significantly degrade system performance. Since reducing the distance between antenna and receiver is only a partial solution, it was decided to eliminate this source of noise altogether by integrating the parametric amplifier with the antenna.

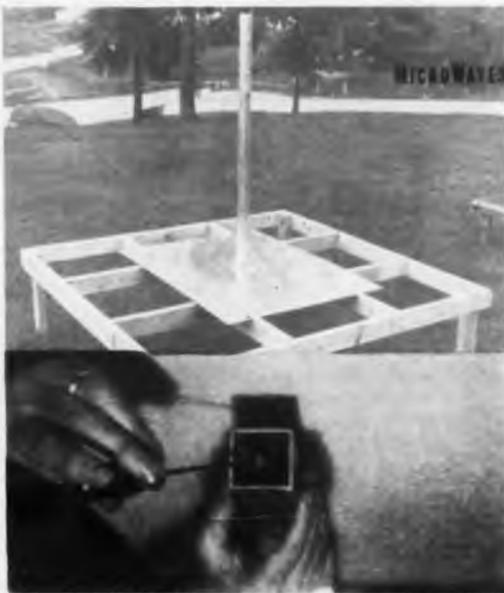
Experiments were performed with half-wave and quarter-wave dipoles because the antenna elements could be most conveniently adapted to serve as the network elements of a parametric amplifier. This was accomplished by adding a concentric inner conductor to the dipole, thus forming a coaxial cavity. Units operating at 108 mc and 54 mc are illustrated in Figs. 1 through 4.

Coupling between the inner region and the outer cylindrical surface of the antenna occurs through incidental fringing capacitance and through shunt varactor diodes. The inner region, through its spectrum of TEM resonances provides the resonant storage necessary for parametric amplification.

### Parant Operates as A Degenerate Amplifier

The parant is operated in the degenerate amplification mode (input frequency = output frequency). The fundamental TEM mode provides the signal frequency; the fifth order mode provides idler storage; and the sixth order mode matches the pumping frequency. A high order even TEM coaxial mode was chosen for pumping to minimize parasitic self-oscillations at or near the signal frequency.

The output signal is extracted from the coaxial region by a rectangular loop appropriately oriented in a radial plane. Coupling to the idler frequency is minimized by



**Fig. 3.** Quarter-wave dipole parant designed for 54-mc operation. Design is similar to the half-wave unit, but note use of a ground plane. Bottom view shows internal construction and varactor diode connected between the inner and outer elements.

cutting loop length to a half-wavelength of the idler. The position of the loop with respect to the standing-wave current pattern in the center conductor also reduces coupling to this mode.

The diode is pumped through the center conductor, which also provides a dc path for the diode reverse bias.

Suitable external circuitry associated with the parant was designed to provide the following:

- Tuning of the idler, pump, and signal modes
- Pump input
- Dc bias

Networks for the half-wave, 108-mc parant and for the quarter-wave, 54-mc parant are shown in Figs. 5 and 6, respectively. Circuit values were chosen to match the characteristics of the 1N894 varactor diodes used in the antennas described here.

Both the half-wave and quarter-wave parants provide stable gains of up to 15 db over passive dipoles. (See gain-frequency curves in Figs. 7 and 8).

#### Antenna Can Be Electronically Switched at High Speeds

Diode reverse bias can be adjusted to vary the parant's gain over a range of 45 db.

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In addition to standard amplifiers, Alfred offers periodic or permanent magnet focused amplifiers where light weight and low input power is required as well as amplifiers designed specifically for phase modulation. Prices: General purpose amplifiers, \$1,490-1,690; Medium power amplifiers, \$1,550-3,590; Low noise amplifiers, \$3,150-4,990.

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fier and oscillator tubes. This instrument provides all normal sources — helix, collector, four separate anodes, grid, heater, solenoid and blower — from one compact unit.

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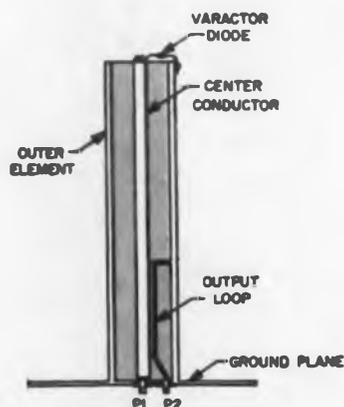


Fig. 4. Construction details of the quarter-wave parant. The antenna is single-ended and uses only one diode. However, additional diodes can be wired in parallel with the first, if desired. Construction of the quarter-wave antenna is simpler than that of the half-wave parant.

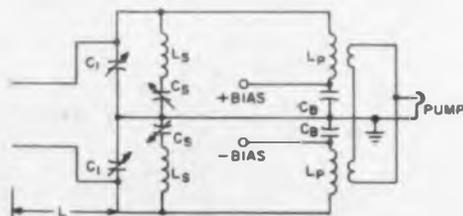


Fig. 5. Tuning networks and bias blocking circuits for the half-wave, 108-mc parant. Length  $L$  represents the distributed impedance of the leads and connectors between the antenna and the circuit. Capacitors  $C_1$  and  $C_2$  tune the idler and signal frequencies, respectively.

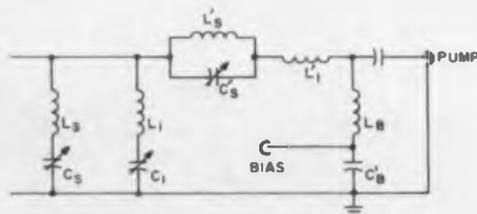


Fig. 6. Tuning networks for the quarter-wave, 54-mc parant. Single-ended characteristic of the antenna eliminates circuit balancing problems inherent in the half-wave design. Only one capacitor is required for tuning the idler or signal frequencies.

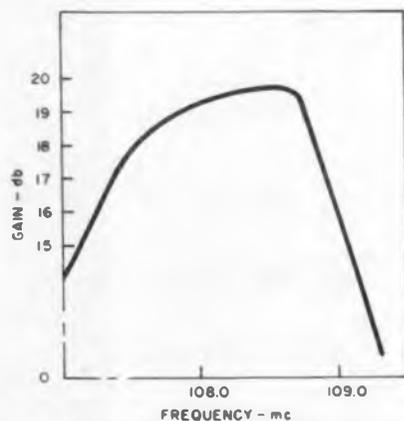


Fig. 7. Gain-frequency characteristic of the half-wave parant. Pump frequency was 600 mc.

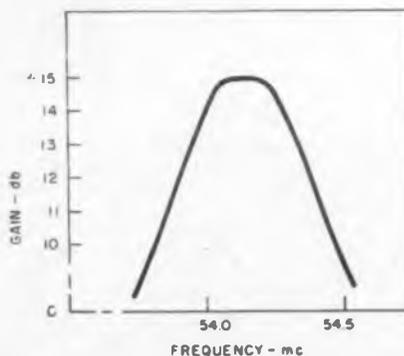


Fig. 8. Gain-frequency characteristic of the quarter-wave parant. Pump frequency was 302 mc.

This change is due to the inhibition of parametric amplification and the combined effect of detuning and resistive shunting of the interior coaxial cavity. By pulsing the bias, an unmodulated signal can thus be conveniently chopped at rates up to 200 kc with 50-db isolations. This ease of switching makes the parant a versatile beginning for many complex types of receiving systems.

The half-wave parant of Fig. 1 was constructed of 1.75 in. square aluminum pipe with a wall thickness of 0.125 in. The flat side walls and increased wall thickness as compared to earlier models built of circular pipes permit convenient use of stripline fittings and more effective support of the inner



Fig. 9. Tuning network for the half-wave, 108-mc parant. Unit is conveniently mounted at center section of the antenna.

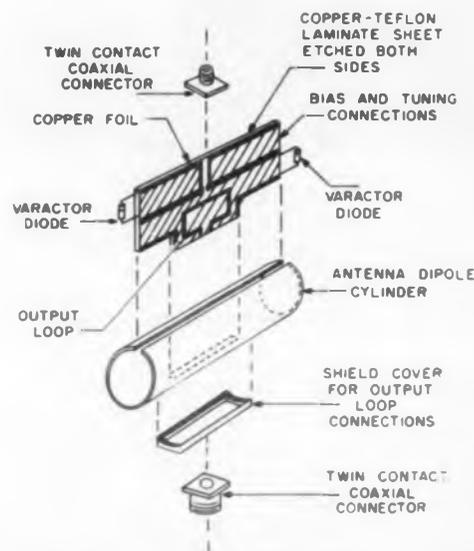


Fig. 10. Etched circuit, half-wave parant. This design approach should prove useful for antennas operating up to 500 mc. The etched circuit board replaces inner conductor of the lower-frequency parants. Resonant region is achieved by the stripline construction. Distributed elements would be used for tuning.

conductor. The circular pipe was, however, retained for the inner conductor. Length was calculated by the equation

$$L = 0.48 \lambda \frac{L/D}{L/D + 1} \quad (1)$$

where

$L$  = antenna length for half-wave dipole

$D$  = antenna diameter

$\lambda$  = free-space signal-wave length.

This expression was found empirically valid for conventional dipoles in which the signal is derived across a mid-point gap of negligible width and coupled to a matched resistive load. The gap in the inner conductor as shown in Fig. 2 provides the necessary dc isolation between the two diodes of the half-

## MICROWAVES

wave parant, but it is also an important factor in the design of tuning circuits for the signal, idler and pump frequencies.

The effect of this gap on the resonance of the inner region is dependent on the relative magnitude of its susceptance, though generally it shifts the resonant frequencies upwards.

### Distributed Impedance Is A Factor in Design

Also across this gap are the composite impedances of the radial connections from gap to plug, connectors, leads (see Fig. 5) and internal wiring as far as capacitor  $C_1$  in the tuning network. These act as an irregular transmission line to provide, together with  $C_1$ , a series resonance as viewed from the gap. Their detuning effect is relatively minor at the 108-mc signal frequency of the antenna, but quite important at the 490-mc idler frequency.

The gap is physically located at a point where the longitudinal current density and voltage gradient are high for the odd order modes. Its location with respect to the even order modes is at a low-current, high-impedance point.

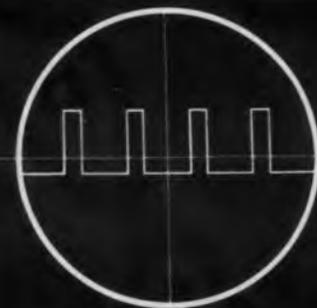
Tuning of the idler and signal frequencies, occurring at odd TEM modes, is accomplished by adjustment of series resonant branches composed of lumped and/or distributed impedance elements. With a signal frequency of 108 mc and a consequent pump frequency near 600 mc, the circuit elements are largely distributed.

The pump signal coupling loops provide an in-phase voltage across the center conductor gap. Thus, any out of phase excitation arising from signal or idler frequency components will not produce a net output along the pumping signal line. Loading and signal loss are thereby avoided.

A tuning network assembled for the half-wave parant is shown in Fig. 9. Early models of the parant were tuned by the insertion of dielectric strips into the coaxial region. It was felt that the adjustable tuning network described here is more suitable for a developmental model, but the use of dielectrics for fixed tuning may be attractive when assembling a large number of

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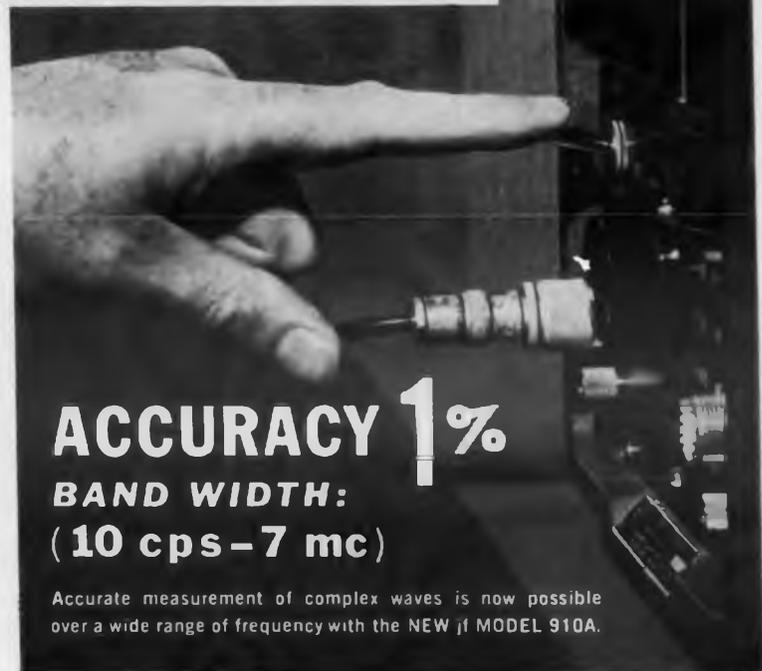
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parants designed for constant-frequency operation at a single frequency.

Matched-diode selection for the half-wave parant emphasized voltage sensitivity and static capacity. These two characteristics were matched as closely as possible within the tolerances obtainable with the low-priced diodes employed. Matching of reverse resistance and forward conduction point was performed less critically.

### Quarter-Wave Parant Considered Simpler to Design and Fabricate

The quarter-wave parant is a more workable design from the standpoint of simplicity in construction and operation. It is essentially a half-section of the half-wave parant with the outer conductor welded to a conducting ground plane.

Its singled-ended configuration, as compared to a symmetrical half-wave dipole, permits more freedom of design for external circuitry and better control of cavity resonances. There is no balancing problem, either of external circuitry or diodes. Circuitry can be placed under the ground plane and there adjusted without affecting fields within the antenna itself.

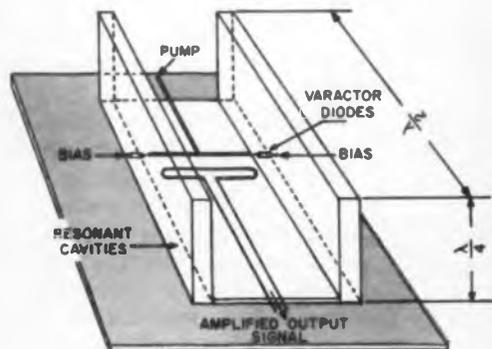
The quarter-wave parant shown in Figs. 3 and 4 was designed for a 54-mc signal thus allowing lumped circuit elements to be used. Tuning networks for the signal and idler resonances (see Fig. 6) are connected across the base of the cavity, as are the dc bias and pumping inputs. In designing these networks, the following precautions should be observed.

- Dc bias must be applied between the center conductor and the dipole cylinder without shorting out the pump signal.
- The bias circuit must not lower the Q of the idler and signal-tuned circuits.
- Idler and signal power must not be dissipated in the pump and bias circuits.

### Etched-Circuit and Slot Parants Being Designed for Higher Frequencies

Parants for use at higher frequencies are now being developed at the Antenna Sys-

## MICROWAVES



**Fig. 11.** Dual slot parant for use up to 2 Gc. Cavities behind slots in ground plane provide resonant storage for parametric amplification. Initial model of this design is undergoing operational tests.

tems Laboratory of the University of New Hampshire. In the region between 200 and 500 mc, an etched circuit antenna using essentially distributed elements for tuning appears feasible. The design shown in Fig. 10 is now being fabricated. A slot antenna, such as illustrated in Fig. 11 would operate at frequencies in the 1.5- to 2-Gc range. An initial model of this type has been completed and development is being continued.

