ELECTRONIC DESIGN

JULY 6, 1960

SPECIAL TRANSISTOR ISSUE

including ELECTRONIC DESIGN's Eighth Annual

TRANSISTOR DATA CHART

ALSO IN THIS ISSUE:

- Seagoing Electronics—2...p 34
- Digital Communications continued...p 98

COVER: To present graphically *ELECTRONIC DESIGN*'s complete breakdown of the transistor types in this issue, our Art Director cut apart a symbol of a transistor and arranged the pieces jig-saw-fashion, on a black field. For *ED*'s report and the Eighth Annual Transistor Data Chart, turn to page 46.

Selected Topics In This Issue

Sidelights of This Issue

Transistors—1960

On page 46 of this issue begins ELECTRONIC DESIGN's annual transistor report, which this year runs to more than 50 pages. It includes the Eighth Annual Transistor Data Chart, with specifications for 1,088 transistors. Also in the report are articles and tables on the transistors most preferred by the military and the airlines, the latter being a $50 million electronics customer. Convenient charts classify approved types into application categories. And be sure to see the article on selecting transistors for logic applications. Associate Editor Howard Bierman spent more than three months preparing this annual report and we think the report is the most complete coverage available.

Twelve Years After

HISTORY AGAIN? In June of 1948, Bell Laboratories first announced the transistor. Last month, almost 12 years to the day from its announcement, Bell came forth with another announcement about transistors which has industry in a high state of excitement. This one told of the development of an epitaxial diffused transistor, which has reduced switching time by a factor of 10 and has also comparably lowered collector resistance. *ED*'s editors, checking around the semiconductor industry, heard comments like "significant breakthrough," "great advance which appears to make the mesa the universal transistor," and "opens the way to tremendous flexibility." The designer can read about this Bell development and its significance in our story on page 4.

A Program for RFI

It's official now. Radio frequency interference is a major problem. At the RFI conference in Washington, plans were announced by government spokesmen for establishing a compatibility program for all major pieces of electronic equipment. Details are available in the news story on page 4. *ED* has long known how critical the RFI situation is. Readers will remember the Special Report in the Feb. 3 issue. And in the June 22 issue we printed for the first time anywhere the new three-service standard on radiation measurements.

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DOD Sets Up RFI Compatibility Plan

Military Electronic Equipment to Be Checked; Analysis and Prediction Center Will Be Set Up

A RADIO frequency interference compatibility program designed to reduce and control RFI between pieces of electronic equipment has been launched by the Department of Defense. Henry Randall of the Office of Defense Research and Engineering outlined the program to engineers attending the 2nd National Symposium of Radio Frequency Interference in Washington, D.C.

Heart of the new program will be an electromagnetic analysis and prediction center to be completed within the next year and a half. It will be operated by one of the military services and will collect and catalog the efforts of the individual services working in the interference field.

As part of the program, all types of military electronics equipment will be examined to establish:

- Interference measurement and instrumentation techniques.
- Test equipment standards for measurement.
- Equipment specifications which will reduce the extent and effect of spurious emissions. This will also involve setting up receiver susceptibility limits.
- Compatibility requirements and spurious emission levels.
- A library of equipment spectrum signatures.
- An environmental file which will catalog the amount and types of equipment, their location, frequency, duty cycle, etc.
- An electromagnetic analysis center to serve as a clearing house for interference research and study.

Initial emphasis of the program will be on radar. A series of new standards will be established which will set radar band-width limits and frequency allocations, spurious radiation levels, and antenna side lobe power levels.

The library of spectrum signatures and the environmental file will be stored at the analysis center. The spectrum library will be made up of frequency-response characteristics which will have to be furnished with each piece of equipment supplied for the military. These spectrum signatures together with the spectrum-like characteristics

Vapor-Phase Devices Made by Bell, IBM

Many Other Semiconductor Makers Planning Early Switch to New Fabrication Process

SUCCESSFUL fabrication of high-quality semiconductor devices using vapor-phase growth techniques has led to widespread excitement throughout the semiconductor industry.

Bell Telephone Laboratories has produced what it calls an "epitaxial diffused transistor," offering an order of magnitude decrease in both switching time and collector resistance when compared to conventional devices. The term epitaxial indicates that a film grown on a semiconductor wafer is a direct extension of the single-crystal structure of the substrate.

International Business Machines Corp. has fabricated tunnel diodes, an improved variable capacitance diode, and other devices of good quality using vapor-phase processes. Some of the IBM work is being conducted under a one-year Army Signal Corps contract ending in July (*ED*, June 8, p 4), and other work is the result of a three-year internal research program.

Some of the work going on in this field was outlined at the recent Solid State Research Conference in Pittsburgh. Previous vapor-phase work at Merck & Co., Inc., Rahway, N. J., (*ED*, March 16, p 66) has been primarily in developing materials rather than fabricating devices.

Transistor manufacturers told ELECTRONIC DESIGN that they are particularly enthusiastic about the Bell Labs development, because it can be easily adapted to present production lines. Devices produced by this method will soon be on the market, they said.

Dr. C. Lester Hogan, general manager of Motorola, Inc.'s Semiconductor Products Div., Phoenix, Ariz., said that his company planned to shift over to the new technique immediately on mesa transistor production lines.

Dr. Hogan feels that although the process adds one more step to production, the higher yields resulting from precise control of materials can lead to lower costs. The particular process being considered by Motorola involves the decomposition of germanium tetrachloride and the directing of the vapor formed over a seed crystal by means of a stream of hydrogen carrier gas.

Collector Resistance Problem Solved

The problem with diffused-base transistors

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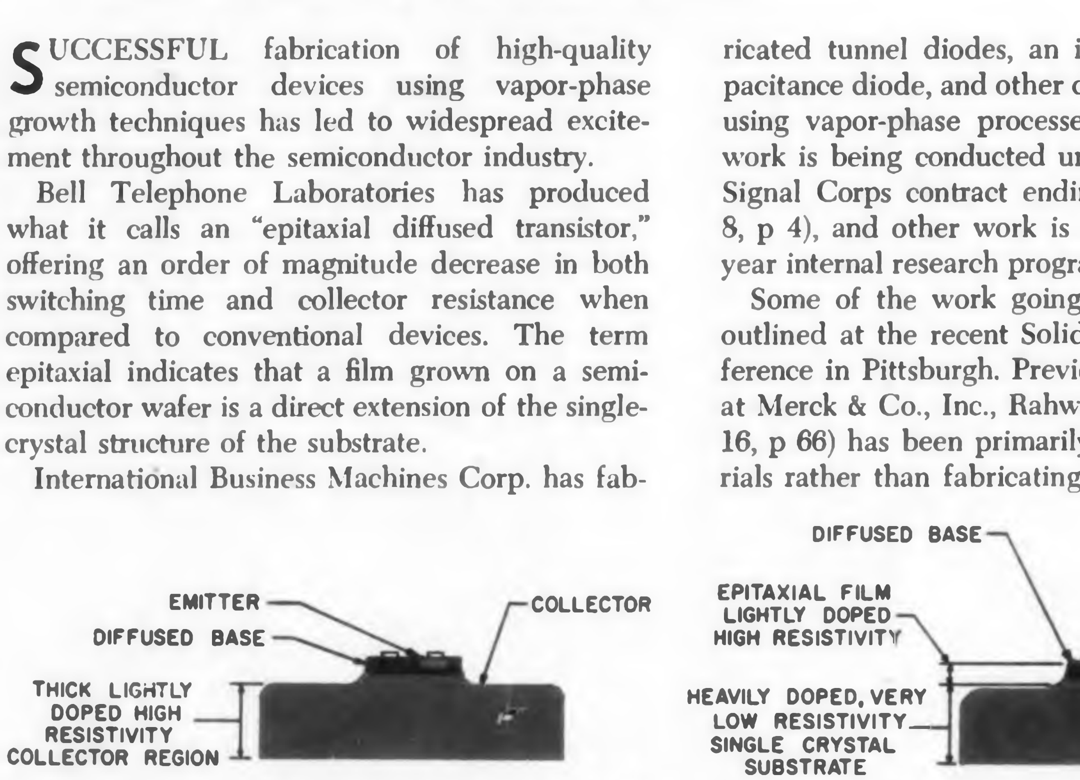

Conventional diffused-base transistor, left, is compared to Bell Labs epitaxial-growth type, right. Collectors and emitters are n material, bases p material.

for propagation path attenuation, plus information taken from the environmental file will be fed into a computer. The computer will then be able to calculate the electromagnetic radiation picture at a given geographic location.

RF Spectrum Standard Now Available

Made available for the first time at the Symposium were copies of MIL-STD-449, the military standard titled "Measurement of Radio Frequency Spectrum Characteristics." This standard previously reported in ELECTRONIC DESIGN (June 22, pp 4-5) is mandatory for use by all three services. It establishes uniform measurement techniques for determining the rf spectral characteristics of military electronic equipment.

Planned for issuance in the near future, is a modification of the Navy interference specification MIL-I-16910. To be assigned a "B" designation, this specification will deal with:

- Susceptibility requirements for receivers.
- Interference limits on high voltage power transmission lines.
- Line-impedance stabilization networks. Design information will be given for these networks which are to be flat to 100 mc.
- Radar design standards. This section will limit radar bandwidths, skirt values, spurious radiation levels, etc.
- Clamp-on devices. The measurement of conducted interference will be permitted with clamp-on devices.

The Navy also disclosed at the symposium that it is interested in frequencies up to 100 kmc and is already making measurements in that frequency area. A spectroscope which will operate from 10 kc up to 100 kmc is under development. It will be operable in seven or eight bands and the display will appear on a 17-in. tube.

Areas of Spec Improvement

Of great interest at the Symposium was a round table discussion on RFI and compatibility specifications. Each of the services as well as the Federal Communications Commission was represented on the panel. Albert R. Kall, president of the ARK Engineering Co., Philadelphia, outlined the industry position, noting that early military specifications and present FCC regulations, dealt mainly with outgoing interference sources and that only recently was emphasis placed on limiting receiver susceptibility. He also detailed areas where government RFI specifications could be improved. Some of his suggestions:

- Because the power of pure random noise varies directly with receiver bandwidth, and the voltage varies as the square-root of the bandwidth, the standard unit of random-noise inter-

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RFI

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ference should be microvolts-per-square-root-bandwidth. However, specification interference is divided into just two classes: narrow band (or cw) and broadband impulsive (or pulsed cw). The former does not involve bandwidth and the latter varies directly with bandwidth. FCC specifications restrict limits solely to microvolts or microvolts-per-meter, with no distinction based on whether the measured disturbance is narrow band or broadband. The FCC limits of Part 15 and 18, based on field intensity at various specified distances, should take into account, for broadband interference, the bandwidth of the measuring receiver.

■ More exact limits should be given when determining whether a piece of equipment complies with a given interference specification. To this end, he outlined three areas of compliance—absolute compliance, absolute non-compliance, and transitional compliance.

■ To decrease the time involved in making in-

Vapor-Phase

(continued from page 3)

has been the requirement for a relatively high resistivity collector region in order to attain low capacitance and high voltage breakdown. This region has been in general about 30 times thicker than required electrically, since ease in mechanical handling has been a prime requirement.

The excess thickness has increased collector resistance, and, through carrier storage, the switching time.

Bell overcame the problem by growing lightly doped epitaxial films onto a low-resistivity germanium and silicon wafers, thus attaining the desired combination of electrical properties and mechanical strength.

IBM researchers feel that the advantages of the vapor-growth processes they are developing include:

■ Closely controlled, arbitrary impurity distributions.

■ Heterogeneous junctions are possible—between germanium and gallium arsenide for example.

■ Resistivity layers can be deposited between junctions—as in the Bell Labs work.

■ Entire diode or transistor matrices might be made at once.

■ Multilayer microcircuit films seem feasible.

■ Large area junctions, useful in solar cells terference measurements, it may be wise to go to panoramic sweep techniques to augment present point-by-point methods. Also, the point-by-point method could be supplemented by a single reading on a vacuum tube voltmeter peak-type detector circuit.

■ In the area of susceptibility testing, there should be special rf radiated tests based on the tactical situation which the piece of equipment will encounter. These tests would be in addition to the rf radiated, rf conducted, and audio-line conducted tests currently specified. Thus, for example, a computer to be installed near a radar would be irradiated by a radar transmitter having similar characteristics. This will help determine the threshold level at which malfunctioning occurs. The acceptable level should then be set on the basis of the actual rf environment to be encountered, with a reasonable safety factor included.

■ There should be a clearer definition of conditions which require RFI measurements in the field, instead of in a shielded enclosure. This definition should be tied in with consideration of equipment classification and area of use. ■ ■

can be produced.

Most of the IBM work has been done with compounds of iodine and semiconductors, with vapors formed passing over a seed crystal in a lower temperature region. A closed-tube process developed by IBM provides higher purity with less process tending.

Open Tube Better for Quantity

A more conventional open tube process is more suitable for quantity production, however, according to IBM researchers.

IBM has found that hybrid transistors such as Bell Labs has produced are better than those made completely by vapor deposition. A primary problem has been to get enough doping in the emitter region. If doping levels are raised to necessity levels, poor injection efficiencies result.

In silicon work it has been difficult to clean substrate crystals before deposition because of extremely stable silicon oxide surface layers.

Work with germanium and intermetallic compounds has been much more successful, according to IBM. ■ ■

Static firing of all eight Saturn engines will provide data for processing by Marshall Space Flight Center's new IBM 7090.

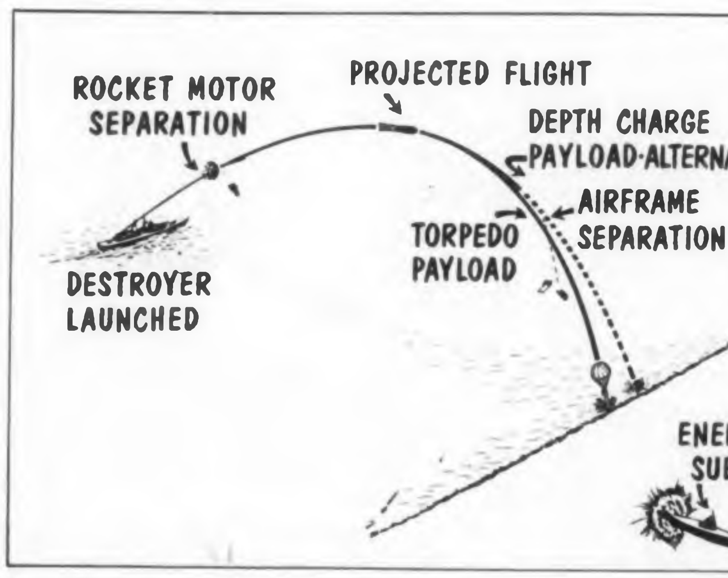
Month Marked by Significant Firings

June Missiles Busted Out All Over; Saturn, Satellites, ASROC Successful

ELECTRONICS missile men—in fact, all missile men—were elated. In the space of a few days, a number of significant firings were achieved and the skies which sometimes had seemed grey now seemed almost black—with missiles.

At Huntsville, Ala., the Saturn heavy space vehicle underwent its eighth completely successful test firing with an IBM 7090 computer processing all the data.

Aboard the U.S.S. Norfolk off Key West, Fla., the Navy's new antisubmarine rocket ASROC was successfully tested against a target nuclear submarine. Rear Adm. P. O. Stroop, chief of the Navy's Bureau



ASROC ballistic missile, new Sunday punch for the Navy's anti-submarine forces, is programed and launched from shipboard by digital computer.

Transit II-A and the radiation-m ing satellite above it orbited to of Weapons, called it "a significant advance in the Navy's anti-submarine warfare program."

And most spectacular of all, an Air Force Thor-Able-Star rocket was launched from Cape Canaveral and successfully put into orbit two Navy-developed satellites.

Saturn: Tons into Space in '64

For two minutes, the Alabama hills reverberated with the roar of Saturn's eight rocket engines delivering a thrust of 1.3 million lb to bring closer the day when the huge space vehicle will put a multi-ton payload in orbit.

Speaking at the dedication of the 7090, Dr. Wernher von Braun, director of the Marshall Space Flight Center at Huntsville, said 11 flights are scheduled for Saturn. The first flight, next summer, will use only a single stage of the vehicle, as will the second and third flights. The fourth to the tenth flights will be R&D flights, using other stages. Then, in May, 1964, Saturn will blast off with its huge payload.

The 7090, IBM's most powerful commercially installed computer, will process information from nearly 1,000 instrument channels attached to the Saturn booster. Instrument readings, taken at rates up to 50 per second, will yield information on some 300 pressures, 200 temperatures, 24 flow rates and vibration and strain.

The solid-state 7090 will calibrate all measurements, change them into engineering units, and convert all parameters to equivalent vacuum conditions. It will compute thrust, pressure losses in different parts of the plumbing, loads on members where strain is not measured, and specific impulse (a measurement of rocket efficiency equal to flow rate/thrust).

ASROC: Tests Successful

ASROC, the Navy's newest, most effective anti-submarine weapons system, was tested in the waters off Key West in a blaze of glory. With ASROC, it is possible to deliver an

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NEWS

acoustic homing torpedo or depth charge to an enemy submarine thousands of yards beyond the range of present-day ship-launched torpedoes.

The new system uses sonar to detect and track targets, then programs the missile by means of a digital computer and launches it.

After the missile is accelerated, the rocket engine is dropped and the missile continues on its way. Just prior to entering the water in the vicinity of the target, the weapon drops its airframe and a torpedo is dropped by parachute for a soft landing on the surface. If a depth charge is the warhead, it is dropped without parachute.

ASROC is a ballistic missile whose trajectory and range is pre-set. Because of relatively simple plumbing and instrumentation, it is cheap, has a shelf life as long as the ship itself, and can be transferred at sea. The fact that setting is done by digital computer means that the missile itself need not be modified or scrapped as detection gear improves in quality.

The launcher is a pepper-box design, with each cell serving as an individual launcher. All eight cells turn together and each pair of over-under cells elevates individually. ASROC can be fired as rapidly as 10 seconds apart.

Prime contractor was Minneapolis-Honeywell, under direction of the Naval Ordnance Test Center at Pasadena, Calif. Librascope developed the computer and Universal Match Corp.'s Armament Div. the launcher.

Transit II-A: Two Up

Early performance of the Transit II-A navigational satellite launched late last month in tandem with a radiation-measuring package, is exceeding hopes of its designers, who attribute much of the success to a single design decision. The decision: to use a new type of solar-cell array in conjunction with nickel-cadmium batteries as the only power supply for the package.

This eliminated the silver-zinc battery pack that was used as an alternate power supply in Transit I-B, and saved enough space and weight to permit inclusion of a binary clock, an infrared scanner and a galactic-noise receiver in the package. The use of a single, nickel-cadmium supply may be the start of a trend toward this type of power source for many new satellites, reports the Applied Physics Laboratory of Johns Hopkins University, prime contractor for the Navy on the transit program.

Transit II-A, which is now orbiting between 400 and 490 mi above the earth, differs from the still-circling Transit I-B in the following respects:

- The usual heavy quartz shielding protecting the solar cells has been replaced by thin glass covers over each cell shingle. This reduces weight of the array and provides optical filtering of solar radiation. Because of the weight saving, the number of cells in Transit II-A is about double that of Transit I-B.
- The telemetry system has been redesigned to provide an fm/pm channel independent of the Doppler transmissions. In Transit I-B, one of the Doppler links was used for telemetering the orbital and frequency data that are the heart of the navigational system. With an independent pm telemetry link, more bandwidth is available more of the time to transmit greatly increased quantities of data. In effect, the satellite's duty cycle has been lengthened.
- A more rugged crystal, developed by Bliley Electric Co., Erie, Pa., is operating in the ultra-stable oscillators used in the system.
- The de-spin equipment in Transit II-A uses shunted coils for greater efficiency. The coils enhance the electromagnetic effect of the high-permeability rods, which are mounted in the satellite to counter the earth's magnetic field.
- An infrared scanner was included to measure rotation of the earth, partly as a check on the effectiveness of the de-spinning system.
- The binary clock, developed by the Applied Physics Laboratory, counts down from the crystal-oscillator frequency in binary steps to an 11-sec interval, which is used to trigger the telemetry cycling system. By detecting leading edges of the pulse train, ground-based stations are able to calibrate time signals to an accuracy of 1 msec, about an order of magnitude better than present worldwide time standards. With special stations, a global time-standard service may eventually provide accuracies of about 1 microsec.
- The galactic-noise receiver riding in the Transit package was developed by the Defense Research Telecommunications Establishment, Ottawa, Canada. Its operation was part of a program jointly pursued by DRTE, APL and NASA to measure galactic noise at various frequencies. This data will be used later for making radiosonde measurements from above the ionosphere. The ultra-sensitive Canadian receiver operated at 3.8 mc until the set was turned off by plan last week.

The "piggy-back" satellite launched with Transit II-A was designed by the Naval Research Laboratory to measure solar-generated X-rays and Lyman-alpha ultraviolet radiation. This data is being transmitted on an 8-channel 108-mc telemetry link by a 2-transistor transmitter that delivers about 40 mw to the antenna system. ■ ■

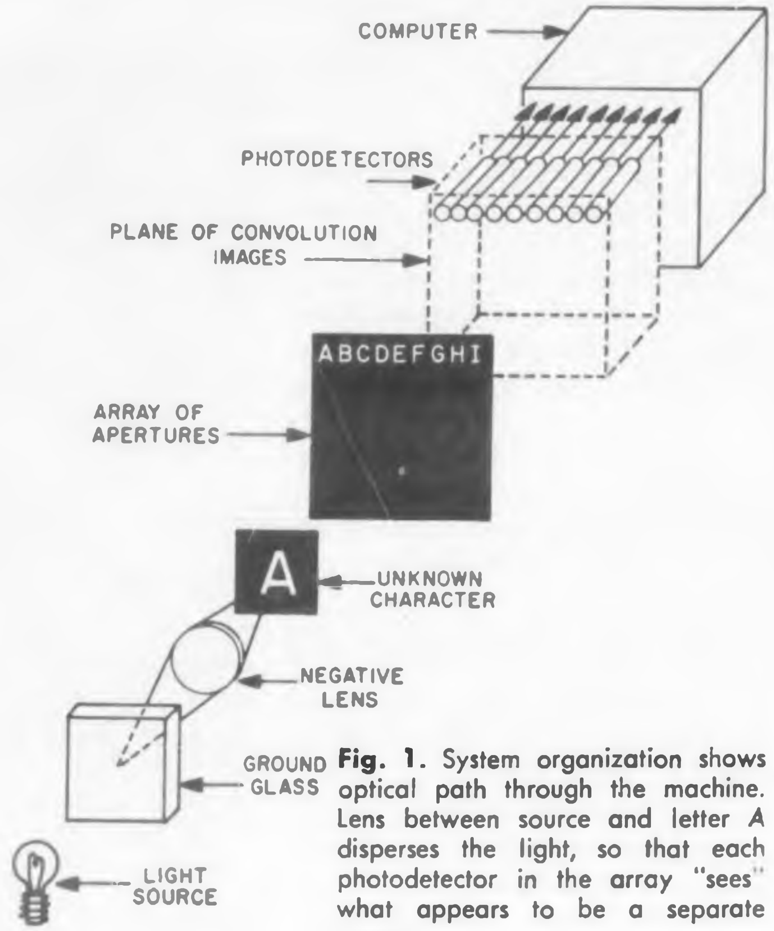


Fig. 1. System organization shows optical path through the machine. Lens between source and letter *A* disperses the light, so that each photodetector in the array "sees" what appears to be a separate source.

Russian Reader Uses Defocused Optics

Will Read 1,000 Characters per Second; Can Adapt to Any Language or Type Face

An OPTICAL system designed to read automatically Russian text at 1,000 characters per second is scheduled for delivery to the Rome Air Development Center, Rome, N. Y., this fall.

Russian text will be photographed on 70-mm film for input into the reading machine, now being developed by Baird-Atomic, Inc., Cambridge, Mass. The output of the machine, coded to represent the character being identified, will be stored on magnetic tape for subsequent input to a translating computer under development by International Business Machines Corp., New York. Currently input to the IBM translator is manual, by typewriter keyboard, at about 40 characters per minute.

Signal Subtraction Process

The reading machine uses defocussing optics and a novel signal subtraction process. The ability to read punctuation marks easily, and to be adapted to any type font or language, are key features of the equipment. Character identification is accomplished by simultaneous correlation of the outputs of an array of photodetectors, each representing a character in a type font, with a decision made electronically. No time-consuming scanning is required unless the text includes more than one type font.

In operation, a beam from an arc source is directed through a dispersive lens, and then through the image of the character on the 70-mm negative.

The dispersed light then passes through a master negative containing images of all the characters in the type font being read. An array of photodetectors is located behind this master negative. Each of these detectors "looks" at the character being identified through a different character aperture in the master set.

Fig. 2. A system in which the amount of light transmitted by each character in the master type font apertures is balanced by the amount of light *not* transmitted is represented by *(a)*. A similar effect can be achieved in an optical system by using positive and negative masks, such as *(b)* and *(c)*, with shaded areas blocking the light. Apertures *(b)* would transmit a maximum amount of light shining through the character "A" being identified, and aperture (c) would block a maximum amount of light.

Because of the optical properties of this dispersed light system, the largest signal is generated by the detector which looks at the character being read through the same character in the master set.

For example, if the letter being read is an *A*, most of the light coming through that letter would be transmitted through the *A* aperture in the master set. Much of the light would be blocked, however, by the *B* aperture, or any other aperture in the set, because of the difference in shape of the other letters and symbols.

Thus the *A* photodetector would provide a maximum output for this character, so that a set clipping point in the *A* photodetector amplifier is exceeded. This would cause a signal representing an *A* to be generated and recorded on magnetic tape.

Actually, the system under development is more complex than this, so that larger signal differences are provided. Distinguishing a comma from a period, or an *O* from a *Q*, for instance, would be difficult with the simple system because of the small differences in light reaching the photodetectors.

From a theoretical standpoint, a system which gave positive weight to the amount of light transmitted, and negative weight to the light *not* transmitted by each character in the master set, would provide more information for making an identification.

Such a system is illustrated by parts (b) and (c) of Fig. 2. In addition to a complete master aperture set, a set of blocking images and a second array of photodetectors would be required for this scheme.

One More Aperture

A more efficient technique has been developed, however, which requires only one additional aperture in the master set and one added photodetector.

If the positive transmittance for any particular aperture in the master set is designated P_i, and the negative transmittance for the ith character N_i, then the function provided by such a system can be designated $P_i - N_i$.

The same result might be obtained by a system providing the function $2P_i - (P_i + N_i)$. The $2P_i$ term might be obtained by doubling the output of each character's photodetector.

The $(P_i - N_i)$ term is supplied for each character by adding an aperture to the master set which amalgamates the shapes of all characters. The photodetector behind this aperture receives all the light that would pass through any aperture, plus all of the light that would be blocked by that aperture—which is $P_i + N_i$.

Although it has not been proven theoretically, tests have indicated that a signal at least 15 per cent higher than any other signal is provided by the proper character in the master set. This permits positive identification of any character without too much difficulty.

Actual applications of the system bring several important problems. In some texts type fonts may

GE Plans Multi-Function Comp

TUBES combining several functions into a single envelope are being developed for the entertainment market by General Electric Co.'s Tube Department, Owensboro, Ky.

GE expects its "compactrons" to lead to function-for-function price decreases of 20 per cent in comparison with conventional tubes. The extremely small size of the new units should make much tighter packaging of tube-type entertainment equipment possible.

Compactrons being readied for production are 12-pin types with base diameters of 0.075-in.

Six units are now under development, and GE expects to introduce nine others within the next year. An eventual line of 75 to 100 compactrons is planned.

To illustrate the compact designs possible, GE built a five-tube radio using two compactrons. The unit measures 2-1/2 x 2-1/2 x 10-1/2 in., with extra width required to accommodate the speaker.

A TV receiver can be built using 10 compactrons to replace the conventional 15 tubes and three diodes, or 24 transistors and 11 diodes, according to GE.

be interspersed. In the machine being built for the Air Force 12 Russian type-font master aperture sets are being prepared. When the machine can not identify a character it will automatically search through the 12 sets in order of decreasing likelihood of occurrence.

Sizes of letters also differ, so that the machine may not be capable of reading larger size characters mixed with ordinary type sizes.

If the machine fails to identify a character, an image of the line being read will be presented on a cathode ray tube on the operator's panel. A trace underneath the line of text will have gaps in it wherever characters can not be identified. This will permit the operator to identify the character manually.

Currently, research is being directed toward a system similar to the one described, but with the ability to read original documents rather than filmed versions of them.

Since photography permits sharpening of character images and elimination of fingerprints or other spurious marks on a document, direct reading offers more problems.

Plans for the reading equipment after the Air Force development is completed are not yet firm, according to a company spokesman. ■ ■

Compactron Tubes

The compactrons under development for table radios are a combined oscillator, converter and if amplifier to replace the 12BA6 and 12BE6, and a combined second detector, audio amplifier, audio power output amplifier and rectifier to replace the 35W4, 50C5, and 12AV6.

Television receiver compactrons being developed, followed by the tube types they will replace in parentheses, are:

- Horizontal oscillator and afc (6CG7 and 6AL5).
- Horizontal damping diode (6AX4GTB).
- Vertical deflection amplifier and oscillator (6DN7).
- Horizontal deflection amplifier (6DQ6B).

Some compactrons are being designed to replace only a single tube because of power and voltage limitations.

The move to multi-function tubes was indicated at the IRE Convention in New York in March. Tung-Sol Electric Inc. and CBS-Electronics both showed 12-pin units (ED, Apr. 13, p 105).

Further engineering details on the compactrons will appear in a future issue. ■ ■

Engineers Concentrate Efforts On 'Flat-Screen' Television

To achieve "picture-on-the-wall" TV, the ultimate in flat-screen picture-tube efforts, considerable development effort is being concentrated on increasing kinescope-deflection angle to decrease over-all tube length. Since deflection-power requirements are increased as tube length is shortened, more efficient sweep circuits and deflection yokes are being sought.

Another approach to reduce sweep power for conventional ac-operated TV as well as battery-powered transistor TV involves scan magnification techniques. Efforts to achieve these goals and advance the status of transistorized TV were described at the Chicago Spring Conference on Broadcast and TV Receivers.

In 1946, 10-in. "round" picture tubes possessed a deflection angle of 53 deg while 1959 17-in. and 21-in. rectangular tubes were 110 deg types, this represents a 2:1 improvement in length-to-diagonal ratio.

By departing from the conventional uniform 1-1/8 in. diameter common to 110-deg kinescopes and modifying the region in the yoke vicinity to a 3/4-in. diam, an 18-in., 122-deg tube has been developed.

Philco engineer R. A. Bloomsburgh revealed that the new tube structure, plus a toroidal yoke design coupled with circuit optimization, has resulted in full deflection with 20 per cent saving in horizontal deflection power and 30 per cent less vertical sweep energy than existing 110-deg receivers. The substantial over-all bulb decrease and power savings are decided contributions for the quest of more compact, cooler-operating TV portables.

Scan Magnification Success Still Distant

Another area for power saving, the heater supply, was discussed by H. E. Smithgall of Sylvania Electric Products, Inc. Under a Signal Corps sponsored contract, a 1.5-v, 150-ma cathode-heater arrangement has been developed for portable scopes and military equipment. This represents a 94 per cent saving over conventional 6.3-v, 600-ma kinescopes. However, Mr. Smithgall pointed to the need for automation in fabrication and test before high-quality, low-cost TV could be considered.

Post-acceleration schemes for scan magnification could decrease deflection-power requirements by as much as 50 per cent. Two- and three-ring internal aquadag coating techniques plus mesh-type screens in front of the kinescope faceplate are under consideration.

Simplification With Flexibility Is Keynote of British IEA Show

Five hundred exhibitors from 15 countries displayed their wares at the Third International Instruments, Electronics, and Automation Exhibition at London's Olympia exhibition hall last month. The accent was on simplification with flexibility. Observers noted a tendency towards more complex instruments and systems packaged in smaller and more flexible subassemblies.

Mullard Equipment Ltd. showed four ranges of electronic subassembly "building bricks" and counters, described as "the shortest route from block diagram to complete equipment":

1. Preset counters for multiple programs in industrial control equipment.
2. Plug-in decade counting units.
3. Combi-element "building bricks" for electronic equipment—a comprehensive set of completely transistorized circuits, including flip-flops, multivibrators, pulse-shapers and inverters. These units can be used for nonsynchronous of synchronous logic.
4. Norbit "building bricks" for industrial control systems, using transistors as the basic switching unit. Applications include machine or lathe control and shape recognition and control.

Computer of Compact Versatility

Ferranti Ltd. played a variation on the same theme of compact simplicity without sacrifice of functional versatility. At Olympia the company displayed the prototype of a small, general-purpose, all-transistorized, digital computer called Sirius.

The basic store in Sirius is 1,000 words, each of 10 decimal digits. It can be extended to a maximum of 10,000 words by inserting plug-in packages. Basic digit frequency is 500 kc. Word-time is 80 μsec. The computer uses pulse techniques with transformers. Union transformer circuit is arranged to provide an output when a majority of the inputs are positive. Any of the four primary windings on the transformer can be reversed to provide an inhibit input.

Many potential users have distinctive needs which can be met neither by a "fixed" computer nor by a "fixed" data-processing system. For those firms the only answer is a flexible nucleus, around which *ad hoc* systems can be built.