As a simple dipole, the parant can be employed alone or together with Yagi arrays, parabolas, corner reflectors, etc. Multiple units with in-phase pumping and adjusted for equal gain merit consideration in high speed electronically-scanned arrays or in direction finding systems using a Wullenweber antenna or Luneberg lens. ■ ■

### Acknowledgment

The parant concept was evolved in connection with Doppler tracking at the University of New Hampshire of early U. S. and Soviet satellites and is being developed under the sponsorship of the Electronics Research Directorate, Air Force Cambridge Research Laboratories.



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MICROWAVES

## New Definitions Of Receiver Noise Performance



*Shortly before the 1961 National Symposium of the IRE's Professional Group on Microwave Theory and Techniques, five authorities in the field of noise measurement undertook to agree on a workable set of definitions of receiver noise. Whether Messrs. William Mumford and Rudolf Engelbrecht of Bell Telephone Laboratories, Hermann Haus, Massachusetts Institute of Technology, Robert Adler, Zenith Radio Corp., and Matthew Lebenbaum, Airborne Instruments Laboratory, have indeed said the last word in this long-standing controversy remains to be seen. Their significant report to the symposium, abstracted here, is nevertheless strongly commended to the interest of microwave designers.*

THE noise performance of a system is evaluated in terms of its output signal-to-noise power ratio under operating conditions,  $S_o/N_o$ . Output power is expressed as the signal power at the input multiplied by the signal gain,  $G_s$ .

The output noise power can be expressed in terms of the signal gain,  $G_s$ , input signal power,  $S_i$ , output signal bandwidth,  $B_o$ , and an operating noise temperature,  $T_{op}$ . Hence, the output signal-to-noise ratio is:

$$\frac{S_o}{N_o} = \frac{G_s S_i}{G_s k T_{op} B_o} = \frac{S_i}{k T_{op} B_o} \quad (1)$$

Two receiving systems have the same output signal-to-noise ratio if they have the same  $S_i/kT_{op}B_o$  ratio.

In a single response receiver (in which one frequency at the input corresponds to a single output frequency, regardless of the complexity of the gain-frequency characteristic) the output noise power,  $N_o$ , is defined as

$$N_o = G_s k B_o (T_g + T_e) \quad (2)$$

The term  $T_g$  is the input generator noise temperature.  $T_e$  is called the "Effective Input Noise Temperature." For a two-port transducer, this is the temperature which, when

the input is connected to a noise-free equivalent of the transducer, would result in the same output noise power as that of the actual transducer connected to a noise-free input source.

To measure  $T_e$ , the designer can observe the output noise power for two different temperatures of the generator. If the ratio of the two output noise powers is  $Y$ ,

$$T_e = \frac{T_g(\text{hot}) - Y T_g(\text{cold})}{Y - 1} \quad (3)$$

The term  $T_{op}$ , occurring in Eq. 1 can be expressed as

$$T_{op} = T_g + T_e \quad (4)$$

An alternative definition of receiver noise, that of the Noise Figure, remains useful. Since, however, the literature contains several conflicting definitions of Noise Figure, the authors recommend the definition in the IRE standards on electron tubes.<sup>1</sup> In terms of Noise Figure,  $F$ , the operating noise temperature can be written as

$$T_{op} = T_g + 290(F - 1) \quad (5)$$

In a multiple response receiver, such as a superheterodyne receiver with response at the image frequency or a parametric amplifier with response at the idler frequency,

there are two distinct contributions to noise:

$N_{go}$  — output noise due to the noise power available from the impedance connected to the amplifier input.

$N_N$  — All other contributions to the input noise power. These are due to noise generated within the receiver components and noise resulting from any frequency conversions within the receiver.

Letting  $B_N$  be the limiting noise bandwidth common to all responses,

$$N_{go} = k B_N (T_{g1} G_1 + T_{g2} G_2 + \dots + T_{gn} G_n) \quad (6)$$

where  $G_n$  is the transducer gain of the  $n^{\text{th}}$  response. That is, the ratio of output power to the corresponding input power available to the  $n^{\text{th}}$  input response.

$N_N$  can be characterized by a temperature,  $T_b$ , common to all responses, so that

$$N_N = k B_N T_b (G_1 + G_2 + \dots + G_n) \quad (7)$$

The total output noise is then

$$N_o = k B_N [G_1 (T_{g1} + T_b) + G_2 (T_{g2} + T_b) + \dots + G_n (T_{gn} + T_b)] \quad (8)$$

$T_b$  is obtained from Eq. 3.

The operating noise temperature is given by

$$T_{op} = \frac{N_o}{k B_o G_s} \quad (9)$$

Since most modern noise generators provide broadband noise, their use in direct measurement of noise injects the noise equally into all responses. That is,

$$T_g = T_{g1} = T_{g2} = \dots = T_{gn} \quad (10)$$

Eq. 8 thus reduces to

$$N_o = k B_N (T_g + T_b) (G_1 + G_2 + \dots + G_n) \quad (11)$$

To measure  $T_b$  in terms of Noise Figure, use

$$T_b = 290(F_b - 1) \quad (12)$$

where  $F_b$  is the multiple channel or "broadband" Noise Figure.

To evaluate  $F_b$ , use

$$F_b = \left[ \frac{T_g(\text{hot})}{290} - 1 \right] - Y \left[ \frac{T_g(\text{cold})}{290} - 1 \right] \quad (13)$$

When the input signal occupies only one

response,  $G_s = G_1$ . If the system is designed for lowest operating noise temperature, i.e., noise bandwidth  $B_n$  matches signal bandwidth  $B_o$ , the operating noise temperature is given by

$$T_{op} = T_{g1} + T_b + \frac{G_2}{G_1} (T_{g2} + T_b) + \frac{G_3}{G_1} (T_{g3} + T_b) + \dots + \frac{G_n}{G_1} (T_{gn} + T_b) \quad (14)$$

For the special case when, under operating conditions, the generator noise temperatures applied to all input responses are equal, Eq. 14 reduces to

$$T_{op} = (T_g + T_b) \left( 1 + \frac{G_2}{G_1} + \dots + \frac{G_n}{G_1} \right) \quad (15)$$

When the received input signal is distributed over more than one input response, only the term  $G_s$  of Eq. 9 is affected. When the portions of the input signal are uncorrelated, with powers of  $S_{i1}, S_{i2}, \dots, S_{in}$ ,

$$G_s = \frac{S_{i1}G_1 + S_{i2}G_2 + \dots + S_{in}G_n}{S_{i1} + S_{i2} + \dots + S_{in}} = \frac{S_o}{S_i(\text{total})} \quad (16)$$

Substituting  $G_s$  into Eqs. 8 and 9 yields

$$T_{op} = \frac{N_o}{k B_o G_s} \quad (17)$$

$$= \frac{B_n [G_1(T_{g1} + T_b) + \dots + G_n(T_{gn} + T_b)]}{B_o \left[ \frac{S_{i1}G_1 + S_{i2}G_2 + \dots + S_{in}G_n}{S_{i1} + S_{i2} + \dots + S_{in}} \right]}$$

It is concluded that to evaluate the signal-to-noise ratio of any receiving system, the designer must know  $T_{op}$ ,  $B_o$ , and the total input signal power  $S_i$  (having the same distribution over the various input responses assumed in the evaluation of  $T_{op}$ ).

The multiple-channel effective input noise temperature,  $T_b$ , (i.e.,  $T_g$  for a single response receiver) is computed by Eq. 3, the gains of the various responses, and the noise bandwidth,  $B_n$ .

With these terms, the designer can calculate his particular system's operating noise temperature,  $T_{op}$  by inserting them in the general Eq. 17, or an appropriate simpler form. ■ ■

#### Reference

1. *Proceedings of the IRE*, July, 1957, Vol. 45, p 1000.

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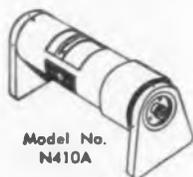
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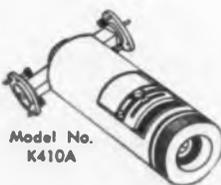
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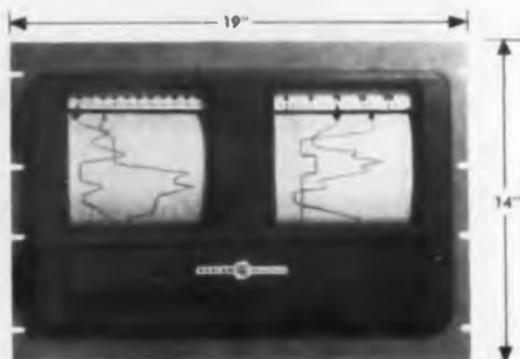


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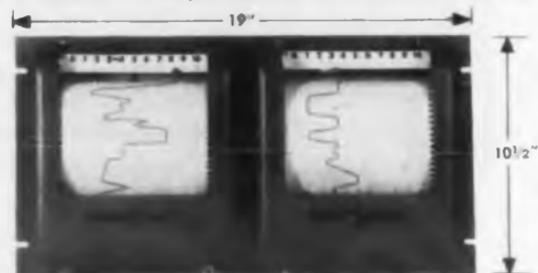
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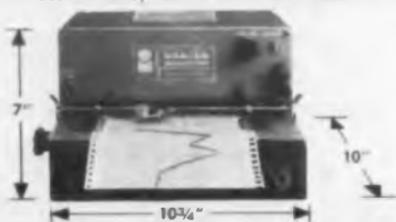
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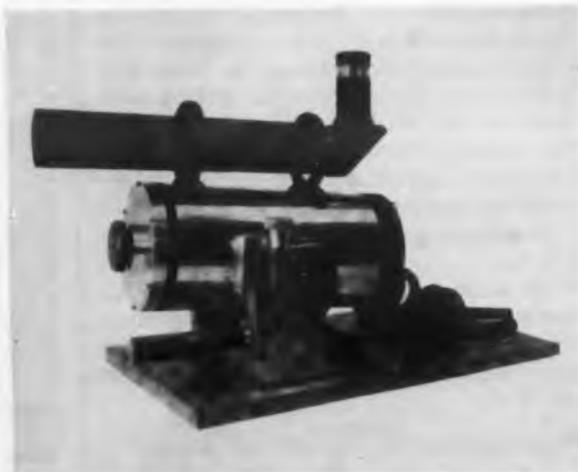
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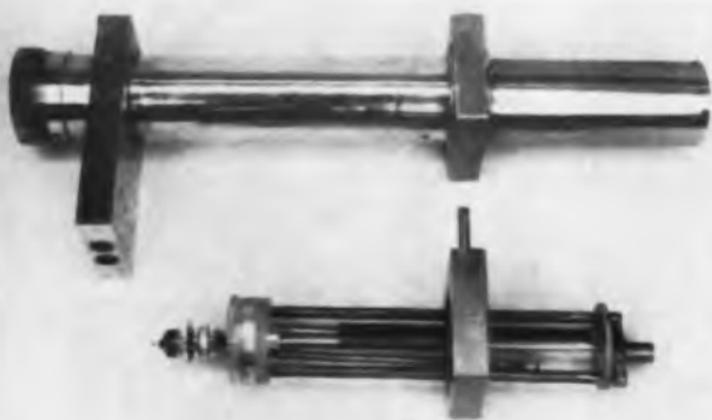
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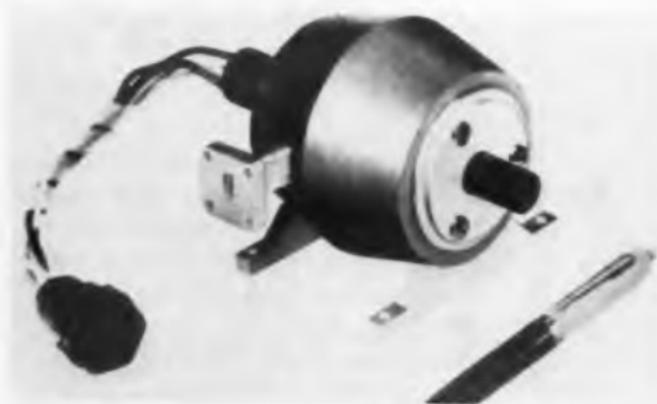


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**H. L-3430 CUBE MINIATURE MAGNETRON:** A one-kilowatt miniature magnetron, fixed tuned at  $9300 \pm 30$  mc, weighing less than 9 ounces and no bigger than a normal X-band waveguide flange. Developments at other power levels and frequencies are planned.

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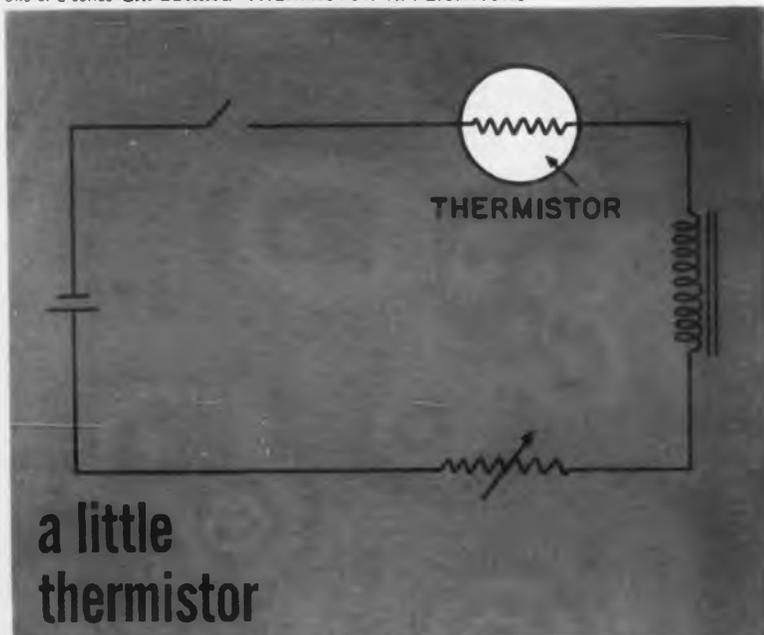


*For information on our tube line, exclusive of classified types, send for the 1961 Electron Tube Condensed Catalog. Write to: Marketing Dept., Electron Tube Division, 960 Industrial Road, San Carlos, California*



**LITTON INDUSTRIES**  
**Electron Tube Division**

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Circuits like the one above are often used where variable or fixed delay are required. Circuit ingredients: a thermistor and a variable resistor, in series with a battery and a relay.

With the switch closed, current flow is limited by the high resistance of the thermistor. The thermistor then heats up, permitting sufficient current flow to close the relay. Delay time can be increased or decreased by increasing or decreasing series resistance.

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There are just two kinds of thermistors, really: ordinary, which are good; and FENWAL ELECTRONICS', which are a little bit better. One reason is that FENWAL ELECTRONICS has the edge in experience. We pioneered in this field. Another reason is that we can suit your application exactly — FENWAL ELECTRONICS has the most complete line of thermistors available anywhere.

For details, application assistance, and new Thermistor Catalog EMC 4, write:

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MICROWAVES PRODUCTS

### Variable Attenuator

470



Range is 25 db. Model 1146 is a continuously variable attenuator with less than 0.5 db insertion loss and adjustment range of 25 db over the 500 to 1,000 mc range. Attenuation is essentially constant with frequency ( $\pm 0.4$  db max); unit handles 8 w average power. Connectors are BNC or TNC.

Radar Design Corp., Dept. ED, Pickard Drive, Syracuse 11, N. Y.  
P&A: \$ 210 ea; 8 week.

### Waveguide Isolators

378



Broad-band ferrite load isolators in five models cover spans between 2.60 and 12.4 Gc. Insertion loss of the type 101 units is 1 db max, isolation 20 to 40 db min. They are designed for use with medium-power equipment.