Such are the new Stantec Computing Systems, exhibited by Standard Telephones and Cables Ltd. In each system the nucleus is a Stantec Computer.

The basic Stantec has a word-time of 312 μsec. Its main store is a magnetic drum (capacity 8,192 words; speed 6,000 rpm). For additional storage, various magnetic-tape equipment is available.

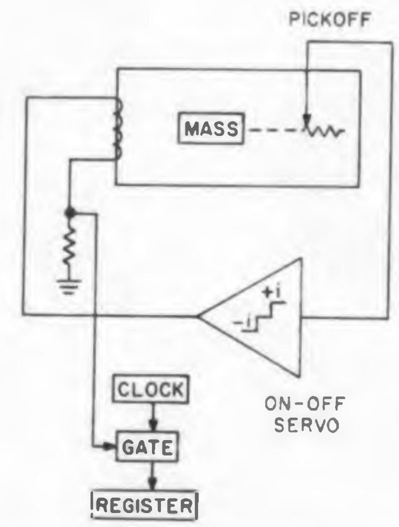
Guidance System Uses

Could Be Employed In Aircraft, Missiles

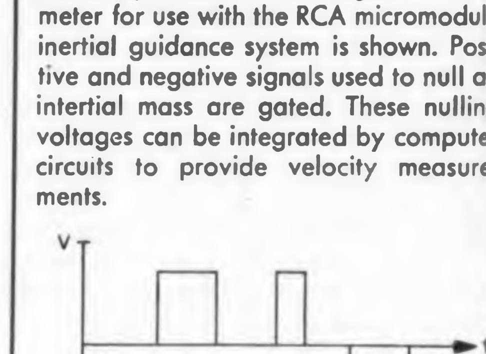
AN OPERATING inertial guidance system using micromodule electronics has been built by Radio Corp. of America's Missile Electronics and Controls Div., Burlington, Mass.

Performance of the system could typically navigate an aircraft within 1 to 3 mph, or control missile cutoff velocity within 0.05 per cent. Significant improvements over this performance are expected in planned micromodule inertial systems, according to RCA engineers.

A digital differential analyzer will include about 1,500 transistors and 600 diodes in 600 micromodules. Some of the modules will not be full



Basic operation of the digital velocity meter for use with the RCA micromodule inertial guidance system is shown. Positive and negative signals used to null an intertial mass are gated. These nulling voltages can be integrated by computer circuits to provide velocity measurements.



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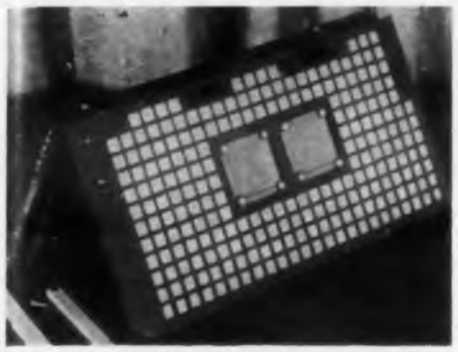


Model of micromodule digital differential analyzer being built by RCA for use with the micromodule inertial guidance system.

sized so that circuit interconnection problems are simplified, RCA engineers explained.

Some Electronics on Inner Gimbal

Micromodularized preamplifiers are carried on the inner gimbal of the system, allowing the number of slip-rings to be cut by 30 per cent. This could have been reduced further, but it was felt that the use of alternate current paths to increase reliability was a more important consideration.

An "egg-crate" type package has been used for micromodules. Each module is held tightly in place by a frame spring insert, designed to carry heat from module wall to the crate wall.

The inertial system can provide as gimbal output angles either a resolver or synchro output with accuracy up to 1 min, or an unambiguous 14-bit digital serial output.

A digital velocity meter has been designed for use with the inertial system. If the inertial mass in this system moves in one direction, an on-off servo provides a nulling signal. The nulling signals are directed into a gating system which is also receiving clock pulses.

The gating logic combined with the clock pulses supplies an acceleration input to the navigation computer. This is integrated to provide a velocity measurement. ■ ■

CIRCLE 17 ON READER-SERVICE CARD ➤

Nuclear Weather Detector To Aid Nation's Forecasters

A nuclear weather detector, called Tracersonde, is under development by Tracerlab of Waltham, Mass., for the U.S. Weather Bureau.

The Tracersonde will be similar in size, weight, and appearance to a conventional Weather Bureau Weathersonde normally borne aloft by a balloon to radio back to earth information about temperature, barometric pressure, and humidity at various heights. In operation, the Tracersonde will differ from the Weathersonde in that it will use ultrasensitive radio-chemical detection techniques to determine ozone and radioactive chemical, "clathrate," in the apparatus.

This reaction produces an effluent radioactive gas which is detected by a Geiger tube. The amount of gas that is produced is proportional to the concentration of ozone at any given point.

Tracersonde has grown out of two recent scientific breakthroughs. First is the development by Tracerlab scientists of "clathrate," and the second is the meteorological theory that weather patterns could be more readily predicted if our weathermen had more information about the ozone clouds caused by solar radiation.

3-D Closed-Circuit System Employs Double Polarized Image

A three-dimensional closed-circuit television system has been developed by Kin Tel Div. of Cohu Electronics, Inc.

The system consists of two standard Kin Tel closed-circuit cameras, two camera-control units, and a polarized optical system. The optical system presents the overlapping images from each camera on a single viewing plane, with one image polarized vertically and the other horizontally.

Watching the image through special polarized glasses or a viewing hood gives a 3-D effect.

The system has automatic compensation for light levels up to 4,000 to 1 and maximum full-range adjustment time of 0.25 sec. One line, the 1988, uses equal horizontal and vertical resolution greater than 500 lines; the 1986 system has a vertical resolution of 650 lines and a horizontal resolution of 525 lines. Depth perception may be accentuated by camera separation and the unit may be switched from 3-D to normal two-dimensional viewing.

The standard unit employs 14 in. monitors, but the manufacturer can supply systems with monitors ranging in size from 8 in. to 27 in. Price on the standard model is $9,500.

CIRCLE 18 ON READER-SERVICE CARD

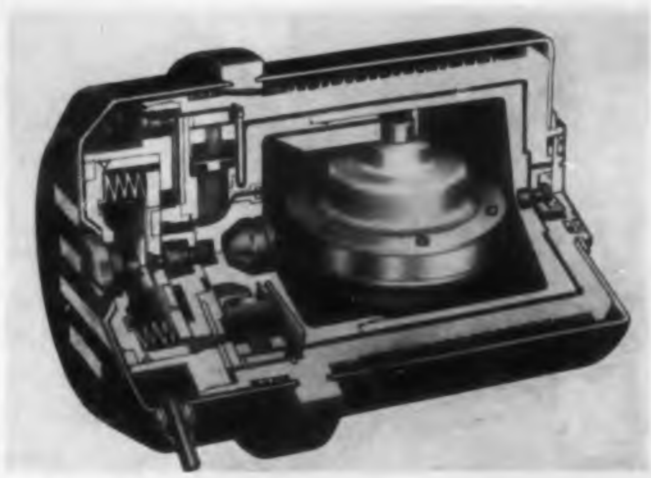
Honeywell Ceramic Gyro Employs a Gas Bearing

Using a new sapphire-hard ceramic and a self-generating gas bearing, Minneapolis-Honeywell has developed what it says is the aerospace industry's first ceramic gyroscope.

The gyro is also said to represent a 10-fold improvement in gyro accuracy. The combination of ceramics and gas bearings has purportedly reduced the prime causes of gyro drift inaccuracies.

A film of helium gas only 25 millionths of an inch thick flows between the bearing and the seat. The 8-oz gyro is 2.82 in. long and has a diameter of 2 in.

The tiny ceramic spin motor of the gyro is encased in its gimbal, also of ceramic. The ability of the ceramic material to withstand heat up to 1,500 F without losing its original dimensions represents a major improvement over ball bearings.



The bell-shaped part of the gyro is the new ceramic spin motor. Its interior spins at 24,000 rpm suspended on a film of helium gas only 25 millionths-in. thick.

WASHINGTON REPORT

Ephraim Kahn

VEGA-AGENA B HASSLE, which the General Accounting Office claims to have lost the government at least $15 million, may spur officials to make sure that they have covered all bases when they check out proposed new programs. An extensive system of informational interchange already exists. In the case of the Vega and Agena-B, both upper stages for use with the Atlas as a booster, the Accounting Office's major objection seems to be that the two projects did not represent "the calculated pursuit of two alternative approaches to better insure success." The auditing agency asserts that "there was no evident communication by the Department of Defense of NASA of planning for the Atlas-B," despite that NASA (which has since cancelled the Vega) first spoke of it to representatives of the military in December 1959.

MULTIPLE SOURCES of supply for complex electronic guidance systems for missiles are being carefully examined at the Pentagon. As production needs grow, the military is getting more than a mite uncomfortable at the thought of being tied to a single producer—one that might be knocked out in a single attack, leaving a major arm of defense in the lurch. Steps have been taken to double-track supply of the Polaris guidance system in anticipation of a go-ahead this summer for stepped-up production.

SKYBOLT MISSILE'S COST is put at $800 million by the Air Force. Through 1965, about $200 million will go for research, development, test and evaluation of this air-launched ballistic missile while $600 million will be spent on procurement. Costs have not been projected beyond 1965, but about $60 million is in the 1961 budget.

INVENTIVE PROPOSALS PROCEDURE has been standardized by the Army. From now on, when unsolicited inventive proposals are received, they will be sent to the technical service thought to have primary interest. After a preliminary (and non-technical) analysis one of the following actions will be taken: (1) it will be re-referred to another technical service if this seems desirable; (2) it will be sent to the Commerce Department's National Inventors Council if the Army does not want to investigate further.

DESIGN PLAN for an advanced communications satellite system proposed by the Army is understood to have been approved by the Advanced Research Projects Agency. Known as "Project Decree," it is expected to use at least three satellites for world-wide coverage.

AIR FORCE BASIC RESEARCH will be raised over the years to just about double current levels. Target is annual expenditure of $70 million for basic inquiry.

HEFTIER MILITARY BUDGETS are urged on the Senate by Gen. Maxwell Taylor. With more emphasis than has been permitted to military men on active duty, Taylor suggested that the Defense Department be allowed to program its needs over five years, with financing to be based on "an annual sum approximating 10 per cent of the gross national product." This would add about $9 billion to the military's spending money.

USERS OF ELECTRONIC SYSTEMS in the Air Force will be represented when the systems are being planned by the Command and Control Systems Office, Hanscom Field, Bedford, Mass. Though the office does not yet represent all elements of the Air Force—SAC and TAC are not yet there—it expects eventually to be able to examine and criticize proposed design improvements and new systems from the viewpoints of all the men who will be working with them.

$500 MILLION NATO AIR DEFENSE costs will be shared by the U.S., which expects to pony up about $125 million. In fiscal 1960, about $30 million was scheduled for buying both large and gap-filler radar equipment, and NATO is expected to get almost $70 million more toward its air defense system in fiscal 1961. In addition, foreign allies of the U.S. will be supplied with missiles worth more than $210 million (including almost $22 million worth of spares and maintenance equipment). Total foreign military assistance is to cost about $2 billion in fiscal 1961.

PATENT POLICY CHANGE is under serious study at the Defense Department. If changes are made, they will not necessarily conform to the proposals embodied in the House-passed NASA bill. If more restrictive patent policies (such as those observed before 1955) are recommended, the Pentagon will have to decide whether the contracting officer or a higher authority will be empowered to decide whether the government or the contractor should get title to patents developed in the course of work under federally financed contracts.

COMPETENCE AND EXPERIENCE are keys to Navy R&D contracts. Rear Adm. Charles D. Martell, Assistant Chief of Naval Operations (Development) suggests that seekers after such pacts weigh their abilities carefully and concentrate on fields in which they excel.

BETTER QUALITY CONTROL throughout the contract cycle is urged on industry by Col. J. G. Schneider, quality control chief for the Air Materiel Command. Stressing that success of a quality control program "depends as much on the industry partner of the team as on the Air Force," Col. Schneider predicts that the quality controls now being applied to ballistic missiles and space systems will in short order be expanded to other weapons systems.

CHANGES IN PRICES AND AVAILABILITY

DIFFUSED-JUNCTION SILICON RECTIFIERS, having peak inverse voltage ratings from 100 to 600 v, have been reduced in price ranging up to 45 per cent by Radio Corp. of America of Somerville, N.J. Types affected are the following: 1N444B, 1N445B, 1N537B, 1N538, 1N539, 1N540, 1N547 and 1N1095.

MICRO-DIODES have been reduced in price by Pacific Semiconductors, Inc. of Los Angeles, Calif. The price was set at $20 each a little less than a year ago. This announcement pegs the Micro-Diode price at the same level as several EIA counterpart types for an average price of $3.29 each in 100 to 999 quantities. For example, Micro-Diode type 1N914 is priced at $4.50; 1N663 at $3.15; 1N643 at $2.97; 1N658 at $3.40; 1N547 at $2.75; 1N458 at $3.03 and 1N459 at $3.23.

MOLDED CASE CIRCUIT BREAKERS, panel boards, safety switches, bus duct, and circuit breaker and fusable load centers have been increased 10 per cent in price by I-T-E Circuit Breaker Co. of Philadelphia, Pa.

CAPACITORS and other electronic products have been increased in price by Cornell-Dubilier Electric Corp. of Plainfield, N.J. The price changes include from 5 to 10 per cent on most dc electrolytic capacitors; 10 per cent on paper, metalized paper, oil and film types of tubular capacitors; 3 per cent on fluorescent ballast oil type capacitors and 10 per cent on most other oil type capacitors; 5 per cent on filters; 5 to 10 per cent on selected types of vibrators and power supplies.

Is your company making changes in prices or availability of its products? Send the details to *ELECTRONIC DESIGN*, 830 Third Ave., New York 22, N.Y.

◄CIRCLE 21 ON READER-SERVICE CARD
CIRCLE 22 ON READER-SERVICE CARD ►

British Show Design Ideas At New York Exhibition

An aircraft-control system using direction finders to track planes and a closed-circuit TV system to display the tracking data was introduced at the British Exhibition in New York by Standard Telephone and Cables, Ltd., England.

The system was part of a wide assortment of British electronic equipment on display from both industrial and commercial segments of the industry.

The STC system uses wide aperture direction finders at several locations operating on communications frequencies to locate aircraft by triangulation. The bearing is sent to a control center and displayed on a cathode-ray tube indicator in the form of a bearing line.

Mirrors over various crt's reflect bearing traces so that they can be superimposed onto a TV display map of the area.

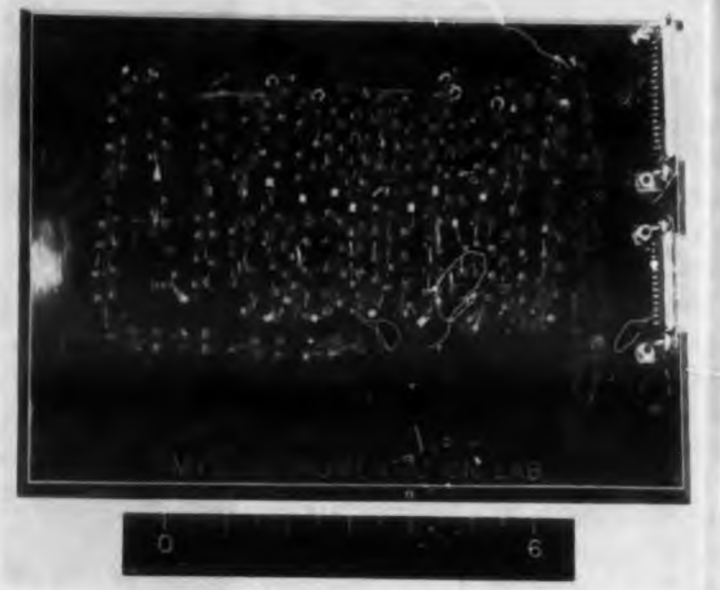
Automated Cigarette Equipment Shown

A full-scale electronically automated cigarette production system was displayed in action by Molins Machine Co., Ltd., London. A machine which automatically produces 1350 filter tip cigarettes a minute is about $50,000, according to a company spokesman.

An atomic reactor simulator was shown by Vickers-Armstrongs (Aircraft) Ltd. This equipment was designed primarily for use in education and for research laboratories.

Component leads are pushed through holes in punched plastic boards and connected by wires in the telegraph switching system displayed by Standard Telephones and Cables Ltd. at the British Exhibition.

CIRCLE 22 ON READER-SERVICE CARD



Breadboarded 256 core rope is capable of holdin
256 words of 8 bits each in fixed storage.

Space Computer Designed at MIT

Use of "Core Rope" Linear Select Memory, Split Clock Cycles Used in Mars Computer

A COMPUTER for a three-year round trip to Mars has been accomplished by Massachusetts Institute of Technology's Instrumentation Laboratory.

The object of the program was to develop design approaches to the space-computer problem rather than a specific machine, Dr. R. L. Alonzo, Instrumentation Lab staff member, explained at the recent National Specialists Meeting on Guidance of Aerospace Vehicles in Boston. A typical machine was designed, however, to illustrate the principles evolved.

The critical periods for a computer on such a flight would be at in-flight correction points and during the approach to Mars, according to Dr. Alonzo and his co-worker, Dr. J. Halcombe Laning Jr., deputy associate director of the Lab.

Because of the long, relatively inactive periods between these points in the flight it was decide to make power consumption proportional to spee of operation, so that low-powered, leisurely com putation can be performed during these period

Need Flexibility for Emergencies

Flexibility is required because the problems o a Mars flight are not completely known and th computer must be programed for emergencies.

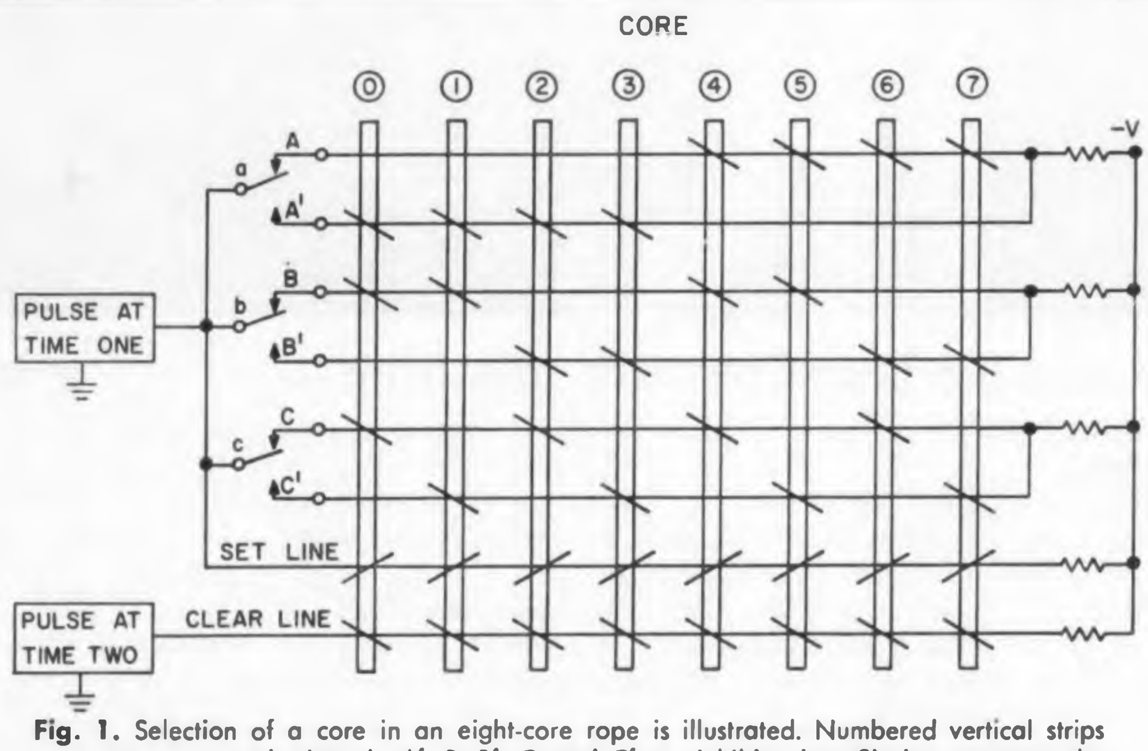


Fig. 1. Selection of a core in an eight-core rope is illustrated. Numbered vertical strips represent cores, and wires *A*, *A′*, *B*, *B′*, C, and C′ are inhibit wires. Slashes represent the direction of wire threading through the core. All cores are initially at ZERO. At time one a pulse in the set line attempts to set all cores to ONE. With electronic switches *a*, *b* and *c* as shown, however, the pulse only passes through positions *A*, *B* and C. Where an inhibit wire is threaded through the core as indicated by slashes, the setting is prevented. Thus wire *A* inhibits cores *4*, *5*, *6* and *7*; wire *B* inhibits cores 0 and *1*; and wire C inhibits core 2. Thus core 3 is selected by this position of the switches *a*, *b* and *c*. Cores are selected by setting these switches.

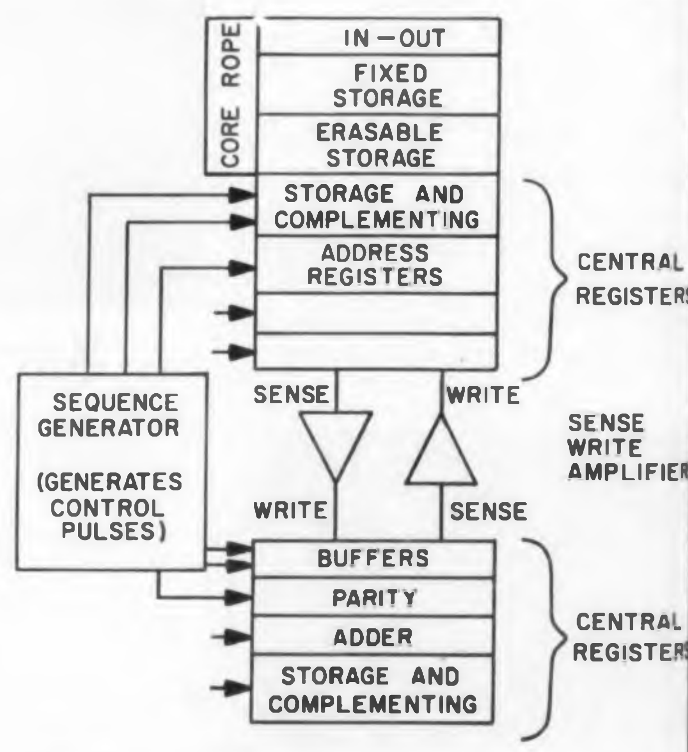
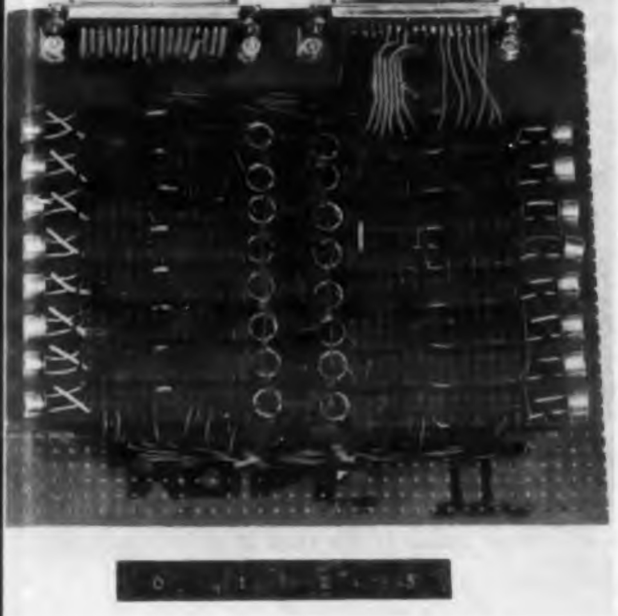


Fig. 2. Organization of the space computer designed b MIT's Instrumentation Lab shows how central registers a split into two groups. During the first, or α, portion of clock pulse information flows through the left sense-wri amplifier toward the buffers. During the second, or β po tion of the clock cycle the flow is in the reverse directio toward the erasable storage.



asable-storage unit has 16 registers capable of lding 12 bits each. A core rope for selecting a gister is at the center.

During the flight, a priority circuit continu-sly monitors some 100 input lines from various ints in the vehicle. Activity in one of these lines presents an alarm, so that the computer imme-ately stops the task it is working on to deal with e input.

The speed of computation can be increased ac-rding to the input requirements, and then owed again when the computer automatically turns to its previous task.

Continuous monitoring is felt to be more effi-ent than a sequential-type scan, Dr. Alonzo id, because scanning would require an increase computer speed with added input channels.

igh-Density Storage Cuts Size

To minimize size and weight, various portions the computer have been designed to handle ore than one task. Addition is synthesized using t by bit OR circuits, and multiplication is per-rmed by use of a subroutine.

The computer memory is based on the "core pe" memory developed by Lincoln Laboratories, exington, Mass. Cores are used as ac-coupled nsformers for fixed storage so that the number bits stored per core depends on the number of condary windings on the cores.

The erasable-storage section requires one core r bit. The major computer storage requirements r such a trip, however, is for constants and ed program.

In the MIT design, about 4,000 words of fixed rage and 128 words of volatile storage are ecified.

Fixed-memory storage density is about 1,000 ts per cu in.—about 100 times greater than pres-t computer memories, according to Dr. Alonzo.

A 16-word erasable-storage system has been buil with bit density of about 100 per cu in.

All memory transfers are performed in paralle rather than serially, requiring less power. Transis tors used in the memory only draw power whe actually transferring data.

The complete memory system consists of fixe storage, erasable storage, and a group of erasable type central registers under direct control of th computer logic.

Because of the special electrical requirement of the erasable registers, it was decided to spli the central registers into two separate sections Each clock pulse is divided into two equal parts designated α and β.

During the α portion of the cycle, informatio flows from the upper registers toward the buffe through the sense amplifier at the left in Fig. During the β portion, information flows towar the erasable storage through the sense amplifie

These operations do not occur simultaneousl because of the chance that a single core might b cleared and written into at the same time.

Address registers are used to address the fixe and erasable storage sections through energizin the proper inhibit and sense wires.

Other special central registers are designed t perform specific functions in the computer spec fied by particular instructions.

Sequence Generator Provides Logic

The sequence generator is the logic section the computer. It provides control-pulse sequence associated with instructions stored in the fixe or erasable-storage sections.

Sequences are provided by threading or no threading a wire through cores in a row of a co

Space Computer Specifications

Power (proportional to speed)	0.1-20 w
Clock rate	0-100 kc
Size (estimated)	0.37 cu ft
Weight (estimated)	20 lb
Memory (parallel transfer)	
Program and constants	4,000 wor
Volatile	128 word
Word length	24 bits
Life (estimated)	3 yr
Average speeds at 100 kc	
Multiplication	7.5 msec
Addition	0.27 mse
Transistors	1,500
Diodes	5,000

matrix. Different sequences are provided by varying core threading combinations from row to row. Selection of sequences is provided by selecting row in the matrix. When the row is selected all cores in the row are set to ONE, and a ONE is also set on the first core of a controlling shift register row at the bottom of the matrix.

As the ONE is shifted across the shift register, sequential switching of the cores in the selected row from ONE to ZERO occurs. A wire across the row will carry a pulse whenever a core through which it is threaded shifts from ONE to ZERO.

If a wire is threaded through every core in the row a pulse is generated with each cycle of the controlling shift register, providing a continuous pulse sequence. If two or more wires are threaded through cores in the selected row, a sequence of pulses is generated in each wire corresponding to the threading pattern.

Various trick techniques permit optimal use of the sequence generator in providing control signals for the central registers. ■ ■

R & D Costs Hit $8.2 Billion In 1958, Science Report Says

Research and development accounted for $8.2 billion of American industry expenditures in 1958, according to a report by the National Science Foundation. This was a seven per cent increase over the figure for 1957, and more than double that of 1953.

The $8.2 billion for industry represents about three-fourths of the national dollar volume of research and development, estimated at $11 billion for 1958. The remaining fourth was performed by the federal government, colleges and universities, and other nonprofit institutions.

The report, based on a survey conducted for the foundation by the Bureau of the Census, cites a 10 per cent increase in research and development for the electrical equipment and communication industry.

NASA Sets Up New Office Of Information and Education

The National Aeronautics and Space Administration has established a new Office of Technical Information and Educational Programs. Shelby Thompson, formerly with the Atomic Energy Commission's Div. of Information Services, has been appointed director.

The new office is expected to consolidate NASA's present public information services, such as the distribution of brochures.

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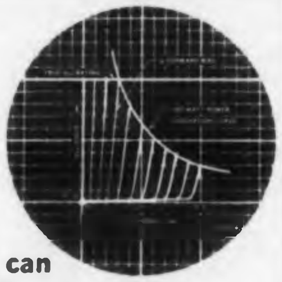

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NEWS

Automatic Navigator Designed to Project Aircraft Position on Map Screen for Pilot

Engineer at International Business Machines laboratory at Owego, N.Y. inspects the glass hemisphere in a new navigation system. The 6-in. globe has a map of half the earth photographically reproduced on its inner surface.

AN EXPERIMENTAL navigation system may eventually enable pilots of supersonic planes to check their position by merely glancing at a screen on the instrument panel. The system, under development at International Business Machines Corp., Federal Systems Div., Owego, N.Y., uses a map-projection technique.

It reportedly projects a highly accurate circular map of an area 400 miles in diameter (125,000 sq miles) on a 7-1/2 in. screen. An airborne computer performs all the calculations to position the map on the screen and to pinpoint the plane's position.

The key unit in the system is a glass hemisphere of about 6 in. diam. A detailed map of half the earth is reproduced photographically on the inside of the glass. A beam of light illuminates a small section of the map, which is then projected onto a flat, translucent screen in front of the pilot. As the plane moves, computer automatically adjusts map presentation.

IBM says a similar device could be used in space navigation.

To use the system in space, a technique known as stellar map

Map projection technique used in the navigation system is illustrated during a laboratory test. The system, still under development, uses a computer to position a map of half the earth inside a glass hemisphere in such a way that the area over which a plane is flying is projected onto a display screen. Engineers Richard W. Kern (left) and John F. Creedon are presently working towards refinement of the system.

atching might be employed. A ellar map, or chart of the heavens, ould replace the map of the earth side the glass hemisphere and be rojected onto the screen. Then a elescopic view from the space craft ould also be projected onto the reen, superimposed on the space ap projection. When the stellar ap and the telescope view were ned up, the computer could autoatically determine the position of e space craft.

The entire system is comparable the ATRAN guidance system now ed in the Air Force Mace missile. TRAN is a map-matching system at compares the terrain over hich the Mace is projected with a nthetic film strip of the proamed route produced from topoaphical maps. The system is said be completely independent of man control at all times.

Uses of ATRAN are not restricted missiles, according to the develer, Goodyear Aircraft Corp. of ron, Ohio. The company has rently demonstrated the guidance pabilities of the system in a comercial aircraft.

Design details of ATRAN have en classified by the Air Force. ■ ■

CIRCLE 30 ON READER-SERVICE CARD ➤

This concluding section of* ELECTRONIC DESIGN'S *report on electronics in oceanography describes some of the systems for collecting, transmitting and processing the data obtained with the measuring instruments discussed in the first part of the report. Oceanographic systems afford the possibility for long-run production and may thus be of greater interest to industry than the measuring instruments, which although of sophisticated design, are generally less complex and required in only limited quantities.

Oceanography—Opportunities in Systems Design

Manfred W. Meisels
Assistant Editor

OCEANOGRAPHY, perhaps more than any other science, must resort to the design and construction of its own electronic instruments. Little else beyond basic components is available "off the shelf." Instruments are hand-tailored and the electronics section of an oceanographic laboratory typically resembles a prototype shop in land-based industry.

In the absence of commercially available systems or sub-systems, an inordinate amount of time is spent in assembling power supplies, modulators, transmitters, sonar packages, etc. Though requirements may differ somewhat for each particular experiment, much of the electronic gear could be assembled from standard packages—if such packages were available.

With the anticipated growth of oceanography in the '60s, many areas of instrumentation may prove attractive for commercial exploitation. Some of the more promising opportunities for industry are described here. Ingenuity of design has been the keynote of oceanographic equipment and will be a continuing requirement. The design problems are complex and the funds available are as yet limited; but the field is growing and oceanographers stress that now is the time for industry to get in on the ground floor.

'Please Go Near the Water!'

Electronic engineers at the various oceanographic institutes have learned by repeated experience that it pays to go to sea.

"Once you've been seasick and had to work on a piece of equipment, you build it differently," is how Bernard Luskin, chief engineer at the Lamont Geological Observatory, put it. "You have to human engineer your devices for use by people who are not at their best."

This means leaving out knobs and switches which, in accordance with the principle of perverse probability, will inevitably be set to the wrong position. Printed circuits and miniaturization make sense in missiles, but to repair such packages on a vibrating, rolling ship is next to impossible—cold solder joints are all that can be produced.

Stable power supplies are taken for granted ashore, but the performance of a ship's electrical system cannot approach that of your local utility company. The result—equipment that checks out in the lab but is useless on shipboard.

Nothing on ship stays dry, so design your equipment accordingly. Don't wait for packaged prototypes—get your breadboard to sea and avoid unpleasant surprises later. Survey ships may be at sea for 10 months or more, so design for reliability. Are your computers and other equipment designed to operate in a clean, well lit, air conditioned environment? Go aboard an oceanographic vessel and face reality.