Caswell Electronics Corp., Dept. ED, 414 Queens Lane, San Jose, Calif.  
P&A: \$165 to \$310 ea; 1 to 30 days.

### Water Loads

379



Magnetron output termination of low vswr for cw and pulsed testing is provided by these water loads. Available with or without a variable-phase magnetron pulling slug, loads may be pressurized to 30 psig. Seven types operate between 2.6 and 71.0 Gc.

Bomac Laboratories, Inc., Dept. ED, Salem Road, Beverly, Mass.

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for TO-3 Transistors or Diodes



for TO-36 Transistors



for 2N-1015 Transistors

Augat's new Heat Dissipators utilize a minimum of space and still offer the large radiating surfaces needed for maximum transfer of heat. All Augat dissipators feature a parallel, open-fin construction assuring low thermal resistance. They are readily adaptable to forced air cooling for even lower resistance.

Augat Heat Dissipators are manufactured in three styles to accommodate the TO-3, TO-36 and 2N-1015 transistors or their equivalent.

Write for Bulletin No. HD-261 which describes this new line in full detail.

**AUGAT BROS., INC.**  
31 Perry Avenue, Attleboro, Mass.  
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## MICROWAVES

### Coaxial Isolator 390



Broad-band ferrite coaxial isolator C992-100-409 operates from 2 to 4 Gc. Bandwidth isolation is 15 db, insertion loss 1 db, vswr less than 1.25:1. The 2-lb isolator is 6.16 in. long. Type N female coaxial connectors are standard, with other types optional.

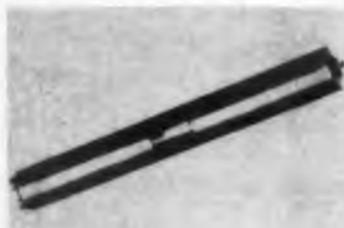
General Precision, Inc., Kearfott Div., Microwave Products, Dept. ED, 14844 Oxnard St., Van Nuys, Calif.

### Microwave Garnet 404

Low-loss, microwave garnet, MCL-300 is intended for use in the uhf and L-band regions. This material is available in bars, cylinders and disk form. Typical applications include 3- or 4-port low-loss circulators, either in full waveguide or coaxial. Curie temperature is 125 C.

Microwave Chemicals Laboratory, Inc., Dept. ED, 282 Seventh Ave., New York 1, N.Y.

### Traveling-Wave Tube 356



A periodic-permanent, magnet-focused, low-noise traveling-wave tube, the HA-54 is for operation in the S-band. When operated from 2.4 to 3.4 Gc the tube has a noise figure of 13 db max, small signal gain of 25 db min and saturation power output of 5 dbm min. It measures 18 in. long with a 2 in. OD and weighs 3-1/2 lb.

Huggins Laboratories, Inc., Dept. ED, 999 E. Arques Ave., Sunnyvale, Calif.

P&A: \$2,500 ea; 8 to 10 weeks.

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\*Reg. Trade-mark of General Electric Co.

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are available from stock for 85C and 125C applications.

Data on G-E High Voltage Tantalytic Capacitors is found in Bulletin GEA-7065. Ask your G-E Sales Engineer for a copy today. Or write to General Electric Co., Schenectady, N. Y. *Capacitor Department, Irmo, South Carolina.* 410-02

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**"A CASE"  
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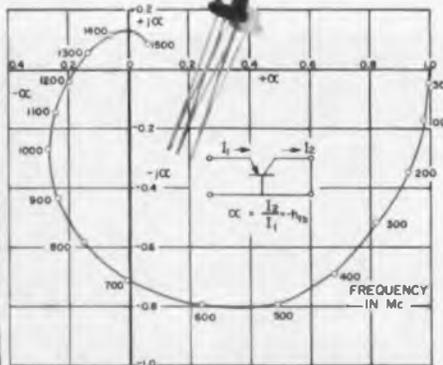
Bulletin  
GEA-7226



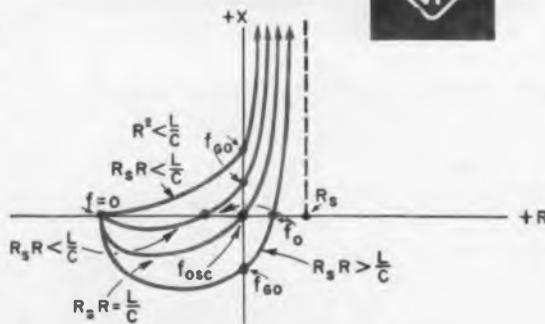
**125C CYLINDRICAL  
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CAPACITORS**

Bulletin  
GEA-7085





$\alpha$ - $h_{fb}$  versus frequency for a diffused-base transistor, as measured with Type 1607-A Bridge.



Tunnel-diode impedance characteristics plotted to determine approximate values for the self-resonant and resistive cut-off frequencies.



Type 1607-A Transfer Function and Immittance Bridge... \$1775

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- ★ **LOW R-F SIGNAL APPLIED** — may be held below 5 mv for transistor measurements.
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★ **TRANSISTOR TEST MOUNTS AVAILABLE:**

- **Type 1607-P101** (0.200-in.-pin-circle, common base, \$60.)
- **Type 1607-P102** (0.200-in.-pin-circle, common emitter, \$60.)
- **Type 1607-P111** (0.100-in.-pin-circle, common base, \$65.)
- **Type 1607-P401** (0.200-in.-pin-circle, tetrode, \$65.)

*This Instrument Takes In Stride Advances In Solid-State Devices — it can measure all theoretical two-, three-, and four-terminal characteristics*

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MICROWAVES PRODUCTS

### Monitoring Diode 401

RF power monitoring diode MA-462 is for measurement applications in the X-band region. It is housed in a hermetically sealed, reversible polarity cartridge and is guaranteed for operation to 150 C. It meets the environmental conditions of MIL-S-19500B. A rectified output voltage with controlled variation is provided for input power levels between 10  $\mu$ w and 10 mw cw.

Microwave Associates, Inc., Dept. ED, Burlington, Mass.

**Availability: Immediate.**

### Y-Circulator 358



For the 2-Gc region, this Y-Circulator is 2 in. in diameter. It can be magnetically tuned with electromagnets or permanent magnets which become an integral part of the package. Standard configuration is with TNC connectors at 120 deg spacing. A 6% bandwidth is obtained across a frequency range of 2 to 4 Gc. Insertion losses are less than 0.4 db with an isolation of -20 db (-30 db at  $f_o$ ) and vswr of 1.3 (1.1 at  $f_o$ ).

Hycon Manufacturing Co., Dept. ED, 700 Royal Oaks Drive, Monrovia, Calif.

**Availability: Immediate.**

### Coaxial Mixer Diode 403

The MA-445 series of coaxial silicon mixer diodes are rated conservatively at 1-erg burnout. Primary applications include use in single-ended or balanced hybrid mixers and communication and radar applications in the 10- to 18-Gc frequency range. Specifications for the MA-445 are: conversion loss, 7.5 db max; output noise ration, 2.5 max; if impedance, 325 to 625 ohms.

Microwave Associates, Inc., Semiconductor Div., Dept. ED, Burlington, Mass.

**Availability: Immediate.**

ANOTHER ADVANCED MICROWAVE TUBE DEVELOPMENT  
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MICROWAVES

**Crystal Detectors 354**

For K and R band waveguide systems, models K422A and R422A have sensitivity of 0.05 v per mw and flat response within 2 db. Maximum vswr is 2.5. Both models have feed-through terminations which may be removed when greater sensitivity is required. Model K422A is for 18 to 26.5 Gc and the R422A is for 26.5 to 40 Gc.

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

**P&A:** Single units are \$200; matched pairs are \$420.

**C-Band Oscillator 353**



A microminiature, C-band oscillator 3/4-in. in diameter and 3/8 in. long, model 9180 is for both plate pulse and cw service. The plate pulse service unit can be built in the 4 to 6 Gc spectrum with a tuning range of any 300 mc segment of that section. Peak pulse power is 50 to 100 w. The cw version can tune any 100 mc segment of the 4.0 to 5.5 Gc spectrum. Power output is approximately 5 mw.

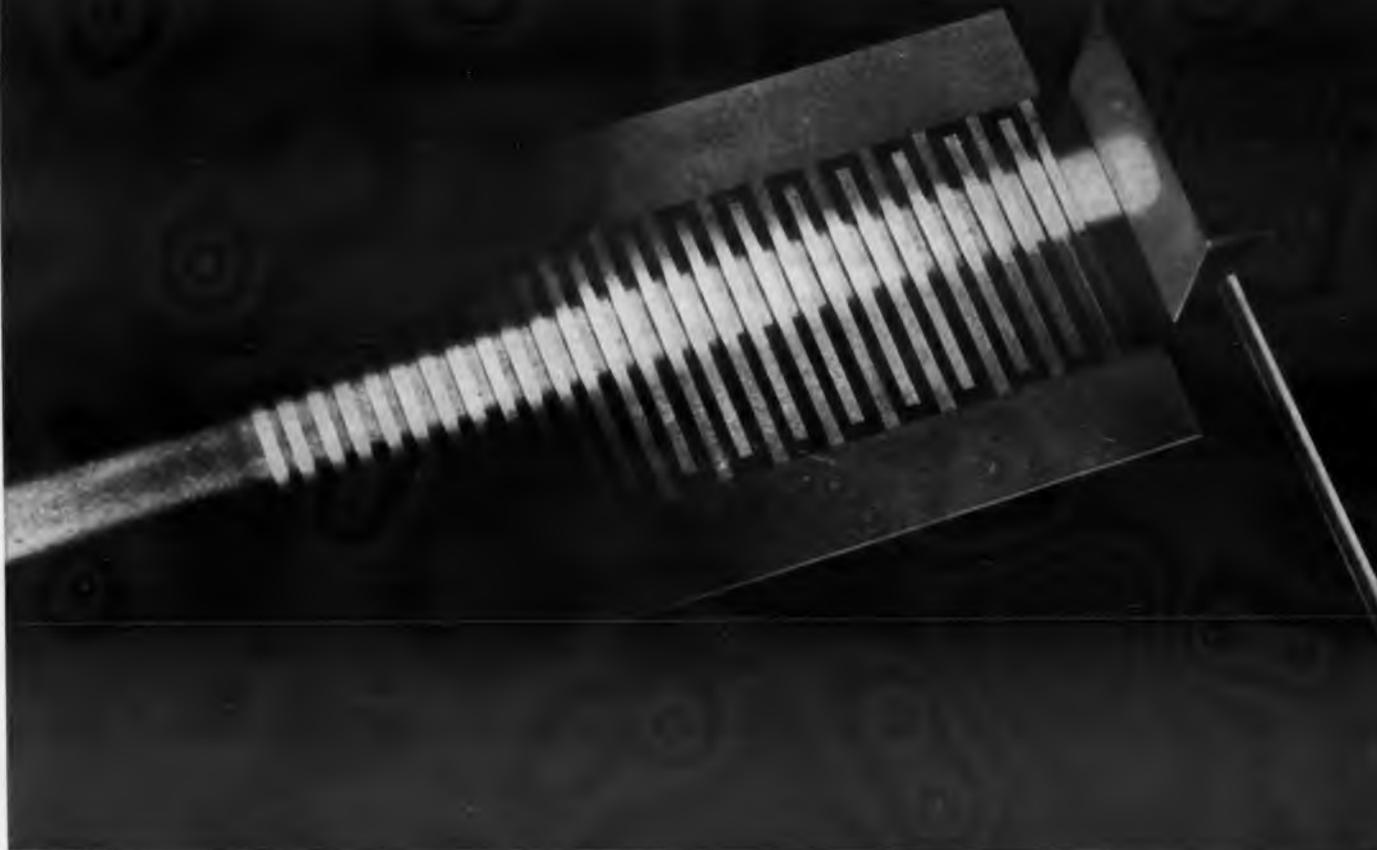
Trak Microwave Corp., Dept. ED, Tampa, Fla.

**Pulse Modulator 360**

The PM-87 pulse moderator is designed to test, for life and performance, super power klystrons, continuous-duty radar transmitters and similar equipment. Peak power is 64 megawatts continuous; average power is 75 kw. Continuously adjustable pulse range is 75 kv to 250 kv with pulse current of 260 amp at 250 kv. Frequency is 30 to 360 pps; pulse height deviates from flatness  $\pm 2\%$ . Rise time at 10 to 90% voltage is 0.8  $\mu$ sec; decay time is 1.5  $\mu$ sec at the same voltages.

Ling-Temco Electronics, Inc., Dept. ED, 1515 S. Manchester Ave., Anaheim, Calif.

**Availability:** 30 to 60 days.



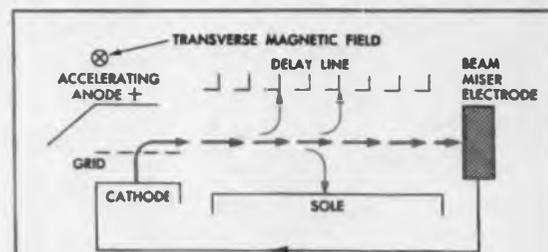
## How new Raytheon "BEAM MISER" boosts efficiency in crossed field devices

Unique depressed collector greatly improves efficiency of "M" BWO's and crossed field amplifiers.

"Beam Miser" is Raytheon's newest advance in crossed field oscillator and amplifier design. With it are opened many new design possibilities for applications requiring voltage tunability or bandwidth plus high reliability and efficiency.

Incorporating the "Beam Miser" into existing crossed field tubes will yield improved performance and will not require any mechanical or electrical changes in equipment.

Write for further information on Raytheon developments in crossed field devices. Microwave & Power Tube Division, Raytheon Company, Waltham 54, Massachusetts. In Canada: Waterloo, Ontario.



"BEAM MISER" consists of an additional electrode in the crossed field device which collects a portion of the spent beam at cathode potential and returns it to the cathode by means of an internal conductor.

**RAYTHEON COMPANY**

MICROWAVE & POWER TUBE DIVISION

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MICROWAVES PRODUCTS

Communications System

469



Operates at 6 Gc. The 50 series is a solid-state microwave package including rf, multiplex, telegraph carrier and alarm equipment. Modular construction and circuit cards are used throughout. Klystron provides 1 w output, is rated for 20,000 hr of continuous operation. Up to 600 voice channels may be used, with 18 frequency-shift channels per voice circuit. Monitoring equipment can serve 22 stations with 8 points continuously scanned at each station.

Motorola Inc., Communications Div., Dept. ED, 4501 W. Augusta Blvd., Chicago 51, Ill.

Mixer Diode

467

Noise figure is 7 db. Glass packaged diode type 1N831A, useful in strip-line circuits, can be conveniently mounted in coaxial circuits for broad-band, low-noise mixer applications. Operating from 1 mc to 4 Gc, burn-out rating is 250 mw cw. The device exhibits a noise figure of 7.0 db max for a 30-mc if noise figure of 1.5 db at 3,060 Gc.

Microwave Associates, Inc., Dept. ED, Burlington, Mass.

P&A: On request; stock.

Delay Line

468



For X-band. Waveguide line lengths of 13 to 1,228 ft are contained in a mobile unit. The step-variable line is composed of coiled, rigid waveguide. Improved bending techniques result in minimum distortion of the waveguide and reduction of discontinuities. Length is changed quickly and accurately through use of high-isolation waveguide switches.

Turbo Machine Co., Dept. ED, Lansdale, Pa.

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ELECTRONIC DESIGN • July 5, 1961

## MICROWAVES

### RF Detector

367



Model XD-6A rf detector consists of two separate detection circuits in a single package. Each section has an operating range of 100 kc to 1 Gc. Input impedance is 50 ohms for each section; vswr rating is 1.2 to 1 max at 1 Gc. Unit comes complete with BNC connections on both inputs and both outputs. TNC and N-type connectors are also available.

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

### Shielded Grid Triode

402

Designed as a switch tube in hard-pulse modulations, the ML-7845 delivers more than 4 megawatts pulse power output for radar, communications and similar applications. The cathode is unipotential and oxide-coated. When cooled by forced air the anode is capable of dissipating 3 kw with 150 cfm air flow. When the tube is immersed in a suitable dielectric gas such as sulfur hexafluoride, its maximum ratings are 75 kv dc and 80 kv peak.

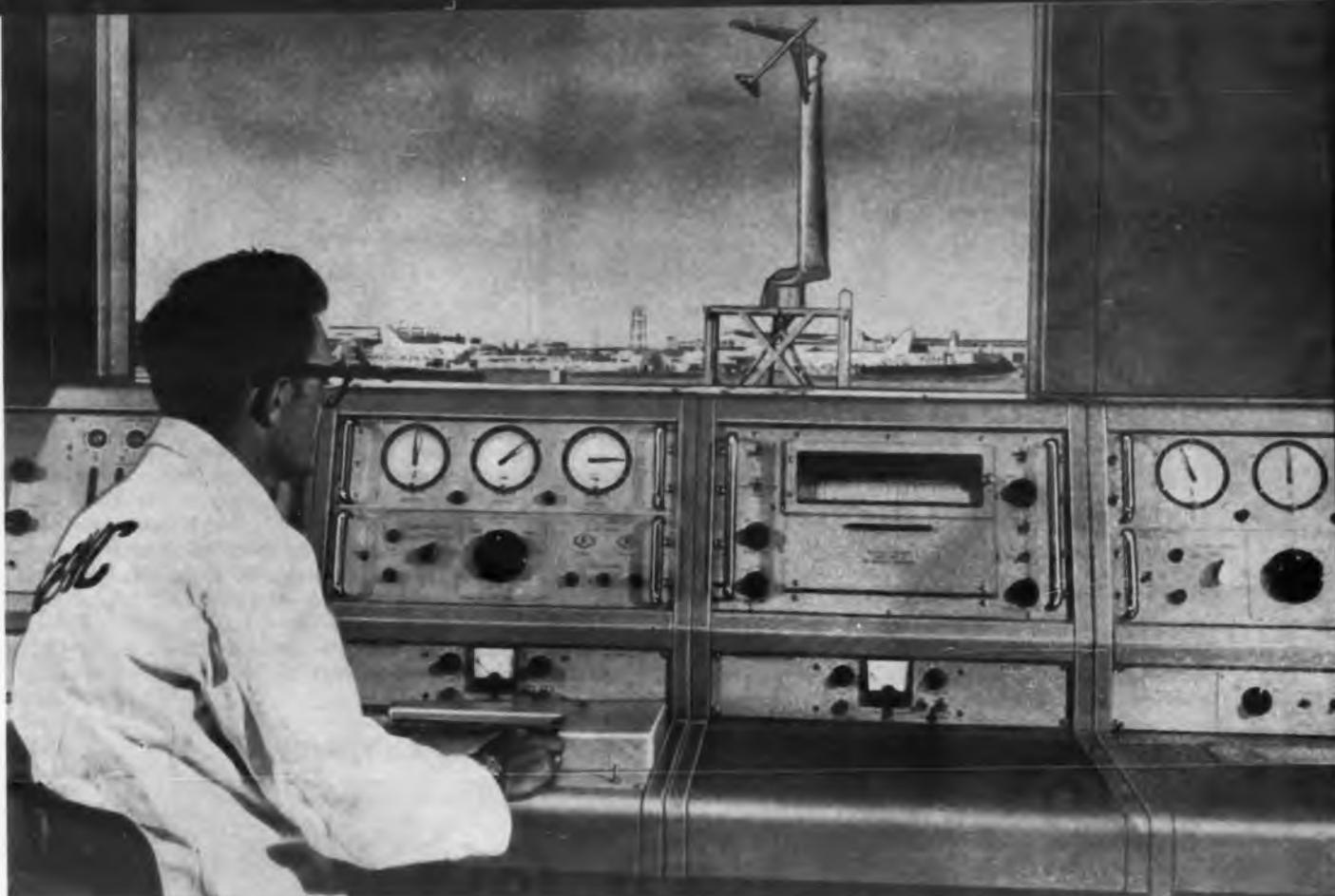
Machlett Laboratories, Inc., Dept. ED, Springdale, Conn.  
P&A: \$2,415; 30 days.

### Junction Circulator

380

Broad-band junction circulator model SL-43-3, operating at 2.2 to 2.7 Gc, is one of a line covering 1 to 35 Gc. The devices have better than 20 db isolation, less than 0.5 db insertion loss, and vswr less than 1.2:1 over a 15 to 20% frequency band. S, X, and SL band models with insertion loss of 0.15 db or less are available.

Cascade Research Div., Lewis and Kaufman Electronics Corp., Dept. ED, 5245 San Fernando Road West, Los Angeles 39, Calif.  
Availability: 2 weeks.



Scientific-Atlanta antenna pattern recording console at Boeing Airplane Company, Wichita, Kansas, with Scientific-Atlanta model range tower in background.

## Advancing the Art of Aircraft Antennas

*Boeing uses versatile Scientific-Atlanta equipment to design and evaluate antennas for B-52H bombers*



A Boeing B-52H global bomber packs more total firepower than that expended by all the Allied and Axis bombers in World War II. Each B-52H will carry four Skybolt missiles plus a potent assortment of other weapons. Equipped with penetration aids, including electronic countermeasures (ECM) and decoys, the B-52H can strike as many as five military targets on a single mission. It is produced for the Air Force's Strategic Air Command at the Wichita, Kansas, Division of Boeing.

Obviously, the design of antennas for such an aircraft demanded nothing short of "state of the art." As it turned out, Boeing engineers advanced the state of the art in the design of ECM antennas for B-52Hs and B-47s. They were aided significantly by a new antenna test facility, consisting predominately of Scientific-Atlanta equipment—including pattern recorders, wide range receivers, signal sources, and a model range tower.

The foremost advantage of Scientific-Atlanta instrumentation is versatility. Complete frequency coverage is provided with recordings proportional to voltage, power, or db in

either rectangular or polar coordinates. Owing to the equipment's wide frequency coverage, sensitivity, and flexibility, many other laboratory measurements can be made including calibration of microwave attenuators, insertion loss and gain measurements. These, and other features which enable Boeing to derive data faster and easier, have resulted in significant savings of research time.

There's one other point that should be mentioned. At Boeing's antenna test facility, Scientific-Atlanta's equipment has operated with good reliability. Whenever help is needed, Scientific-Atlanta engineers are there in a hurry.

Scientific-Atlanta will accept full responsibility for the design, construction, and manufacture for any antenna test facility that suits your needs. For details, write



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7848 San Fernando Road, Sun Valley, California



\*between mounting holes

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## PROBING THE "TRANSPROBE" WAVEGUIDE SWITCH



The only moving parts of the "Transprobe" are solenoid plunger and a light weight, dielectrically supported metal probe. Result... greater flexibility, longer life, ability to switch under full waveguide power. The design can be applied to any waveguide size. Unit shown is a single-pole-double-throw, X-band switch.

The design is equally successful for adaptation to SPDT, SP3T, transfer switch or special configurations. Typical specifications: Frequency... 8.2-12.4 KMC, VSWR... 1.20, Insertion Loss... 0.2 db, Crosstalk... 35 db, Life... 2,000,000 operations. To probe more thoroughly the unusual advantages in this new approach to waveguide switching write Transco Products, Inc., 12210 Nebraska Avenue, Los Angeles 25, California.



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## MICROWAVES PRODUCTS

### Cavity Amplifiers

365



Miniature cavity amplifiers, series 20, are entirely gold-plated and designed for heat sink type mounting and operation. Frequency range covered is 215 to 2,325 mc. All units can be used as building blocks stacked side by side on 4 surfaces.

Resdel Engineering Corp., Dept. ED, 330 S. Fair Oaks Ave., Pasadena, Calif.

Availability: 20 days.

### Waveguide Fittings

361



Broached or unbroached waveguide fittings are manufactured to MIL-F-3922 from forgings, castings or bar stock for microwave applications. Magnesium and oxygen free copper flanges are available.

Pem Machine Tool Co., Inc., Dept. ED, 1456 Chestnut Ave., Hillside, N. J.

Availability: From stock.

### Variable Attenuator

471



For field equipment. Type 170 series of panel-mounting attenuators is made for operation over full waveguide bandwidth, or with direct-reading dials for narrow-band use. Frequency range of type X170 is 8.5 to 10.5 Gc, with accuracy  $\pm 2$  db from 0 to 50 db. Insertion loss is 0.75 db max, vswr 1.15:1 max. Average power handling capability is 1 w, peak lower 1 kw.

General Microwave Corp., Dept. ED, 47 Gazza Blvd., Farmingdale, N. Y.

## world's shortest short-form catalog on BWOs

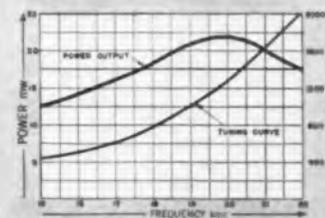
You don't have to send for it

This is it!

TYPE #	FREQ. RANGE kmc	POWER mw
OD 1-2	1-2	50-200
OD 2-4	2-4	30-120
OD 3.7-5.9	3.7-5.9	30-45
OD 4-8	4-8	10-70
OD 5.2-8.3	5.2-8.3	10-40
OD 6-11	7-11	10-40
OD 6-12	6-12	10-30
OD 7-13	8.2-12.4	10-15
OD 10-15	10-15.5	10-20
OD 12-18	12.4-18	10-25
OD 15-22	15-22	10-20

But don't give up if the tube you need isn't listed here... these are just the BWOs we usually keep on the shelf in quantity, ready to ship today. We also produce, in either experimental or production quantities, oscillators covering partial, octave, and even greater-than-octave bandwidths.

Would you like a copy of our honest-to-goodness catalog, with complete performance curves, specifications, and operating data? Just drop us a note. Here's a sample set of curves, on the Type OD 15-22 backward wave oscillator:



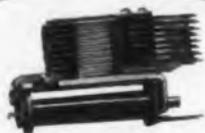
We'd also like to hear from you if you're interested in permanent-magnet-focused tubes or traveling wave amplifiers.

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**KEYS:** Cam-type and push-button. Send for Bulletin T-5002R.



**STEPPING SWITCHES.** Fast and dependable. Bulletin T-5001R.



**JACKS & PLUGS:** For many electrical and electronic uses. Send for Bulletin T-5003.



**TELEPHONE HANDSETS:** Standard or with switch assemblies. Send for Bulletin T-5005.

For bulletins and more information contact the nearest Sales Branch office: Atlanta—750 Ponce de Leon Place N.E.; Chicago—564 W. Adams Street; Kansas City (Mo.)—2017 Grand Avenue; Rochester—1040 University Avenue; San Francisco—1805 Rollins Road.

**GENERAL DYNAMICS  
ELECTRONICS**

CIRCLE 153 ON READER-SERVICE CARD

ELECTRONIC DESIGN • July 5, 1961

MICROWAVES

Hybrid Mixer

373



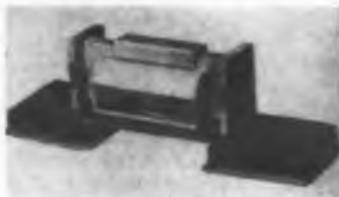
Compact hybrid mixer V-8306C performs without adjustment over 7.0 to 8.0 Gc. It is designed for waveguide coupling in both local oscillator and signal arms. Typical noise figure of 8.0 db includes a 3-db image and 1.5 db if strip contribution. Maximum vswr in both signal and local oscillator arms is 2.0. Isolation is 20 db min. Made of aluminum it weighs 6 oz.

Varian Associates, Dept. ED, 611 Hansen Way, Palo Alto, Calif.

Price: \$495 job Palo Alto.

Waveguide Isolator

386



X-band waveguide isolator C994-100-932 provides isolation greater than 70 db. Insertion loss is 1.0 db max, vswr 1.2:1 max. Center frequency is  $\pm 100$  mc, power handling capability 1 w avg. The 9-oz isolator is 3 in. long.

General Precision, Inc., Kearfott Div., Microwave Products, Dept. ED, 14844 Oxnard St., Van Nuys, Calif.

Ceramic Seals

381



Coaxial ceramic seals for traveling-wave tubes consist of dense alumina insulator sealed to a monel inner conductor and surrounded by a nickel outer conductor. Metallization process results in good rf match characteristics.

Ceramics International Corp, Dept. ED, 39 Siding Place, Mahwah, N. J

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MODEL CB-31

In this Calorimeter the R.F. power to be measured is compared to an accurately known D.C. power, by means of a null indicator and 260 thermocouples in 2 differential thermopiles, which sense the very low temperature rise of .0015 degrees C per milliwatt of the circulating fluid. This fluid is flowing at the rate of  $\frac{2}{3}$  of an ounce per minute.

Since R.F. power is compared to

D.C. power, both of which will depend to an equal extent on the ambient temperature, the effect of the ambient temperature on this power measurement is cancelled out. The R.F. power is then read directly on a  $\frac{1}{4}$  % D.C. milliammeter, calibrated in milliwatts. The null indicator pointer is deflected  $\frac{1}{4}$ " by a power difference of 100 microwatts.

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### Traveling-Wave Tube

372



A 3-mw pulse amplifier traveling-wave tube, the VA-126 is rated at 5 kw average power. Frequency range is 5.4 to 5.9 Gc. Efficiency is 30%; gain is 35 db. The liquid-cooled unit is self-centering in its electromagnet for ease in mounting.

Varian Associates, Dept. ED, 611 Hansen Way, Palo Alto, Calif.

### Video Receiver

371



Self contained, battery operated, X-band cw crystal video receiver, model R115, employs video chopping. It is designed for direct connection to an antenna and provides a dc output proportional to the X-band signal input. Nominal sensitivity is -45 dbm.

AEL, Inc., Dept. ED, 121 N. 7th St., Philadelphia, Pa.

### Step Attenuator

385



Operating from dc to 500 mc, the D170 step attenuator has six switch positions permitting selection of attenuation from 0 to 41 db in 1-db increments. Accuracy is within 0.3 db; vswr is 1.10:1 max, power handling capability 1 w. Impedance is 50 ohms.

General Microwave Corp., Dept. ED, 47 Gazza Blvd., Farmingdale, N. Y.

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For detailed technical bulletins, call the American Bosch Arma marketing offices in Washington, Dayton or Los Angeles. Or write or call Tele-Dynamics Division, American Bosch Arma Corporation, 5000 Parkside Avenue, Philadelphia 31, Pa. Telephone TRinity 8-3000.

4411

## TELE-DYNAMICS DIVISION

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# 153

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Adding the conductors, triplets, and a point each for filler, braid, jacket, tape and outer jacket, you come up with 153 good reasons—skill, experience, and specialized equipment—why you should take your next cable problem to a cable specialist, such as Rome.

Inquiries invited. Write to Rome Cable Division of Alcoa, Dept. 11-71, Rome, N. Y.



CIRCLE 165 ON READER-SERVICE CARD

ELECTRONIC DESIGN • July 5, 1961

## NEW LITERATURE

### Planar Semiconductors 261

Reliability, performance, cost and adaptability of planar diodes and transistors are discussed in this 12-page color brochure. Technical data, including performance curves and electrical specifications, are included. Planar transistors, manufactured with a protective oxide coating, are compared with their mesa equivalents. Fairchild Semiconductor Corp., 545 Whisman Road, Mountain View, Calif.