These rules, which apply in spades for the design of electronic gear for the Navy, are often ignored. The first Loran-C receivers delivered to the Navy were marvels of packaging and miniaturization but were soon replaced by less glamorous units designed for easier servicing. The leftovers have been offered gratis for oceanographic use but have found no takers. SINS equipment is another instance where designers found themselves at sea by not going to sea in the first place.

The rule to be followed in designing electronics for the sea is "Please go near the water."

Telemetry

The buoy is to oceanography what the satellite is to space exploration. Each vehicle carries instruments to regions where man cannot go in safety or convenience. In each, telemetry devices are necessary to recover the data collected by the instruments.

At sea, two modes of telemetry are possible—radio telemetry for a floating buoy, and acoustic telemetry from a submerged instrument package. Each method is presently limited by an almost total lack of equipment to do the job.

Sonar techniques have been used successfully to track and locate submersible and "Swallow" buoys. Passive, active, and transponding methods are employed. In addition, sonar is now being exploited as a means of underwater telemetry and communication. Pulse-coded and frequency modulation of the acoustic signal offer the most likely possibilities at present. Amplitude modulation is restricted by the variable attenuating properties of the scattering and thermal layers in the oceans. Sub-carrier and multiplexing also appear feasible, but further development is needed in applying these techniques to an acoustic carrier.

As in ASW devices, the trend is toward the use of lower frequencies. (The attenuation of a low-frequency acoustic signal is roughly 0.2 f (in kc) db per thousand yards.) Unlike most sonars, however, the telemetry device must operate at great depths, where pressures exceed 10,000 lb per sq in. Ordinary crystal transducers, when backed with oil or otherwise designed to with-

N. Y. Times photo

The Schooner "Vema," research ship of the Lamont Geological Observatory of Columbia University. "Vema," now circumnavigating the Antarctic, is typical of the vessels being used in oceanography. Modern ships, soon to be built, will certainly be more efficient, but hardly as glamorous.

stand these pressures, deteriorate markedly in efficiency. Magnetostrictive transducers, which are free-flooding and hence not pressure-sensitive, are inefficient to begin with. Clearly, a family of efficient, high-pressure transducers would greatly extend the range of practical applications for acoustic telemetry.

Wanted: Acoustic Telemetry Packages

Transducers should cover a frequency range from 1 kc to 30 kc at efficiencies of 30 per cent or more. Such orders of efficiency are needed to provide a reasonably long operating life with presently available power sources. Accompanying the transducers there should be a line of packaged acoustic equipment including generators, data samplers, modulators, transponders, repeating beepers, etc. Modular construction and matched components would permit the oceanographer to assemble an acoustic telemetry or beacon system with maximum ease.

Design problems are greatly simplified by the low data transmission rates involved. A capacity of 10 measurements per minute would be more than adequate for an acoustic telemetry system. On the other hand, design for high-pressure operation must be total. Oceanographers report instances where transducers and hydrophones claimed to be designed for use at 10,000 lb per sq in. came equipped with ordinary connectors and feedthroughs. Occasionally, equipment is delivered in which the instrument case is used for a chassis ground, a procedure totally unsuited for immersible equipment.

Oceanographers have ambitious plans for submersible buoys. Ocean-bottom seismographs, temperature and current monitors, and navigation beacons are in active development. All require acoustic equipment which no oceanographic laboratory is equipped to build in quantity.

Emphasis on Low-Frequency Radio Telemetry

Radio telemetry from a surfaced buoy is a more straightforward affair in that the design problems have long since been solved. The need here is for equipment designed to operate at suitably low frequencies. The emphasis in telemetry has been on missile and space applications where the high data-transmission rates involved have led to the use of vhf equipment. The resultant line-of-sight transmission range makes such gear of little use to oceanographers, who are thinking of transmission ranges of up to 1,000 miles. Winter and rough weather generally curtail oceanography and a system of telemetering buoys could make it a year-round trade.

A complete line of telemetry equipment in the 2 to 4 mc range would satisfy the bulk of oceanographic requirements. In certain applications, such as weather buoys, frequencies might go to perhaps 15 mc, but no higher. Data rates are again comparatively low. Ten cps per channel with up to 8 channels would suffice for any buoys now in sight. Some of the modulation schemes developed for missile use, particularly fm/fm, are of interest to oceanographers, who would like to see them adapted for use at lower frequencies. Data conversion should present no difficulty. The greater part of oceanographic measurements involve temperature and pressure, the telemetry of which is routine in space and missile tests.

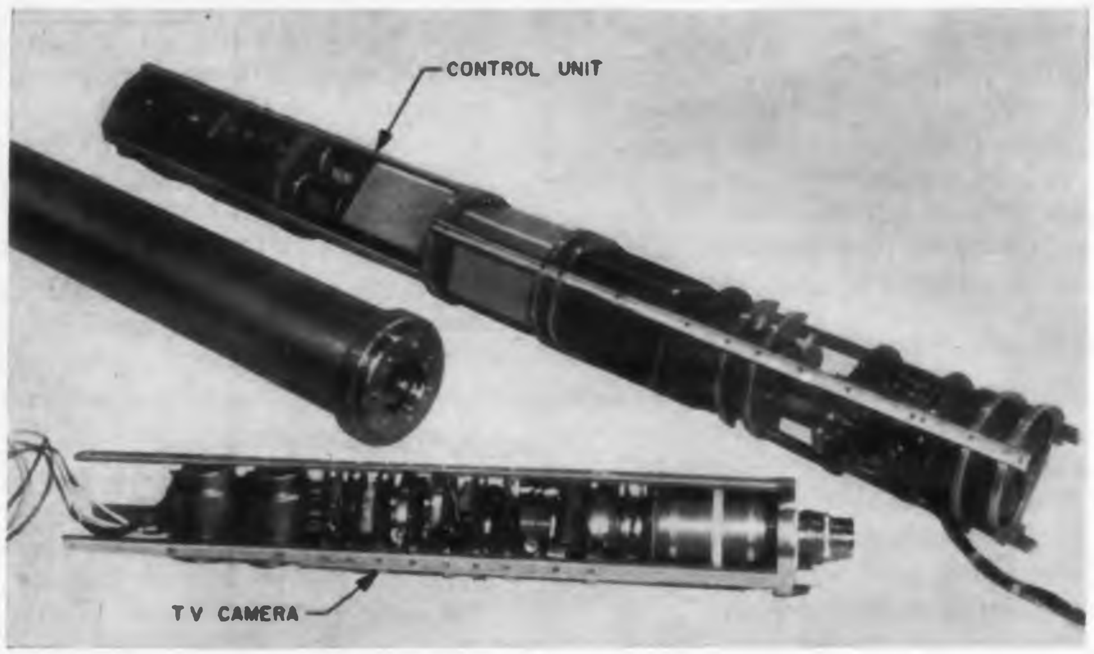
Buoys in Gulf Stream

Present activity in radio telemetry by oceanographers is rather limited. Woods Hole has a chain of temperature and current measuring buoys in the Gulf Stream, the Bureau of Standards and the Naval Research Laboratory have been ex-

This unlikely looking vehicle could be the answer to many an oceanographer's prayer. It is a Remote Underwater Manipulator (RUM) complete with 3-D television sonar obstacle locator and double-jointed handling arm. RUM will perform a variety of inspection, installation and servicing functions underwater and by remote control. The vehicle was designed for the Office of Naval Research with the Scripps Institution of Oceanography as the prime contractor. RUM can operate out to 5 miles from shore and at depths to 20,000 feet. It is driven by a pair of 7.5 hp series motors and cranks up a top speed of 3 mph. Power, communication, and control are via a coaxial cable to a control van on the beach.

The TV equipment, designed and built by Orbitran, Lakeside, Calif., consists of four cameras which can be switched for either stereo or two-dimensional viewing. In the 3-D mode, a 250-line picture is transmitted at 7.5 frames per second; for two dimensional viewing, a 530-line 15-frame picture can be transmitted. The cameras and a TV power and control unit are each housed in ½-in. steel casings and can operate at pressures to 18,000 psi.

The manipulator arm is a modification of the General Mills handlers for nuclear materials.



perimenting with weather buoys, and the Scripps Oceanographic Institution at La Jolla, Calif. obtains wave measurements from a remote measuring station.

The Woods Hole buoys are part of an order of 40 buoys being filled by Prodelin Inc. of Kearney, N.J. These units are interrogable and transmit ocean-temperature data from a 25-unit thermistor chain. Telemetry is in the 2 to 3 mc range at about 20 w giving a range of about 100 miles. A 20-w transistor operating in this frequency range, said to be in development, will increase operating life and improve reliability. The buoys are priced at about $1,500 each.

The shortage of trained oceanographers will lead to the increased use of buoys for data collection as our oceanographic efforts accelerate, and every buoy launched will be equipped with a telemetering device. The implication to electronics designers is obvious.

Power Sources

New power sources are needed for the heavily instrumented, long-lived buoys being designed for oceanography. The carbon-zinc and lead-acid cells now in general use are adequate for small vehicles, but weather buoys, ocean-bottom instrument packages, and radar and sonar beacons call for more sophisticated power devices.

Emphasis in battery design has been on high output, short-lived cells for missile use whereas oceanographic requirements are for low drain, long-lived sources. Weight and volume, so critical in missiles, are of limited importance in the science of oceanography.

But even generous weight allowances preclude the continued use of ordinary cells. A constant drain of only 1 ma amounts to 9 amp hr per year. A good many milliamps, often at more than 2 v, are required in oceanographic systems. For example, one prototype weather buoy developed by the National Bureau of Standards draws an average current of 175 ma at 12 v. Transistorized circuitry and improved design would reduce current demand, but the power required by weather buoys and other complex systems is nevertheless quite considerable.

Every Possibility to Be Tried

Thus, oceanographers are willing to examine every reasonable possibility leading to new power sources. Among the methods now under study are: wind-powered generators, wave-powered generators, solar cells, fuel cells, nuclear batteries and sea water activated cells.

NBS, as a part of its work on weather buoys, is considering a variety of power sources. Two wind-powered generators having a combined output of 30 w in a 10-knot wind will be tested on a weather buoy this summer. Wind powered generators are at first glance an ideal means of powering a surfaced buoy, but their reliability and uniformity of power output have yet to be determined. In arctic regions, the chance of icing rules out their use.

By next year, NBS will test a propane-gas-powered fuel cell using thermoelectric elements. A catalyst will be used to generate heat without an open flame and a single propane cylinder is expected to be sufficient for a year's operation. Such cells are, of course, usable only on surfaced buoys.

Solar Cells, Too

NBS has also investigated solar cells to power its buoy. A 1 sq ft array of solar cells can deliver up to 7 ma at 15 v. Salt spray and humidity do not affect performance and solar cells would appear ideally suited for use in tropical waters. The cost of solar cells, however, is considered excessive; the array tested ran to about $500.

The Naval Research Laboratory, also working on weather buoys, is planning to test a nuclear-powered battery in about two years. Power requirements for large NRL weather buoys are equivalent to 1 w-hr continuous drain; the nuclear cell is expected to deliver about 5 w-hr. The cell will use heat from strontium-90 decay to power a thermopile.

The NRL buoys drift with the ocean currents and the possibility exists that someone could irradiate himself if a buoy with a nuclear battery drifted ashore. One buoy that landed recently in Nicaragua was opened with a machete before the Navy could recover it.

The Scripps Institution is developing a carbon-magnesium, sea-water activated cell. Results are not yet available, but this or perhaps other electrode combinations offer interesting possibilities.

Shipboard Equipment

Shipboard equipment will account for a significant share of oceanography's electronic budget. Up to $1 million worth of instruments is to be installed on each of the new survey ships now being planned. U.S. oceanographers would like to have as many as 25 of these new ships and stand a reasonable chance of getting at least a large share of them in the next 10 years. Stepped-up oceanographic activity in other western countries will lead to the construction of still more survey ships. It has been estimated that a full-scale, world-wide program of oceanography would require the construction of more than 100 new vessels, each crammed to the gunwales with electronic equipment.

Until now shipboard electronics has been a crazy-quilt affair, growing in complexity and re-

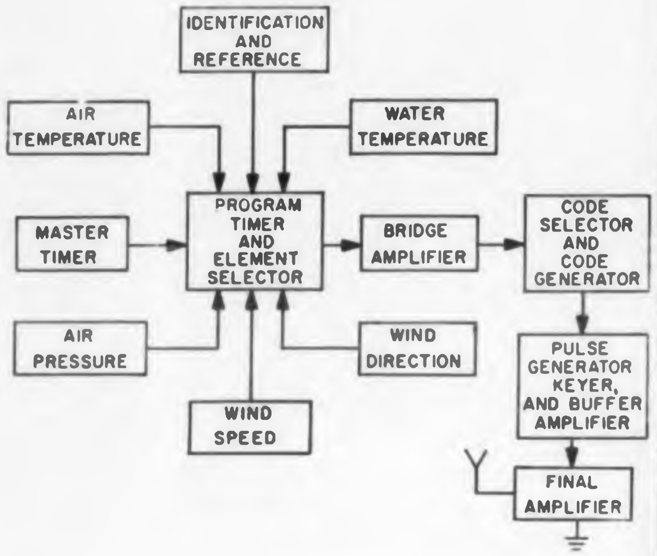
◄ CIRCLE 31 ON READER-SERVICE CARD

CIRCLE 32 ON READER-SERVICE CARD

dundancy with each introduction of a new instrument. A systems approach in the design of shipboard electronics is urgently needed and equipment designs reflecting this attitude will certainly be selected.

Funds Available

Funds have been allocated for the first of the new survey ships and construction will begin



Large, seagoing weather buoy developed by National Bureau of Standards. The buoy collects and telemeters a wide variety of oceanographic and weather data and could readily accommodate other sensors. Transmission is programed for six-hour intervals, but cuts in more frequently during storms. As shown in block diagram, output of each sensor is fed, in turn, to self-balancing bridge amplifier. Transmission is by morse-coded cw system.

shortly. The electronics aboard this vessel will include the following:

- Multichannel precision-depth recorders.
- Multiple sonar arrays with provisions to vary frequency, pulse rate, pulse duration, beam width, etc. Four or five depth sounders will be included in the array.
- Navigation and communication equipment.
- Magnetometers, both of the flux-gate and nuclear-precision types, together with associated electronics.
- Gravity meters mounted on a gyro-stabilized platform.
- Auxiliary acoustic generators such as spark gaps, gas burners, thumpers and explosives.
- Auxiliary power sources.
- Test equipment.
- Hydrophones both hull-mounted and variable-depth types for seismic work.

The standard depth sounder for oceanography is the Navy's UQN-1E sonar apparatus, thought to be the best of its type. English Kelvin Hughes and German Elac depth sounders have also been used but do not quite match the performance of the UQN-1E. Elac equipment is known to be in service aboard Russian oceanographic ships.

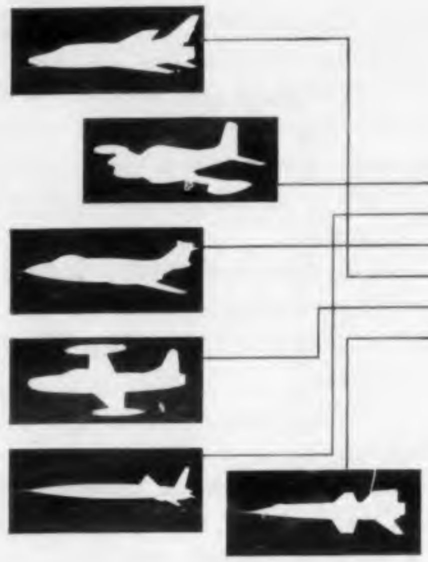
Aboard the Lamont Geological Observatory's "Vema" the UQN-1E is used together with a Westrex Mark 5 precision depth recorder. An accurate time standard, perhaps the major consideration in depth sounding, was developed by Westrex from the tuning-fork standards used in its facsimile machines. The Mark 5 is a versatile chart recorder equipped for automatic scale changing, variable gating and simultaneous recording on the chart of ship's heading, logged miles, magnetometer data, and all other pertinent information.

The next advance in depth sounding equipment will be the integration of recorders and sonars into a single system. Lamont, to which the first new survey ship has been assigned, plans to install a system of this type aboard the vessel.

Static Converters and Test Equipment Needed

Static power converters are another "must" for oceanographic ships. Many measurements are taken under "quiet ship" conditions in which not even ventilating fans are permitted to operate. Storage batteries are now used to power equipment at such times, but static dc-dc and dc-ac converters would be of major convenience and would permit the use of a greater variety of instruments not readily adaptable to battery operation. Converters should deliver several kilowatts at stable voltages and with great reliability.

Shipboard test equipment should, wherever possible, be designed for battery operation. This is desirable for portability in making "on the deck" repairs and adjustments and to assure stable



power for such instruments as oscilloscopes, frequency generators and counters.

A complete line of battery-operated test equipment designed for use at sea would be welcomed by oceanographers who now have to fuss with power packs, adapters, and other jury-rigs.

Data Collection and Processing

Equipment for the storage, recovery, and processing of instrument data is a critical need in oceanography. "The first rule in this business," according to Bernard Luskin, chief engineer at the Lamont Geological Observatory, "is to look at your data right away—you may never be able to find the place again. If something interesting turns up, you've got to exploit it then and there." This rule is not always observed, with consequent loss of much valuable information. Data processing on shipboard can thus give oceanographers greater mileage from the information they collect.

The data input to a well-equipped survey ship is enormous and justifies the use of the most modern, high speed data-reduction and computing equipment. Typical input rates to a ship are:

- Depth soundings—1 per second.
- Gravity measurements—continuous.
- Magnetic measurements—1 per 6 seconds.
- Seismic measurements—up to 5,000 per day.
- Temperature, current and pressure readings

Small weather buoy designed by National Bureau of Standards measures and telemeters wind direction and velocity, air temperature, and barometric pressure. Buoy's electronic package at right includes programer and transmitter (top), barometer and magnetic compass.

telemetered from buoys or taken over the side—many thousands per day.

Chart recorders are a time-honored means of reducing data for immediate visual inspection. For depth soundings, they can hardly be improved upon. Nevertheless, ingenuity of design, such as demonstrated in the thermal contour plotter, can improve the utility of chart recorders and help to present data in a more significant form.

Combined Displays a Good Idea

Seismic measurements are charted as a series of pips along a time base and must be interpreted by trained observers. A major advance would be the development of an integrated graphic display of seismic, sonar, gravity and magnetic data to give a complete picture of the bottom and sub-bottom structure.

Similarly, temperature, current, density and other related measurements might be automatically combined into a graphic display of the ocean's fine structure. Here again, sonar readings could be presented together with data telemetered from buoys to illustrate the relation of bottom topography upon these measurements.

Conventional digital computers would form an important part of any such integrated data-reduction and display system. Even now, computers would prove useful in shipboard data reduction, but the design or modification of a business or scientific type of digital computer for operation at sea is a job that has yet to be tackled.

Data storage in buoys can be important in reducing power requirements since telemetry equipment represents the largest part of the energy expended. An obvious solution here would be the use of a tape recorder, but the models available are generally overdesigned—and hence overpriced—for oceanographic use.

Time compression would be a necessary feature of any buoy-storage system. Measurements taken continuously over several hours should be transmitted in a small fraction of that time. Ideally, a ratio of 100 to 1 is desired. So far, in work at the Scripps Institution, a ratio of 64 to 1 has been achieved.

Other storage means, including electrostatic tubes, magnetic cores, or film, might prove applicable, but no serious attempts have been made to adapt these techniques to oceanography. Pioneer V's telebit memory, though perhaps too limited in capacity for use in buoys is indicative of the type of equipment required here.

Weather Buoys

Weather is made over the oceans, which cover 70 per cent of the earth's surface. Yet, as Dr. Columbus O'D. Iselin, former head of the Woods

SEAGOING ELECTRONICS—2

Hole Oceanographic Institution, points out, "We practically run out of weather information at the water's edge."

Some weather reports are received from ships and aircraft in transit and a very small number of weather ships are maintained on station by the U.S. and other countries. But operating costs for a single weather ship can run to $1,000 a day without including the cost of other ships in dry-dock and in transit which are needed to support year-round operation.

$10 Million Market Possible

Thus, unmanned weather buoys present an attractive alternative to weather ships from the standpoint of cost and area of coverage. According to Dr. Iselin, 1,000 weather buoys would be needed for world-wide coverage. Some 250 of these might be stationed in the Atlantic, where a program of this kind would probably be initiated. Projected costs for such buoys would be on the order of $5,000-10,000 each, if manufactured in quantity.

A more likely proposal is one put forward by Texas A & M University for a chain of 10 weather buoys in the Gulf of Mexico to warn of incipient hurricanes. This proposal is based on a weather buoy under development by the National Bureau of Standards.

NBS has anchored a weather buoy 300 miles out in the Gulf of Mexico for the last two summers. The heavily instrumented device measures and telemeters the following data:

- Water temperatures down to 1,000 feet at 40 foot intervals
- Air temperature
- Barometric pressure
- Wind direction and speed

The buoy is programmed to telemeter at 6-hour intervals, but a wind-velocity switch cuts in for transmission every three hours during storms.

Instrument readings are encoded into a three-letter Morse code group. The sampling, encoding aud transmitting operation requires approximately four minutes.

Telemetry frequency is 5.34 mc with data transmitted by rf pulse modulation. Peak pulse power is 4 kw. A pulse length of 250 μsec at 180 pulses per second gives an average power of about 180 w. The output stage is a 3E29 dual triode and feeds a vertical, grounded antenna.

It was found necessary to increase peak rf power from 1 kw for adequate reception over the required 300 mile range.

A more ambitious weather-buoy program, encompassing ship-launched and air-dropped types, is being conducted by the Naval Research Laboratory. NRL is putting its money on drifting rather than on anchored buoys. Anchoring problems have never been adequately solved and a free buoy can "roll with the punch" in heavy seas, thus reducing wear and tear on the electronic devices it contains.

Improvements on the Way

The first version of the new free ship-launched buoy, tested last fall, carried the same types of measuring instruments as the NBS buoy. Temperature sensors, however, consisted of wire-wound resistance thermometers rather than the thermistors commonly used in oceanography. Although thermistors are accurate, they are not very uniform and must be individually calibrated. NRL, thinking in terms of larger systems prefers to avoid this nuisance.

The buoy broadcasts at a frequency of 15 mc by day and 9 mc by night at an average power of 75 w. Morse code cw modulation is employed and usable signals have been heard at a distance up to 4,000 miles.

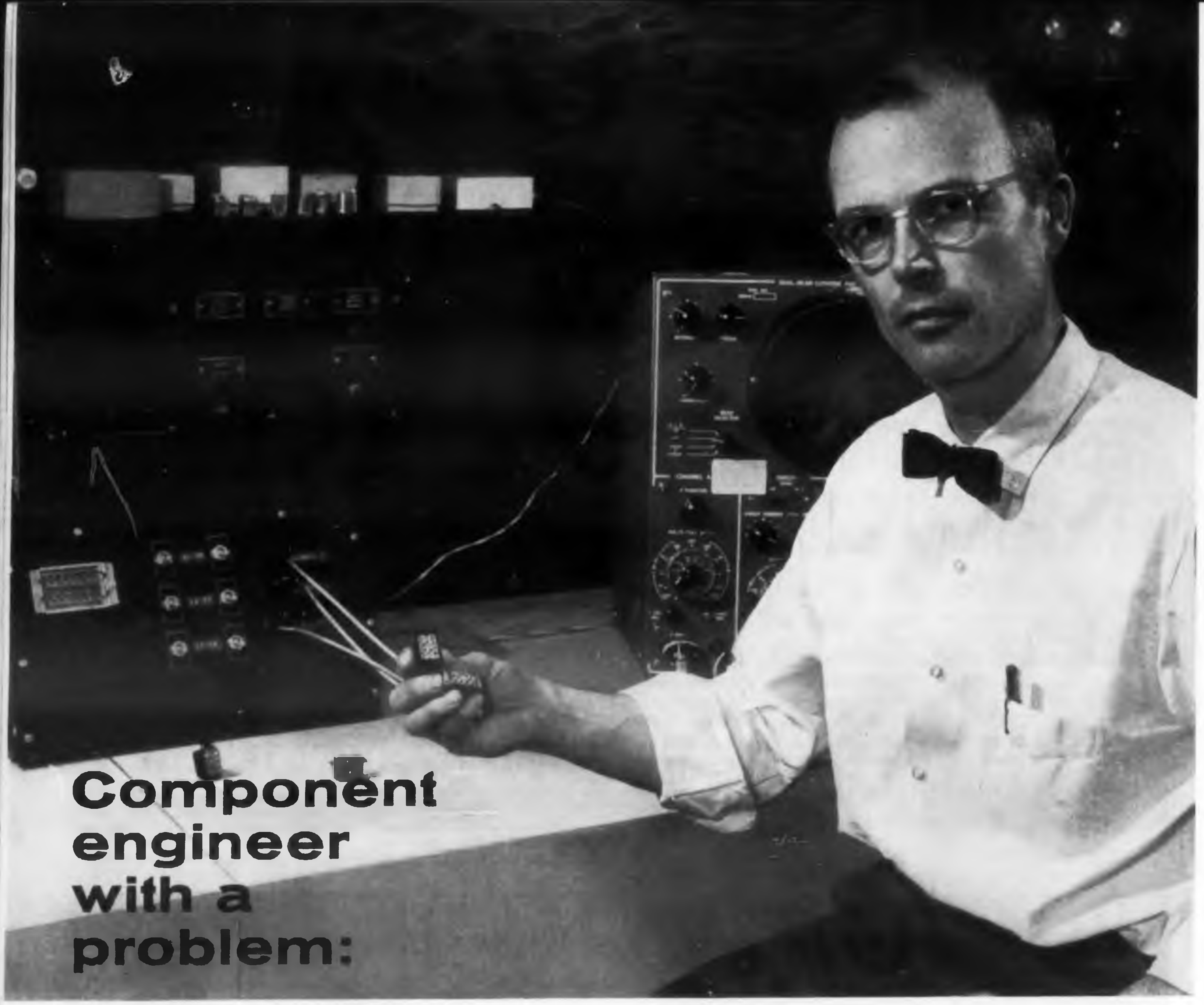
This summer, four improved models of the buoy will be spotted in the Caribbean hurricane zone. Provisions have been made for the inclusion of "Splashnik" wave meters and other oceanographic gear. Command receivers will permit interrogation of the buoy in addition to the usual 6-hr telemetry program. Storage batteries will permit up to a year of operation.

Air-launched buoys, smaller than ship-launched but carrying similar instrumentation, are being readied for use during this year's hurricane season. NRL hopes to drop these buoys into actual hurricanes in order to obtain accurate on-the-spot weather data.

Sophisticated Telemetry and Shore Stations Envisioned

For large-scale systems composed of many elaborately instrumented buoys, present Morse code telemetry methods must give way to more sophisticated, higher-speed transmission techniques. Telemetry will have to be compatible with data storage devices aboard the buoys which will provide rapid playback of continuous readings accumulated over a long period.

Shore stations containing the receiving and data-processing equipment for a weather-buoy system have yet to be designed. Certainly, a shore station would have to include telemetry receivers, direction finders, command transmitters, computers for reduction and analysis of data and communications equipment to forward the data to weather forecasting centers. ■ ■



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Vibration: 55 to 2000 cps at 30G's with 0.195" max. excursion 10 to 55 cps.

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Temperature range: 125 C to −65 C.

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EDITORIAL

Missing From the Transistor Data Chart

Electronic Design has been justly proud of its annual Transistor Data Chart. Despite the increasing growth of the number of transistors—1,088 this year—we have tried to keep our charts to manageable size by eliminating less important data and improving the organization. Missing from this year's chart, as in previous years, is reliability data.

Semiconductor materials inherently have an indefinite life—if perfectly sealed off in an ideal environment of their own. Unfortunately, even 12 years after the appearance of the first transistor, engineers and scientists know little about surface phenomena. Transistor characteristics do change, largely as a result of surface changes, and what reliability has been achieved has been accomplished by empirical approaches.

The reliability that has been achieved is pretty vague. There is no standard definition of what constitutes a failure. Neither are there standards established for the conditions of tests. One company can get a million-dollar transistor-testing contract and boast about achieving a reliability failure rate that is not as good as that carried in other companies' ads!

Some organizations are reluctant to specify transistors for design in their equipment until performance over its intended operating life has been proven (See ARINC specifying practices, p. 54). Premature use of transistors has often caused serious trouble. However, it is encouraging to note that proven high reliability transistors are better than the most reliable tubes yet made.

Much must be done to get greater reliability in more types. At the Solid State Conference earlier this year, several spokesmen admitted that the industry had no standards for reliability but claimed that a reliable product must be produced before standards can be established. We agree that a reliable product is needed, but we disagree that a standard can't be set now. Reliability indexes would be a desirable addition to next year's Transistor Data Chart.

Selecting Transistors and Diodes for Logic Applications

Charles Askansas
Chief Automation Eng.

Carl Uretsky
Senior Applications Eng.

General Transistor Corp.
Jamaica, N. Y.

Logic arrangements such as direct-coupled transistor logic (DCTL), resistor-transistor logic (RTL), resistor capacitor transistor logic (RCTL), diode logic (DL) and current mode logic (CML) are discussed and pertinent factors affecting semiconductor requirements are evaluated for each.

A sizable portion of the $200 million spent on transistors last year can be attributed to overspecification, insist co-authors Charles Askansas (right) and Carl Uretsky (left). They are convinced that, by carefully evaluating specs and designing around selection limits rather than typical characteristics, design engineers could produce more efficient circuitry at lower cost.

WITH MORE than 1100 different transistor types and over 1500 small signal diode types available to the design engineer, selection of one particular device for a specific logic function can be complicated. However, by careful evaluation of the semiconductor requirements involved for each logic mode, key parameters become apparent and final choice can rapidly be narrowed down.

Direct Coupled Transistor Logic (DCTL)

An important set of computer circuits to consider are those designed to use the transistor as both the logical gating and power amplifying element. Although it requires many transistors, it does not use interstage coupling elements between gates, or between gates and amplifiers. The same building block could be used as an AND gate, OR gate, inverter or flip-flop. A single low voltage supply (4 or 5 v) is the only one required for this logic mode.

With DCTL, circuit logic is performed by combinations of direct coupled transistors in series and in parallel. Since it is necessary for V_{CE} of an "on" transistor to be less than V_{BE} of the coupled transistor, saturated switching is required. V_{CE} and V_{BE} measured with the transistor in saturation define the two logic levels, illustrating the need for V_{CE} to be much lower than V_{BE} to insure stability and circuit flexibility.

Fig. 1a shows a DCTL flip-flop. When T_1 is "on", the V_{CE} voltage of T_1 is very low (0.1 v) and not sufficient to turn T_2 "on" while V_{CE} of T_2 is about 0.4 v holding T_1 "on." When T_1 is momentarily turned off by an external trigger, the V_{CE} of T_1 will increase causing T_2 to turn "on" which will then lower the V_{BE} applied to T_1 and cause T_1 to turn "off."

In Fig. 2 is shown a parallel and a series logic gate. The importance of extremely low V_{CE} when the transistors are "on" is particularly apparent in the series gate.

The output voltage V_o must be about 0.1 v when all transistors in the series chain have been turned "on." If this does not occur, the coupled logic will not recognize the negative AND signal. Important consideration must be given to tightly controlled saturated gain, charge storage and input voltage. Since these parameters must remain within close limits during the entire operating life of the transistor, a wide operating temperature range is not possible.

The charge storage of the transistor, as will be explained in greater detail later, is an indication of the time to turn a transistor off. Excessive charge storage in transistors used for DCTL could easily cause a malfunction by not turning "off" with a small trigger voltage excursion on the base.

With the realization of small voltage swings in the order of 0.5 v and the fact that only resistive components are used, it becomes obvious that the transistor is the only speed limiting

Basic Guide

1. Specify what the circuit *actually* requires.
2. Select compatible limits for all necessary parameters.
3. Whenever possible, select a registered specification type.
4. Allow for parameter change with operating point.
5. Design around selection limits, not typical characteristics.

device in the system. For high speed operation, transistors with high common emitter cut-off frequencies or high frequency gain specifications should be selected. This will help to insure fast rise and fall times when the transistors are switching. Maximum voltage ratings are of minimum importance since the supply voltage is usually less than 6 v. The small collector to emitter voltage keeps the power dissipation very low and helps to make this mode of operation well suited to miniaturization. The load resistors as seen in Figs. 1 and 2 are carrying essentially a constant current at all times and are alternately being supplied by either the base or collector of a transistor. It is for this reason, that DCTL is sometimes referred to as operating in the current mode.

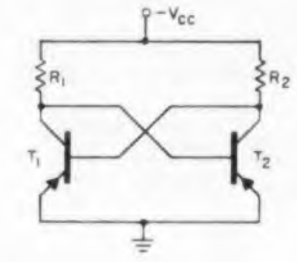

Fig. 1. Direct-coupled transistor logic (*DCTL*) flip-flop circuit. When T_1 is on, the V_{CE} voltage of T_1 is too low to turn on T_2. When T_1 is triggered off, T_1's V_{CE} increases, permitting T_2 to conduct; the V_{BE} applied to T_1 decreases causing T_1 to turn off.