### RF Interference Filters 262

Radio-frequency interference filters designed to reduce conducted interference in shielded-enclosure test activities and ground-support equipment applications are described in this eight-page publication. Entitled "Shielded Room and Ground Support Equipment Filters", the booklet covers the firm's complete line. Genistron, Inc., Sales Dept., 6320 W. Arizona Circle, Los Angeles 45, Calif.

### Environmental Data 263

Common conversion factors, formulas, and data on vibration, shock, pressure and other dynamic phenomena are given in this pocket folder. It is intended primarily for the environmental engineer. The folder has 27 sections, each devoted to a particular topic from the basic trigonometric formulas to a graph of piezoelectric transducer response. Endeveco Corp., 161 E. California Blvd., Pasadena, Calif.

### Electroplating 264

A method of electroplating without requiring immersion tanks is described in this eight-page brochure. Localized areas, it is said, can be plated, with little masking required. Sifco Metachemical, Inc., 935 E. 63rd St., Cleveland 3, Ohio.

### Plugs, Connectors and Switches 265

Banana plugs, phone jacks, alligator clips, test leads, cable connectors, toggle switches and miscellaneous related items are described and illustrated in this 32-page catalog. Physical and electrical specifications and prices are included. GC Electronics Co., Rockford, Ill.

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- Rated residual VSWR under 1.010; rated error in detected signal under 1.005.



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2181-6	100 to 4000 mc	60 inches	\$925

\*Including an input adapter to Type N and an untuned rf probe but excluding output tapered reducers and tunable probes. Prices are F.O.B. Boston, Mass., and are subject to change without notice.



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## NEW LITERATURE

### Measuring Instruments 266

In 96 pages, Catalog S describes over 250 instruments, counting systems, radionuclides and nuclear accessories. Much of the catalog is devoted to new products. Illustrations and technical data are included for each device. Nuclear-Chicago Corp., 359 E. Howard Ave., Des Plaines, Ill.

### Toroidal Cores

Basic design information tips and formulas for toroidal cores are given in this 14-page handbook. Included are temperature curves, analysis of core loss, dc resistance, eddy current loss resistance, hysteresis loss resistance and self-capacitance. Request on company letterhead from Connolly and Co., Dept. ED, P. O. Box 295, Menlo Park, Calif.

### Silicon Diodes 267

Eighty-six glass silicon diodes are cataloged in this four-page brochure, as well as 35 general purpose and 51 computer types. Technical specifications are given. Computer Diode Corp., 250 Garibaldi Ave., Lodi, N. J.

### Long-Life Vacuum Tubes 268

Specifications, descriptions and dimensional drawings for the firm's vacuum tubes are given in this 26-page handbook. Manufacturing techniques and quality control procedures are also described. State Labs, Inc., 215 Park Ave. S., New York 3, N. Y.

### Low-Pressure and Flow Switches 269

Complete specifications, details and prices on low-pressure switches and velocity-actuated flow switches are described in this 30-page catalog. Design information and dimensional diagrams are included. The Henry G. Dietz Co., Inc., 12-16 Astoria Blvd., Long Island City 2, N. Y.

### Flashtubes for LASERS 270

Flashtubes capable of driving LASERS are described in this four-page booklet. Information on operation and application is included. Data on power requirements and capabilities of three assemblies are given. General Electric Co., Dept. LP-15, Nela Park, Cleveland 12, Ohio.

## SOLVE 5 CRITICAL DESIGN PROBLEMS WITH TURBOTEMP® Teflon FEP/Nylon WIRE

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ELECTRONIC DESIGN • July 5, 1961

## DC Power Supplies

271

The firm's model CVQ transistorized power supply is described in this eight-page brochure. Theory of operation of the 100-w, regulated supply is discussed. Specifications are included. Sola Electric Co., Busse Road at Lunt, Elk Grove Village, Ill.

## Clutches and Brakes

272

Electromagnetic clutches and brakes, mechanical clutches, torque indicators, torque standards and multi-speed transmissions are described in 40-page manual No. 361. Engineering and applications information is included. Autotronics, Inc., Dept. 30, Florissant, Mo.

## Photoelectric Systems

273

Applications of photoelectric systems in automation are described in this 20-page bulletin, No. 611. Light sources, photo units, electronic controls and timers are discussed, with electrical and physical specifications included. Photomation, Inc., 96 S. Washington Ave., Bergenfield, N. J.

## Temperature-Measuring Paints

274

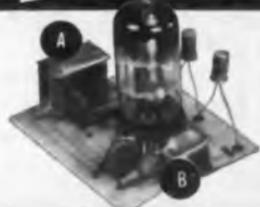
Paints and crayons which can be used to measure surface temperatures are described in this folder. Pigments change color at specified temperatures, indicating whether surface is hotter or colder than desired. Princeton Div., Curtis-Wright Corp., Princeton, N. J.

## Semiconductor Technical Bulletins

275

A series of technical bulletins on semiconductors are available. No. 60S17-1, "Index of Technical Bulletins", lists technical data sheets on the firms semiconductor products. No. ICE-235, "RCA 2N404 Family", gives data on six transistors. No. ST-1945, "Reliability of the RCA-USAF-2N404 at High Stress Levels", presents test data on the 2N404 transistor. No. ICE-229, "RCA Silicon Rectifier Interchangeability Guide", lists available silicon rectifiers. No. ICE-228, "Application Guide-RCA VHF Silicon Transistors", includes information on transistor design, construction and circuitry. No. ST-2106, "Micromodule Reliability Status Report", presents reliability information on the firm's micromodules. Radio Corp. of America, Semiconductor and Materials Div., Somerville, N. J.

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Composite photo demonstrating that magnetic shielding qualities of Rigid Netic Alloy Material are not significantly affected by vibration shock (including dropping or bumping) etc. Netic is non-retentive, requires no periodic annealing.



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This construction offers compactness, long shelf life, exceptional service life. A 30% increase in battery life at no increase in size.

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# IDEAS FOR DESIGN

## 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.

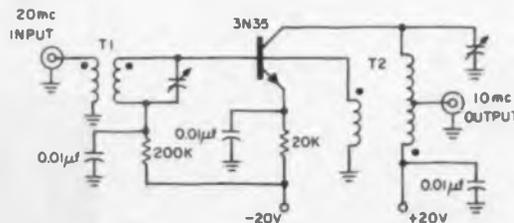
The Ideas chosen as the most valuable in each issue will be eligible for the \$1,000 Idea of the Year award.

So vote for the Ideas you find most valuable. And, after you've voted, why not send in an Idea of your own?

## Simple Circuit Halves 734 20-Mc Supply Frequency

A simple circuit was required to supply a 10-mc signal from a 20-mc source. The circuit shown fulfilled the requirement quite adequately.

Transformer  $T_1$  is resonant at the 20-mc input frequency. Transformer  $T_2$  is resonant at 10 mc, with a portion of the 10-mc energy coupled back into the transistor. The loop gain is low enough to keep the circuit from oscillating with the drive removed.



Frequency divider has two resonant circuits—the input circuit at 20 mc, the output at 10 mc.

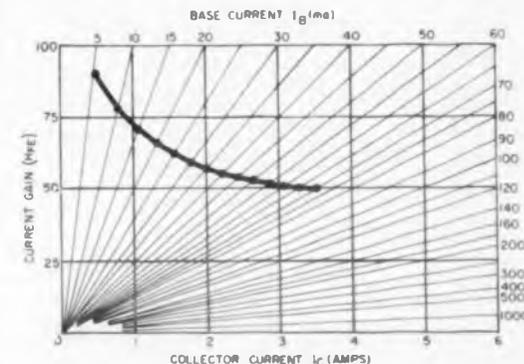
*Herbert F. Verse, Jr., Research Engineer, Jet Propulsion Laboratory, Pasadena, Calif.*

If this Idea is valuable to you, give it a vote by circling Reader-Service number 734.

## Power Gain Plot Can Be 733 Made Directly From Measurements

When plotting the large current gain of power transistors the plot can be made rather quickly by eliminating the division step.

Current gain is given by  $H_{FE} = I_c/I_b$ . The graph paper is used as shown in the figure, with base current values laid out beforehand on the graph. The intersection of the measured base current line and the collector current abscissa yields a correct point on the  $H_{FE}$  vs  $I_c$  curve.



Current gain  $H_{FE}$  is plotted directly from  $I_b$  and  $I_c$  measurements by laying out base current "guidelines" beforehand.

*John T. Lamb, Research Engineer, The Tappan Co., Mansfield, Ohio.*

If this Idea is valuable to you, give it a vote by circling Reader-Service number 733.

## Fourth \$50 "Most Valuable of Issue" Award For Curve-Tracing Attachment

Chester B. Shapero, self-employed research engineer of Cupertino, Calif., has won ELECTRONIC DESIGN's fourth \$50 Most Valuable of Issue Award.

Mr. Shapero receives the award for his Idea for Design, "Low-Cost Scope Traces Transistor Characteristic Curves," which appeared in the April 12 issue. The idea described a circuit which enabled a low-cost oscilloscope to be used for displaying transistor characteristic curves.

## SEVENTH ANNIVERSARY AWARDS

# IDEAS-FOR-DESIGN

*Entry Blank*

### 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.

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.  
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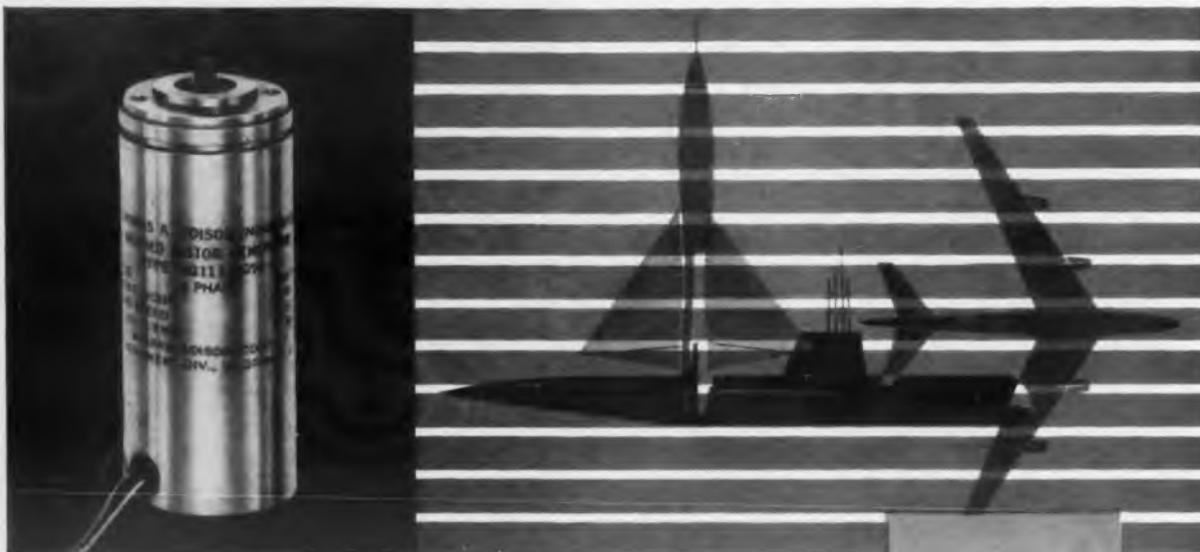
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are available with  
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## IDEAS FOR DESIGN

### Long Period Multivibrator 748 Reduces Timing Capacitor Size

Building a transistorized monostable multivibrator for pulse widths of 10 msec or more can be a problem if space is at a premium. The problem arises because the finite  $\beta$  of  $Q_1$  (circuit *a* in the figure) places an upper limit on resistor  $R$ . This, in turn, means that  $C$  must be large, both electrically and physically, to yield the large  $RC$  product required for long pulse widths.

The maximum permissible value of  $R$  is given approximately by:

$$R = \frac{V_1 - 1.3}{V_1/R_L \cdot \frac{1}{\beta}}$$

The quantity 1.3 accounts for the drop across  $CR_1$  and the base-to-emitter junction of  $Q_1$  when the transistor is on.  $V_1/R_L$  is the collector current of  $Q_1$  when  $Q_1$  is on. Not considered is the effect of the collector-to-emitter drop of  $Q_1$  when it is on, and the bleeder current required to hold  $Q_2$  off.

As an example, consider the typical values below:

$$\begin{aligned} V_1 &= 30 \text{ v} \\ R_L &= 3.3 \text{ K} \\ \beta &= 40 \end{aligned}$$

Then,

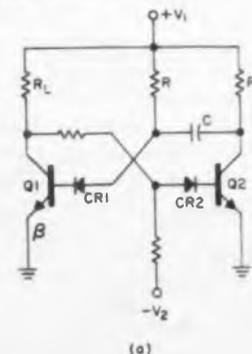
$$R = \frac{30 - 1.3}{3.3 \cdot \frac{1}{40}} = 126.3 \text{ K}$$

If a pulse width of 20 msec is required, the time constant is derived from:

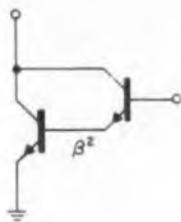
$$t \approx 0.68 RC$$

Choosing a standard value for  $R$  of 120 K, we have

$$C = \frac{20 \times 10^{-3}}{0.68 \times 120 \times 10^3} = 0.245 \mu\text{f}$$



(a) Maximum value of  $R$  in this monostable multivibrator is limited by the value of  $\beta$  for transistor  $Q_1$ . Thus, for long pulse widths, capacitor  $C$  must be large.



(b)

(b) Replacing  $Q_1$  with two-transistor Darlington connection effectively squares the value of  $\beta$ . This allows a larger  $R$ , and reduces both the value and size of  $C$ .

Compared to the other components in the circuit, this capacitor is physically very large. This is especially true if the capacitor must be both accurate and stable.

However, the size of the capacitor can be considerably reduced if transistor  $Q_1$  is replaced by the two-transistor Darlington connection. The over-all  $\beta$  is now  $40 \times 40 = 1,600$ , and  $R$  can be 40 times larger than before. Hence,  $C$  can be 40 times smaller. Using a practical value of  $R = 1$  meg, we have

$$C = \frac{20 \times 10^{-4}}{0.68 \times 1 \times 10^6} = 0.0294 \mu\text{f}$$

Obviously, a much smaller capacitor will be required.

*W. E. Zrubek, Design Engineer, Westinghouse Electric Corp., Baltimore, Md.*

If this idea is valuable to you, give it a vote by circling Reader-Service number 748.

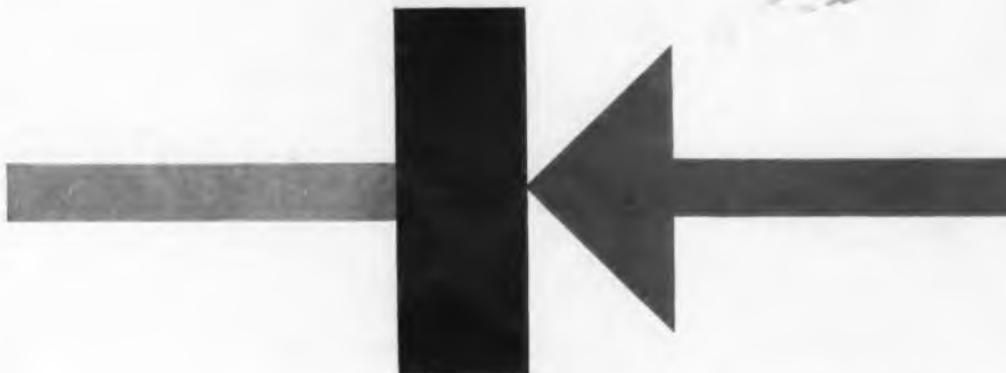
## One-Shot Pulse Output Has 746 Greater Than 100% Duty Cycle

Greater than 100 per cent duty cycle pulse generators can be designed by connecting two one-shot multivibrators in series.

Such a generator was needed to produce display pulses variable from microseconds to seconds. The pulses were to be triggered by a four-decade, preset counter when the counter reached a preselected number. The maximum frequency of the display was 100 kc.

At the end of the display pulse time, the counters were to be reset, ready to be triggered again, within  $10 \mu\text{sec}$ . Thus, if the preset selector is set to a low number such as 0002, and if the counter receives pulses at a 100-kc rate, coincidence is again reached 20 to  $30 \mu\text{sec}$  after the counter is reset to zero.

Thus, if the output display pulse time is 1 sec, the pulse generator has to operate with



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But each particular situation requires treatment on its own terms. If you are concerned with the protection of silicon, germanium or other metallic rectifiers, chances are Heinemann engineers can help you. *Your inquiries are invited.*

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ever, presents circuitry problems which can get complex.

This problem was solved by using a simple servo bridge balancing circuit with a high back-resistance silicon diode. The servo used with this diode is able to proceed in the direction of the greatest ratio of lobe peak to null depth. When the diode is properly oriented, the servo direction cannot be reversed. To regain the original 1:1 ratio, it is only necessary to short out the diode momentarily. The servo then swings back to its unity ratio.

*Edwin S. Oxner, Sr. Engineer, Varian Associates, Radiation Div., Palo Alto, Calif.*

**If this idea is valuable to you, give it a vote by circling Reader-Service number 735.**

## Tunnel Diode Trigger Circuit Can Reset Itself 731

The tunnel diode trigger circuit, Fig. 1, resets itself without the need for a clipping line or additional reset pulses. A trigger applied as shown switches the tunnel diode from the low state (state 1) to the high state (state 2). The diode now presents a higher impedance than in the original state, and its current decreases to  $I_2$ , Fig. 2. The original current through the tunnel diode is

$$I_1 = \frac{V_s - V_1}{R' + R}$$

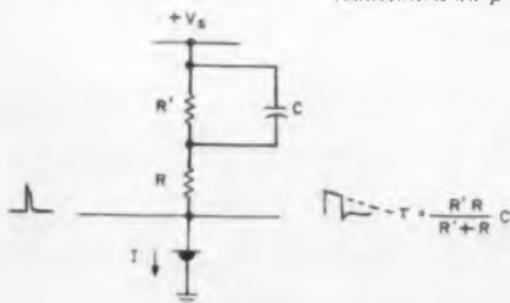
If capacitor  $C$  were sufficient to maintain the voltage across  $R'$ , the current through the tunnel diode immediately after switching to state 2 would be

$$I_2 = \frac{V_s - V_2 - V_{R'}}{R}$$

Since the voltage across capacitor  $C$  changes with the time constant of  $C$ ,  $R$ , and  $R'$  in parallel, the current through the tunnel diode will decrease toward

$$I' = \frac{V_s - V_2}{R' + R}$$

(continued on p 164)



**Fig. 1.** Presence of voltage holding capacitor  $C$  allows tunnel diode trigger circuit to reset itself.

# .tough going ahead!

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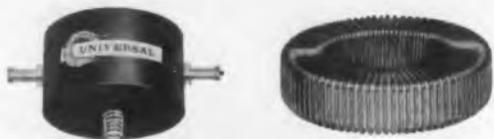


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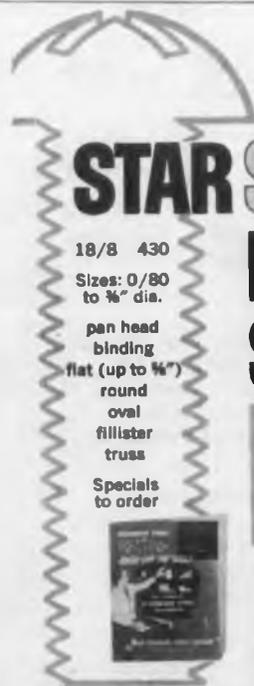


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## IDEAS FOR DESIGN

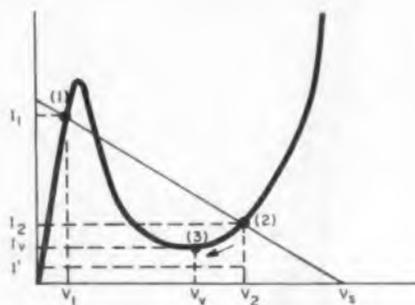


Fig. 2. After being switched to state 2 by trigger pulse, capacitor C causes current to decrease to  $I_2$  and the diode switches back to its original state.

Thus the voltage across the tunnel diode will decrease exponentially, moving from point 2 to point 3.

When the current through the tunnel diode reaches  $I_1$  (the valley current), the diode will switch back to its original state.

The conditions for the tunnel diode to re-set to state 1 are:

$$I' < I_v \text{ where } I' = \frac{V_s - V_2}{R' + R}$$

Since  $V_s$  and  $R$  are chosen by normal circuit considerations, and  $I_v$  and  $V_2$  are obtained from the tunnel diode specifications, the value of  $R'$  is determined as:

$$R' = \frac{V_s - V_2 - I_v R}{I_v}$$

The "on-time" of the tunnel diode is determined by the time constant  $T$  where:

$$T = \frac{R'RC}{R' + R}$$

Since the values of  $R'$  and  $R$  are determined by the previous considerations, the on-time of the trigger circuit is fixed by the choice of the value of  $C$ .

*Robert N. Larsen, Assist. Electrical Engineer, Argonne National Laboratory, Argonne, Ill.*

If this idea is valuable to you, give it a vote by circling Reader-Service number 731.

## Emitter-Coupled Limiter Produces HF Square Waves

732

A sine-to-square wave converter can be easily designed by using diode clippers. But

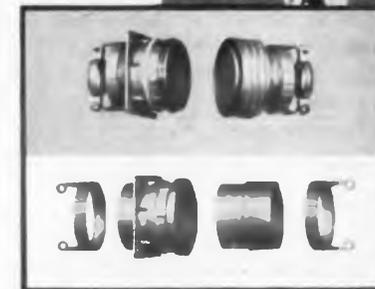
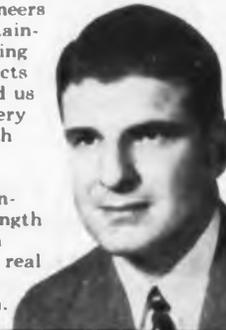
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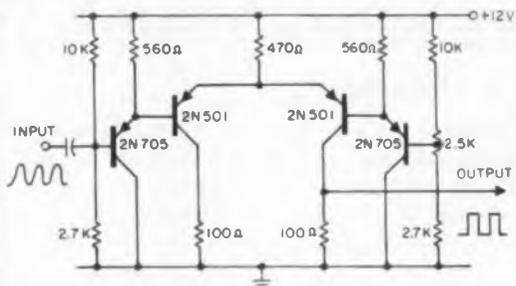
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High frequency sine-to-square wave converter is made up of transistorized emitter-coupled stages.

the rise time of the square wave then depends on the magnitude of the input sine wave. Thus, the ratio of the peak-to-peak values of the input to the output should be at least 3.

However, an emitter-coupled limiter not only needs a much smaller input voltage, but its rise-time is limited only by the switching times of the transistors. These can be reduced by driving the switching transistors out of a common collector stage.

The circuit shown produces, once the potentiometer is adjusted, a fast rise time, symmetrical square wave. A 5-mc sine wave with 2 v peak-to-peak at the input gives a 2-v peak-to-peak square wave with a rise time of approximately 20 nsec. For an input voltage of 6 v peak-to-peak, the rise time reduces to less than 10 nsec with a slight overshoot.

*Harald Hahn, Assist. Electrical Engineer, Brookhaven National Laboratory, Upton, L.I., N.Y.*

If this Idea is valuable to you, give it a vote by circling Reader-Service number 732.

### 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.

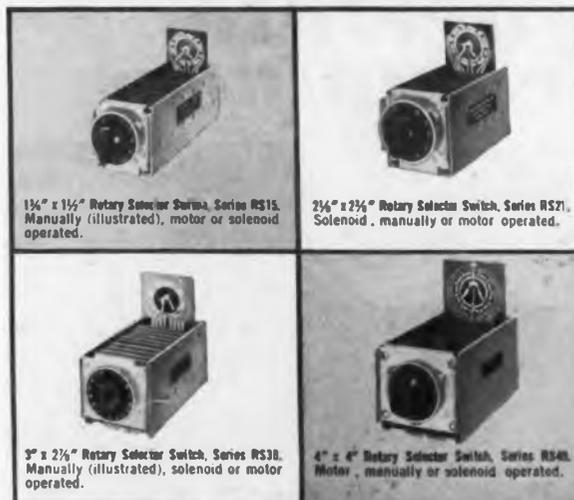
The Ideas chosen as the most valuable in each issue will be eligible for the \$1,000 Idea of the Year award.

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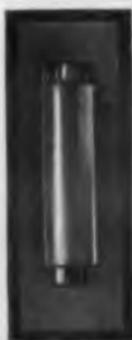
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## REPORT BRIEFS

### Tem Diode Switching

The theory and technique for the design of a broadband (100-to-1 frequency range) TEM microwave diode switch are presented. A coaxial transmission line switch has been constructed that provides 26 db or greater isolation and insertion loss ranging from 1.6 db to less than 1 db from 40 mc to 4000 mc. An analysis is given of the switching action of one and of two or more diodes. Also discussed is the biasing of the center conductor of a TEM transmission line over broad frequency bandwidths so as not to interact with the rf signal. *Theory of TEM Diode Switching, Robert V. Garver, Diamond Ordnance Fuze Laboratories, Washington, D. C., Oct., 1960, 56 pp, Microfilm \$3.60, Photocopy \$9.30. Order PB 153579 from Library of Congress, Washington 25, D. C.*

### RFI-Duplexer Tubes

An investigation was conducted on several types of TR duplexer tubes and a waveguide filter commonly used in systems, to determine their effectiveness in rejecting spurious microwave radiation. The devices studied were all designed for operation in the 2.8-Gc frequency band. The low power level characteristics of these devices were checked over a frequency range of 2.6 to 35 Gc. Results of the investigation showed that neither the TR tube nor the waveguide filter can provide adequate protection against unwanted signals at frequencies higher than the system frequency. *Characteristics of Microwave Duplexer Tubes Under Spurious Radiation Conditions, Irving Reingold, Army Signal Research and Development Labs., Fort Monmouth, N. J., March 31, 1959, 27 pp, Microfilm \$2.70, Photocopy \$4.80. Order PB 147821 from Library of Congress, Washington 25, D. C.*

### Waveguide Components

Presents the design and development of components for use in a circular waveguide system employing the low-loss  $TE_{01}$  circular electric wave mode. Components were investigated with regard to direct scaling for use with 2.710-in. ID and 0.725-in. ID circular waveguide at 9.375 Gc and 35 Gc, respectively.

Several new components were developed. These include a straight waveguide section,

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# METERS

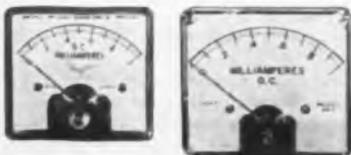
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## Printed Antennas

Discusses several types of printed antenna arrays and related feeds and baluns. Detailed consideration is given to the Franklin array, Chireix-Mesny array, and the capacitively coupled collinear array. Experimental techniques, such as probing the magnitude and phase distribution of the current along a printed array and measuring the impedance and phase velocity that characterize printed balanced lines are described. The antenna performance characteristics for the types of arrays that were studied are given including gain, loss, impedance, size, side-lobe levels, and half-power beamwidths. *Study of Printed Antennas*, J. A. McDonough, R. G. Malech, J. Kowalsky, Airborne Instruments Lab., Inc., Mineola, N. Y., Aug., 1955, 57 pp, Microfilm \$3.60, Photocopy \$9.30. Order PB 150667 from Library of Congress, Washington 25, D. C.

## Transistors

A hybrid parameter equivalent circuit for the common emitter connection is developed. The basic circuit is modified for high-frequency use in such a way that the parameters of the equivalent circuit are independent of frequencies. Methods of measuring these various parameters are discussed in detail and circuit diagrams are provided for each such measurement. The proposed transistor equivalent circuit is then used in the analytical development of circuit design equations and criteria for low-pass, high-pass, and band-pass amplifiers. *Transistor Equivalent Circuit Criteria*, Thomas L. Martin Jr., David J. Sakrison, et al, Arizona University, Tucson, Ariz., Aug. 30, 1956, 83 pp, Microfilm \$4.80, Photocopy \$13.80. Order P B 147539 from Library of Congress, Washington 25, D. C.

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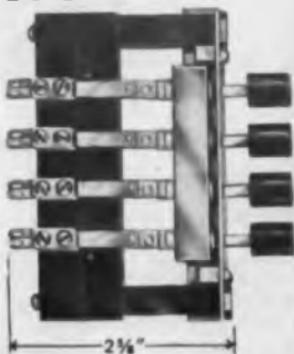
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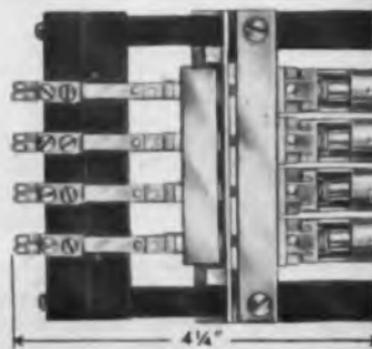
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## REPORT BRIEFS

### Radiation Damage in Semiconductors

A diode resistant to nuclear radiation damage was constructed as a result of extensive studies of nuclear irradiation effects on semiconducting materials. The diode uses p-type germanium with resistivity of about 0.20 ohm-cm as the base material. Principal object of the study was to determine the mechanisms by which radiation degrades semiconductor devices. The researchers state that one of the most significant accomplishments of the program was the development of the instrumentation and techniques of measurement used with the General Atomic electron linear accelerator. *Research in Radiation Damage in Semiconductors*, J. W. Harrity and others, General Dynamics Corp. for U. S. Air Force, Feb. 1960, 157 pp, \$3.00. Order PB 16167.1 from OTS, Washington 25, D. C.

### Ground Support Functions

This study was conducted to determine the relations between automation and personnel requirements for guided missile ground support functions. Three systems—Snark, Bomarc, Mace—were investigated in regard to organization-level maintenance of electronic equipment. The study shows that automatic equipment, itself, is not the cause of increased personnel requirements, but rather the use to which automation is put within the over-all support organization. *Automation and Personnel Requirements for Guided Missile Ground Support Functions*, General Electric Co. for Wright Air Development Center, May 1959, pp 49, \$1.25. Order PB 151978 from U. S. Department of Commerce Field Office, 1031 S. Broadway, Los Angeles 15, Calif.

### Ceramic Tubes

This Air Force "phasing-in" study reports on the results of a survey to facilitate the prompt use of newly developed high-temperature ceramic tubes and components in aviation electronic equipment. Many of the supporting components investigated were still in the research and development stages. Various materials and construction methods were tested in a search for simple, efficient, and economical means of installation and servicing. *Adaptation of Ceramic Tube Types*,

## DEPENDABLE SWITCHING



of contact loads  
to 25 amps . . .