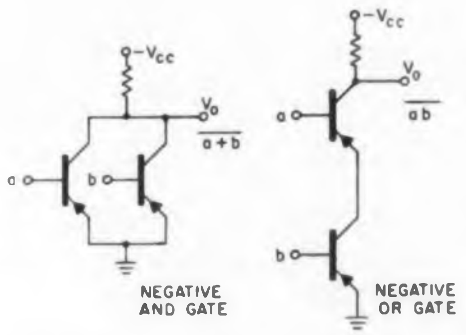

Fig. 2. A parallel *DCTL* logic gate (a) and a series gate (b). Only small voltage swings, in the order of 0.5 v, are handled and the switching speed is limited only by the transistor selected.

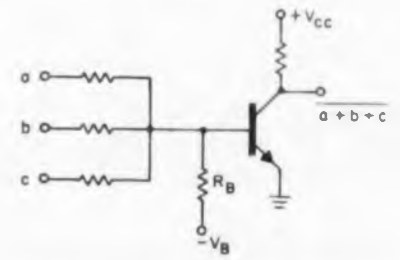

Fig. 3. Resistor-transistor logic (*RTL*) circuits are popular for medium speed, medium current applications since relatively cheap transistors can be used.

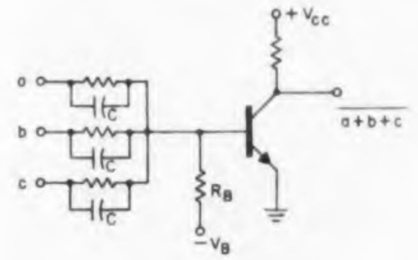

Fig. 4. By adding a capacitor to compensate for stored charge effects in the *RTL* arrangement, an *RCTL* circuit is created for faster speed applications. An *RCTL* NOR circuit is shown.

Resistor Transistor Logic (RTL)

RTL circuits are straightforward saturated switching circuits designed for medium speed, medium current logic operations; Fig. 3 shows an RTL NOR circuit.

All logic operations can be performed by this single logic circuit since any positive input produces an inverted output regardless of the other inputs. Conversely, all inputs must be negative to give a positive output. A large number of audio and medium speed transistors readily meet the requirements for this type of operation, but special attention should be given to voltage ratings, dc beta, and charge storage Q_S.

When selecting a transistor, the first consideration should be given to the maximum voltage between collector and emitter, V_{CE}, when the transistor is in the "off" condition. In many instances this voltage can exceed the rated V_{CEO} of the transistor depending on the value of R_B and V_B in Fig. 3. As the reverse bias is increased, the V_{CE} breakdown will increase. Always specify the V_{CE} rating with the base reverse biased by V_B and R_B.

The required dc gain (h_{FE}) should be specified at the operating current of the circuit. If a minimum saturated gain is required at a specific collector current, the transistor should be selected to just meet that condition.

Transistors with a very high gain will insure fast turn-on time ($t_d + t_r$), but must sacrifice turn-off time ($t_s + t_f$). This is due to the fact that operating the transistor in saturation produces charge storage effects which are proportional to the degree of saturation. Thus, as the charge storage (Q_s) and the storage time of the transistor increases, it will take a longer period of time for the stored charge to leave the base region of the transistor and permit it to turn off. Further, it should be noted that h_{FE} is a function of I_c; although a transistor might meet a minimum h_{FE} requirement at say 5 ma, there is no guarantee that h_{FE} would be acceptable at $I_c = 50$ ma.

RTL circuits can also be operated in an unsaturated switching mode. This would eliminate the charge storage effects. Unfortunately though, it will require greater power dissipation in the transistor and more components. The logic levels will also be closer together than they would be in the saturated mode.

Resistor Capacitor Transistor Logic (RCTL)

Resistor-capacitor logic (RCTL) is basically the same as the RTL with the addition of speed up capacitors to minimize the storage time by supplying a charge equal to the stored base charge. The additional components, and a carefully selected charge storage (Q_s) specification will optimize the RTL circuits as illustrated in Fig. 4, where the value of the speed up capacitor is chosen so that it will effectively compensate for the stored charge.

The value of C may be calculated by

$$\frac{Q_s}{V_{in}} = C$$

where Q_s is the maximum rated value of charge storage and V_{in} is the input voltage swing.

As expected, this transistor will be slightly more expensive since it is a well specified, highly efficient switching transistor. The maximum pulse repetition rate for most practical circuits will be limited by the RC time constant in the base.

Diode Logic (DL)

Diode logic has the advantages of high speed, low cost, and simplified circuitry. Diodes perform the logic, and transistors are used as amplifiers and inverters since there is no inversion in diode logic. A diode AND circuit is shown in Fig. 5a.

The output voltage of the AND circuit ap-

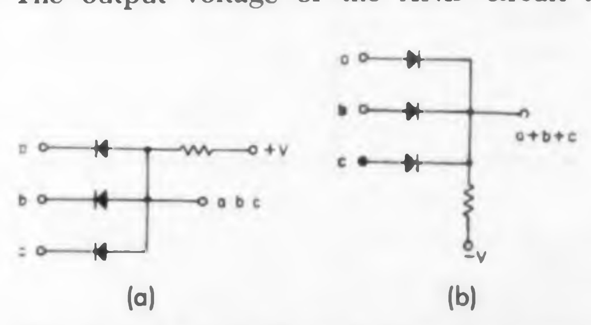

Fig. 5. A diode AND circuit for positive inputs (a). Diode logic (*DL*) permits high speed at low cost; transistors are used as amplifiers and inverters following the logic operation. In (b) is shown a diode OR circuit for positive inputs.

proximately equals the most negative input voltage. This is true regardless of the number of inputs. An OR circuit for positive inputs, where the output voltage approximately equals the most positive input voltage is shown in Fig. 5b.

The back resistance of diodes in AND/OR circuits acts as a load on the driving circuits. When this effective back resistance is too low, the driving source (another diode circuit or emitter follower) cannot supply enough current to maintain proper down levels, or maintain required rise and fall times. Diode AND/OR circuits with six or seven inputs are used and these circuits present the problem of lowered effective back resistance. If cascaded inputs are used, back resistance can be greatly increased. Figs. 6a and 6b show how cascaded diode logic will improve the load impedance as seen by the driving source (—20 v). (The back resistance of each diode is approximately 400 K.)

The rise and fall times of diode logic circuits are primarily a function of the circuit capacitance including the diode capacitance and the limiting resistor. Usually, for circuit design, the rise or fall time and the stray capacitance are known, and by transient analysis the value of limiting resistance can be calculated. For an AND circuit the fall time usually follows the input, while for an OR circuit the rise time usually follows the input.

Specification of the diodes should include peak inverse voltage, maximum reverse dc operating voltage, forward voltage and current and reverse recovery time. From the reverse dc condition, the value of back resistance can be calculated from which to select a minimum design value.

The maximum reverse voltage should be selected such that the diode will not break down under the worst bias conditions existing in the circuit. Recovery time should be specified relative to the clock rate of the computer to insure that the diodes will recover between operations. Always specify recovery time simulating actual circuit conditions as closely as possible.

Selection of transistors for inversion and amplification would be the same as for RTL circuits except that switching times should be selected to be compatible with the switching speed of the diodes. The use of transistors unsuitable for DCTL circuits, low impedances and low voltage swings, the lack of serious noise problems, as well as the small number of transistors required, make this mode of operation very desirable.

Current Mode Logic (CML)

Another important type of operation is current mode logic which makes use of the full potential speed of switching transistors. Biasing the circuit so that the transistor will not go into saturation will eliminate the problem of charge storage as discussed earlier. Since it is known that the cutoff frequency and the collector capacitance vary with operating point, operating conditions can be selected to give a maximum cutoff frequency and at the same time, a minimum output capacitance. Collector capacitance is proportional to the square root of $1/V_{CB}$ and frequency cut-off is a function of I_E and V_{CB}. From this guide, it can be shown that an operating point of about 5 v V_{CB} and ma for I_E will satisfy both conditions and give good frequency response.

Drift transistors are ideally suited for current mode switching. They are biased by constant current supplies to keep them out of saturation. Voltage excursions are small, but the circuitry is relatively unaffected by noise.

Fig. 7 shows a typical current mode NOR circuit. The transient response of the transistor is very nearly the same as for common-base operation. Because of the current source in the emitter, the entire common-base frequency response of the transistor can be realized.

When specifying drift transistors for computer circuits, certain parameters should be particularly selected. The collector emitter breakdown voltage should be specified so as not to be exceeded by the voltage of the constant current supply. Because of the high frequency cut-off of drift tra

Table 1. A Comparison of Five Semiconductor Logic Arrangements with Comments on the Criteria for Device Selection.

Logic Mode	Features	Limitations	Semiconductor Parameters to be Specified
DCTL	1) Simple Circuitry. 2) Saturating logic. 3) Low power dissipation. 4) Small supply voltages. 5) High speed. 6) Transistors that have low breakdown voltages can be used.	1) Storage effect limits turn off time. 2) Small voltage swings. 3) Expensive, requires a large number of transistors.	1) Strict control of V_{CE}, V_{BE} $V_{CE} \ll V_{BE}$ 2) Low charge storage. 3) High common emitter frequency characteristics. 4) Gain at operating conditions.
RTL	1) Economical use of transistors. 2) Large voltage swings can be handled. All logic functions can be performed.	1) Medium speed. 2) Serious charge storage limiting t_{off} speed. 3) Higher power dissipation than DCTL.	1) Collector-emitter avalanche voltage. 2) Gain at operating collector current. 3) Charge Storage. 4) V_{CBO} and V_{PI}
RCTL	Same as RTL except higher speed possible.	Additional components required (speed up capacitor).	Same as RTL except charge storage requirements are more critical.
DL (Diode Logic)	1) Very economical. 2) Relatively simple design. 3) High speed easily obtained. 4) Low power dissipation. 5) Large number of inputs possible.	1) Logic does not perform inversions.	1) Peak inverse voltage. 2) Maximum reverse dc operating voltages. 3) Forward voltage and current characteristics. 4) Reverse recovery time. 5) Reverse impedance.
CML (Current Mode Logic)	1) Uses full potential speed of the transistor. 2) No charge storage problems. 3) Relatively unaffected by noise. 4) Increased base drive for faster t_{on}, without sacrificing t_{off}.	1) Higher dissipation than other modes. 2) Small voltage swings. 3) Requires additional transistors. 4) Requires constant current supply.	1) f_{ab} or gain-bandwidth product. 2) Unsaturated low current gain.

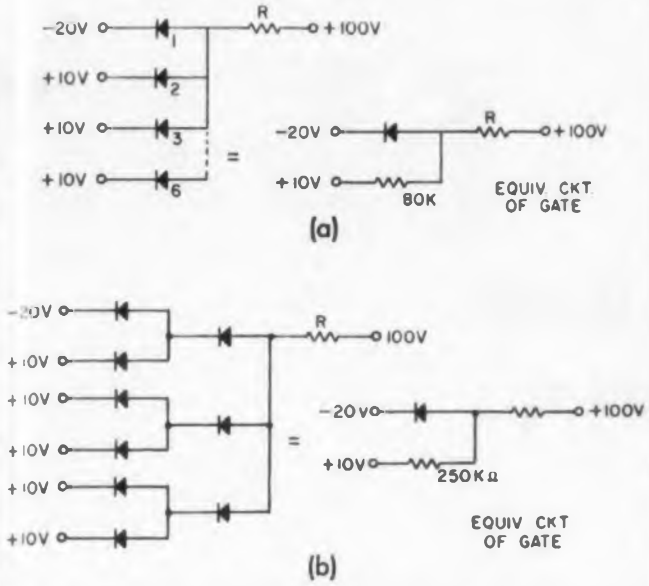

Fig. 6. By cascading diode logic inputs (b), the driving source impedance increases to 250 k (assuming each diode has a reverse resistance of 400 k) compared to 80 k when all inputs are in parallel (a).

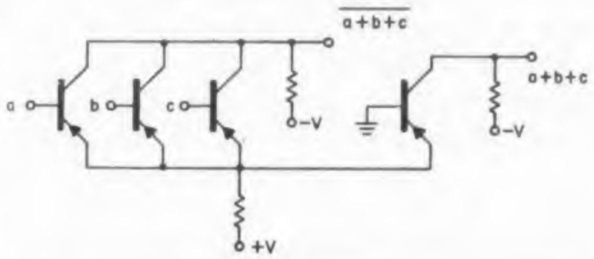

Fig. 7. Current mode logic (CML) NOR circuit with inverter. Biasing is such that the transistor does not saturate thereby eliminating the charge storage problem which limits speed.

sistors, a gain bandwidth measurement is substituted for the common base cut-off frequency. Gain bandwidth is measured in the common emitter configuration and defined as the gain frequency product when the gain fall off with frequency is 6 db per octave, and is approximately 0.7 of the frequency cut-off. This relationship differs for each type of transistor. In the mesa transistor, GBW is usually considerably larger than $f\alpha_b$, while for some types of drift transistors, the GBW can be only half of the $f\alpha_b$. In other words, a transistor with GBW of 30 mc could have a frequency cut-off of 50-60 mc.

Other important parameters to specify are dc gain (h_{FE}) in an unsaturated condition, usually $I_B = 500$ μa, and $V_{CE} = 1$ v. The 2N602 and 2N603 are specially designed drift transistors for very high speed and reliable current mode logic circuits. ■ ■

Bibliography

Design of Transistorized Circuits for Digital Computers—A. Pressman; Rider 1959.
Pulse and Digital Circuits—J. Millman—H. Taub; McGraw-Hill 1956.
Transistor Circuit Engineering—W. F. Chow et al; John Wiley & Sons 1957.

Transistors Most Frequently Used In Signal Corps R&D Equipment

Irving J. Ross
U. S. Army Signal Research and Development Laboratory
Fort Monmouth, N. J.

THE MOST frequently used types of transistors used in Signal Corps research and development equipment are shown in Tables I and II. The tables show a breakdown by categories of transistor application and by quantities of transistors used. The information for this report was based primarily on submissions of transistor complement reports by contractors of Signal Corps research and development equipment. It must be realized that in the design of research and development equipment, the transistor complements are not frozen and may change with subsequent circuit design modifications. The information given is, therefore, the status as of April 30, 1960.

The total number of development equipment models represented in this compilation is roughly 4,900 and encompasses the full range of military equipment being developed for the Signal Corps. Included are such categories as data processing (computers), radar, communications, countermeasures, and instrumentation (test equipment).

The tables include only those transistor types for which military specifications have been prepared. This includes all silicon types shown in Table II. It should be noted that the majority of transistor types are germanium (24 types) as against silicon (17). It is expected that the trend for silicon transistors will be increased as high junction temperatures are required for compact, high performance military equipment. ■ ■

Table 1. Most frequently used germanium transistors covered by military specifications.

Category	500 –1,000	1,000 –2,000	2,000 –5,000	5,000 –10,000	>10,000
NPN Low Power Low Freq.	*2N119	2N335 2N1247	2N332 2N333		
PNP Low Power Low Freq.		2N1026			
NPN Med Freq 3-30 Mc		2N495	2N338		
PNP Switch Low Speed < 5 µsec	2N328A				
NPN Med Speed Switch 1-5 µsec	2N545				
NPN High Speed > 1 µsec				2N706	
NPN Med Pwr 300 mw-3w	2N342	2N341	2N697		2N718
NPN 3w-30w	2N497				

Table 2. Most frequently used silicon transistors covered by military specificatons.

Category	500 –1,000	1,000 –2,000	2,000 –5,000	5,000 10,000	10,000 –20,000	> 20,000
PNP Low Power Low Freq.	2N467 2N526		*2N43A 2N465		2N466	
PNP Med Freq. 3-30Mc		2N274 2N416				
PNP High Freq. 30 Mc	2N502A	2N499		2N384		
PNP Med Speed Switch 1-5 µsec				2N404	*2N123 *2N240 2N248	
NPN Med Speed Switch 1-5 µsec	2N1000			2N388	2N167	
PNP High Speed Switch > 1 µsec				2N501A		2N393 2N1411
PNP High Power > 30 w	2N575	2N297A	2N174			

*These types are not recommended for future Signal Corps R&D equipment.

CIRCUITRY NOTES

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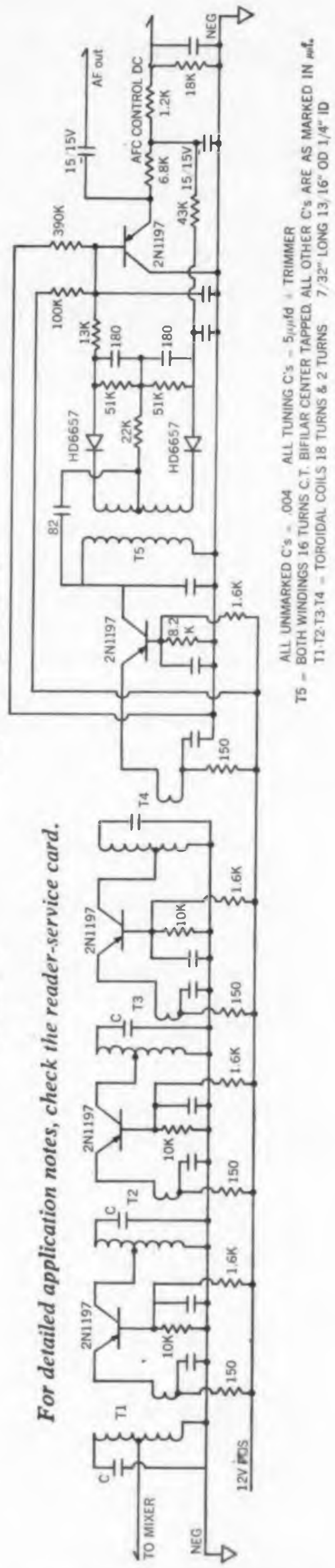
30MC AMPLIFIER & DISCRIMINATOR USING HUGHES SILICON MESA TRANSISTORS

3db Band Width 1 MC

80db Gain

For detailed application notes, check the reader-service card.



ALL UNMARKED C's - .004   ALL TUNING C's - 5μμfd + TRIMMER

T5 - BOTH WINDINGS 16 TURNS C.T. BIFILAR CENTER TAPPED. ALL OTHER C's ARE AS MARKED IN μfd.

T1-T2-T3-T4 - TOROIDAL COILS 18 TURNS & 2 TURNS 7/32" LONG 13/16" OD 1/4" ID

CIRCLE 46 ON READER-SERVICE CARD

CIRCLE 47 ON READER-SERVICE CARD

Guide to Military Transistor Specs

TO FACILITATE logistic support of transistorized military equipment a limited number of transistor types have been approved, by the Department of Defense, for engineers to consider during design and production. In MIL-STD-701A, see p 55, a list of preferred and guidance type transistors are given under joint approval of the Departments of the Army, Navy, and Air Force.

In MIL-STD-701A, preferred types are "the best available, those which have been in production, comply to particular military specifications and are listed on a Qualified Products List." Guidance types are "the best available, comply to a particular specification completed or in preparation, and possess a type designation acceptable to the military departments."

In addition, each service has its own particular list of approved types. A complete tabulation of *all* approved types that have been issued and their current status are presented on the facing page. ■ ■

Military-Approved Transistor Types

Detail Specification	Date Of Issue	Transistor Type	Remarks
IL-T-19500/1	14 June 1957	JAN-2N220	
IL-T-19500/2	12 December 1957	JAN-2N118	
IL-T-19500/3(NAVY)	- - -	2N230	Dropped
IL-T-19500/4A	16 January 1958	JAN-2N331	
IL-T-19500/5(USAF)	- - -	2N200	Dropped
IL-T-19500/6(USAF)	10 April 1958	2N44A	Amendment 1
IL-T-19500/7(NAVY)	- - -	2N43A	Dropped—See
			MIL-T-19500/18(USAF)
L-T-19500/8(SigC)	21 July 1958	2N129	
L-T-19500/9A	12 June 1959	JAN-2N128	
L-T-19500/10(USAF)	- - -	2N78	Dropped
L-T-19500/11(USAF)	3 April 1958	2N167	Amendment 1
L-T-19500/12(NAVY)	- - -	2N117	Dropped—See
			MIL-T-19500/35(Navy)
L-T-19500/13A	8 January 1958	JAN-2N174	
L-T-19500/14(USAF)	- - -	2N245	Dropped
L-T-19500/15(USAF)	- - -	2N246	Dropped
L-T-19500/16A	8 January 1958	JAN-2N342	
		JAN-2N343	
L-T-19500/17(USAF)	- - -	2N343	Dropped—See
			MIL-T-19500/16A
L-T-19500/18(USAF)	10 November 1958	2N43A	Amendment 2
L-T-19500/19	- - -	- - -	Never Used
L-T-19500/20(USAF)	25 March 1959	2N404	
L-T-19500/21(USAF)	10 April 1958	2N431	Obsolete
L-T-19500/22(USAF)	10 April 1958	2N432	Obsolete
L-T-19500/23(USAF)	10 April 1958	2N433	Obsolete
L-T-19500/24(NAVY)	20 September 1957	2N158	
L-T-19500/25(NAVY)	20 November 1957	2N240	
L-T-19500/26(SigC)	3 October 1957	2N274	
L-T-19500/27(SigC)	14 October 1957	2N384	
L-T-19500/28(USAF)	- - -	2N333	Dropped—See
			MIL-T-19500/37A(NAVY)
L-T-19500/29(USAF)	- - -	2N144	Dropped
L-T-19500/30(USAF)	4 February 1959	2N123	
L-T-19500/31(USAF)	- - -	2N339	Undated
		2N340	
		2N341	
L-T-19500/32	- - -	- - -	Never Used
L-T-19500/33	- - -	- - -	Never Used
L-T-19500/34(USAF)	- - -	2N243	Dropped
		2N244	
L-T-19500/35(NAVY)	15 March 1958	2N117	
		2N118	
		2N119	
T-19500/36A(SigC)	17 November 1958	2N297A	
T-19500/37A(NAVY)	18 June 1959	2N332	
		2N333	
		2N334	
		2N335	
T-19500/38(NAVY)	28 May 1958	2N539	
T-19500/39(Pro JAN)	- - -	2N299	Dropped
T-19500/40		JAN-2N325	Final Draft In
		JAN-2N326	Preparation
T-19500/41A(SigC)	26 January 1959	2N425	
T-19500/42A(SigC)	26 January 1959	2N426	
T-19500/43A(SigC)	26 January 1959	2N427	
T-19500/44A(SigC)	26 June 1959	2N428	
T-19500/45(USAF)	7 July 1958	2N461	
T-19500/46(SigC)	22 May 1958	2N574	
T-19500/47(SigC)	22 May 1958	2N575	
T-19500/48(USAF)	- - -	2N247	Dropped
T-19500/49B(SigC)	3 February 1959	2N464	

Detail Specification	Date Of Issue	Transistor Type	Remarks
MIL-T-19500/50A(SigC)	3 February 1959	2N465	
MIL-T-19500/51A(SigC)	3 February 1959	2N466	
MIL-T-19500/52B(SigC)	3 February 1959	2N467	
MIL-T-19500/53(SigC)	- - -	2N325	Dropped—See
			MIL-T-19500/61
			(SigC)
MIL-T-19500/54A(SigC)	13 August 1959	2N495	
MIL-T-19500/55(SigC)	21 July 1958	2N300	
MIL-T-19500/56A(SigC)	3 February 1959	2N416	
MIL-T-19500/57A(SigC)	3 February 1959	2N417	
MIL-T-19500/58A(SigC)	17 November 1958	2N665	
MIL-T-19500/59(Pro JAN)	- - -	JAN-2N333	Work temporarily
		JAN-2N335	suspended
MIL-T-19500/60B(NAVY)	29 June 1959	2N526	
MIL-T-19500/61(SigC)	23 October 1958	2N325	
MIL-T-19500/62(SigC)	5 December 1958	2N501A	
MIL-T-19500/63A(NAVY)	26 June 1959	2N358A	
MIL-S-19500/64A(NAVY)	14 September 1959	2N396A	
MIL-T-19500/65(NAVY)	20 March 1959	2N388	
MIL-T-19500/66A(NAVY)	26 June 1959	2N422	
MIL-T-19500/67(SigC)	22 January 1959	2N1011	
MIL-T-19500/68(SigC)	10 February 1959	2N1120	
MIL-T-19500/69A(NAVY)	26 June 1959	2N337	
		2N338	
MIL-T-19500/70(NAVY)	14 May 1959	2N463	
MIL-T-19500/71A(NAVY)	29 June 1959	2N1195	
MIL-T-19500/72(SigC)	5 March 1959	2N499	
MIL-T-19500/73(NAVY)	26 June 1959	2N560	
MIL-T-19500/74(NAVY)	30 June 1959	2N497	
		2N498	
		2N656	
		2N657	
MIL-T-19500/75(USAF)	- - -	2N489	Undated
		2N490	
		2N491	
		2N492	
		2N493	
		2N494	
MIL-T-19500/76(NAVY)	4 February 1960	2N1100	Undated
MIL-T-19500/77A(SigC)	30 October 1959	2N393	
MIL-T-19500/78A(SigC)	7 December 1959	2N1025	
		2N1026	
		2N1026A	
MIL-T-19500/79(SigC)	22 June 1959	2N1000	
MIL-T-19500/80(SigC)	22 June 1959	3N35	
MIL-T-19500/81(SigC)	17 July 1959	2N1001	
MIL-T-19500/82	10 August 1959	2N624	Never Used
MIL-T-19500/83(SigC)	10 August 1959	2N1002	
MIL-T-19500/84(USN)		2N545	
MIL-T-19500/85	14 Oct 1959	2N496	
MIL-T-19500/89(USN)		2N1039, 1041	
MIL-T-19500/99A	1 April 1960	2N696, 697	
MIL-T-19500/100	30 Nov 1959	2N537	
MIL-T-19500/101	30 Nov 1959	2N1201	
MIL-T-19500/102(USAF)		2N1016B	
MIL-T-19500/103	18 Dec 1959	2N1082	
MIL-T-19500/105	28 Dec 1959	2N1200	
MIL-T-19500/110	1 April 1960	2N328A	
MIL-T-19500/111	1 April 1960	2N329A	
MIL-T-19500/112	4 April 1960	2N502A	
MIL-T-19500/113	4 April 1960	2N1158A	

TRANSISTORS-1960

Airline Industry Completes Transistor Preferred List

AN OUTSTANDING example of a concentrated and well organized effort to prepare a transistor "Preferred List" is that of the Airlines Electronic Engineering Committee (AEEC), a body within Aeronautical Radio, Inc. (ARINC).

Activities of ARINC, a corporation in which U.S. scheduled airlines are major stockholders, include the operation of an extensive system of domestic and overseas land stations, allocation and assignment of operating frequencies, coordination of communication and electronic systems and the formulation of standards such as the ARINC Preferred Tube List and Preferred Transistor List.

Glamour vs Reliability

In 1947, an ARINC committee and the Military jointly prepared a listing of 10 tube types as a basis for the ARINC Preferred Tube List and the Military Standard Preferred List of Electron Tubes. In later years, 15 additional types were added to the ARINC list while the military (with a wider scope of applications) included 65 more types.

Tube and equipment manufacturers criticized the stubborn attitude of the ARINC body because of the failure to include latest high g_m, high power or "super-performance" tubes. However, stacks of carefully collected data on long-life operation and in-service reliability have helped to convince many former opponents of ARINC that it is perhaps wiser to "stick with old standbys" until the "new, glittering" devices have proved their performance.

Based on the wide acceptance and success of the ARINC Preferred Tube List, the ARINC Transistor Preferred List project was started in the fall of 1959.

39 U.S. Types on ARINC Transistor List

A total of 21 germanium and 18 silicon U.S. types (plus eight British types awaiting European Airline Electronics Committee approval) were included in the ARINC Preferred Transistor List completed April 1960, shown in Table I. Of these types, 64 per cent appear on the MIL-STD-701 listing, shown in Table II; military representatives at the ARINC meetings indicated that the next STD-701 revision will include several ARINC types presently off the MIL-STD chart. At that time, at least 85 per cent of the ARINC types will be MIL-STD approved. The eight British types, indicated as non-U.S. devices on Table I, are included in recognition of the practical fact that non-U.S. equipment manufacturers need "local" availability sources for production and logistics purposes.

How Transistor Types Were Selected

Criteria for inclusion of a particular transistor type include:

(1) The type must meet the requirements of a maximum number of future applications.

(2) The type should be reliable and of sound basic design with sufficient production experience to prove its process and performance.

(3) The type must be available, not a devel

Table 1. Arinc Transistor Preferred List

		GERMANIUM PNP	GERMANIUM NPN	SILICON PNP	SILICON NPN
Low Power	Audio <300 mw	2N525 2N526 2N466 CV 7008* CV 7006*	2N388	2N327A 2N328A CV 7044*	2N333 2N335 2N336
	Med. Freq. 3 to 30 mc	2N1224 CV 7003*	2N388	2N1132	2N697 2N337 2N338
	High Freq. 30 mc to 100 mc	2N1225 (OC 171)***			3N35
	Higher Freq. 100 mc up	2N1195 2N700			2N716
Switching	Low Speed >5 usec.	2N398 CV 7007*		2N327A 2N328A	
	Med. Speed 1 to 5 usec.	2N404 2N396A	2N167 2N388	2N491	2N337 2N338
	Fast <1 usec.	** CV 7087*		2N1132	2N697
Power	300 mw to 3 w	2N1039 2N1041			2N697 2N341 2N343
	3 to 30 w	2N158A CV 7083*	2N326		2N498 2N657 2N1486
	>30 w	2N174 2N1011 2N677C 2N1412 2N1120			1016B

* Non-U. S. proposed types.

** U. S. equipment manufacturers indicate no immediate requirements for this application; however, U. S. types will be added when the need arises.

***Non-U. S. proposed type which has not yet been assigned a "CV" number.

ient device. Multiple source supply is desirable ith essentially continuous quantity production ssured.

4) A MIL spec should exist which can be met in he event the airlines should wish to buy top-uality, high-yield devices.

5) The cost should be commensurate with per-rmance and reliability.

Equipment manufacturers who wish to use a on-ARINC type are advised to contact ARINC, 700 K St. N.W., Washington 6, D.C. The rea-ns for not approving the type will be outlined r recommendations for future inclusion will be rwarded to the Airlines Electronic Engineering ommittee.

ansistor Manufacturer, User and Military eased at Outcome

Although some transistor manufacturers were estfallen during early standardization meetings hen "pet" types were not endorsed, the final RINC transistor draft appeared favorable to all. addition, the air-borne equipment manufac-rers active during the list preparation indicated at their needs could be well covered by the de-ces approved. Finally, military representatives tive in their individual service standardization forts were pleased with the close compatibility hieved.

rline Customers Can Wait, Military Cannot

Equipment manufacturers are not forced to nform with the ARINC Preferred Transistor st. However, based on the emphasis which the line customers have previously (and still) place the ARINC tube types, it might be considered her unwise for an airborne equipment maker include unlisted transistor types. Sufficient tification for the need of a non-preferred type well as extensive reliability and performance ta would be needed before acceptance would approved, in many cases.

While the practice of incorporating non-MIL e components is certainly not uncommon in ny tightly specified military contracts, waivers often granted to the manufacturer to permit n "to get the job out on time." No waivers, no ivery.

The military urgently needs small, lightweight vices requiring a minimum of battery power—refore, they are often forced to grant waivers. e airline industry, representing an estimated 50 lion dollar annual electronic equipment cus-ner is not in dire need of transistorized equip-nt. Planes are equipped with reliable, tube plemented equipment which have reached a nt where preventive maintenance, parts inven-y and repair are well under control.

For space economy, cooler operation and hopes of longer life operation, the airlines are obviously interested in using transistors. However, they are adamant in their demands to sacrifice nothing in the way of reliability, maintenance, or operation.

This briefly means that the airline industry, as a group or as a single airline, will be extremely reluctant to buy a piece of equipment which includes non-ARINC preferred transistors. They may be quite content to wait, say another year, for the equipment manufacturer to redesign his proposed gear using preferred types or for sufficient data and proof to indicate that the non-ARINC type is suitable. Meanwhile, of course, another manufacturer of similar equipment may submit prototypes using ARINC approved types and walk off with quantity orders. ■ ■

Table 2. List of Mil-STD-701A Transistors

			GERMANIUM PNP	GERMANIUM PNP	SILICON PNP	SILICON NPN
Low Power	Audio <300 mw.	Preferred	2N220 2N331 2N526			2N335
		Guidance	2N43A 2N465 2N535B		2N1026	2N333
	Med. Freq. 3 to 30 mc.	Preferred				
		Guidance			2N495	2N338
	High Freq. >30 mc.	Preferred				
		Guidance	2N537 2N384 2N700			3N35
Switching	Low speed >5 usec total time	Preferred				
		Guidance	2N398		2N328A 2N329A	
	Medium speed 1 to15 µsec.	Preferred	2N404 2N428			
		Guidance	2N599 2N396A	2N1310 2N358A 2N388	2N491 2N496	2N337
	Fast Speed <1 usec.	Preferred	2N393		2N1132	2N697
		Guidance	2N695 2N1195 2N501A			2N560
	Bilateral Switch med. speed	Preferred				
		Guidance				
Power	300 mw to 3 w	Preferred				
		Guidance	2N1039			2N343 2N341
	3 to 30 w	Preferred				
		Guidance	2N539	2N326		2N498 2N657 2N1016E 2N497 2N656
	>30 w	Preferred	2N297A			
		Guidance	2N665 2N174 2N463 2N1120 2N1165			2N389 2N424 2N1050

New RCA Intermediate-Power Transistors feature JEDEC TO-8 case with removable heat sink mounting flange

6 NEW RCA INTERMEDIATE POWER TRANSISTORS

Now—in production quantities—six new RCA PNP germanium alloy junction transistors designed primarily for intermediate-power switching and audio-frequency industrial and military applications. Featuring 100°C maximum junction temperature and a unique case design, these new types can be used with or without the heat-sink mounting flange. With mounting flange in place, these types can dissipate 7.5 watts at 25°C case temperature; without flange, one watt at 25°C.