**"Diamond H" Series W Relays**—The simple, functional construction of this high-quality general-purpose relay assures long-time dependable switching. For a broad range of applications, specifying "Diamond H" Series W Relays makes good sense. Here are some reasons:

**Reliable**—Mechanical life in excess of 10,000,000 cycles.

**Versatile**—a-c or d-c units available with choice of eight different combinations.

**Compact**—Measures  $1\frac{1}{2} \times 1\frac{1}{2} \times 1\frac{1}{2}$  inches—weighs less than 10 oz.

**High Contact Rating**—Conservatively rated up to 25 amps, 240 v a-c or 28 v d-c.

**Easy to mount**—Plug-in design. Panel or side mounts also available.

**Underwriters Laboratory Approval**—U/L File 31481.

**Cost-saving**—Low in initial cost, the Series W is easy to install, saves space, and is easy to service.

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ELECTRONIC DESIGN • July 5, 1961

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In the field of radar, transients must also be removed. These high voltage, high vacuum clippers and rectifiers are designed to give the high efficiency and careful control demanded in modern equipment.

The 4B31 is primarily a clipper tube, but can also be used as a high voltage rectifier. The 8020W is a high voltage, half wave rectifier designed for high ambient temperatures. It has been tested to withstand a shock of 375G. High operating frequencies and high peak inverse voltages of the 8020W preclude the use of gas filled rectifiers.

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Peak Inverse Volts	16,000	40,000
Fil Voltage	5.0	5.0
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ELECTRONIC DESIGN • July 5, 1961

*Aerovox Corp. for Wright Air Development Center, June 1959, 166 pp, \$3.00. Order PB 151922 from U. S. Department of Commerce Field Office, 1031 S. Broadway, Los Angeles 15, Calif.*

### Sampled-Data Systems

Theory of the operational analysis of the finite, pulse-width system is developed. The closed-form expression of the response of such a system is described by several well-known operators such as the z-transform, the modified z-transform and the simple form of the p-transform. Finding the incremental responses and their superposition is the basic principle of the theory. It is applied to two-sampler systems as well as multirate sampling systems. *Operational Analysis of Finite Pulsed Sampled-Data Systems, T. Nishimura, Electronics Research Laboratory, University of California, Berkeley, Calif., May 1960, 39 pp, Microfilm \$3.00, Photocopy \$6.30. Order PB 149092 from Library of Congress, Washington 25, D. C.*

### Reliability

A specific mathematical model is formulated for improving system reliability with a minimum of effort. Also shown is how to determine the allocation of effort among subsystems which yields the desired system reliability at minimum total expenditure of effort. *Increased Reliability With Minimum Effort, Arthur Albert, Frank Proschan, Applied Mathematics and Statistics Labs., Stanford University, Calif., Oct. 9, 1959, 29 pp, Microfilm \$2.70, Photocopy \$4.80. Order PB 149943 from Library of Congress, Washington 25, D. C.*

### Speech Statistics

At a symposium co-sponsored by the Leningrad State University and the Speech Section of the Commission on Acoustics, USSR Academy of Sciences, papers were presented by Soviet scientists on the investigation of speech, linguistics, telephonic acoustics, physiology, mathematics, and related subjects. Fourteen of these research reports on statistical methods have been translated and compiled in this publication. *Problems of Speech Statistics, translated from a Russian-language publication of the Leningrad State University, 1958, 137 pp, \$2.75. Order 6111792 from OTS, Washington 25, D. C.*

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Continued research and investigation into new areas of electronics and space technology has opened up a number of challenging opportunities for creative scientists and engineers at this rapidly growing division of RCA. Immediate openings are available in the following areas:

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- **SPACE SYSTEM ANALYSIS**/Applied mathematics/Thermodynamics and mechanics
- **PROPULSION STUDY AND DESIGN**/For final stage space craft
- **ELECTRONIC SYSTEMS AND CIRCUIT DEVELOPMENT**/Communications/Video and digital data processing/TV camera and pickup tube design
- **INFORMATION PROCESSING**/Data systems analysis/Computer applications and programming research

For a personal interview, communicate with Mr. D. D. Brodhead. Call Collect Hightstown 8-0424 or send resume to Dept. PE-269, Astro-Electronics Division, Princeton, New Jersey

All qualified applicants considered regardless of race, creed, color or national origin.



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 CIRCLE 901 ON CAREER INQUIRY FORM

## YOUR CAREER

### Over 8,000 Requests For "Self-Tests"

The do-it-yourself tests put out by the General Electric Company's Light Military Electronics Department, Utica, N. Y., have proved surprisingly successful. LMED says 8,695 "self-tests" have been sent out in answer to requests.

These tests were originated by LMED as a recruiting "gimmick." They have been publicized in LMED's employment ads during the past year. The result, according to GE recruiter Ron Bach is that about 10 times as many names have come into LMED as might otherwise have been expected. The number and quality of the "hires" resulting from this greater number of "contacts" has been encouraging, Mr. Bach said.

The self-tests are made up of multiple-choice questions and each test averages about six pages in length. They cover the technical specialties of interest to LMED, ranging from electronic packaging to radar and digital computer design. Sample questions from two of the most recent of these tests, the one on digital computers and the sole nontechnical test of the series, are included here to show the nature of the questions. Using the answers given at the back of each test, an engineer can score himself and then, by comparing his score with the norms developed by LMED through testing its own engineers, he can see how he "stacks up" with engineers presently at LMED.

#### GE Doesn't Use Test Results in Its Own Recruiting

GE recruiters themselves do not pay any particular attention to what a man says his score was on one of these self-tests. GE does hope of course that the tests create the right "image" of attitudes and opportunities at LMED and that the tests serve to help applicants voluntarily pre-screen themselves. But the recruiters at LMED still believe that their personal interviews "in depth" are best for determining which men to make offers to.

Mr. Bach says he has found one particular line of questioning the most productive in separating out the better engineers. He first asks the engineer he is interviewing to describe the engineering organizations he has been with. Then, most important, he asks the man to describe in detail his functional relationship with those organizations. What were his individual responsibilities? A man

# 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 AUG. 16, 1961

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.

14

(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

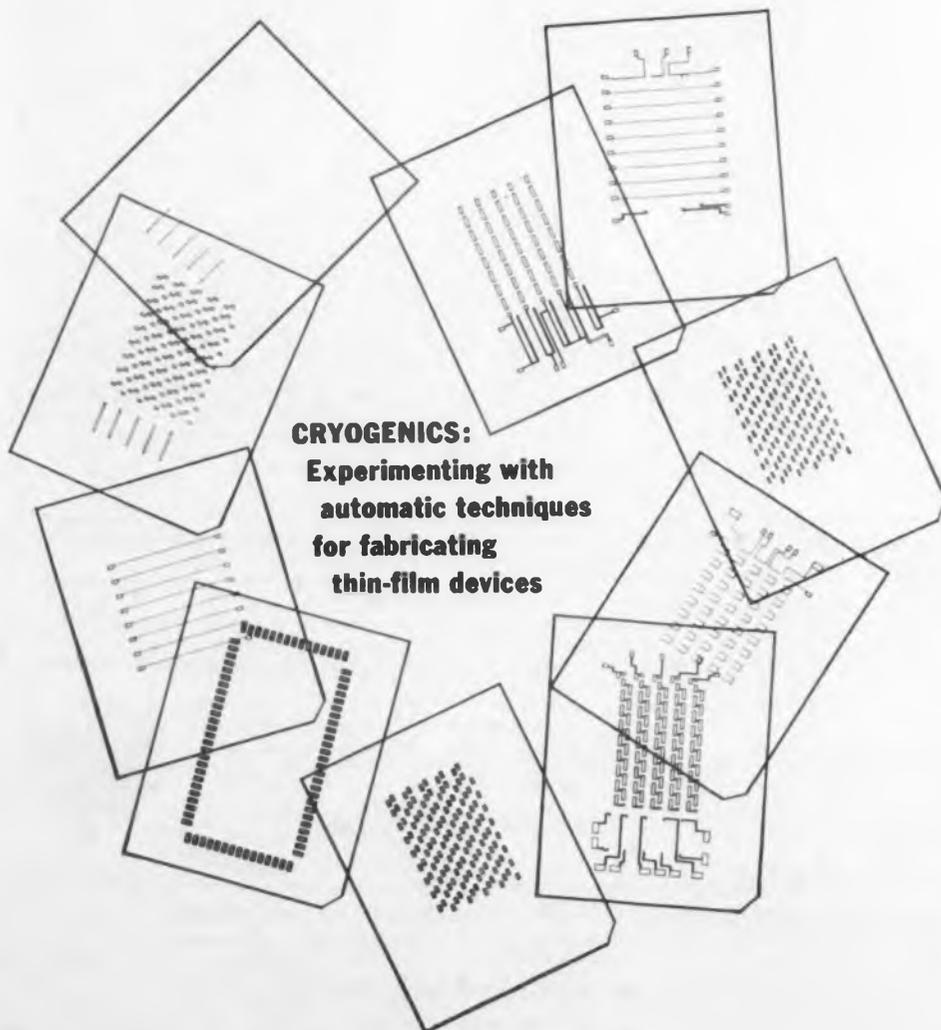
IBM scientists have developed a process of fabricating cryogenic memory planes in a single, automatic cycle. Although still experimental, such work could result in larger, more reliable cryogenic computer memories.

The 135-cryotron memory plane developed by IBM is about the size of a postage stamp. It is built up in 19 thin layers of metal and insulating material. Each layer is evaporated onto a glass substrate through a precisely made pattern or mask. The proper mask for each layer is registered to the required accuracy by means of an automatic mask changer mechanism inside the vacuum system. The control techniques developed by IBM are so sensitive that the evaporation process can form lines finer than a human hair and metallic films so thin they are invisible to the unaided eye.

The IBM engineering group that developed this new method of automatically fabricating experimental memory planes found it had to move back and forth across

technical boundaries to achieve its results. Circuit design engineers, for example, worked closely with physicists and mathematicians to develop special circuits that would operate within the limits imposed by film characteristics and control techniques. This integrated approach to systems development has helped make possible many of the advances that IBM has made recently in such fields as semiconductors, microwaves, optics and magnetics. If imaginative problem-solving in any of these areas interests you—and you have a degree and experience in engineering, mathematics, or one of the sciences—we'd like to hear from you.

All qualified applicants will be considered without regard to race, creed, color or national origin. Please write: Manager of Technical Employment  
IBM Corporation, Dept. 555G1  
590 Madison Avenue  
New York 22, N. Y.



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automatic techniques  
for fabricating  
thin-film devices

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## YOUR CAREER

who can't describe his responsibilities on past engineering jobs (and a great many can not, apparently) would probably not receive an offer through Mr. Bach.

### Nontechnical Test Has Uncovered Good Administrators

An example of the self-screening potential of these tests has been the number of good men for nonengineering, administrative posts within LMED which the one nontechnical test in the group has helped uncover, Mr. Bach said. Nonengineers also read the ads for engineers, he said, and when they see that a nontechnical test is also available, they are encouraged to write to what they would have otherwise considered a hopelessly technical organization like LMED to inquire about the test and employment. Some of these nonengineering applicants have been employed in businesses as far removed from engineering as advertising agencies.

### What Do the Tests Mean?

Since most of the tests are technical, engineers will have little trouble in understanding the right or wrongness of the answers. They may however question the relative meaning of their scores as compared to the norms given for the GE engineers. For example, one *ELECTRONIC DESIGN* editor who did not think himself a match for a LMED computer designer was surprised to find that he self-scored in the second to highest (there were five) group which according to GE indicated he "shows probability of excellent performance in intermediate to high-level computer research, design and development." It was this editor's conclusion that multiple-choice questions favor the widely read person but possibly disfavor the working designer who must concentrate in a certain area.

Nevertheless the tests make for a pleasant evening's exercise and with intelligent self-interpretation can be a quasi-quantitative indication of one's strengths and weaknesses.

### Management Aptitude Test More Subtle

At first sight the answers to the questions in the "Human Relations Quiz" look obvious. "This is what any company would expect you to say." Obviously a manager-type should "want to play cards with a neighbor and his

wife" rather than "build some new furniture in the workshop" (question 5). Obviously he should "tend to identify more with his company than with a profession" (question 29).

Less obvious is question 27 which says that a good manager should not want his subordinates to run to him whenever they had a question but to work out their problems for themselves. Also less obvious is question 12 which says that a good manager ought to be able to readily allay other people's suspicions.

The weighing values given for the answers to the questions help to understand the logic behind the test (actually as GE explains, the tests were developed by the empirical procedure of relating responses of GE managers and individual worker types. A top weight of six points is given the answer to question 38 which indicates that a good manager type should not respect people who seem uncertain about things. But only two points are given for the answer to question 23 which indicates that a good manager thinks that people should try to behave ethically even when it means personal sacrifice.

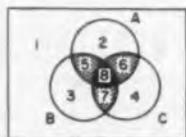
#### Interested Engineers Should Obtain Complete Tests

These sample questions and answers will give some idea of the tests. However, engineers who are seriously interested should obtain the complete tests by writing: Technical Recruiting, Light Military Electronics Dept., French Road, Utica, N. Y.

#### Sample Questions From GE Self-Test

##### Logic Circuits and Digital Computers

- In a junction transistor the base-to-collector current amplification factor is in the range of:
  - $10^{-3}$  to  $10^{-2}$
  - 0.9 to 1.0
  - 20 to 100
  - 700 to 900
- In the Venn diagram below, areas correspond to Boolean functions of the variables A, B, and C. How many of these represent MINTERMS?



- 1
- 2
- 3
- 7
- 8

- With reference to the schematic circuit diagram below (if A = positive voltage and  $\bar{A}$  = no voltage) the Boolean func-



## THANKS FOR SHARING THE LOAD, DR. MAXWELL!

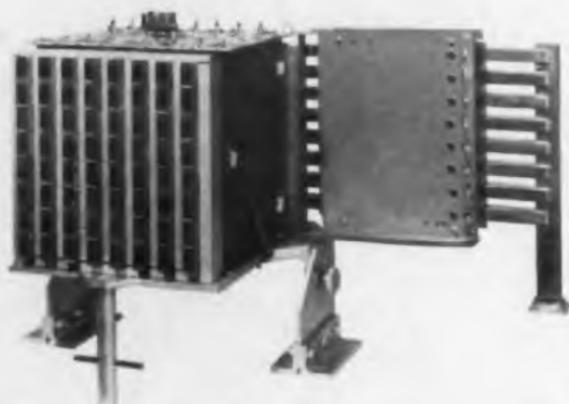
Your equations together with Newton's Laws serve as a basis for explaining classical electromagnetic phenomena. Most important among the outgrowths of your theory are radio and its allied invention, radar. At AC, we are using techniques for the generation and propagation of electromagnetic waves to increase the total capabilities of the B-52 weapons system.

If you are interested in applying yesterday's theories, like Maxwell's, to today's Mach 2 and 3 aircraft, and if you have a BS, MS or PhD in EE, ME, Physics or Math, please contact Mr. G. F. Raasch, Director of Scientific and Professional Employment, Dept. G, 7929 South Howell, Milwaukee 1, Wisconsin.

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Opportunities in Basic Research or Development in the fields of  
**ELECTROMAGNETIC THEORY  
 & ANTENNAS**



■ Requirements of new and continuing projects concerned with space vehicle communications, navigation, and radar have created new openings for electromagnetic theory specialists as well as antenna engineers. The scientists and engineers of the Research and Development Division of the Hughes Aircraft Company Aerospace Group in Culver City are providing broad scientific and technical leadership to government and company funded programs on advanced airborne and space electronic systems, air to air missiles, ballistic missiles, and satellite and interplanetary communication systems. As part of this team, the Antenna Department is responsible for a diversified program of antenna research and development in the following specific areas:

- |  |   |
|--|---|
| <p>1. Advanced techniques for space communication and navigation.</p> <p>2. Information theory and data processing applied to antenna systems.</p> <p>3. Statistical analysis of scattering propagation.</p> | <p>4. Pattern synthesis from sources on arbitrarily curved surfaces.</p> <p>5. Aperture control by application of solid state devices.</p> <p>6. Multi-function aperture and feed capabilities.</p> |
|--|---|

Immediate assignments exist for scientists and engineers of superior ability who meet the qualifications in one of the following categories:

**RESEARCH** ■ Advanced degrees and experience in electromagnetic theory ■ Interest in fundamental research in antennas, wave propagation, scattering theory, plasma effects on electromagnetic radiation, and solid state antennas.

**DEVELOPMENT** ■ Graduates in E. E. or Physics or extensive experience in lieu of degree. ■ Minimum of three years of professional experience in monopulse and conical lobing antennas in reflector and array configurations, electronically scanned arrays, inflatable and erectable antennas, shaped beam arrays from curved surfaces and signal processing antenna systems.

If you meet the above qualifications and are interested in joining other superior scientists and engineers at Hughes, please airmail your resume to **MR. ROBERT A. MARTIN**, Supervisor Scientific Employment, Hughes Aerospace Engineering Division, 11940 West Jefferson Blvd., Culver City 50, California.

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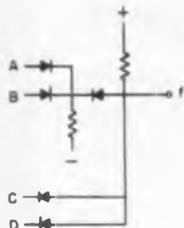
All qualified applicants will receive consideration for employment without regard to race, creed, color or national origin.

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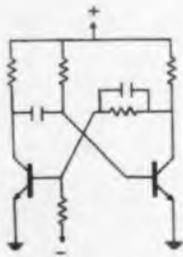
## YOUR CAREER

tion  $f$  is:



- a.  $AB + CD$
- b.  $(A + B) CD$
- c.  $(AB + C) D$
- d.  $(A + B) (C + D)$
- e.  $ABCD$

9. The monostable multivibrator below



- a. Is used in counters.
- b. Generates a gating pulse.
- c. Is free running.
- d. Will not work as drawn.

9. Circuits employing NOR logic

- a. Are found in superspeed computers.
- b. Were first used in the NORC computer.
- c. Are based upon negative resistances.
- d. Contain blocks which execute the negative -OR operation.
- e. Contain transistors and resistors.

### Professional Inventory on Human Relations

1. If you had to choose an occupation other than the one you now have, which would you rather be:
  - a. Physician
  - b. Explorer
5. How would you rather spend an evening:
  - a. Building some new furniture in the workshop
  - b. Playing cards with a neighbor and his wife
7. Which would you least like to do:
  - a. Add several columns of figures
  - b. Be interviewed for a new job
9. You are usually able to "put yourself in someone else's shoes" in order to understand his point of view:
  - a. True
  - b. Not true
10. Are you a keen judge of other people's motives:
  - a. Yes
  - b. No
11. Opportunity to contribute to basic scienc-

## DO YOU HAVE MAGNETIC COMPONENTS ON YOUR MIND?

Acme Electric's long experience in designing and building transformers has been the keystone to our progress with such equipment as direct current static rectifiers, magnetic amplifier controlled saturable reactors, automatic battery chargers, and many other modern types of power equipment.

Acme Electric transformers are designed for a variety of applications ranging from radio and television through missiles and ground control.

If you have had experience in any phase of magnetic component design — and want an opportunity where your efforts and ability can lead to a secure future, then tell Acme Electric all about yourself.



This is one of the 600 KW static, magnetic, rectified direct current power supplies furnished to Brookhaven National Laboratory for use with the 30 BEV Alternating Gradient Synchrotron.

### ACME ELECTRIC CORP.

Personnel Department

907 Water Street Cuba, N. Y.

00A2904/1959



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ELECTRONIC DESIGN • July 5, 1961

tific knowledge is highly important to me:

- a. Agree                      b. Disagree
12. Can you readily allay other people's suspicions:  
a. Yes                      b. No
14. It's more important that a man we hire can do his work well than that he makes friends rapidly among his work associates:  
a. Agree                      b. Disagree
23. People should try to behave ethically, even when it means some personal sacrifice:  
a. Agree                      b. Disagree
24. When internal tensions occur, do you give full attention to their resolution:  
a. Yes                      b. No
27. I would rather that a man who works under my supervision:  
a. Consults me whenever he had a doubt  
b. Tries to work out problems for himself
29. I tend to identify more with my profession and work than with any one company:  
a. True                      b. Not true
38. Do people who seem unsure and uncertain about things lose your respect:  
a. Yes                      b. No

#### Answers to Sample Questions

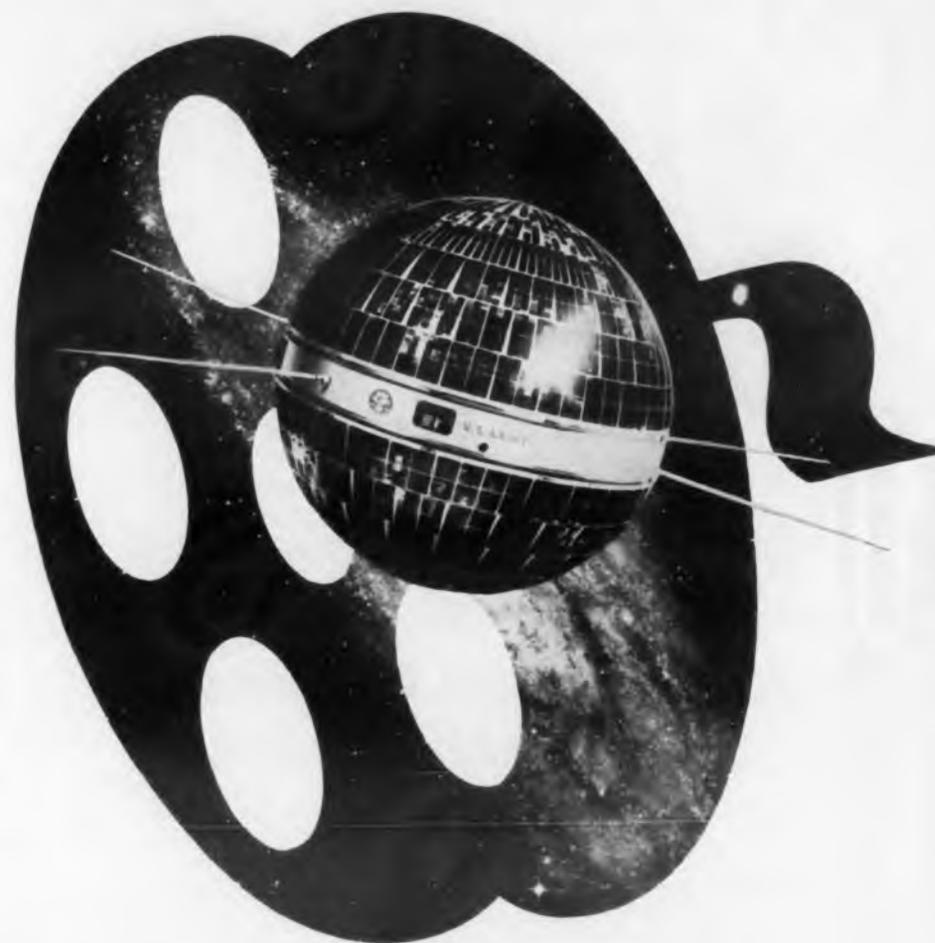
##### Computer Quiz:

1. c  
7. e  
8. b  
9. b  
39. d

##### Human Relations Quiz:

###### Weighing Factor

- |       |   |
|-------|---|
| 1. a  | 4 |
| 5. b  | 6 |
| 7. a  | 4 |
| 9. a  | 2 |
| 10. a | 4 |
| 11. b | 6 |
| 12. a | 4 |
| 14. a | 4 |
| 23. a | 2 |
| 24. b | 4 |
| 27. b | 4 |
| 29. b | 4 |
| 38. a | 6 |



## LP Record—Stellar Style

The message from Courier is just one of the challenges offered to you at PHILCO Western Development Laboratories, whose long record in space communications achievement merely presages the adventure ahead.

From the earliest plans to invade space, PHILCO Western Development Laboratories has played a vital role in satellite vehicle instrumentation, still but *part* of its contribution to space communications. From this newest electronics center on the San Francisco Peninsula comes a continuing flow of advanced missile tracking, range and data processing instrumentation.

Added research projects and growing programs assure *you* a long and rewarding career as a member of the PHILCO Western Development Laboratories. What you think and what you do can be unhampered and uninhibited. Personal recognition and advancement promptly follow performance, with monetary rewards to match. Northern California provides an affluent climate for living, as PHILCO Western Development Laboratories provides a stimulating climate for working. For information on careers in electronic engineering, please write Mr. W. E. Daly, Dept. D-7.

All qualified applicants for employment will be considered without regard to race, creed, color, or national origin; U. S. citizenship or current transferable Department of Defense clearance required.

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McDonnell Aircraft, St. Louis 66, Missouri

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July 5, 1961

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2N574A	2N1157A		
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These compact, rugged, dependable instruments are supplied in the new universal module cabinet combining, in one single instrument, a lightweight, portable bench amplifier and a neat, clean rack mounted unit.

Both Models 489A and 491C incorporate new, permanent-magnet TWTs, offering low power consumption and solving the heat problem of previous TWT amplifiers. Specially designed circuitry provides amplitude modulation from dc to 100 KC, with internal amplification so that small modulation signals cause a large output power change.

Besides allowing amplification with small input signals, the modulation circuitry can provide leveled power output by using external elements completing a feedback loop.

### SPECIFICATIONS

<b>Model:</b>	<b>489A</b>	<b>491C</b>
<b>Frequency Range:</b>	1 - 2 GC	2 - 4 GC
<b>Price:</b>	\$1,970.00	\$1,970.00

### Common Specifications

<b>Output for 1 mw Input:</b>	At least 1 watt
<b>Maximum rf Input:</b>	100 mw
<b>Small Signal Gain:</b>	Greater than 30 db
<b>Amplitude Modulation Passband:</b>	DC to 100 KC
<b>Modulation Sensitivity:</b>	Approx. 20 db rf change for a 20 v peak mod. sig.
<b>Input Impedance:</b>	50 ohms, SWR less than 2.5
<b>Output Impedance:</b>	50 ohms, SWR less than 2.5
<b>Connectors:</b>	Type N, female
<b>Front Panel Controls:</b>	Gain
<b>Meter Monitors:</b>	Anode, helix, collector and cathode current
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	⊕ 490B	⊕ 491A	⊕ 492A	⊕ 494A
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Gain:	30 db min.	30 db min.	30 db min.	30 db min.
Output Power:	10 mw min. into 50 ohm load	1 watt min. into 50 ohm load	20 mw min. into 50 ohm load	20 mw min. into 50 ohm load
Noise Figure:	Less than 25 db	Less than 30 db	Less than 30 db	Less than 30 db
Pulse Rise & Decay Time:	Approx. 0.015 μsec.	Mod. not provided	Approx. 0.015 μsec	Approx. 0.015 μsec.
Input Impedance:	50 ohms, SWR less than 2	50 ohms, SWR less than 2	50 ohms, SWR less than 2	50 ohms, SWR less than 2
Output Internal Impedance:	50 ohms, SWR less than 3	50 ohms, SWR less than 3	50 ohms, SWR less than 3	50 ohms, SWR less than 3
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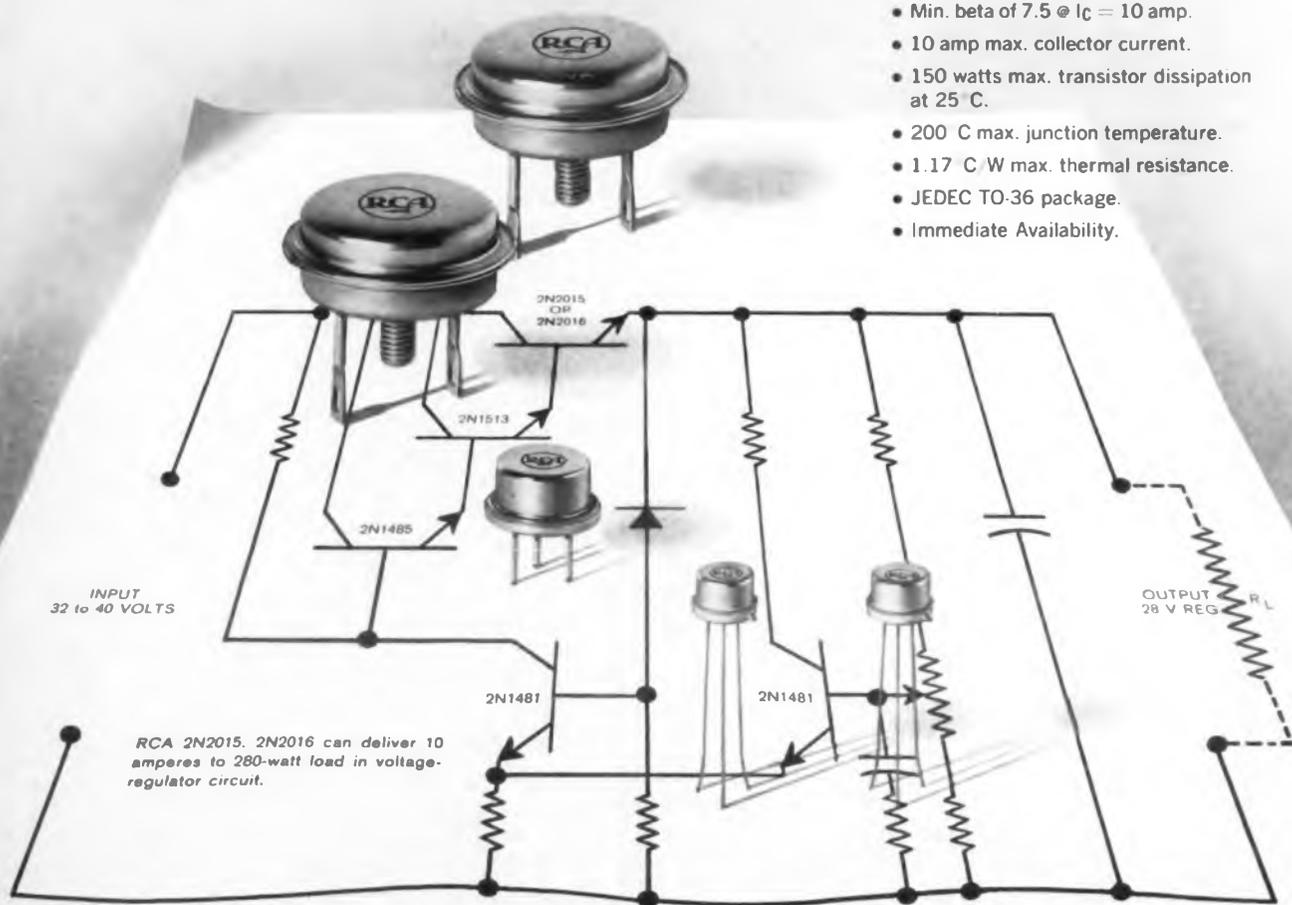
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