These new RCA intermediate-power transistors provide a choice of voltage ratings and beta ranges for design flexibility. They feature low saturation resistance and low leakage current.

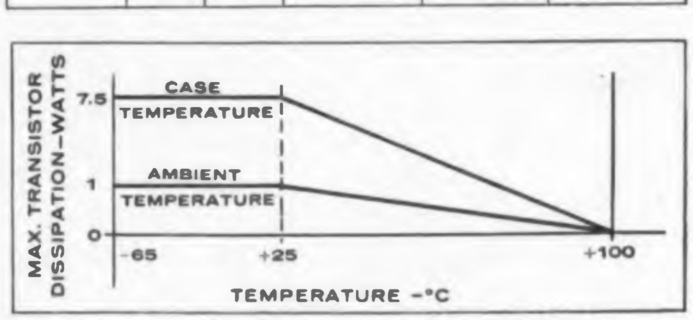
They are particularly useful in power switching circuits such as dc-to-dc converters, inverters, choppers, solenoid drivers, and relay controls; oscillator, regulator, and pulse-amplifier circuits, and as class A and class B push-pull amplifiers for servo and other audio-frequency applications.

RCA intermediate-power germanium transistors were developed in cooperation with the U. S. Army Signal Corps on an Industrial Preparedness Measure for military devices.

Call your nearest RCA field office today for full particulars. For further technical information write RCA Commercial Engineering Sec. G-18-NN-1, Somerville, N. J.

ELECTRICAL CHARACTERISTICS

Type	Min. V_{CES} (I_C = −50 ma)	Min. V_{CEO} (I_C = −50 ma)	Min. V_{CBO} (I_{CBO} = −250 μa)	Min. V_{EB} (I_E = −100 μa)	h_{FE} (I_C = −400 ma)
2N 1183	−35v	−20v	−45v	−20v	20-60
2N 1183A	−50v	−30v	−60v	−20v	20-60
2N 1183B	−60v	−40v	−80v	−20v	20-60
2N 1184	−35v	−20v	−45v	−20v	40-120
2N 1184A	−50v	−30v	−60v	−20v	40-120
2N 1184B	−60v	−40v	−80v	−20v	40-120



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ELECTRONIC DESIGN's Eighth Annual

TRANSISTOR DATA CHART

ELECTRONIC DESIGN's Eighth Annual Transistor Data Chart, following last year's pattern, has been specially tailored to meet the specific needs of the design engineer.

Contrary to existing lists which group transistors by manufacturer or in numerical sequence (fine for salesmen, of limited use to engineers), the 1960 Data Chart has transistors organized into six application categories:

- *Audio*—mostly general purpose types, under 1-w power rating. Types are listed in order of increasing forward-current transfer ratio.
- *Power devices*—transistors rated at 1 w and above are listed in order of increasing collector power dissipation.
- *High frequency*—types ranging up to and above the vhf range and tabulated in order of increasing alpha-cutoff frequency.
- *High-level switching*—devices intended to handle high currents are listed in order of increasing alpha-cutoff frequency.
- *Low-level switching*—low power devices for switching signal circuits are tabulated in order of increasing alpha-cutoff frequency. For both high- and low-level switching devices, rise, storage and fall time are given when supplied by manufacturers.
- *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.

For example, if a 5-w power transistor is required, it is merely necessary to scan down the "W_C" columns in the "Power Transistor" group until "5w" is found. Various units, together with significant characteristics and manufacturers, will be tabulated. Immediately several types are shown and final selection is up to the design engineer. Similar arrangement of the other groups by a key parameter grouping offers rapid selection and sufficient information for initial guidance to proper types. Only U. S. manufactured types are tabulated.

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-conformity in test methods among manufacturers. The manufacturer whose data is used for each particular type is listed under "Mfg." Other suppliers of the same types are found under "Remarks." There is no implication that the company listed under "Mfg." is a 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 specification 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

Type No.	Mfg.	Type	h_{fe} or h_{FE}	Max. Ratings W_c (mw)	T_j (c)	mw/c	V_c V	I_c ma	Characteristics I_{co} μa	NF db	C_c μμf	$f_{\alpha e}$ mc	Remarks	Type No.
2N461	MO	pnp,AJ,ge	.768.985	200	100	2.67	45	–	0.22	20	40	.5		2N461
2N160	RDR	npn,GJ,si	0.93	150	175	–	40	25	0.2	25	7	4		2N160
2N160A	RDR	npn,GJ,si	0.93	150	175	–	40	25	0.2	25	7	4		2N160A
2N349	RDR	npn,GJ,si	0.95	750	175	–	125	40	10	–	–	3		2N349
2N161	RDR	npn,GJ,si	0.96	150	175	–	40	25	0.2	25	7	5		2N161
2N161A	RDR	npn,GJ,si	0.96	150	175	–	40	25	0.2	25	7	5		2N161A
2N348	RDR	npn,GJ,si	0.96	750	175	–	90	50	10	–	–	3		2N348
2N1096	RDR	npn,GJ,si	0.96	500	175	–	90	30	6	–	–	3		2N1096
2N347	RDR	npn,GJ,si	0.98	750	175	–	60	60	10	–	–	3		2N347
2N1095	RDR	npn,GJ,si	0.98	500	175	–	60	40	5	–	–	3		2N1095
2N163	RDR	npn,GJ,si	0.99	150	175	–	40	25	0.2	25	7	6		2N163
2N163A	RDR	npn,GJ,si	0.99	150	175	–	40	25	0.2	25	7	6		2N163A
952	TI	npn,GJ,si	6	750	150	6	80	50	6	–	–	8	2N1155	952
951	TI	npn,GJ,si	9	750	150	6	50	60	5	–	–	8	2N1154	951
953	TI	npn,GJ,si	9	750	150	6	120	40	8	–	–	8	2N1156	953
2N117	TI	npn,GR,si	9-20	150	175	1	45	25	2	20	–	4	TR	2N117
2N332	TI	npn,GR,si	9-20	150	175	1	45	25	2	20	–	6	GE, RDR, TR	2N332
903	TI	npn,GJ,si	9-20	150	175	1	45	25	2	25	–	4	2N1149	903
2N243	TI	npn,GJ,si	9-32	750	150	6	60	60	1	–	–	7		2N243
2N45*	GT	pnp,AJ,ge	12	150	100	2	45	–	10	22	40	–	*MIL	2N45*
2N1439	NA	pnp,AJ,si	12	400	200	2.28	50	100	0.01	12	25	1	audio-med. pow.	2N1439
GT327A	GT	pnp,AJ,si	14	150	150	1.2	50	–	0.1	18	70	0.5	2N327A	GT327A
2N284	AMP	pnp,AJ,ge	15	125	75	2.5	32	125	–	–	–	–		2N284
2N284A	AMP	pnp,AJ,ge	15	125	75	2.5	60	125	–	–	–	–		2N284A
2N339A	TR	npn,DJ,si	15	1000	200	8	55	.1	1	–	–	–	beta specs at $3I_c$ levels	2N339A
2N340A	TR	npn,DJ,si	15	1000	200	8	85	.1	1	–	–	–	beta specs at 3 current levels	2N340A
2N341A	TR	npn,DJ,si	15	1000	200	8	125	.1	1	–	–	–	beta specs at 3 current levels	2N341A
2N1440	NA	pnp,AJ,si	15	400	200	2.28	50	100	0.01	12	25	1	audio/med. pow.	2N1440
2N1623	RA	pnp,AJ,si	15	250	160	0.54	20	50	.005	18	70	.1		2N1623
2N1655	RA	pnp,AJ,si	15	250	160	0.54	125	50	.005	18	70	.2		2N1655
TR34	IND	pnp,AJ,ge	15	120	85	3	40	150	10	15	15	1.6		TR34
2N472A	TR	npn,DG,si	16	200	200	1.1	45	–	.02	22	7	8	100% reliability assurance processed	2N472A
2N118	TI	npn,GR,si	18-40	150	175	1	45	25	2	20	–	5	TR	2N118
2N333	TI	npn,GR,si	18-40	150	175	1	45	25	2	20	–	8	GE, TR	2N333
904	TI	npn,GR,si	18-40	150	175	1	45	25	2	25	–	5	2N1150	904
2N334	TI	npn,GR,si	18-90	150	175	1	45	25	2	20	–	10	GE, TR	2N334
904A	TI	npn,GR,si	18-90	150	175	1	45	25	2	25	–	8	2N1151	904A
2N368	TI	pnp,AJ,ge	19-49	150	85	2	30	50	7	–	33	1		2N368
2N129	PH	pnp,AJ,ge	20	30	85	–	3.0	5.0	–	–	–	30	SPR	2N129
2N1051	WE	npn,DD,si	20	600	150	.25	40	–	–	–	8	60	US,MIL only	2N1051
OC200	AMP	pnp,PADT,si	20	250	150	–	25	50	10			1		OC200
2N406	SY	pnp,AJ,ge	20-80	150	75	3.	20	35	14	–	–	250		2N406
TR722	IND	pnp,AJ,ge	22	150	2.5	3	45	200	10	15	20	2.5		TR722
CK22A	RA	pnp,AJ,ge	22.5	80	85	–	20	100	2	6.5		1.2	micromin	CK22A
CK64	RA	pnp,FA,ge	23	80	85	–	29	100	2	22	–	0.8		CK64
CK64A	RA	pnp,AJ,ge	22.5	80	85	–	29	100	2	22		0.8	micromin	CK64A
2N186A	GE	pnp,AJ,ge	24	200	85	4	25	200	16	–	40	0.8		2N186A
2N189	GE	pnp,AJ,ge	24	75	85	2	25	50	16	15	40	0.8		2N189
2N381	SY	pnp,AJ,ge	24-45	200	85	3.3	25	200	20	–	–	10		2N381
2N44	GE	pnp,AJ,ge	25	240	100	4	45	300	16	6	40	1	MIL, GT	2N44
2N229	SY	npn,AJ,ge	25min	50	75	1	10	–	100	–	–	600		2N229
2N330A	SSD	pnp,AJ,si	25	–	160	3	30	50	.1	8	–	0.5		2N330A
2N402	WH	pnp,FJ,ge	25	180	85	3.3	25	200	15	12	40	0.6	AF driver	2N402
2N460	TS	pnp,AJ,ge	25	200	100	.3	45	400	15	–	–	–		2N460
2N564	IND	pnp,AJ,ge	25	150	85	2.5	30	300	3	12	20	0.8	US	2N564
2N592	GT	pnp,AJ,ge	25	150	100	.2	20	–	5	16	35	0.4	Bilateral	2N592
2N612	WH	pnp,FJ,ge	25	180	85	3.3	25	200	15	12	40	0.6	driver	2N612
2N1265	SY	pnp,AJ,ge	25	50	85	.9	10	100	100	–	–	0.6		2N1265
2N1441	NA	pnp,AJ,si	25	400	200	2.28	50	100	0.01	12	25	1	audio/med. pow.	2N1441
GT328A	GT	pnp,AJ,si	25	150	150	1.2	50	–	0.1	18	20	1	2N328A	GT328A
2N1101	SY	npn,AJ,ge	25-50	180	75	3.6	20	100	50	–	–	0.01	RCA	2N1101
2N1102	SY	npn,AJ,ge	25-50	180	75	3.6	40	100	50	–	–	0.01		2N1102
2N34	SY	pnp,AJ,ge	25-125	150	75	3	40	100	50	–	–	0.01	Driver	2N34
2N35	SY	npn,AJ,ge	25-125	150	75	3	40	100	50	–	–	.01	Driver	2N35
2N306	SY	npn,AJ,ge	25-125	50	85	.83	20	100	100	–	–	.6		2N306
2N464	IND	pnp,AJ,ge	26	150	85	2.5	45	200	6	15	20	0.7	Mo, Ro, US, GT	2N464
2N244	TI	npn,GJ,si	28-90	750	150	6	60	60	1	–	–	0.08		2N244
2N118	TI	npn,GR,si	29	150	175	1	45	25	2	20	–	5		2N118
2N279	AMP	pnp,AJ,ge	30	25	75	2.5	20	10	110	10	–	0.15		2N279
2N475A	TR	npn,DG,si	30	200	200	1.1	45	–	.02	20	7	10	100% reliability assurance processed	2N475A

Index of Manufacturers

Abbrev.	Company	Location
AMP	Amperex Electronic Co.	Hicksville, N. Y.
BE	Bendix Aviation Corp.	Long Branch, N. J.
CBS	CBS-Hytron, Semicon. Operations	Lowell, Mass.
CL	Clevite Transistor Products	Waltham, Mass.
CR	C. P. Clare Transistor Corp.	Glen Head, L. I., N
DE	Delco, General Motors Corp.	Kokomo, Ind.
FA	Fairchild Semicond. Corp.	Palo Alto, Calif.
GE	General Electric Co.	Syracuse, N. Y.
GT	General Transistor Corp.	Jamaica, N. Y.
HO	Hoffman Semiconductor Div.	El Monte, Calif.
HU	Hughes Products, Semicon. Div.	Los Angeles, Calif.
IND	Industro Transistor Corp.	Long Island City, N
MH	Minneapolis-Honeywell	Minneapolis, Minn.
MO8	Motorola, Semiconductor Products Div.	Phoenix, Ariz.
NA	National Semiconductor Corp.	Danbury, Conn.
PH	Philco Corp.	Lansdale, Pa.
PSI	Pacific Semiconductors, Inc.	Culver City, Calif.
RCA	Radio Corp. of America	Somerville, N. J.
RA	Raytheon Mfg. Co.	Newton, Mass.
Rh	Rheem Mfg. Co.	Mountain View, C
RRD	Radio Development and Research Corp.	Paterson, N. J.
STC	Silicon Transistor Corp.	Long Island City,
SSD	Sperry Semiconductor Div.	South Norwalk,
SPR	Sprague Electric Co.	North Adams, Ma
SY	Sylvania Semiconductor Div.	Woburn, Mass.

brev.

Te
Tr
Tu
U.
W
W

Ab

Alloy
Diffus
Doub
Grow
Diffus
Diffus
Drift
Fused
Fused
Grow
Germ
Grow
Grow
Meltb
MADT
Micro
Mesa
Rate
Silicon
Surfac
= Collec
across
open-
= Freque
ward-
of its
= Comm
transfe
= Comm
forwar
= Collect
verse

Company	Location
Texas Instruments, Inc.	Dallas, Tex.
Transitron Electronic Corp.	Wakefield, Mass.
Tung-Sol Electric, Inc.	East Orange, N. J.
U. S. Transistor Corp.	Syosset, L. I., N. Y.
Western Electric Co., Inc.	New York, N. Y.
Westinghouse Electric Corp.	Youngwood, Pa.

Abbreviation of Terms

Alloyed Junction
Diffused Base
Double Diffused
Grown Diffused
Diffused Junction
Diffused Mesa
Drift
Fused Alloy
Fused Junction
Grown Diffused
Germanium
Grown Junction
Grown Rate
Meltback
MADT
Micro Alloy
Mesa
Rate Grown
Silicon
Surface Barrier

= Collector to emitter capacitance measured across the output terminals with the input ac open-circuited.

= Frequency at which the magnitude of the forward-current transfer ratio (small-signal) is 0.707 of its low frequency value.

= Common Emitter-Small signal forward current transfer ratio

= Common Emitter-Static value of short-circuited forward current ratio

= Collector current when collector junction is reverse biased and emitter is dc open-circuited.

Audio *(continued)*

Type No.	Mfg.	Type	h_{fe} or h_{FE}	Max. Ratings W_c (mw)	T_j (c)	mw/c	V_c V	I_c ma	Characteristics I_{co} μa	NF db	C_c μμf	f_{ae} mc	Remarks	Type No.
2N524	SY	pnp,AJ,ge	30	225	100	3	45	500	10	–	–	2	GE	2N524
2N594	GT	npn,AJ,ge	30	100	85	1.67	20	–	2	16	15	2	Bilateral	2N594
2N1248	TR	npn,DG,si	30	30	150	0.24	6	–	2.0	1.1	9	5	Low noise	2N1248
2N1446	IND	pnp,AJ,ge	30	200	85	3.33	45	400	5	6	20	2		2N1446
2N1654	RA	pnp,AJ,si	30	250	160	0.54	80	50	.005	18	70	.2		2N1654
2N1656	RA	pnp,AJ,si	30	250	160	0.54	125	50	5	18	70	.2		2N1656
CK25A	RA	pnp,AJ,ge	30	·80	85	–	20	400	2	–	14	4	micromin RF switch	CK25A
OC201	AMP	pnp,PADT,si	30	250	150	–	25	50	10			4		OC201
2N331	MO	pnp,AJ,ge	30-70	75	85	1.2	30		1	20	50	.4		2N331
2N650A	MO	pnp,AJ,ge	30-70	200	100	2.67	45	500	.33	15	25	.75		2N650A
2N1372	SY	pnp,AJ,ge	30-90	150	100	2	25	200	100	–	–	–		2N1372
2N1373	SY	pnp,AJ,ge	30-90	150	100	2	45	200	100	–	–	–		2N1373
2N1432	SY	pnp,DD,ge	30-120	80	85	1.3	35	10	15	–	–	250		2N1432
2N1380	SY	pnp,AJ,ge	30-300	150	100	2	15	200	14	–	–	–		2N1380
2N1381	SY	pnp,AJ,ge	30-300	150	100	2	25	200	100	–	–	–		2N1381
2N319	GE	pnp,AJ,ge	34	225	85	4	20	200	16	–	25	2.20		2N319
2N403	WH	pnp,FJ,ge	35	180	85	3.3	25	200	15	12	40	0.85	driver	2N403
2N405	RCA	pnp,AJ,ge	35	150	85	2.5	20	70	14	–	–	0.25	SYL	2N405
2N406	RCA	pnp,AJ,ge	35	150	85	–	20	70	14	–	–	–		2N406
2N593	GT	pnp,AJ,ge	35	150	100	2	35	–	5	16	35	0.6	Bilateral	2N593
2N613	WH	pnp,FJ,ge	35	180	85	3.3	25	200	15	12	40	0.85	driver	2N613
2N734	TI	pnp,MS,si	35	1.0	175	–	80	50	1	20	5	50	TO-18	2N734
2N1010	RCA	npn,AJ,ge	35	20	55	–	10	2	10	5	–	2		2N1010
2N1564	TI	npn,MS,si	35	1.2	175	–	80	50	1	20	5	50	TO-5	2N1564
OC57	AMP	pnp,PADT,ge*	35	10	55	–	7	10	1.5			1.4		OC57
OC53	AMP	pnp,AJ,ge	35	10	55	0.7	3	5	0.1	10	–	0.01	Hearing aid	OC53
2N383	SY	pnp,AJ,ge	35-110	200	85	3.3	30	200	20	–	–	10		2N383
2N187A	GE	pnp,AJ,ge	36	200	85	4	25	200	16	–	40	1		2N187A
2N190	GE	pnp,AJ,ge	36	75	85	2	25	50	16	15	40	1		2N190
2N119	TI	npn,GR,si	36-90	150	175	1	45	25	2	20	–	6	TR	2N119
2N335	TI	npn,GR,si	36-90	150	175	1	45	25	2	20	–	13	TR, GE	2N335
905	TI	npn,GR,si	36-90	150	175	1	45	25	2	25	–	6	2N1152	905
2N650	MO	pnp,AJ,ge	40	200	100	2.8	25	250	4	10	20	2	US	2N650
2N653	MO	pnp,AJ,ge	40	200	100	2.8	15	250	4	10	20	2		2N653
2N742	NA	npn,MS,si	40	–	200	1.71	60	100	0.1	–	5	200	Switch	2N742
2N1009	SY	pnp,AJ,ge	40	150	85	2.5	25	20	1	–	–	–		2N1009
2N1191	MO	pnp,AJ,ge	40	175	85	2.8	25	200	4	10	20	1.5		2N1191
CK4	RA	pnp,AJ,ge	40	80	85	–	24	100	2		14	6	Submin. RF switch	CK4
CK4A	RA	pnp,AJ,ge	40	80	85	–	24	100	2	–	14	6	micromin RF switch	CK4A
CK26A	RA	pnp,AJ,ge	40	80	85	–	18	400	2	–	14	6	micromin RF switch	CK26A
TR-650	IND	pnp,AJ,ge	40	150	85	2.5	45	400	1.0	10	20	2	2N650	TR-650
TR-653	IND	pnp,AJ,ge	40	150	85	2.5	30	400	1.0	10	20	2		TR-653
2N382	SY	pnp,AJ,ge	40-76	200	85	3.3	25	200	20	–	–	10		2N382
2N43	GE	pnp,AJ,ge	42	240	100	4	45	300	16	6	40	1.3		2N43
OC79	AMP	pnp,PADT,ge	42	550	75	–	26	300	10	–	–	1.2		OC79
2N104	RCA	pnp,AJ,ge	44	150	85	–	30	50	10	12	–	0.7		2N104
2N215	RCA	pnp,AJ,ge	44	150	85	–	30	50	10	12	–	0.7		2N215
2N525	GE	pnp,AJ,ge	44	225	100	4	45	500	10	6	25	2.5	Sy	2N525
2N238	TI	pnp,AJ,ge	45	150	85	2.5	25	150	6	7.5	–	1.5		2N238
2N291	TI	pnp,AJ,ge	45	180	85	3	25	200	6	7.5	–	1.5		2N291
2N322	GE	pnp,AJ,ge	45	140	85	4	16	100	16	–	25	2.0	Driver	2N322
2N465	IND	pnp,AJ,ge	45	150	85	2.5	45	200	6	15	20	0.8	Mu, Ra, US, GT	2N465
2N595	GT	npn,AJ,ge	45	100	85	1.65	20	–	2	16	15	4	Bilateral	2N595
2N1098	GE	pnp,AJ,ge	45	140	85	4	16	100	16	–	25	–	Driver	2N1098
2N1442	NA	pnp,AJ,si	45	400	200	2.28	50	100	0.01	12	25	1	audio/med. power	2N1442
2N1145	GE	pnp,AJ,ge	45	140	85	4	16	100	16	–	40		Driver	2N1145
2N1372	TI	pnp,AJ,ge	45	250	100	3.3	25	200	3	7	–	1.5		2N1372
2N1373	TI	pnp,AJ,ge	45	250	100	3.3	45	200	3	7	–	1.5		2N1373
2N1447	IND	pnp,AJ,ge	45	200	85	3.3	45	400	5	6	20	3		2N1447
2N1451	IND	pnp,AJ,ge	45	200	85	3.3	45	400	7.5	9	20	1.5		2N1451
CK65	RA	pnp,FA,ge	45	80	85	–	24	100	2	22	–	1		CK65
CK65A	RA	pnp,AJ,ge	45	80	85	–	24	100	2	22		1.0	micromin	CK65A
TR721	IND	pnp,AJ,ge	45	150	2.5	3	30	200	10	15	20	3		TR721
2N280	AMP	pnp,AJ,ge	47	25	75	2.5	20	10	150	10	–	0.1		2N280
2N43A*	GT	pnp,AJ,ge	48	155	100	–	45	–	8	10	40	2	*MIL-GE	2N43A
2N61	WH	pnp,FI,ge	48	180	85	3.3	25	200	15	12	40	1		2N61
2N611	WH	pnp,FJ,ge	48	180	85	3.3	25	200	15	12	40	1		2N611
TR320	IND	pnp,AJ,ge	48	150	85	3	25	100	10	–	25	2.5	2N320	TR320
2N369	TI	pnp,AJ,ge	49-142	150	85	2	30	50	7	–	33	1.3		2N369
2N320	GE	pnp,AJ,ge	50	225	85	4	20	200	16	–	25	2.5		2N320

Audio *(continued)*

Type No.	Mfg.	Type	h_{fe} or h_{FE}	Max. Ratings W_c (mw)	T_j (c)	mw/$_c$	V_c V	I_c ma	Characteristics I_{co} ua	NF db	C_c uuf	$f_{\alpha e}$ mc	Remarks	Type No.
2N331	RCA	pnp,AJ,ge	50	200	85	–	30	200	16	9	–	1.16	GT, BE, IND	2N331
2N363	IND	pnp,AJ,ge	50	150	85	2.5	30	200	10	–	–	1	Ra, US	2N363
2N422	RA	pnp,FA,ge	50	150	85	–	20	100	6	6.5	–	0.8		2N422
2N1251	SY	npn,AJ,ge	50	150	85	2.5	20	100	50	–	–	7.5		2N1251
2N1273	TI	pnp,AJ,ge	50	150	85	2.5	15	150	3	6.5	–	–		2N1273
2N1274	TI	pnp,AJ,ge	50	150	85	2.5	25	150	3	6.5	–	–		2N1274
2N1383	TI	pnp,AJ,ge	50	200	85	3.3	25	200	3	7	–	1.5		2N1383
TR-320	IND	pnp,AJ,ge	50	150	85	2.5	30	200	7.5	–	20	2.5	2N320	TR-320
2N214	SY	npn,AJ,ge	50-100	180	85	3	40	100	50	–	–	0.01	Matched	2N214
2N228	SY	npn,AJ,ge	50-100	50	75	1	40	100	100	–	–	0.01		2N228
2N241A	SY	pnp,AJ,ge	50-100	200	85	3.3	30	200	16	–	–	10		2N241A
2N270	SY	pnp,AJ,ge	50-100	150	85	2.5	25	75	12	–	–	.01		2N270
2N321	SY	pnp,AJ,ge	50-100	200	85	3.3	25	200	16	–	–	10		2N321
2N1059	SY	npn,AJ,ge	50-100	180	75	3.6	20	100	50	–	–	0.01		2N1059
2N651A	MO	pnp,AJ,ge	50-120	200	100	2.67	45	500	.33	15	25	1.0		2N651A
2N408	SY	pnp,AJ,ge	50-135	150	85	2.5	20	70	14	–	–	–		2N408
2N109	SY	pnp,AJ,ge	50-150	50	85	.9	25	75	12	–	–	–		2N109
2N217	SY	pnp,AJ,ge	50-150	–	85	–	25	75	12	–	–	10		2N217
2N323	SY	pnp,AJ,ge	50-150	140	85	2.3	16	100	16	–	–	800		2N323
2N1374	SY	pnp,AJ,ge	50-150	150	100	2	25	200	100	–	–	–		2N1374
2N1375	SY	pnp,AJ,ge	50-150	150	100	2	45	200	100	–	–	–		2N1375
2N188A	GE	pnp,AJ,ge	54	200	85	4	25	200	16	–	40	1.2		2N188A
2N191	GE	pnp,AJ,ge	54	75	85	2	25	50	16	15	40	1.2	Driver	2N191
2N105	RCA	pnp,AJ,ge	55	60	85	–	25	15	7	16.5	–	0.75		2N105
2N566	IND	pnp,AJ,ge	55	150	85	2.5	30	300	3	12	20	1	US	2N566
2N1097	GE	pnp,AJ,ge	55	140	85	4	16	100	16	–	25	–	Driver	2N1097
2N1144	GE	pnp,AJ,ge	55	140	85	4	16	100	16	–	40	–	Driver	2N1144
CK27A	RA	pnp,AJ,ge	55	80	85	–	15	400	2	–	14	11	micromin RF switch	CK27A
OC54	AMP	pnp,AJ,ge	55	10	55	0.7	3	5	0.1	10	–	0.01	hearing aid	OC54
OC58	AMP	pnp,PADT,ge	55	10	55	–	7	10	1.5	–	–	1.6		OC58
2N226	PH	pnp,AJ,ge	60	250	75	5.0	30	150	8	–	140	0.4		2N226
2N480A	TR	npn,DG,si	60	200	200	1.1	45	–	.02	20	7	11	100% reliability assurance processed.	2N480A
2N596	GT	npn,AJ,ge	60	100	85	1.67	20	–	2	16	15	6	Bilateral	2N596
2N633	IND	pnp,AJ,ge	60	150	85	2.5	35	200	10	–	–	0.8	Ra, US	2N633
OC60	AMP	pnp,PADT,ge	60	10	55		7	10	1.5			1.6		OC60
2N526	SY	pnp,AJ,ge	64	225	85	3.7	45	500	10	–	–	3	GE	2N526
2N175	RCA	pnp,AJ,ge	65	50	85	–	10	2	12	6	–	0.85		2N175
2N220	RCA	pnp,AJ,ge	65	50	85	–	10	2	12	6	–	0.85		2N220
2N407	RCA	pnp,AJ,ge	65	150	85	–	20	70	14	–	–	–	SY	2N407
2N408	RCA	pnp,AJ,ge	65	150	85	–	20	70	14	–	–	–		2N408
2N649	RCA	npn,AJ,ge	65	100	85	–	20	100	14	–	–	–		2N649
2N1448	IND	pnp,AJ,ge	65	200	85	3.33	45	400	5	6	20	4		2N1448
2N1452	IND	pnp,AJ,ge	65	200	85	3.33	45	400	7.5	9	20	2.2		2N1452
OC56	AMP	pnp,AJ,ge	65	10	55	0.7	3	5	120	15	–	–	hearing aid	OC56
OC74	AMP	pnp,PADT,ge	65	550	75	–	20	300	10	–	–	1.5		OC74
2N323	GE	pnp,AJ,ge	68	140	85	4	16	100	16	–	25	2.5	Driver	2N323
2N281	AMP	pnp,PADT,ge	70	165	75	–	32	250	4.5	–	–	0.9		2N281
2N361	IND	pnp,AJ,ge	70	150	85	2.5	45	200	10	–	–	–	Ra, US	2N361
2N591	RCA	pnp,AJ,ge	70	100	85	–	32	40	7	–	–	–	SY	2N591
2N647	RCA	npn,AJ,ge	70	100	85	–	25	100	14	–	–	–		2N647
2N735	TI	npn,MS,si	70	1000	175	–	80	50	1	20	5	50	TO-18	2N735
2N1247	TR	npn,DG,si	70	30	150	0.24	6	–	0.8	–	9	5	Low drift dc amp.	2N1247
2N1352	IND	pnp,AJ,ge	70	150	85	2.5	30	200	2.5		18	2.5		2N1352
2N1565	TI	npn,MS,si	70	1200	175	–	80	50	1	20	40	50	TO-5	2N1565
2N213	SY	npn,AJ,ge	70-250	150	85	2.3	40	100	50	–	–	0.01		2N213
TR-383	IND	pnp,AJ,ge	72	200	85	3.33	25	200	7.5	–	20	1.8	2N383	TR-383
2N241	GE	pnp,AJ,ge	73	100	85	3	25	200	16	–	40	1.3		2N241
2N241A	GE	pnp,AJ,ge	73	200	85	4	25	200	16	–	40	1.3		2N241A
2N60	WH	pnp,FJ,ge	75	180	85	3.3	25	200	15	12	40	1.5		2N60
2N109	RCA	pnp,AJ,ge	75	150	85	–	25	70	14	–	–	–		2N109
2N192	GE	pnp,AJ,ge	75	75	85	2	25	50	16	15	40	1.5		2N192
2N217	RCA	pnp,AJ,ge	75	150	85	–	25	70	14	–	–	–		2N217
2N610	WH	pnp,FJ,ge	75	180	85	3.3	25	200	15	12	40	1.1		2N610
2N651	MO	pnp,AJ,ge	75	200	100	2.8	25	250	4	10	20	2.5	US	2N651
2N654	MO	pnp,AJ,ge	75	200	100	2.8	15	250	4	10	20	2.5	US	2N654
2N1192	MO	pnp,AJ,ge	75	175	85	2.8	25	200	4	10	20	2		2N1192
2N1443	NA	pnp,AJ,si	75	400	200	2.28	50	100	0.01	12	25	1	audio/med. power	2N1443
GT74	GT	pnp,AJ,ge	75	150	100	2	25	–	5	6	35	–		GT74
GT81	GT	pnp,AJ,ge	75	150	100	2	25	–	5	16	35	–		GT81
TR-323	IND	pnp,AJ,ge	75	150	85	2.5	16	200	7.5	–	20	2.5	2N323	TR-323
2N1376	SY	pnp,AJ,ge	75-150	150	100	2	25	200	100	–	–	–		2N1376
2N1431	SY	npn,AJ,ge	75-150	180	75	3.6	25	100	50	–	–	10		2N1431

A[illegible]di[illegible] [illegible]ntinued

Type No.	Mfg.	Type	h_{fe} or h_{FE}	Max. Ratings W_c (mw)	T_j (c)	mw/$_c$	NF db	C
2N120	TI	npn,GR,si	76-333	150	175	1	20	–
2N336	TI	npn,GR,si	76-333	150	175	1	20	–
910	TI	npn,GR,si	76-333	150	175	1	20	–
2N185	TI	pnp,AJ,ge	80	150	85	2.[illegible]	6.5	–
2N321	GE	pnp,AJ,ge	80	225	85	4	–	25
2N527	SY	pnp,AJ,ge	80	225.	85	3.7	–	–
2N1370	TI	pnp,AJ,ge	80	150	85	2.5	6.5	–
2N1371	TI	pnp,AJ,ge	80	150	85	2.5	6.5	–
2N1374	TI	pnp,AJ,ge	80	250	100	3.3	6.5	–
2N1375	TI	pnp,AJ,ge	80	250	100	3.3	6.5	–
2N1382	TI	pnp,AJ,ge	80	200	85	3.3	6.5	–
2N1449	IND	pnp,AJ,ge	80	200	85	3.3	6	20
CK28A	RA	pnp,AJ,ge	80	80	85	–	–	14
OC55	AMP	pnp,AJ,ge	80	19	55	0.7	10	–
OC59	AMP	pnp,AJ,ge	80	10	55	–		
TR-321	IND	pnp,AJ,ge	80	150	85	2.5	–	20
2N527	GE	pnp,AJ,ge	81	225	100	4	6	25
2N324	GE	pnp,AJ,ge	85	140	85	4	–	25
2N224	PH	pnp,AJ,ge	90	250	75	5.0	–	125
2N466	MO	pnp,AJ,ge	90	150	85	2.5	15	–
CK22	RA	pnp,FA,ge	90	85	85	–	6.5	–
CK66	RA	pnp,FA,ge	90	80	85	–	22	–
CK66A	RA	pnp,AJ,ge	90	80	85	–	22	–
OC75	AMP	pnp,PADT,ge	90	115	75			
2N1376	TI	pnp,AJ,ge	95	250	100	3.3	5.5	–
2N1377	TI	pnp,AJ,ge	95	250	100	3.3	5.5	–
2N59	WH	pnp,FJ,ge	100	180	85	3.3	12	40
2N207	PH	pnp,AJ,ge	100	50	65	1.25	5	–
2N207A	PH	pnp,AJ,ge	100	60	65	1.25	2	–
2N207B	PH	pnp,AJ,ge	100	50	65	1.25	2	–
2N360	RA	pnp,AJ,ge	100	150	85	2.5	–	–
2N362	IND	pnp,AJ,ge	100	150	85	2.5	–	–
2N535	PH	pnp,AJ,ge	100	50	85	0.83	5	–
2N534	PH	pnp,AJ,ge	100	25	65	1.43	–	–
2N535A	PH	pnp,AJ,ge	100	50	85	0.83	2	–
2N535B	PH	pnp,AJ,ge	100	50	85	0.83	2	–
2N568	IND	pnp,AJ,ge	100	150	85	2.5	12	20
2N609	WH	pnp,FJ,ge	100	180	85	3.3	12	40
2N632	IND	pnp,AJ,ge	100	150	85	2.5	–	–
2N736	TI	npn,MS,si	100	1000	175	–	[illegible]	5
2N1124	PH	pnp,AJ,ge	100	300	85	5.0	–	–
2N1128	PH	pnp,AJ,ge	100	150	85	2.5	–	90
2N1380	TI	pnp,AJ,ge	100	250	100	3.3	[illegible]	–
2N1381	TI	pnp,AJ,ge	100	250	100	3.3	[illegible]	–
TR383	IND	pnp,AJ,ge	100	150	85	3	–	50
2N652A	MO	pnp,AJ,ge	100–225	200	100	2.67	[illegible]	25
2N213A	SY	npn,AJ,ge	100–250	150	85	2.5	–	–
2N223	PH	pnp,AJ,ge	110	250	75	5.0	[illegible]	90
2N265	GE	pnp,AJ,ge	110	75	85	2	[illegible]	40
GT109	GT	pnp,AJ,ge	110	150	100	2	[illegible]	35
2N508	GE	pnp,AJ,ge	112	140	85	4	–	25
2N1018	RA	pnp,AJ,ge	120	80	85	–	–	14
TR-508	IND	pnp,AJ,ge	125	150	85	2.5	–	20
2N543A	TR	npn,DG,si	130	200	200	1.1	[illegible]	7
2N359	RA	pnp,AJ,ge	150	150	85	2.5	–	–
2N570	IND	pnp,AJ,ge	150	150	85	2.5	[illegible]	20
2N631	IND	pnp,AJ,ge	150	150	85	2.5	–	–
2N1008A	SY	pnp,AJ,ge	150	400	85	6.6	–	–
2N1471	IND	pnp,AJ,ge	150	200	85	3.33	–	18
2N652	MO	pnp,AJ,ge	160	200	100	2.8	[illegible]	20
2N655	MO	pnp,AJ,ge	160	200	100	2.8	[illegible]	20
2N1130	PH	pnp,AJ,ge	160	150	85	2.5	–	125
2N1193	MO	pnp,AJ,ge	160	175	85	2.8	[illegible]	20
2N467	IND	pnp,AJ,ge	180	150	85	2.5	[illegible]	20
CK67	RA	pnp,FA,ge	180	80	85	–	[illegible]	–
CK67A	RA	pnp,AJ,ge	180	80	85	–	[illegible]	
2N1129	PH	pnp,AJ,ge	190	150	85	2.5	–	125
2N572	IND	pnp,AJ,ge	200	150	85	2.5	[illegible]	20
2N1378	TI	pnp,AJ,ge	200	250	100	3.3	[illegible]	–
2N1379	TI	pnp,AJ,ge	200	250	100	3.3	[illegible]	–
OCP70	AMP	pnp,AJ,ge	–	25	65	2.5	[illegible]	–

DATA CHART

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Ratings °/c	NF db	C_c uuf	$f_{\alpha e}$ mc	Remarks	Type No.
	20	–	7		2N120
	20	–	13	TR, GE	2N336
1	20	–	7	2N1153	910
.5	6.5	–	2		2N185
1	-	25	3		2N321
.7	-	–	3.3		2N527
.5	6.5	–	2.0		2N1370
.5	6.5	–	2.0		2N1371
.3	6.5	–	2		2N1374
.3	6.5	–	2		2N1375
.3	6.5	–	2		2N1382
.3	6	20	5		2N1449
–	-	14	17	Micromin RF switch	CK28A
.7	10	–	0.01	hearing aid on	OC55
–			2.2		OC59
.5	-	20	3.1	2N321	TR-321
4	6	25	3.3		2N527
4	-	25	3	Driver	2N324
.0	-	125	0.51		2N224
.5	15	–	1	RA, US, GT	2N466
–	6.5	–	1.2		CK22
–	22	–	1.2		CK66
–	22	–	1.2	micromin	CK66A
			0.75		OC75
3.3	5.5	–	2		2N1376
1.3	5.5	–	2		2N1377
3.3	12	40	1.2		2N59
1.25	5	–	2		2N207
1.25	2	–	2		2N207A
1.25	2	–	2		2N207B
2.5	-	–	1.2	IND, US	2N360
2.5	-	–	–	Ra, US	2N362
0.83	5	–	2		2N535
1.43	-	–	–		2N534
0.83	2	–	2		2N535A
0.83	2	–	2		2N535B
2.5	12	20	1.5	US	2N568
3.3	12	40	1.2		2N609
2.5	-	–	1	Ra, US	2N632
–	20	5	50	TO-18	2N736
5.0	-	–	1.0		2N1124
2.5	-	90	1		2N1128
3.3	5.5	–	2		2N1380
3.3	5.5	–	2		2N1381
3	-	50	1.8	2N383	TR383
2.67	5	25	1.25		2N652A
2.5	-	–	10		2N213A
5.0	-	90	0.6		2N223
2	5	40	1.5	Driver	2N265
2	6	35	–		GT109
4	-	25	3.5	Driver	2N508
–	-	14	25	micromin RF switch	2N1018
2.5	-	20	3.5	2N508	TR508
1.1	20	7	15	100% reliabiltiy assurance processed.	2N543A
2.5	-	–	1	IND, US	2N359
2.5	2	20	2		2N570
2.5	-	–	1.2	RA	2N631
6.6	-	–	25		2N1008A
3.33	-	18	5		2N1471
2.8	0	20	3		2N652
2.8	0	20	3	US	2N655
2.5	-	125	0.75		2N1130
2.8		20	2.5		2N1193
2.5	5	20	1.2	Mo, Ra, US, GT	2N467
–	2	–	1.5		CK67
–	2			micromin	CK67A
2.5	-	125	0.75		2N1129
2.5	2	20	3		2N572
3.3		–	3		2N1378
3.3		–	3		2N1379
2.5	-	–	–	relay photo	OCP70

Po

Type No.	Mfg.	Type	W_C W	Max. Rat w/c	T_j °C	V_c V	racteristi	Pow Gai db
2N339	TI	npn, GR, si	1.0	0.008	150	55		30
2N340	TI	npn,GR,si	1.0	0.008	150	85		30
2N341	TI	npn,GR,si	1.0	0.008	150	125		30
2N342	TI	npn,GR,si	1.0	0.008	150	60		30
2N342A	TI	npn,GR,si	1.0	0.008	150	85		30
2N343	TI	npn,GR,si	1.0	0.008	150	60		30
2N1206	TR	npn,GR,si	1.2	0.01	200	60		–
2N1566	TI	npn,MS,si	1.2	–	175	80	mc	
2N1207	TR	npn,GR,si	1.2	–	200	60		–
2N1335	PS1	npn,MS,si	2.8	.024	150	120	mc	
2N1336	PS1	npn,MS,si	2.8	.024	150	120	mc	
2N1339	PS1	npn,MS,si	2.8	.024	150	120	mc	
2N1340	PS1	npn,MS,si	2.8	.024	150	120	mc	
2N1341	PS1	npn,MS,si	2.8	.024	150	120	mc	
2N1561	MO	pnp,MS,ge	3	.04	100	25	mc	
2N1562	MO	pnp,MS,ge	3	.04	100	25	mc	
OC30	AMP	pnp,PADT,ge	3.6	–	75	32		
2N497	TI	npn,DJ,si	4.0	.023	200	60	mc	
2N498	TI	npn,DJ,si	4.0	.023	200	100	mc	
2N656	TI	npn,DJ,si	4.0	.023	200	60	mc	
2N657	TI	npn,DJ,si	4.0	.023	200	100	mc	
2N1172	DE	pnp,AJ,ge	4	0.07	95	40		34
2N1479	RCA	npn,DJ,si	4		175	60	mc	
2N1480	RCA	npn,DJ,si	4	–	175	100	mc	
2N1481	RCA	npn,DJ,si	4	–	175	60	mc	
2N1482	RCA	npn,DJ,si	4	–	175	100	mc	
2N1067	STC	npn,DJ,si	5	0.067	175	60		–
H3A	MH	pnp,AJ,ge	5	0.07	95	60		–
H4A	MH	pnp,AJ,ge	5	0.07	95	60		–
2N326	SY	npn,AJ,ge	7	0.11	85	35		–
2N1183	RCA	pnp,AJ,ge	7.5		100	45		
2N1183A	RCA	pnp,AJ,ge	7.5		100	60		
2N1183B	RCA	pnp,AJ,ge	7.5		100	80		
2N1184	RCA	pnp,AJ,ge	7.5		100	45		
2N1184A	RCA	pnp,AJ,ge	7.5	–	100	–60		
2N1184B	RCA	pnp,AJ,ge	7.5	–	100	–80		
2N255	BE	pnp,AJ,ge	8.5	0.3	85	15		23
2N256	BE	pnp,AJ,ge	8.5	0.3	85	30		26
2N122	TI	npn,GR,si	8.75	0.07	150	120		28
2N176	SY	pnp,AJ,ge	10	0.15	90	30		35.5
2N350	SY	pnp,AJ,ge	10	0.13	100	40		32
2N351	RCA	pnp,AJ,ge	10	1.0	90	40		34
2N376	RCA	pnp,AJ,ge	10	1.0	90	40		35
2N669	MO	pnp,AJ,ge	10	1.5	90	30		40
2N1068	IND	npn,DJ,si	10	0.133	175	60		–
CDT1310	CL	pnp,AJ,ge	10	1.5	95	40		40-120
CDT1311	CL	pnp,AJ,ge	10	1.5	95	60		40-120
CDT1312	CL	pnp,AJ,ge	10	1.5	95	80		40-120
CDT1313	CL	pnp,AJ,ge	10	1.5	95	100		40-120
CST1740	CL	pnp,AJ,ge	10	2.5	95	4		28-33
CST1741	CL	pnp,AJ,ge	10	2.5	95	40		32-35
CST1742	CL	pnp,AJ,ge	10	2.5	95	4		34-37
CST1743	CL	pnp,AJ,ge	10	2.5	95	4		36-39
CST1744	CL	pnp,AJ,ge	10	2.5	95	8		28-37
CST1745	CL	pnp,AJ,ge	10	2.5	95	8		28-33
CST1746	CL	pnp,AJ,ge	10	2.5	95	8		32-37
CTP1104	CL	pnp,AJ,ge	10	2.0	85	4		28
CTP1105	CL	pnp,AJ,ge	10	2.0	85	4		30
CTP1106	CL	pnp,AJ,ge	10	2.0	85	2		27

ECTRO

Po

Max. Ratings ... Vc V	...characteristics	Powr. Gain db	Powr. Out. w	Remarks	Type No.
55	6	30	–	TR	2N339
85	6	30	–	TR	2N340
125	6	30	–	TR	2N341
60	6	30	–	TR	2N342
85	6	30	–	TR	2N342A
60	8	30	–	TR	2N343
60		–	–		2N1206
80	mc			TO-5	2N1566
60		–	–		2N1207
120	0 mc			high frequency, high power	2N1335
120	0 mc			high frequency, high power	2N1336
120	0 mc			high frequency, high power	2N1339
120	0 mc			high frequency, high power	2N1340
120	0 mc			high frequency, high power	2N1341
25	0 mc			high frequency, high power	2N1561
25	0 mc			high frequency, high power	2N1562
32					OC30
60	mc			TR	2N497
100	mc			TR	2N498
60	mc			TR	2N656
100	mc			TR	2N657
40		34	–	driver	2N1172
60	mc				2N1479
100	mc				2N1480
60	mc				2N1481
100	mc				2N1482
60		–	–		2N1067
60		–	–		H3A
60		–	–		H4A
35		–	–		2N326
45					2N1183
60					2N1183A
80					2N1183B
45					2N1184
–60					2N1184A
–80					2N1184B
15		23	–	2N234A, CL	2N255
30		26	2	2N234A, CL	2N256
120		28	–		2N122
30		35.5		Rca, Mo, Be	2N176
40		32		Mo	2N350
40		34	4	Mo. SY	2N351
40		35	4	Mo	2N376
30		40	2		2N669
60		–	–	STC	2N1068
40		40-120			CDT1310
60		40-120			CDT1311
80		40-120			CDT1312
100		40-120			CDT1313
40		28-33			CST1740
40		32-35			CST1741
40		34-37			CST1742
40		36-39			CST1743
80		28-37			CST1744
80		28-33			CST1745
80		32-37			CST1746
40		28	1.2		CTP1104
40		30	1.2		CTP1105
20		27	0.6		CTP1108

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Type No.	Mfg.	Type	W_C W	Max. Ratings w/c	T_j c	V
CTP1109	CL	pnp,AJ,ge	10	2.0	90	20
CTP1111	CL	pnp,AJ,ge	10	2.0	90	80
CTP1728	CL	pnp,AJ,ge	10	2.5	95	40
CTP1729	CL	pnp,AJ,ge	10	2.5	95	80
CTP1730	CL	pnp,AJ,ge	10	2.5	95	100
CTP1731	CL	pnp,AJ,ge	10	2.5	95	40
CTP1732	CL	pnp,AJ,ge	10	2.5	95	80
CTP1733	CL	pnp,AJ,ge	10	2.5	95	100
CTP1735	CL	pnp,AJ,ge	10	2.5	95	60
CTP1736	CL	pnp,AJ,ge	10	2.5	95	60
CST1739	CL	pnp,AJ,ge	10	2.5	95	40
2N1314/ OC26	AMP	pnp,PADT,ge	11	–	90	32
2N301A	SY	pnp,AJ,ge	12	0.2	85	60
2N1315/ OC27	AMP	pnp,PADT,ge	12.5	–	90	32
CTP1112	CL	pnp,AJ,ge	14	1.5	90	100
CTP1117	CL	pnp,AJ,ge	14	1.5	90	40
CTP1133	CL	pnp,AJ,ge	14	1.5	90	40
CTP1137	CL	pnp,AJ,ge	14	1.5	90	40
2N307	BE	pnp,AJ,ge	15	0.2	75	35
2N307A	SY	pnp,AJ,ge	17	0.34	75	35
2N1483	RCA	npn,DJ,si	15	–	175	60
2N1484	RCA	npn,DJ,si	15	–	175	100
2N1485	RCA	npn,DJ,si	15	–	175	60
2N1486	RCA	npn,DJ,si	15	–	175	100
2N155	CBS	pnp,AJ,ge	20	.33	85	30
2N156	CBS	pnp,AJ,ge	20	0.33	85	30
2N157	CBS	pnp,AJ,ge	20	0.33	85	60
2N157A	CBS	pnp,AJ,ge	20	0.33	85	100
2N158	CBS	pnp,AJ,ge	20	0.33	85	60
2N158A	CBS	pnp,AJ,ge	20	0.33	85	80
2N255A	CBS	pnp,AJ,ge	20	0.5	85	15
2N256A	CBS	pnp,AJ,ge	20	0.5	85	25
2N401	BE	pnp,AJ,ge	20	0.5	90	40
2N1042	TI	pnp,AJ,ge	20	.28	95	40
2N1043	TI	pnp,AJ,ge	20	.28	95	6
2N1044	TI	pnp,AJ,ge	20	.28	95	80
2N1045	TI	pnp,AJ,ge	20	.28	95	100
2N1078	CBS	pnp,AJ,ge	20	0.33	85	60
2N1291	CBS	pnp,AJ,ge	20	0.33	85	30
2N1292	CBS	npn,AJ,ge	20	0.33	85	30
2N1293	CBS	pnp,AJ,ge	20	0.33	85	60
2N1294	CBS	npn,AJ,ge	20	0.33	85	60
2N1295	CBS	pnp,AJ,ge	20	0.33	85	80
2N1296	CBS	npn,AJ,ge	20	0.33	85	80
2N1297	CBS	pnp,AJ,ge	20	0.33	85	100
2N1298	CBS	npn,AJ,ge	20	0.33	85	100
2N1320	CBS	pnp,AJ,ge	20	0.33	85	30
2N1321	CBS	npn,AJ,ge	20	0.33	85	30
2N1322	CBS	pnp,AJ,ge	20	0.33	85	60
2N1323	CBS	npn,AJ,ge	20	0.33	85	60
2N1324	CBS	pnp,AJ,ge	20	0.33	85	80
2N1325	CBS	npn,AJ,ge	20	0.33	85	80
2N1326	CBS	pnp,AJ,ge	20	0.33	85	100
2N1327	CBS	npn,AJ,ge	20	0.33	85	100
2N1328	CBS	pnp,AJ,ge	20	0.33	85	30
2N1329	CBS	npn,AJ,ge	20	0.33	85	30
2N1330	CBS	npn,AJ,ge	20	0.33	85	60
2N1331	CBS	pnp,AJ,ge	20	0.33	85	80
2N1332	CBS	npn,AJ,ge	20	0.33	85	80
2N1333	CBS	pnp,AJ,ge	20	0.33	85	100
2N1334	CBS	npn,AJ,ge	20	0.33	85	100
2N1437	CBS	pnp,AJ,ge	20	0.33	85	100
2N1438	CBS	pnp,AJ,ge	20	0.33	85	100
2N1465	CBS	pnp,AJ,ge	20	0.33	85	120
2N1466	CBS	pnp,AJ,ge	20	0.33	85	120
2N1504	CBS	pnp,AJ,ge	20	0.33	85	80
CDT1319	CL	pnp,AJ,ge	20	1.5	100	40
CDT1320	CL	pnp,AJ,ge	20	1.5	100	60
CDT1321	CL	pnp,AJ,ge	20	1.5	100	80
CDT1322	CL	pnp,AJ,ge	20	1.5	100	100

DATA CHART

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(…ued)

Ratings V_c V	Characteristics f_ae kc	Powr. Gain db	Powr. Out. w	Remarks	Type No.
20	6	35	0.6		CTP1109
80	4	29	1.2		CTP1111
40	15	30-75			CTP1728
20	8	30-75			CTP1729
100	8	30-75			CTP1730
40	10	60-150			CTP1731
80	6	60-150			CTP1732
100	6	60-150			CTP1733
60	15	30-75			CTP1735
60	10	60-150			CTP1736
40	7	28-39			CST1739
32	60				2N1314/OC26
60	5	35	–	CL, RCA, BE, CBS	2N301A
32	00			OC27	2N1315/OC27
100	–	–	–		CTP1112
40	5	35	4		CTP1117
40	20	30	1.2		CTP1133
40	5	34	1.2		CTP1137
35	–	–	–	2N234A	2N307
35	5	33	–	BE	2N307A
60	mc			STC	2N1483
100	mc			STC	2N1484
60	mc			STC	2N1485
100	mc			STC	2N1486
30	5	–	2	CL	2N155
30	5	–	2		2N156
60	5	–	2		2N157
100	5	–	2		2N157A
60	5	–	2		2N158
80	5	–	2		2N158A
15	5	25	2		2N255A
25	5	25	2		2N256A
40	-	30	5		2N401
40	10			TR	2N1042
6	10			TR	2N1043
80	10	–	–	TR	2N1044
100	10	–	–	TR	2N1045
60	5		2		2N1078
30	5		2		2N1291
30	5		2		2N1292
60	5		2		2N1293
60	5		2		2N1294
80	5		2		2N1295
80	5		2		2N1296
100	5		2		2N1297
100	5		2		2N1298
30	5		2	TO-10	2N1320
30	5		2	TO-10	2N1321
60	5		2	TO-10	2N1322
60	5		2	TO-10	2N1323
80	5		2	TO-10	2N1324
80	5		2	TO-10	2N1325
100	5		2	TO-10	2N1326
100	5		2	TO-10	2N1327
30	5		2	TO-13	2N1328
30	5		2	TO-13	2N1329
60	5		2	TO-13	2N1330
80	5		2	TO-13	2N1331
80	5		2	TO-13	2N1332
100	5		2	TO-13	2N1333
100			2	TO-13	2N1334
100			2	TO-13	2N1437
100			2	TO-10	2N1438
120			2	TO-13	2N1465
120			2	TO-10	2N1466
80			2		2N1504
40					CDT1319
60					CDT1320
80					CDT1321
100					CDT1322

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Pow inued)

Type No.	Mfg.	Type	W_C W	Max Ratings w/c	T_j c	V_c V	Character f kc	
LT-11	CBS	pnp,AJ,ge	20	0.33	85	80	5	
LT-12	CBS	pnp,AJ,ge	20	0.33	85	100	5	
LT-13	CBS	pnp,AJ,ge	20	0.33	85	120	5	
LT-14	CBS	pnp,AJ,ge	20	0.33	85	150	5	
LT-15	CBS	pnp,AJ,ge	20	0.33	85	200	5	
2N234A	BE	pnp,AJ,ge	25	0.5	90	30	–	
2N235A	BE	pnp,AJ,ge	25	0.5	90	40	6	
2N235B	BE	pnp,AJ,ge	25	0.5	90	40	–	
2N236A	BE	pnp,AJ,ge	25	0.5	95	40		
2N250	TI	pnp,AJ,ge	25	0.36	85	30	–	
2N251	TI	pnp,AJ,ge	25	0.36	85	60	–	
2N285A	BE	pnp,AJ,ge	25	0.5	95	40	–	
2N296	SY	pnp,AJ,ge	25	0.33	100	60	4	
2N350A	MO	pnp,AJ,ge	25	1.5	100	40	7	
2N351A	MO	pnp,AJ,ge	25	1.5	100	40	7	
2N376A	MO	pnp,AJ,ge	25	1.5	100	40	7	
2N399	BE	pnp,AJ,ge	25	0.5	90	40		
2N400	BE	pnp,AJ,ge	25	0.5	95	40	–	
2N419	BE	pnp,AJ,ge	25	0.5	95	45	–	
2N639	BE	pnp,AJ,ge	25	0.5	100	40	–	
2N639A	BE	pnp,AJ,ge	25	0.5	100	80	–	
2N639B	BE	pnp,AJ,ge	25	0.5	100	70	–	
2N1146	CL	pnp,AJ,ge	25	0.7	95	40	4	
2N1146A	CL	pnp,AJ,ge	25	0.7	95	60	4	
2N1146B	CL	pnp,AJ,ge	25	0.7	95	80	4	
2N1146C	CL	pnp,AJ,ge	25	0.7	95	100	4	
2N1147	CL	pnp,AJ,ge	25	0.7	95	40	4	
2N1147A	CL	pnp,AJ,ge	25	–	95	60	4	
2N1147B	CL	pnp,AJ,ge	25	–	95	80	4	
2N1147C	CL	pnp,AJ,ge	25	–	95	100	4	
2N1245	CBS	pnp,AJ,ge	25	0.5	85	25	5	
2N1246	CBS	pnp,AJ,ge	25	0.5	85	25	5	
B-177	BE	pnp,AJ,ge	25	0.5	90	30	–	3
B-178	BE	pnp,AJ,ge	25	0.5	90	30	40	3
B-179	BE	pnp,AJ,ge	25	0.5	90	40	25	2
CTP1500	CL	pnp,AJ,ge	25	1.0	95	100		
CTP1503	CL	pnp,AJ,ge	25	1.0	95	80	–	
CTP1504	CL	pnp,AJ,ge	25	1.0	95	60	–	
CTP1508	CL	pnp,AJ,ge	25	1.0	95	40	–	
CTP1544	CL	pnp,AJ,ge	25	1.0	95	60	3	
CTP1545	CL	pnp,AJ,ge	25	1.0	95	80	3	
CTP1552	CL	pnp,AJ,ge	25	1.0	95	40	3	
CTP1553	CL	pnp,AJ,ge	25	1.0	95	100	3	
2N236B	CBS	pnp,AJ,ge	30	–	85	40	5	3
2N242	SY	pnp,AJ,ge	30	0.33	100	45		3
2N257	BE	pnp,AJ,ge	30	0.5	90	40	–	3
2N268	BE	pnp,AJ,ge	30	0.5	90	80	6.0	3.
2N1505	PSI	npn,MS,si	30	–	175	50	50 mc	
2N1506	PSI	npn,MS,si	30	–	175	60	50 mc	
2N538	MH	pnp,AJ,ge	32	0.45	95	80	200	–
2N539	MH	pnp,AJ,ge	32	0.45	95	80	200	–
2N540	MH	pnp,AJ,ge	32	0.45	95	80	200	–
2N1202	MH	pnp,AJ,ge	32	0.45	95	80	200	–
2N1203	MH	pnp,AJ,ge	32	0.45	95	120	200	–
2N1261	MH	pnp,AJ,ge	32	0.45	95	80	200	–
2N1262	MH	pnp,AJ,ge	32	0.45	95	80	200	–
2N1263	MH	pnp,AJ,ge	32	0.45	95	80	200	–
2N1501	MH	pnp,AJ,ge	32	0.45	95	60	200	
2N1502	MH	pnp,AJ,ge	32	0.45	95	40	200	
H45	MH	pnp,AJ,ge	32	0.45	95	80	200	–
2N297A	MO	pnp,AJ,ge	35	0.5	95	80	5	
2N392	DE	pnp,AJ,ge	35	0.7	95	60	6	–
2N463	WE	pnp,AJ,ge	35	2	100	60	.5	–
2N553	DE	pnp,AJ,ge	35	0.5	95	80	25	–
2N665	DE	pnp,AJ,ge	35	0.5	95	80	25	–
2N1011	BE	pnp,AJ,ge	35	1.2	95	–	–	–
2N1073	BE	pnp,AJ,ge	35	1.2	100	40	–	–
2N1073A	BE	pnp,AJ,ge	35	1.2	100	80	–	–
2N1073B	BE	pnp,AJ,ge	35	1.2	100	120	–	–
2N1168	DE	pnp,AJ,ge	35	0.7	95	50	10	–
2N1047	TI	npn,DJ,si	40	0.25	200	80	–	–

DATA CHART

Pow... (...inued)

Ratings V_c V	Characteristics f_{ae} kc	Powr. Gain db	Powr. Out. w	Remarks	Type No.
80	5	–	–		LT-11
00	5	–	–		LT-12
20	5	–	–		LT-13
150	5	–	–		LT-14
00	5	–	–		LT-15
30	–	25	2	CBS	2N234A
40	6	36	2	CBS, CL	2N235A
40	–	38			2N235B
40		35	4		2N236A
30	–	30	–	CL	2N250
60	–	30	–		2N251
40	–	39			2N285A
60	4	–	–		2N296
40	7	31	4		2N350A
40	7	33	4		2N351A
40	7	35	4		2N376A
40		33	8		2N399
40	–	35	6		2N400
45	–	–	5		2N419
40	–	–	–		2N639
80	–	–	–		2N639A
70	–	–	–		2N639B
40	4	–	–		2N1146
60	4	–	–		2N1146A
80	4	–	–		2N1146B
100	4	–	–		2N1146C
40	4	–	–	solder lugs	2N1147
60	4	–	–	solder lugs	2N1147A
80	4	–	–	solder lugs	2N1147B
100	4	–	–	solder lugs	2N1147C
25	5	–	–		2N1245
25	5	–	–		2N1246
30	–	36	–		B-177
30	40	33	–		B-178
40	25	28	–		B-179
100					CTP1500
80	–				CTP1503
60	–				CTP1504
40	–				CTP1508
60	3				CTP1544
80	3				CTP1545
40	3				CTP1552
100	3				CTP1553
40	5	37	4	BE	2N236B
45		36	–	CL, BE	2N242
40	–	33		CL	2N257
80	6.0	35		SY, CL	2N268
50	250 mc			High frequency, high power	2N1505
60	250 mc			High frequency, high power	2N1506
80	200	–	–		2N538
80	200	–	–		2N539
80	200	–	–		2N540
80	200	–	–		2N1202
120	200	–	–		2N1203
80	200	–	–		2N1261
80	200	–	–		2N1262
80	200	–	–		2N1263
60	200				2N1501
40	200			Sat. volt =0.15v	2N1502
80	200	–	–		H45
80	5				2N297A
60	6	–	–		2N392
60	.5	–	–	US, MIL only.	2N463
80	25	–	–		2N553
80	25	–	–	2N665 SIG.	2N665
–	–	–	–	MO	2N1011
40	–	–	–		2N1073
80	–	–	–		2N1073A
120	–	–	–		2N1073B
50	10	–	–		2N1168
80	–	–	–	STC	2N1047

electrical tests

mechanical tests

shock tests

centrifuge tests

vibration tests

humidity tests

storage life tests

Approved "MEG-A-LIFE" units

MOTOROLA "MEG-A-LIFE" INDUSTRIAL POWER TRANSISTORS

Only Motorola power transistors offer 90 watts power dissipation, 0.2°C/W maximum thermal resistance and 100°C junction operating temperature.

6 AMP

h_{FE} (V_{CE} = 2V, I_C = 3A)	BV_{CBO} 40V	60V	80V	100V
75 - 150	2N1544A	[illegible]	[illegible]	[illegible]
50 - 100	2N1539A	2N1540A	2N1541A	[illegible]
35 - 70	2N1534A	[illegible]	[illegible]	[illegible]
20 - 40	2N1529A	2N1530A	2N1531A	[illegible]

15 AMP

h_{FE} (V_{CE} = 2V, I_C = 10A)	BV_{CBO} 40V	60V	80V	100V
50 - 100	[illegible]	[illegible]	[illegible]	[illegible]
30 - 60	2N1553A	2N1554A	2N1555A	[illegible]
10 - 30	[illegible]	2N1550A	2N1551A	[illegible]

25 AMP

h_{FE} (V_{CE} = 1V, I_C = 25A)	BV_{CBO} 50V	80V	100V
15 - 65	2N1162A	2N1164A	[illegible]
15 - 65	2N1163A	2N1165A	[illegible]

Motorola "MEG-A-LIFE" program extended

NOW CERTIFIED RELIABILITY FOR INDUSTRIAL POWER TRANSISTORS

46 types in 3 current ranges provide military reliability for industrial applications

Now you can have the same assurance of reliability for your critical industrial power transistor applications as you do when using military-approved types for military applications. Motorola, in its "Meg-A-Life" quality assurance program (with written certification) now offers 46 "military-quality" industrial power transistors in three current ratings with voltages of 40 to 100 and betas to 150.

When you use Motorola "Meg-A-Life" industrial power transistors, you can be sure they have successfully passed electrical, mechanical and environmental tests (including shock, centrifuge, vibration, humidity and temperature tests) and 1000-hour storage life tests at 100°C in accordance with MIL-S-19500. You can be sure because written certification of compliance to "Meg-A-Life" reliability requirements is available to you. Only Motorola offers such documentation of quality. Approved "Meg-A-Life" units are stored and shipped to you from a bonded area.

Since all tests represent the most adverse conditions for which these devices are designed, Motorola's "Meg-A-Life" program provides you with an assurance of reliability not previously available in industrial units.

FOR COMPLETE "MEG-A-LIFE" BROCHURE and specification sheets on new Motorola "Meg-A-Life" power transistors, contact your Motorola district office:

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MOTOROLA
Semiconductor Products Inc.

A SUBSIDIARY OF MOTOROLA, INC.

CIRCLE 55 ON READER-SERVICE CARD

Pow ontinued

Type No.	Mfg.	Type	W_C W	Max. Ratings w/c	T_j c	V	Charac- $f_{\alpha e}$ kc	
2N1048	TI	npn,DJ,si	40	0.25	200	120	–	
2N1049	TI	npn,DJ,si	40	0.25	200	80	–	
2N1050	TI	npn,DJ,si	40	0.25	200	120	–	
2N1453	CBS	pnp,AJ,ge	40	0.66	85	30	5	
2N1454	CBS	pnp,AJ,ge	40	0.66	85	30	5	
2N1455	CBS	pnp,AJ,ge	40	0.66	85	60	5	
2N1456	CBS	pnp,AJ,ge	40	0.66	85	60	5	
2N1457	CBS	pnp,AJ,ge	40	0.66	85	60	5	
2N1458	CBS	pnp,AJ,ge	40	0.66	85	80	5	
2N1461	CBS	pnp,AJ,ge	40	0.66	85	30	5	
2N1462	CBS	pnp,AJ,ge	40	0.66	85	30	5	
2N1463	CBS	pnp,AJ,ge	40	0.66	85	60	5	
2N1464	CBS	pnp,AJ,ge	40	0.66	85	60	5	
2N1120	BE	pnp,AJ,ge	45	1.0	95	–	–	
2N173	DE	pnp,AJ,ge	50	1.0	95	60	10	
2N277	DE	pnp,AJ,ge	50	1.0	95	40	10	
2N278	DE	pnp,AJ,ge	50	1.0	95	50	10	
2N441	DE	pnp,AJ,ge	50	1.0	95	40	10	
2N442	DE	pnp,AJ,ge	50	1.0	95	50	10	
2N443	DE	pnp,AJ,ge	50	1.0	95	60	10	
2N561	RCA	pnp,AJ,ge	50	1.0	100	80	–	
2N627	MO	pnp,AJ,ge	50	0.8	90	30	8	
2N628	MO	pnp,AJ,ge	50	0.8	90	45	8	
2N629	MO	pnp,AJ,ge	50	0.8	90	60	8	
2N630	MO	pnp,AJ,ge	50	0.8	90	80	8	
2N1014	RCA	pnp,AJ,ge	50	1.0	100	100	–	
2N1021	TI	pnp,AJ,ge	50	0.667	95	100	430	
2N1022	TI	pnp,AJ,ge	50	0.667	95	120	430	
2N1031	BE	pnp,AJ,ge	50	1.0	100	30	–	
2N1031A	BE	pnp,AJ,ge	50	1.0	100	40	–	
2N1031B	BE	pnp,AJ,ge	50	1.0	100	70	–	
2N1031C	BE	pnp,AJ,ge	50	1.0	100	80	–	
2N1032	BE	pnp,AJ,ge	50	1.0	100	30	–	
2N1032A	BE	pnp,AJ,ge	50	1.0	100	40	–	
2N1032B	BE	pnp,AJ,ge	50	1.0	100	70	–	
2N1032C	BE	pnp,AJ,ge	50	1.0	100	80		
2N1069	STC	npn,DJ,si	50	1.0	175	60	–	
2N1070	STC	npn,DJ,si	50	1.0	175	60	–	
2N1159	DE	pnp,AJ,ge	50	0.8	95	80	10	
2N1160	DE	pnp,AJ,ge	50	0.8	95	80	10	
2N1470	RA	npn,DJ,si	55	3.0	200 +200	60	1 mc	
2N1136	BE	pnp,AJ,ge	60	1.2	100	40	–	–
2N1136A	BE	pnp,AJ,ge	60	1.2	100	70	–	–
2N1136B	BE	pnp,AJ,ge	60	1.2	100	80	–	–
2N1137	BE	pnp,AJ,ge	60	1.2	100	40	–	–
2N1137A	BE	pnp,AJ,ge	60	1.2	100	70	–	–
2N1137B	BE	pnp,AJ,ge	60	1.2	100	80	–	–
2N1138	BE	pnp,AJ,ge	60	1.2	100	40	–	–
2N1138A	BE	pnp,AJ,ge	60	1.2	100	70	–	–
2N1138B	BE	pnp,AJ,ge	60	1.2	100	80	–	–
2N1487	RCA	npn,DJ,si	60	–	175	60	1mc	
2N1488	RCA	npn,DJ,si	60	–	175	100	1mc	
2N1489	RCA	npn,DJ,si	60	–	175	60	1mc	
2N1490	RCA	npn,DJ,si	60	–	175	100	.25mc	
2N174	DE	pnp,AJ,ge	70	0.8	95	80	10	–
2N1099	DE	pnp,AJ,ge	70	1.2	95	80	10	–
2N1100	DE	pnp,AJ,ge	70	1.2	95	100	10	–
2N174A	TS	pnp,AJ,ge	75	–	95	80	10	
3N45	MH	pnp,AJ,ge	75	1.0	100	60	00	–
3N46	MH	pnp,AJ,ge	75	1.0	100	80	00	–
3N47	MH	pnp,AJ,ge	75	1.0	100	40	00	
3N48	MH	pnp,AJ,ge	75	1.0	100	60	50	
2N511A	TI	pnp,AJ,ge	80	1.07	100	60	60	
2N511B	TI	pnp,AJ,ge	80	1.07	100	80	60	
2N512	TI	pnp,AJ,ge	80	1.07	100	40	80	
2N512A	TI	pnp,AJ,ge	80	1.07	100	60	80	
2N512B	TI	pnp,AJ,ge	80	1.07	100	80	80	
2N389	TI	npn,DJ,si	85	.48	200	60	mc	
2N424	TI	npn,DJ,si	85	.48	200	80	mc	
2N1210	TR	npn,DJ,si	85	.27	200	60	mc	

Pow(continued)

V_c V	f_ae kc	Powr. Gain db	Powr. Out. w	Remarks	Type No.
120	–	–	–	STC	2N1048
80	–	–	–	STC	2N1049
120	–	–	–	STC	2N1050
30	5		4	TO-13	2N1453
30	5		4	TO-13	2N1454
60	5		4	TO-13	2N1455
60	5		4	TO-13	2N1456
80	5		4	TO-13	2N1457
80	5		2	TO-13	2N1458
30	5		4	TO-10	2N1461
30	5		4	TO-10	2N1462
60	5		4	TO-10	2N1463
60	5		4	TO-10	2N1464
–	–	–	–	MO	2N1120
60	10	–	20		2N173
40	10	–	20		2N277
50	10	–	20		2N278
40	10	–	20		2N441
50	10	–	20		2N442
60	10	–	20		2N443
80	–	26	30		2N561
30	8	38	–		2N627
45	8	38	–		2N628
60	8	38	–		2N629
80	8	38	–		2N630
100	–	26	30		2N1014
100	430			TR	2N1021
120	430			TR	2N1022
30	–	–	–		2N1031
40	–	–	–		2N1031A
70	–	–	–		2N1031B
80	–	–	–		2N1031C
30	–	–	–		2N1032
40	–	–	–		2N1032A
70	–	–	–		2N1032B
80					2N1032C
60	–	–	–		2N1069
60	–	–	–		2N1070
80	10	–	–		2N1159
80	10	–	–		2N1160
60	1 mc				2N1470
40	–	–	–		2N1136
70	–	–	–		2N1136A
80	–	–	–		2N1136B
40	–	–	–		2N1137
70	–	–	–		2N1137A
80	–	–	–		2N1137B
40	–	–	–		2N1138
70	–	–	–		2N1138A
80	–	–	–		2N1138B
60	1mc			STC	2N1487
100	1mc			STC	2N1488
60	1mc			STC	2N1489
100	.25mc			STC	2N1490
80	10	–	40	JAN, 2N174A	2N174
80	10	–	40		2N1099
100	10	–	40		2N1100
80	10				2N174A
60	700	–	–	Sat. volt =0.15v	3N45
80	400	–	–	Sat. volt =0.15v	3N46
40	700			Sat. volt =0.15v	3N47
60	350			Sat. volt =0.15v	3N48
60	260				2N511A
80	260				2N511B
40	280				2N512
60	280				2N512A
80	280				2N512B
60	mc			STC, TR, RA	2N389
80	mc			STC, TR, RA	2N424
60	mc				2N1210

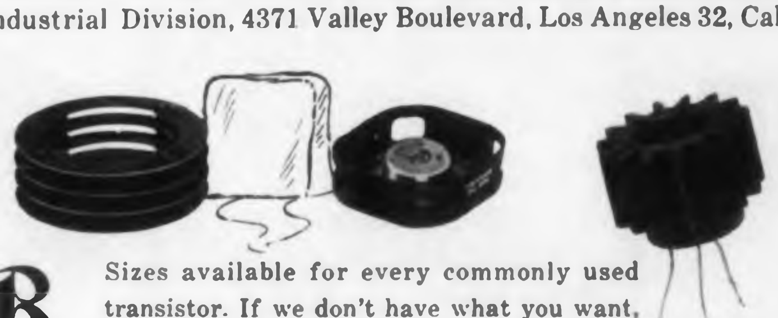
TRANSISTORS–1960

Powe[r] (continue[d])

Type No.	Mfg.	Type	W_C W	Max. Ratings w/c	T_j c	V_c V
2N1211	TR	npn,DJ,si	85	.27	200	80
2N1616	TR	npn,DJ,si	85	.27	200	60
2N1617	TR	npn,DJ,si	85	.27	200	100
2N1618	TR	npn,DJ,si	85	.27	200	100
2N1619	TR	npn,DJ,si	85	.27	200	80
ST440	TR	npn,DJ,si	85	.27	200	60
ST450	TR	npn,DJ,si	85	.27	200	60
STC1101	STC	npn,DJ,si	85	–	200	60
STC1102	STC	npn,DJ,si	85	–	200	100
STC1103	STC	npn,DJ,si	85	–	200	60
STC1104	STC	npn,DJ,si	85	–	200	100
2N1162	MO	pnp,AJ,ge	90	1.2	100	35
2N1163	MO	pnp,AJ,ge	90	1.2	100	35
2N1164	MO	pnp,AJ,ge	90	1.2	100	60
2N1165	MO	pnp,AJ,ge	90	1.2	100	60
2N1166	MO	pnp,AJ,ge	90	1.2	100	80
2N1167	MO	pnp,AJ,ge	90	1.2	100	80
2N1359	MO	pnp,AJ,ge	90	1.2	–	50
2N1360	MO	pnp,AJ,ge	90	1.2	–	50
2N1362	MO	pnp,AJ,ge	90	1.2	–	100
2N1363	MO	pnp,AJ,ge	90	1.2	–	100
2N1364	MO	pnp,AJ,ge	90	1.2	–	120
2N1365	MO	pnp,AJ,ge	90	1.2	100	120
2N1529	MO	pnp,AJ,ge	90	1.2	100	40
2N1530	MO	pnp,AJ,ge	90	1.2	100	40
2N1531	MO	pnp,AJ,ge	90	1.2	100	80
2N1532	MO	pnp,AJ,ge	90	1.2	100	100
2N1533	MO	pnp,AJ,ge	90	1.2	100	120
2N1534	MO	pnp,AJ,ge	90	1.2	100	40
2N1535	MO	pnp,AJ,ge	90	1.2	100	60
2N1536	MO	pnp,AJ,ge	90	1.2	100	80
2N1537	MO	pnp,AJ,ge	90	1.2	100	100
2N1538	MO	pnp,AJ,ge	90	1.2	100	120
2N1539	MO	pnp,AJ,ge	90	1.2	100	40
2N1540	MO	pnp,AJ,ge	90	1.2	100	60
2N1541	MO	pnp,AJ,ge	90	1.2	100	80
2N1542	MO	pnp,AJ,ge	90	1.2	100	100
2N1543	MO	pnp,AJ,ge	90	1.2	100	120
2N1544	MO	pnp,AJ,ge	90	1.2	100	40
2N1545	MO	pnp,AJ,ge	90	1.2	100	60
2N1546	MO	pnp,AJ,ge	90	1.2	100	80
2N1547	MO	pnp,AJ,ge	90	1.2	100	100
2N1548	MO	pnp,AJ,ge	90	1.2	100	120
2N1549	MO	pnp,AJ,ge	90	1.2	100	40
2N1550	MO	pnp,AJ,ge	90	1.2	100	60
2N1551	MO	pnp,AJ,ge	90	1.2	100	80
2N1552	MO	pnp,AJ,ge	90	1.2	100	100
2N1553	MO	pnp,AJ,ge	90	1.2	100	40
2N1554	MO	pnp,AJ,ge	90	1.2	100	60
2N1555	MO	pnp,AJ,ge	90	1.2	100	80
2N1556	MO	pnp,AJ,ge	90	1.2	100	100
2N1557	MO	pnp,AJ,ge	90	1.2	100	40
2N1558	MO	pnp,AJ,ge	90	1.2	100	60
2N1559	MO	pnp,AJ,ge	90	1.2	100	80
2N1560	MO	pnp,AJ,ge	90	1.2	100	100
3N49	MH	pnp,AJ,ge	94	1.25	100	60
3N50	MH	pnp,AJ,ge	94	1.25	100	80
3N51	MH	pnp,AJ,ge	94	1.25	100	40
3N52	MH	pnp,AJ,ge	94	1.25	100	60
2N574	MH	pnp,AJ,ge	100	1.43	95	60
2N574A	MH	pnp,AJ,ge	100	1.43	95	80
2N575	MH	pnp,AJ,ge	100	1.43	95	60
2N575A	MH	pnp,AJ,ge	100	1.43	95	80
2N1157	MH	pnp,AJ,ge	100	1.43	95	60
2N1157A	MH	pnp,AJ,ge	100	1.43	95	80
PT900	PSI	npn,MS,si	125	1	150	80
PT901	PSI	npn,MS,si	125	1	150	140

(continued)

Characteristics				
f_{ae} kc	Powr. Gain db	Powr. Out. w	Remarks	Type No.
15mc	–	–		2N1211
15mc	–	–		2N1616
15mc	–	–		2N1617
15mc	–	–		2N1618
15mc	–	–		2N1619
6mc	–	–		ST440
6mc				ST450
1mc				STC1101
1mc				STC1102
1mc				STC1103
1mc				STC1104
4	–	–		2N1162
4	–	–		2N1163
4	–	–		2N1164
4	–	–		2N1165
4	–	–		2N1166
4	–	–		2N1167
7				2N1359
5				2N1360
7				2N1362
5				2N1363
7				2N1364
5				2N1365
10				2N1529
10				2N1530
10				2N1531
10				2N1532
10				2N1533
8.5				2N1534
8.5				2N1535
8.5				2N1536
8.5				2N1537
8.5				2N1538
4				2N1539
4				2N1540
4				2N1541
4				2N1542
4				2N1543
4				2N1544
4				2N1545
4				2N1546
4				2N1547
4				2N1548
10				2N1549
10				2N1550
10				2N1551
10				2N1552
6				2N1553
6				2N1554
6				2N1555
6				2N1556
5				2N1557
5				2N1558
5				2N1559
5				2N1560
700			Sat. volt =0.15v	3N49
450			Sat. volt =0.15v	3N50
700			Sat. volt =0.15v	3N51
450			Sat. volt =0.15v	3N52
75	–	–		2N574
75	–	–		2N574A
75	–	–		2N575
75	–	–		2N575A
75	–	–		2N1157
75	–	–		2N1157A
0mc			High frequency, high power	PT900
0mc			High frequency, high power	PT901



High Frequen

Type No.	Mfg	Type	$f_{\alpha e}$ MC	Max. Ratings W_c (mw)	T_j (c)	mw/c	Characteristics I_{co}
2N444A	GT	npn,AJ,ge	1	150	100	2	2
2N1024	SSD	pnp,AJ,si	1	150	150	1.2	25
2N1025	SSD	pnp,AJ,si	1	150	150	1.2	25
2N94	SY	npn,AJ,ge	2	50	75	1	50
2N139	SY	pnp, AJ,ge	2(min)	.080	85	.75	50
2N169A	SY	npn,AJ,ge	2	65	75	.8	5
2N193	SY	npn,AJ,ge	2	50	75	1	50
2N194	SY	npn,AJ,ge	2	50	75	1	50
2N194A	SY	npn,AJ,ge	2	50	75	1	50
2N211	SY	npn,AJ,ge	2	50	70	1.1	20
2N233A	SY	npn,AJ,ge	2	50	75	r	50
2N413A	SY	pnp,AJ,ge	2	150	85	2.5	10
2N445	CBS	npn,AJ,ge	2	100	85	1.67	6
2N515	SY	npn,AJ,ge	2	50	75	1	50
2N516	SY	npn,AJ,ge	2	50	75	1	50
2N517	SY	npn,AJ,ge	2	50	75	1	50
2N519A	GT	pnp,AJ,ge	2	150	100	2	1
2N1026	SSD	pnp,AJ,Si	2	150	150	1.2	25
2N1469	SSD	pnp,AJ,si	2	150	150	1.2	25
2N413	RA	pnp,FA,ge	2.5	150	85	–	2.0
CK13	RA	pnp,FA,ge	2.5	80	85	–	2.0
GK13A	RA	pnp,AJ,ge	2.5	80	85		2.0
2N356	CBS	npn,AJ,ge	3	100	85	1.67	5
2N438	CBS	npn,AJ,ge	3	100	85	1.67	10
2N438A	CBS	npn,AJ,ge	3	150	85	2.5	10
2N445A	GT	npn,AJ,ge	3	150	100	2	2
2N481	RA	pnp,AJ,ge	3	200	85	3	3
2N614	WH	pnp,FJ,ge	3	125	85	2.1	6
2N1222	GT	pnp,AJ,si	3	150	150	1.2	0.05
2N482	IND	pnp,AJ,ge	3.5	150	85	2.5	3
TR-482	IND	pnp,AJ,ge	3.5	150	85	2.5	3
2N212	SY	npn,AJ,ge	4	50	75	1	50
2N385	CBS	npn,AJ,ge	4	150	100	2.0	35
2N414A	SY	pnp,AJ,ge	4	150	85	2.5	20
2N1027	SSD	pnp,AJ,si	4	150	150	1.2	25
2N1058	SY	npn,AJ,ge	4	50	75	1	50
2N94A	SY	npn,AJ,ge	5	50	85	.8	50
2N168A	SY	npn,AJ,ge	5	65	85	1.1	5
2N292	SY	npn,AJ,ge	5	65	85	.9	5
2N395	RA	pnp,AJ,ge	5	150	85	–	2.0
2N438	RA	npn,AJ,ge	5	100	85	–	3
2N439	CBS	npn,AJ,ge	5	100	85	1.67	10
2N439A	CBS	npn,AJ,ge	5	150	85	2.5	10
2N446	CBS	npn,AJ,ge	5	100	85	1.67	6
2N448	GE	npn,RG,ge	5	65	85	1.1	5
2N520A	GT	pnp,AJ,ge	5	150	100	2	11
2N615	WH	pnp,FJ,ge	5	125	85	2.1	6
2N634	CBS	npn,AJ,ge	5	150	85	2.5	5
2N1090	CBS	npn,AJ,ge	5	120	85	2	8
2N483	RA	pnp,FA,ge	5.5	150	85	–	3.0
2N357	CBS	npn,AJ,ge	6	100	85	1.67	5
2N377	CBS	npn,AJ,ge	150	6	150	2.0	5
2N446A	GT	npn,AJ,ge	6	150	100	2	2
2N1221	GT	pnp,AJ,si	6	150	150	1.2	0.05
OC45	AMP	pnp,PADT,ge	6	83	75		.5
ST4150	TR	npn,DJ,si	6	5W	200	45	15
2N139	RCA	pnp,AJ,ge	6.8	80	85	1	6
2N218	RCA	pnp,AJ,ge	6.8	80	85	–	6
2N409	RCA	pnp,AJ,ge	6.8	80	85	–	10
2N410	RCA	pnp,AJ,ge	6.8	80	85	–	10
2N412	SY	pnp,AJ,ge	7	50	75	1	5
2N414	RA	pnp,FA,ge	7	150	85	–	2.0
2N414B	IND	pnp,AJ,ge	7	200	85	3.33	2
2N439	RA	npn,AJ,ge	7	100	85	–	3
2N617	WH	pnp,FJ,ge	7	125	85	2.1	6

Characteristics				
I_{co}	NF	C_{coe}	Remarks	Type No.
2	12	14	CR	2N444A
25	–	7		2N1024
25	–	7		2N1025
50	–	–		2N94
50	–	–		2N139
5	–	–		2N169A
50	–	–		2N193
50	–	–	Mixer	2N194
50	–	–	Converter	2N194A
20	–	–		2N211
50	–	–		2N233A
10	–	–	CR	2N413A
6	–	12	CR	2N445
50	–	–		2N515
50	–	–		2N516
50	–	–		2N517
1	12	14	Ind, CR	2N519A
25	–	7		2N1026
25	–	7		2N1469
2.0	7	–	Ind., US, CR	2N413
2.0	7	–		CK13
2.0	7		micromin	GK13A
5	–	12	RCA, GT, SY, CR	2N356
10	–	12	GT, CR	2N438
10	–	12	CR	2N438A
2	12	14	CR	2N445A
3	–	14		2N481
6	10	8		2N614
0.05	16	9		2N1222
3	–	12	RA, US	2N482
3		12		TR–482
50	–	–	Converter	2N212
35	–	4	SY, CR	2N385
20	–	–	CR	2N414A
25	–	7		2N1027
50	–	–	Converter	2N1058
50	–	–		2N94A
5	–	–		2N168A
5	–	–	GE	2N292
2.0		12	TO–5 RF switch	2N395
3	–	9	TO–5 RF switch	2N438
10	–	12	GT, SY, CR	2N439
10	–	12	CR	2N439A
6	–	12	CR	2N446
5	–	2.4		2N448
11	12	14	Ind, CR	2N520A
6	10	8		2N615
5	–	12	GE, CR	2N634
8	–	12		2N1090
3.0	–		Ind, US	2N483
5	–	12	RCA, GT, SY, CR	2N357
5	–	12	SY, CR	2N377
2	12	14		2N446A
0.05	16	7		2N1221
0.5				OC45
15		80		ST4150
6	8	–	SY	2N139
6	–	–		2N218
10	–	–	SY	2N409
10	–	–		2N410
5	–	–		2N412
2.0	6	–	IND, US, CR	2N414
2	6	12		2N414B
3	–	9	TO–5 RF switch	2N439
6	10	8	Converter	2N617

High Frequency (continued)

Type No.	Mfg	Type	$f_{\alpha e}$ MC	W_c (mw)	T_j (c)	mw/c	I_{co}
2N1090	RA	npn,AJ,ge	7	150	85	–	3
2N1119	GT	pnp,AJ,si	7	150	140	1.3	50
CK14	RA	pnp,FA,ge	7	80	85	–	2.0
ST903	TR	npn,GR,si	7	150	150	1.0	0.1
2N485	IND	pnp,AJ,ge	7.5	200	85	3	3
2N168A	GE	npn,RG,ge	8	65	85	1.1	5
2N169	GE	npn,RG,ge	8	65	85	1.1	5
2N293	GE	npn,RG,ge	8	65	85	1.1	5
2N388	CBS	npn,AJ,ge	8	150	100	2.0	5
2N396	RA	pnp,AJ,ge	8	150	85	–	2.0
2N449	GE	npn,RG,ge	8	65	85	1.1	72
2N581	RA	pnp,AJ,ge	8	100	85	–	3
2N1086	GE	npn,RG,ge	8	65	85	1.1	3
2N1086A	GE	npn,RG,ge	8	65	85	1.1	3
2N1087	GE	npn,RG,ge	8	65	85	1.1	3
2N1121	GE	npn,RG,ge	8	65	85	1.1	5
S500	SSD	pnp,AJ,si	8	150	150	1.2	25
2N358	CBS	npn,AJ,ge	9	100	85	1.67	5
2N447	CBS	npn,AJ,ge	9	100	85	1.67	6
2N521A	GT	pnp,AJ,ge	9	150	100	2	1
2N616	WH	pnp,FJ,ge	9	125	85	2.1	6
ST904	TR	npn,GR,si	9	150	150	1.0	0.1
2N140	RCA	pnp,AJ,ge	10	80	85		6
2N219	RCA	pnp,AJ,ge	10	80	85	–	6
2N411	RCA	pnp,AJ,ge	10	80	85	–	10
2N412	RCA	pnp,AJ,ge	10	80	85	–	10
2N414B	IND	pnp,AJ,ge	10	200	85	2.5	3
2N416	RA	pnp,FA,ge	10	150	85	–	2.0
2N440	CBS	npn,AJ,ge	10	100	85	1.67	10
2N440A	CBS	npn,AJ,ge	10	150	85	2.5	10
2N447A	GT	npn,AJ,ge	10	150	100	2	2
2N473	TR	npn,GR,ge	10	200	200	1.1	0.01
2N474	TR	npn,GR,si	10	200	200	1.1	0.01
2N475	TR	npn,GR,si	10	200	200	1.1	0.01
2N484	RA	pnp,FA,ge	10	150	85	–	3.0
2N635	CBS	npn,AJ,ge	10	150	85	2.5	5
2N1091	CBS	npn,AJ,ge	10	120	85	2	8
CK16	RA	pnp,FA,ge	10	80	85	–	2.0
GK16A	RA	pnp,AJ,ge	10	80	85	–	2.0
ST905	TR	npn,GR,si	10	150	150	1.0	0.1
2N118A	TI	npn,GR,si	11	150	175	0.8	0.1
2N478	TR	npn,GR,si	11	200	200	1.1	0.01
2N479	TR	npn,GR,si	11	200	200	1.1	0.01
2N480	TR	npn,GR,si	11	200	200	1.1	0.01
2N1417	TR	npn,GR,si	11	150	150	1.2	–
2N1418	TR	npn,GR,si	11	150	150	1.2	0.01
ST15	TR	npn,GR,si	11	200	200	1.1	0.02
ST35	TR	npn,GR,si	11	200	200	1.1	0.02
ST45	TR	npn,GR,si	11	200	200	1.1	0.02
ST904A	TR	npn,GR,si	11	150	150	1.0	0.1
ST910	TR	npn,Gr,si	11	150	150	1.0	0.1
2N397	RA	pnp,AJ,ge	12	150	85	–	2.0
2N486	IND	pnp,AJ,ge	12	–	85	3	3
2N751	RA	npn,DJ,si	12	150	175	0.75	0.01
2N1390	RA	npn,DJ,si	12	300	175	0.5	0.01
2N440	RA	npn,AJ,ge	15	100	85	–	3
2N541	TR	npn,GR,si	15	200	200	1.1	0.01
2N542	TR	npn,GR,si	15	200	200	1.1	0.01
2N543	TR	npn,GR,si	15	200	200	1.1	0.01
2N636	CBS	npn,AJ,ge	15	150	85	2.5	5
2N1091	RA	npn,AJ,ge	15	150	85	–	3
OC44	AMP	pnp,PADT,ge	15	83	75		0.5
2N522A	GT	pnp,AJ,ge	17	150	100	2	1
2N582	RA	pnp,AJ,ge	18	100	85	–	3
2N1428	PH	pnp,SAT,si	19.5	100	140	0.87	0.1
2N1429	PH	pnp,SAT,si	19.5	100	140	0.87	0.1

(continued)

Characteristics I_{co}	NF	C_{coe}	Remarks	Type No.
3		9	TO–5 RF switch	2N1090
50	–	6		2N1119
2.0	6	–		CK14
0.1	25	7		ST903
3	–	12	RA, US	2N485
5	–	2.4		2N168A
5	–	2.4		2N169
5	–	2.4		2N293
5	–	12	GT, SY, CR	2N388
2.0		12	TO–5 RF switch	2N396
72	–	2.4		2N449
3	–	12	TO–5 RF switch	2N581
3	–	2.4		2N1086
3	–	2.4		2N1086A
3	–	2.4		2N1087
5	–	2.4		2N1121
25	–	7		S500
5	–	12	GT, SY, CR	2N358
6	–	12	CR	2N447
1	12	14	CR	2N521A
6	10	8	Reflex	2N616
0.1	25	7		ST904
6	8	–	SY	2N140
6	–	–		2N219
10	–	–	SY	2N411
10	–	–		2N412
3	–	12		2N414B
2.0	4	–	Ind., US, GT, CR	2N416
10	–	12	GT, SY, CR	2N440
10	–	12	CR	2N440A
2	12	14	CR	2N447A
0.01	20	7		2N473
0.01	20	7		2N474
0.01	20	7		2N475
3.0	–		US	2N484
5	–	12	GE CR	2N635
8	–	12		2N1091
2.0	4	–		CK16
2.0	4		micromin	GK16A
0.1	25	7		ST905
0.1	25	7	JAN, TR	2N118A
0.01	19	7		2N478
0.01	19	7		2N479
0.01	19	7		2N480
-	19	7		2N1417
0.01	19	7		2N1418
0.02	22	7		ST15
0.02	22	7	2N332	ST35
0.02	22	7	2N332	ST45
0.1	25	7		ST904A
0.1	20	7		ST910
2.0	–	12	TO–5 RF switch	2N397
3	–	12	Ra, US	2N486
0.01	–	6		2N751
0.01	–	6		2N1390
3	–	9	TO–5 RF switch	2N440
0.01	19	7		2N541
0.01	19	7		2N542
0.01	19	7		2N543
5	–	12	GE, CR	2N636
3	–	9	TO–5 RF switch	2N1091
0.5				OC44
1	12	14	CR	2N522A
3	–	12	TO–5 RF switch	2N582
0.1	–	14		2N1428
0.1	–	14		2N1429

High Frequ...ed)

Type No.	Mfg	Type	f_{ab}	Max. Ratings W_c (mw)	T_j (c)	mw/c	V_c	Characteri... I_{co}	N...
2N417	RA	pnp,FA,ge	20	150	85	–	10	2.0	
2N602	GT	pnp,DR,ge	20	120	85	2	20	3	1
CK17	RA	pnp,FA,ge	20	80	85	–	10	2.0	
CK17A	RA	pnp,AJ,ge	20	80	85	–	10	2.0	
2N495	PH	pnp,SA,ge	21	150	140	1.3	25	1.0	
2N523A	GT	pnp,AJ,ge	23	150	100	2	20	1	1
2N1065	GT	pnp,DR,ge	25	120	85	2	40	4	1
2N1118	PH	pnp,SAT,si	25	150	140	1.3	25	1.0	–
2N1118A	PH	pnp,SAT,si	25	150	140	1.3	25	1.0	–
2N247	RCA	pnp,DR,ge	30	80	85	–	35	16	–
2N274	RCA	pnp,DR,ge	30	80	85	–	35	16	–
2N370	RCA	pnp,DR,ge	30	80	85	–	20	20	–
2N371	RCA	pnp,DR,ge	30	80	85	–	20	20	–
2N372	RCA	pnp,DR,ge	30	80	85	–	20	20	–
2N373	RCA	pnp,DR,ge	30	80	85	–	25	8	–
2N374	RCA	pnp,DR,ge	30	80	85	–	25	8	–
2N544	RCA	pnp,DR,ge	30	80	85	–	18	8	–
2N1109	TI	pnp,GD,ge	30	30	85	–	16	5	–
2N1224	SY	pnp,DD,ge	30	120	100	1.6	40	12	–
2N1224	RCA	pnp,DR,ge	30	120	85	–	40	12	–
2N1226	RCA	pnp,DR,ge	30	120	85	–	60	16	
2N1395	RCA	pnp,DR,ge	30	120	85	–	40	16	
2N1425	RCA	pnp,DR,ge	33	120	85	–	24	16	
2N1426	RCA	pnp,DR,ge	33	120	85	–	24	16	
2N1108	TI	pnp,D,ge	35	30	85	–	16	5	–
2N1110	TI	pnp,GD,ge	35	30	85	–	16	5	–
2N1111	TI	pnp,GD,ge	35	30	85	–	20	5	–
2N1111A	TI	pnp,GD,ge	35	30	85	–	20	5	–
2N1111B	TI	pnp,GD,ge	36	30	85	–	27	5	–
2N603	GT	pnp,DR,ge	40	120	85		30	3	14
2N750	RA	npn,DJ,si	40	150	175	0.75	50	10	
2N1107	TI	pnp,GD,ge	40	30	85	–	16	5	–
2N1389	RA	npn,DJ,si	40	300	175	0.5	50	10	–
2N640	RCA	pnp,DR,ge	42	80	85	–	34	5	–
2N641	RCA	pnp,DR,ge	42	80	85	–	34	7	–
2N642	RCA	pnp,DR,ge	42	80	85	–	34	7	–
2N1196	HU	pnp,Ms,si	45	350	200	2	70	2	6
2N248	TI	pnp,GD,ge	50	30	75	0.6	25	5	–
2N344	PH	pnp,SB,ge	50	20	55	1.33	5	0.7	–
2N345	PH	pnp,SA,ge	50	20	55	1.33	5	0.7	–
2N604	GT	pnp,DR,ge	50	120	85	2	30	4	14
3N36	GE	npn,MB,ge	50	30	85	0.5	6	3	–
PT900	PS1	npn,MS,si	50	125 W	150	1000	80	30	–
PT901	PS1	npn,MS,si	50	125 W	150	1000	140	30	–
2N1197	HU	pnp,MS,si	55	350	200	2	70	.006	6
2N393	PH	pnp,MAD,ge	60	25	85	0.63	6	1.5	–
2N749	RA	npn,DJ,si	60	150	175	0.75	45	10	–
2N1388	RA	npn,DJ,si	60	300	175	0.5	45	10	–
OC170	AMP	pnp,DJ,ge	70	60	75	2	[illegible]	2	–
2N346	PH	pnp,SB,ge	75	20	55	1.3	5	0.7	–
2N696	TR	npn,DJ,si	80	2W	175	13.35	60	0.1	–
RT5002	RH	npn,MS,si	120	3W	175	20	60	.1	–
2N128	PH	pnp,SB,ge	85	25	85	0.4	4.5	0.6	10
3N37	GE	npn,MB,ge	90	30	85	0.5	6	3	–
2N384	RCA	pnp,DR,ge	100	80	85	–	30	16	–
2N697	TR	npn,DJ,si	100	2W	175	13.3	60	0.1	–
2N1180	RCA	pnp,DR,ge	100	80	85	–	30	12	
2N1225	RCA	pnp,DR,ge	100	120	85	–	40	12	
2N1396	RCA	pnp,DR,ge	100	120	85	–	40	16	
3N34	TI	npn,GD,si	100	125	150	1	30	0.4	20
OC171	AMP	pnp,DJ,ge	100	60	75	2	20	2	–
2N497	RH	npn,MS,si	120	4W	175	26.5	60	.1	–
2N498	RH	npn,MS,si	120	4W	175	26.5	100	.1	–
2N656	RH	npn,MS,si	120	4W	175	26.5	60	.1	–
2N657	RH	npn,MS,si	120	4W	175	26.5	100	.1	–
2N698	RH	npn,MS,si	120	2W	175	13.2	120	.1	

DATA CHART

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Characteristics I_{co}	NF	C_{cne}	Remarks	Type No.
2.0	4	–	Ind, US, GT, CR	2N417
3	14	4		2N602
2.0	4	–		CK17
2.0	4	–	micromin	CK
1.0	–	7		2N495
1	12	14	Ind, CR	2N523A
4	12	3		2N1065
1.0	–	6		2N1118
1.0	–	6		2N1118A
16	–	–	SY	2N247
16	–	–		2N274
20	–	–	SY	2N370
20	–	–	SY	2N371
20	–	–	Mixer, SY	2N372
8	–	–	SY	2N373
8	–	–	Converter, SY	2N374
8	–	–	SY	2N544
5	–	1.5		2N1109
12	–	–		2N1224
12	–	–		2N1224
16				2N1226
16				2N1395
16				2N1425
16				2N1426
5	–	1.5		2N1108
5	–	1.5		2N1110
5	–	1.5		2N1111
5	–	1.5		2N1111A
5	–	1.5		2N1111B
3	14	3		2N603
10		6		2N750
5	–	1.5		2N1107
10	–	6		2N1389
5	–	–		2N640
7	–	–		2N641
7	–	–		2N642
2	6	3		2N1196
5	–	1.2		2N248
0.7	–	3	SPR	2N344
0.7	–	3	SPR	2N345
4	14	3		2N604
3	–	2	Tetrode	3N36
30	–	1	High Frequency high power	PT900
30	–	1	High frequency high power	PT901
.006	6	3	TO-5 package	2N1197
1.5	–	3.5	SPR	2N393
10	–	6		2N749
10	–	6		2N1388
2	–	–		OC170
0.7	–	3	SPR	2N346
0.1	–	20	FA, RH, PSI, HO	2N696
.1	–	30		RT5002
0.6	10	2.5	SPR	2N128
3	–	1.5	Tetrode	3N37
16	–	–		2N384
0.1	–	20	FA,RH,PST,HO	2N697
12				2N1180
12				2N1225
16				2N1396
0.4	20	–	Tetrode	3N34
2	–	–		OC171
.1	–	20		2N497
.1	–	20		2N498
.1	–	20		2N656
.1	–	20		2N657
.1		15		2N698

CIRCLE 64 ON READER-SERVICE CARD

CIRCLE 65 ON READER-SERVICE CARD

High Frequency *continued*

Type No.	Mfg.	Type	W_C W	Max. Ratings w/c	T_j c	V_c V	I	Characteristics f kc	P G
2N699	RH	npn,MS,si	120	2W	175	13.2	120	.1	–
2N1023	RCA	pnp,DR,ge	120	120	85	–	[illegible]	12	
2N1066	RCA	pnp,DR,ge	120	120	85	–	[illegible]	12	
2N1252	RH	npn,MS,si	120	2W	175	13.2	[illegible]	.1	–
2N1253	RH	npn,MS,si	120	2W	175	13.2	[illegible]	.1	–
2N1397	RCA	pnp,DR,ge	120	120	85	–	[illegible]	16	
2N1409	RH	npn,MS,si	120	2.8W	150	22.5	[illegible]	.1	–
2N1410	RH	npn,MS,si	120	2.8W	150	22.5	[illegible]	.1	
2N1420	RH	npn,MS,si	120	2W	175	13.2	[illegible]	.1	–
2N1507	RH	npn,MS,si	120	2W	175	13.2	[illegible]	.1	–
2N1613	RH	npn,MS,si	120	3W	200	17.2	[illegible]	.025	–
RT5001	RH	npn,MS,si	120	3W	175	20	[illegible]	.1	–
RT5003	RH	npn,MS,si	120	3W	175	20	[illegible]	.1	–
RT5004	RH	npn,MS,si	120	3W	175	20	[illegible]	.1	–
2N715	TI	npn,MS,si	125	1.2W	175	8	[illegible]	1	–
2N716	TI	npn,MS,si	125	1.2W	175	8	[illegible]	1	–
2N1177	RCA	pnp,DR,ge	140	80	85	–	[illegible]	12	
2N1178	RCA	pnp,DR,ge	140	80	85	–	[illegible]	12	
2N1179	RCA	pnp,DR,ge	140	80	85	–	[illegible]	12	
2N728	TR	npn,DJ,si	150	300	175	–	[illegible]	0.5	–
2N729	TR	npn,DJ,si	150	300	175	–	[illegible]	0.5	–
2N1267	PH	npn,SADT,si	150	100	150	0.8	[illegible]	10	–
2N1268	PH	npn,SADT,si	150	100	150	0.8	[illegible]	10	–
2N1269	PH	npn,SADT,si	150	100	150	0.8	[illegible]	10	–
3N35	TI	npn,GD,si	150	125	150	1	[illegible]	0.4	14
2N1335	PSI	npn,MS,si	170	2.8 W	150	24	[illegible]	8	–
2N1336	PSI	npn,MS,si	170	2.8 W	150	24	[illegible]	8	–
2N1337	PSI	npn,MS,si	170	2.8 W	150	24	[illegible]	8	–
2N1270	PH	npn,SADT,si	200	100	150	0.8	[illegible]	10	–
2N1271	PH	npn,SADT,si	200	100	150	0.8	[illegible]	10	–
2N1272	PH	npn,SADT,si	200	100	150	0.8	[illegible]	.01	–
2N1339	PSI	npn,MS,si	220	2.8 W	150	24	[illegible]	8	–
2N1340	PSI	npn,MS,si	250	2.8 W	150	24	[illegible]	8	–
2N588	PH	pnp,MAD,ge	250	30	85	0.75	[illegible]	3	5
2N695	MO	pnp,DM,ge	250	75	100	1	[illegible]	.2	–
2N1491	RCA	npn,MS,si	250	3	175	–	[illegible]	10	
2N1492	RCA	npn,MS,si	275	3	175	–	[illegible]	10	
2N1341	PSI	npn,MS,si	280	2.8 W	150	24	[illegible]	8	–
2N710	MO	pnp,MS,ge	300	150	100	4	[illegible]	.2	–
2N1493	RCA	npn,MS,si	300	3	175	–	[illegible]	[illegible]	
2N503	PH	pnp,MAD,ge	320	25	85	0.63	[illegible]	3	–
2N499	PH	pnp,MAD,ge	340	30	85	0.75	[illegible]	1.0	–
2N1505	PSI	pnp,MS,si	350	30 W	175	–	[illegible]	[illegible]	–
2N1506	PSI	npn,MS,si	350	30 W	175	–	[illegible]	[illegible]	–
2N741	MO	pnp,MS,ge	360	150	100	4	[illegible]	.2	
2N706	RH	pnp,MS,si	400	1W	175	6.6	[illegible]	.1	–
2N502	PH	pnp,MAD,ge	440	25	85	0.63	[illegible]	3	–
2N502A	PH	pnp,MAD,ge	440	25	100	0.45	[illegible]	3	–
2N1143	TI	pnp,DB,ge	480	750	100	10	[illegible]	[illegible]	–
2N700	MO	pnp,DM,ge	500	75	100	1	[illegible]	[illegible]	–
2N1562	MO	pnp,MS,ge	500	3W	100	40	[illegible]	[illegible]	–
2N1561	MO	pnp,MS,ge	500	3W	100	40	[illegible]	[illegible]	–
2N1142	TI	pnp,DB,ge	600	750	100	10	[illegible]	[illegible]	–
2N528	WE	pnp,DG,ge	750	100	100	.5	[illegible]	[illegible]	–
2N537	WE	pnp,DG,ge	750	250	100	.3	[illegible]	[illegible]	–

DATA CHART

(...ency (continued)

...c /	f_{ae} kc	Powr. Gain db	Powr. Out. w	Remarks	Type No.
3.2	.1	–	15		2N699
–	12				2N1023
–	12				2N1066
3.2	.1	–	30		2N1252
3.2	.1	–	30		2N1253
–	16				2N1397
2.5	.1	–	20	PSI	2N1409
2.5	.1		20	PSI	2N1410
3.2	.1	–	20		2N1420
3.2	.1	–	20		2N1507
7.2	.025	–	20		2N1613
20	.1	–	30		RT5001
20	.1	–	30		RT5003
20	.1	–	30		RT5004
8	1	–	3	h_{FE} 10–50	2N715
8	1	–	3	h_{FE} 10–50	2N716
–	12				2N1177
–	12				2N1178
–	12				2N1179
–	0.5	–	8		2N728
–	0.5	–	8		2N729
0.8	10	–	1.5		2N1267
0.8	10	–	1.5		2N1268
0.8	10	–	1.5		2N1269
1	0.4	14	–	Tetrode	3N35
24	8	–	4	High freq., high power	2N1335
24	8	–	4	High freq., high power	2N1336
24	8	–	4	High freq., high power	2N1337
0.8	10	–	1.5		2N1270
0.8	10	–	1.5		2N1271
0.8	.01	–	1.5		2N1272
24	8	–	4	High freq., high power	2N 1339
24	8	–	4	High freq., high power	2N1340
0.75	3	5	–	SPR	2N588
1	.2	–	3,5		2N695
–	10				2N1491
–	10				2N1492
24	8	–	4	High freq., high power	2N1341
4	.2	–	–	Switch	2N710
–	10				2N1493
0.63	3	–	1.0		2N503
0.75	1.0	–	1.3		2N499
–	10	–	15	High freq., high power	2N1505
–	10	–	8	High frequency, high power	2N1506
4	.2		6	Amp VHF	2N741
6.6	1	–	5		2N706
0.63	3	–	1.0		2N502
0.45	3	–	1.0		2N502A
10	7	–	1.5	PG = 22 db at 200 mc	2N1143
1	4	–	1.1	UHF amp	2N700
40	5	–	7	High freq., high power	2N1562
40	5	–	7	High freq., high power	2N1561
10	7	–	1.5	PG = 26db at 200 mc	2N1142
.5		–	–	U.S., MIL only	2N528
.3		–	2.8	U.S. MIL only	2N537

High Frequen(continued)

Type No.	Mfg	Type	f_{ae}	Max. Ratings W_c (mw)	T_j (c)	mw/c	Characteristics I_{co}
2N1094	WE	pnp,DM,ge	750	250	100	0.3	1.2
2N1141	TI	pnp,DB,ge	750	750	100	10	.7
2N1195	WE	pnp,DM,ge	750	250	100	0.3	1.2
2N218	SY	pnp,AJ,ge		80	85	1.3	50
2N231	PH	pnp,SBT,ge	–	9	55	0.9	3
2N232	PH	pnp,SBT,ge	–	9	55	0.9	6
2N233	SY	npn,AJ,ge	–	50	75	1	50
2N312	CBS	npn,AJ,ge	–	75	85	–	60
2N410	SY	pnp,AJ,ge	–	50	75	1	5
2N544	SY	pnp,DJ,ge	–	80	85	1.3	4
2N544	SY	pnp,DD,ge	–	80	100	1.1	16
2N624	SY	pnp,DJ,ge	–	100	100	1.3	30
2N1264	SY	pnp,DD,ge	–	50	75	1	50
2N1266	SY	pnp,AJ,ge	–	80	85	1.3	100
2N1515/ OC169	AMP	pnp,PADT,ge	–	83	75	–	-
GT1665	GT	pnp,AJ,ge	–	150	100	2	4
ST3031	TR	npn,DJ,si	–	150	175	–	-

Abbreviations Terms

AJ Alloyed Junction
DB Diffused Base
DD Double Diffused
DG Grown Diffused
DJ Diffused Junction
DM Diffused Mesa
Dr Drift
FA Fused Alloy
FJ Fused Junction
GD Grown Diffused
GE Germanium
GJ Grown Junction
GR Grown Rate
MB Meltback
MD MADT
MA Micro Alloy

Special Types

Type No.	Mfg	Type	f_{ae}	Max. Ratings W_c (mw)	T_c (c)	mw/c	Characteristics NF
2N469A	GT	pnp,AJ,ge	1.8 mc	50	85	0.83	16
2N1311	GT	npn,AJ,ge	1.5 mc	120	100	1.5	10
2N1312	GT	npn,AJ,ge	2 mc	120	100	1.5	10
2N1392	GT	pnp,AJ,ge	1 mc	50	85	0.83	16
2N1310	GT	npn,AJ,ge	1.0 mc	120	100	1.5	10
2N1393	GT	pnp,AJ,ge	3.4 mc	50	85	0.83	16
2N1394	GT	pnp,AJ,ge	1 mc	50	85	0.83	16
2N1408	GT	pnp,AJ,ge	–	150	100	2	10
GT1624	GT	npn,AJ,ge	–	150	100	2	–

)30 **DATA CHART**

e quen... (...tinued)

...Ratings mw/c	V	Characteristics I_{co}	NF	C_{coe}	Remarks	Type No.
.3	[illegible]	1.2	–	4	U.S.,MIL only	2N1094
10	[illegible]	.7	–	1.5	PG=30 db at 200 mc	2N1141
.3	[illegible]	1.2	–	4	Ho	2N1195
.3	[illegible]	50	–	–		2N218
.9	[illegible]	3	–	–	SPR	2N231
.9	[illegible]	6	–	–	SPR	2N232
1	[illegible]	50	–	–		2N233
–	[illegible]	60	–	12	SY	2N312
1	[illegible]	5	–	–		2N410
1.3	[illegible]	4	–	–		2N544
1.1	[illegible]	16	–	–		2N544
1.3	[illegible]	30	–	–		2N624
1	[illegible]	50	–	–		2N1264
1.3	[illegible]	100	–	–		2N1266
–	[illegible]	–	–	–	OC169	2N1515/ OC169
2	[illegible]	4	–	–	Drift	GT1665
–	[illegible]	–	–	–		ST3031

...viatio... Terms

...nction ...s Mesa
...ase ...G Rate Grown
...ffused ... Silicon
...ffused ...BT Surface Barrier
...nction ... = Collector to emitter capacitance measured across the output terminals with the input ac open-circuited.
...esa

...y ... = Frequency at which the magnitude of the forward-current transfer ratio (small-signal) is 0.707 of its low frequency value.
...tion
...ffused
...n ... = Common Emitter-Small signal forward current transfer ratio.
...nction
...te ...FE = Common Emitter-Static value of short-circuited forward current ratio.
... = Collector current when collector junction is reverse biased and emitter is dc open-circuited.
...py

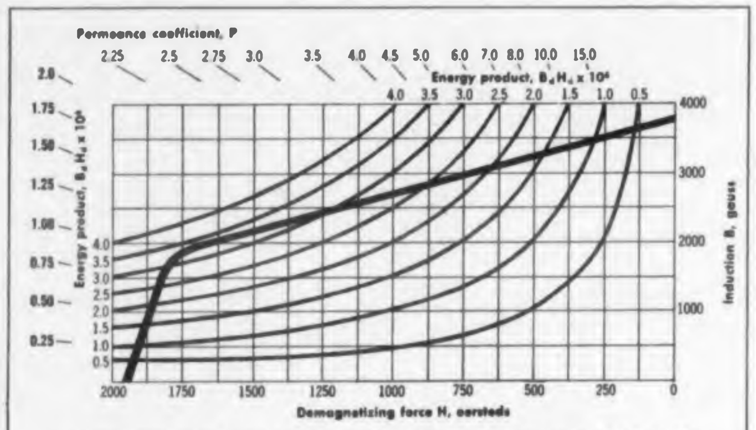
...ecial ...ypes

...Ratings mw/c	V...	...racteristics ...o	NF	C_{coe}	Remarks	Type No.
0.83	[illegible]	[illegible]	16	30	Photo	2N469A
1.5	[illegible]	[illegible]	10	11	High Voltage	2N1311
1.5	[illegible]	[illegible]	10	11	High Voltage	2N1312
0.83	[illegible]	[illegible]	16	30	Photo	2N1392
1.5	[illegible]	[illegible]	10	11	High Voltage	2N1310
0.83	[illegible]	[illegible]	16	30	Photo	2N1393
0.83	[illegible]	[illegible]	16	30	Photo	2N1394
2	[illegible]	[illegible]	10	35	High Voltage	2N1408
2	[illegible]	[illegible]	–	–	High Voltage	GT1624

INDOX V opens NEW design avenues in permanent magnet applications

Use of Indiana Steel's INDOX V *by design engineers continues to grow by leaps and bounds. So much so that the company has just completed a new plant solely for the production of this remarkable ceramic magnet material. Designers find it the answer where other materials didn't measure up. Today it's in big volume demand by major users of permanent magnets.*

Here's a summary of basic data on INDOX V. *Investigate this material. It has helped others outstrip competition — both in product design and cost reduction. It could do the same for you. Whatever you're working on, keep this information close at hand — or write for the complete story on* INDOX V, *and ask about design help on any project that involves permanent magnets.*



Demagnetization and energy product curves for oriented ceramic magnet material, Indox V.

What Is Indox V?

INDOX V is a *highly oriented* barium ferrite permanent magnet material—the first to be produced in this country on a commercial scale. Like other ceramics, it is a non-conductor, hard, brittle and lightweight—much lighter than metallic alloy magnets. It has an energy product 3½ times that of non-oriented ceramic magnets.

Typical Characteristics of Indox V

Coercive Force (H_c), oersteds	2,000
Residual Induction (B_r), gauss	3,840
Peak Energy Product ($B_d H_d$)	$3.5 \times 10_6$
Reversible Permeability	1.05
Temperature Coefficient of Reversible Flux Change	−0.19%/°C.
Magnetization Field for Saturation, oersteds	10,000
Chemical Composition	$BaFe_{12}O_{19}$
Specific Gravity	5.0 or .181 lb/cu in

INDOX V is made of readily available, non-critical materials — an important design consideration for long-range production plans. In the precisely controlled manufacturing process, magnet shapes are die-formed from powdered material under high pressure, then sintered in a special high-temperature furnace. Standard shapes of INDOX V magnets available from stock include wafers, rings and cylinders in most practical sizes. Special shapes and sizes can be produced for unusual applications.

Special Properties

The unique characteristics of INDOX V often have indicated its use in areas of design where the application of permanent magnets formerly was considered impossible.

High resistance to demagnetization. The high coercive force of INDOX V permits much shorter magnet lengths than is possible with other materials, but larger magnet area is necessary because of lower flux density.

High resistivity. As a non-conductor, INDOX V can be used where other materials would create unwanted current paths. In the presence of high-frequency alternating fields, eddy current losses and associated heating effects are extremely low.

Low incremental permeability. The change in flux that results from a change in demagnetizing influence is lower in INDOX V than in any other magnetic material. Thus, INDOX V maintains a more constant field in the presence of external fields because variations in its flux are small.

High energy per unit volume. On an equivalent weight basis, the energy product of INDOX V is comparable to that of Alnico V — the strongest permanent magnet material available — and 3½ times that of non-oriented ceramic magnets. Optimum area is 5⅓ times the area of an equal Alnico V magnet, about half the area of a non-oriented ceramic. Optimum length is 28 percent that of Alnico V. Since INDOX V requires less magnetic material and less space, the cost per unit of usable energy is extremely low.

Resistance to radiation environments. Recent comprehensive studies of the effects of nuclear radiation on permanent magnet materials indicate that INDOX V meets or exceeds environmental requirements for equipment likely to be used in nuclear-powered aircraft and ballistic missiles.

APPLICATIONS

Electronic	Loudspeakers Ion pumps
Holding	Door closers: refrigerators Conveyors and automation Magnetic switches Magnetic chucks
Electro-Mechanical	Synchronous drives: Motors DC fields AC rotors Generators
Miscellaneous	Temperature control Magnetic separation

INDOX V has proved successful on the above applications. If you want to know more about this outstanding material in relation to your product write. M-7

INDIANA STEEL PRODUCTS
Division of
Indiana General Corporation
VALPARAISO, INDIANA

INDIANA PERMANENT MAGNETS

IN CANADA: The Indiana Steel Products Company of Canada Limited, Kitchener, Ontario

CIRCLE 69 ON READER-SERVICE CARD

TRANSISTORS–196

High Leve

Type No.	Mfg.	Type	f_{ae} KC	Max. Ratings W_c W	T_j °C	W/°C
2N1238	HU	pnp,FJ,si	0.8	1.0	200	–
2N1239	HU	pnp,FJ,si	0.8	1.0	200	–
2N1240	AU	pnp,FJ,si	1.0	1.0	200	–
2N1241	HU	pnp,FJ,si	1.0	1.0	200	–
2N1242	HU	pnp,FJ,si	1.0	1.0	200	–
2N1243	HU	pnp,FJ,si	1.0	1.0	200	–
2N1244	HU	pnp,FJ,si	1.2	1.0	200	–
2N1073	BE	pnp,DJ,ge	1.5	35	100	1.5
2N1073A	BE	pnp,DJ,ge	1.5	35	100	1.5
2N1073B	BE	pnp,DJ,ge	1.5	35	100	1.5
B-1085	BE	pnp,DJ,ge	1.5	35	100	1.5
2N1651	BE	pnp,DJ,ge	3.0	–	110	1.3
2N1652	BE	pnp,DJ,ge	3.0	–	110	1.3
2N1653	BE	pnp,DJ,ge	3.0	–	110	1.3
2N1518	DE	pnp,AJ,ge	4	70	95	1.2
2N1519	DE	pnp,AJ,ge	4	70	95	1.2
2N1520	DE	pnp,AJ,ge	4	70	95	1.2
2N1521	DE	pnp,AJ,ge	4	70	95	1.2
2N1522	DE	pnp,AJ,ge	4	70	95	1.2
2N1523	DE	pnp,AJ,ge	4	70	95	1.2
2N297	CL	pnp,AJ,ge	5	4	85	.4
2N297A	CL	pnp,AJ,ge	5	12	95	2.0
2N618	CL	pnp,AJ,ge	5	14	90	1.5
2N375	CL	pnp,AJ,ge	7	–	95	–
2N378	TS	pnp,AJ,ge	7	50	100	1.2
2N379	CL	pnp,AJ,ge	7	5	85	.3
2N380	TS	pnp,AJ,ge	7	50	100	0.8
2N458	TI	pnp,AJ,ge	7	50	95	0.72
2N459	TS	pnp,AJ,ge	7	50	100	0.8
2N511	TI	pnp,AJ,ge	7	80	95	1.4
2N511A	TI	pnp,AJ,ge	7	80	95	1.4
2N511B	TI	pnp,AJ,ge	7	80	95	1.4
2N512	TI	pnp,AJ,ge	7	80	95	1.4
2N512A	TI	pnp,AJ,ge	7	80	95	1.4
2N512B	TI	pnp,AJ,ge	7	80	95	1.4
2N513	TI	pnp,AJ,ge	7	80	95	1.4
2N513A	TI	pnp,AJ,ge	7	80	95	1.4
2N513B	TI	pnp,AJ,ge	7	80	95	1.4
2N514	TI	pnp,AJ,ge	7	80	95	1.4
2N514A	TI	pnp,AJ,ge	7	80	95	1.4
2N514B	TI	pnp,AJ,ge	7	80	95	1.4
2N1011	DE	pnp,AJ,ge	7	35	95	0.8
2N387	PH	pnp,AJ,ge	9	12.5	75	0.5
2N386	PH	pnp,AJ,ge	10	12.5	75	0.5
2N1038	TI	pnp,AJ,ge	10	20	100	.27
2N1039	TI	pnp,AJ,ge	10	20	100	.27
2N1040	TI	pnp,AJ,ge	10	20	100	.27
2N1358	DE	pnp,AJ,ge	10	70	95	1.2
2N1412	DE	pnp,AJ,ge	10	70	95	1.2
2N1046	TI	pnp,AJ,ge	12	15	65	0.37
2N1609	DE	pnp,AJ,ge	17	4	95	0.7
2N1610	DE	pnp,AJ,ge	17	4	95	0.7
2N1611	DE	pnp,AJ,ge	17	4	95	0.7
2N1612	DE	pnp,AJ,ge	17	4	95	0.7
OC22	AMP	pnp,PADT,ge	25	10	75	–
OC23	AMP	pnp,PADT,ge	25	10	75	–
OC24	AMP	pnp,PADT,ge	25	10	75	–
WX1015	WH	npn,FJ,si	25	150	150	1.4
WX1015A	WH	npn,FJ,si	25	150	150	1.4
WX1015B	WH	npn,FJ,si	25	150	150	1.4
WX1015C	WH	npn,FJ,si	25	150	150	1.4
WX1015D	WH	npn,FJ,si	25	150	150	1.4
WX1015E	WH	npn,FJ,si	25	150	150	1.4
WX1015F	WH	npn,FJ,si	25	150	150	1.4
WX1016	WH	npn,FJ,si	25	150	150	1.4
WX1016A	WH	npn,FJ,si	25	150	150	1.4
WX1016B	WH	npn,FJ,si	25	150	150	1.4
WX1016C	WH	npn,FJ,si	25	150	158	1.4
WX1016D	WH	npn,FJ,si	25	150	150	1.4
WX1016E	WH	npn,FJ,si	25	150	150	1.4

DATA CHART

Characteristics			Switching			
I_{co} ma	Powr. Gain db	Powr. Out W	Rise Time μsec	Stor. Time μsec	Remarks	Type No.
.1	–	–	–	–		2N1238
.1	–	–	–	–		2N1239
.1	–	–	–	–		2N1240
.1	–	–	–	–		2N1241
.1	–	–	–	–		2N1242
.1	–	–	–	–		2N1243
.1	–	–	–	–		2N1244
2.0						2N1073
2.0						2N1073A
2.0						2N1073B
2.0						B-1085
–	–	–	–	–		2N1651
						2N1652
						2N1653
100		40	20	7	min. gain of 12 at 25A	2N1518
100		40	20	7	min. gain of 12 at 25A	2N1519
100		40	20	7	min. gain of 12 at 35A	2N1520
100		40	20	7	min. gain of 12 at 35A	2N1521
100	–	40	20	7	min. gain of 12 at 50A	2N1522
100	–	40	20	7	min. gain of 12 at 50A	2N1523
3	–	–	–	–	BE	2N297
3	–	–	–	–	BE, DE	2N297A
3	–	–	–	–	MO	2N618
–	–	–	–	–	MO	2N375
0.5						2N378
5	–	–	–	–		2N379
0.5						2N380
1	–	–	12	12.5	CL	2N458
0.5						2N459
0.2	–	–	11.2	2.5		2N511
0.2	–	–	11.2	2.5		2N511A
0.2	–	–	11.2	2.5		2N511B
0.2	–	–	11.2	2.5		2N512
0.2	–	–	11.2	2.5		2N512A
0.2	–	–	11.2	2.5		2N512B
0.2	–	–	10.8	2.0		2N513
0.2	–	–	10.8	2.0		2N513A
0.2	–	–	10.8	2.0		2N513B
0.2	–	–	10.3	2.0		2N514
0.2	–	–	10.3	2.0		2N514A
0.2	–	–	10.3	2.0		2N514B
100	–	–	5	2	2N1011 Sig C	2N1011
1.0	33	5				2N387
0.8	33	5				2N386
50	–	–	–	–		2N1038
50	–	–	–	–		2N1039
50	–	–	–	–		2N1040
100	–	40	15	5		2N1358
100		40	15	5		2N1412
0.2	–	–	0.7	1.2		2N1046
10	–	400 mw	3	1		2N1609
10	–	400 mw	3	1		2N1610
10	–	400 mw	3	1		2N1611
10	–	400 mw	3	1		2N1612
30						OC22
30						OC23
30						OC24
10	–	–	5	1		WX1015
10	–	–	5	1		WX1015A
10	–	–	5	1		WX1015B
10	–	–	5	1		WX1015C
10	–	–	5	1		WX1015D
10	–	–	5	1		WX1015E
10	–	–	5	1		WX1015F
10	–	–	5	1		WX1016
10	–	–	5	1		WX1016A
10	–	–	5	1		WX1016B
10	–	–	5	1		WX1016C
10	–	–	5	1		WX1016D
10	–	–	5	1		WX1016E

CIRCLE 70 ON READER-SERVICE CARD

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Type No.	Mfg	Type	f_{ae} KC	Max. Ratings W_c W	T_j °C	W/°C	V_c V	Characteris… I_{co} ma	P… G…
WX1016F	WH	npn,FJ,si	25	150	150	1.4	300	10	
2N1041	TI	npn,AJ,ge	33	20	100	.27	100	50	
OC28	AMP	pnp,PADT,ge	200	13	90	–	80	100	
OC29	AMP	pnp,PADT,ge	200	13	90	–	60	100	
OC35	AMP	pnp,PADT,ge	200	13	90	–	60	100	
OC36	AMP	pnp,PADT,ge	200	13	90	–	80	100	
2N418	BE	pnp,AJ,ge	400	25	100	0.5	80	1.5	
2N420	BE	pnp,AJ,ge	400	25	100	0.5	45	0.5	
2N420A	BE	pnp,AJ,ge	400	25	100	0.5	70	1.5	
2N637	BE	pnp,AJ,ge	400	25	100	0.5	40	0.5	
2N637A	BE	pnp,AJ,ge	400	25	100	0.5	70	2	
2N637B	BE	pnp,AJ,ge	400	25	100	0.5	80	2	
2N638	BE	pnp,AJ,ge	400	25	100	0.5	40	0.5	
2N638A	BE	pnp,AJ,ge	400	25	100	0.5	70	2	
2N638B	BE	pnp,AJ,ge	400	25	100	0.5	80	2	
2N456	TI	pnp,AJ,ge	430	50	100	0.67	40	0.2	
2N457	TI	pnp,AJ,ge	430	50	100	0.67	60	0.6	
2N671	PH	pnp,AJ,ge	700	1	85	.017	40	25	
2N673	PH	pnp,AJ,ge	700	1	85	.017	25	75	
2N675	PH	pnp,AJ,ge	700	1	85	.017	75	100	
GA52830	WE	pnp,AJ,ge	4 mc	500	85	60	40	10	–
GA53242	WE	pnp,AJ,ge	4 mc	500	85	60	40	10	–
GF45017	WE	pnp,AJ,ge	4 mc	500	85	60	40	10	–
2N547	TR	npn,DJ,si	6 mc	5	200	0.045	60	.001	–
2N548	TR	npn,DS,si	6 mc	5	200	0.045	30	.001	–
2N549	TR	npn,DJ,si	6 mc	5	200	0.045	60	.0004	–
2N550	TR	npn,DJ,si	6 mc	5	200	0.045	30	.0004	–
2N551	TR	npn,DJ,si	6 mc	5	200	0.045	60	.001	–
2N552	TR	npn,DJ,si	6 mc	5	200	0.045	30	.001	–
2N1116	TR	npn,DJ,si	6 mc	5	200	0.045	60	.001	–
2N1117	TR	npn,DJ,si	6 mc	5	200	0.045	60	.0004	–
2N1250	TR	npn,DJ,si	6 mc	85	200	0.267	60	20	–
ST401	TR	npn,DJ,si	6 mc	85	200	0.27	45	20	–
ST402	TR	npn,DJ,si	6 mc	50	200	0.33	60	20	–
ST403	TR	npn,DJ,si	6 mc	50	200	0.33	45	20	–
2N545	TR	npn,DJ,si	8 mc	5	200	0.045	60	0.07	–
2N546	TR	npn,DJ,si	8 mc	5	200	0.045	30	0.05	–
2N1212	TR	npn,DJ,si	10 mc	45	200	0.267	60	10	–
2N1208	TR	npn,DJ,si	12 mc	85	200	0.267	60	10	–
2N1209	TR	npn,DJ,si	12 mc	85	200	0.267	45	20	–
2N1046A	TI	pnp,DJ,ge	20 mc	30	100	0.4	130	.3	–
2N1046B	TI	pnp,DJ,ge	20 mc	30	100	0.4	130	.3	
2N1072	WE	ppn,DD,si	60 mc	12	150	65	60	.1	–
2N696	FA	npn,DM,si	100mc	2	175	–	40	0.01	–
2N697	FA	npn,DM,si	100mc	2	175	–	40	0.01	–
2N730	TI	npn,MS,si	100mc	1.5	175	0.01	60	0.01	
2N731	TI	npn,Ms,si	100mc	1.5	175	0.01	60	0.01	
2N1131	FA	pnp,DM,si	100mc	2	175	.0133	30	0.01	
2N1132	FA	pnp,DMsi	100mc	2	175	.0133	30	0.01	
RT5001	Rh	npn,Mesa,si	120mc	3	175	20	60	0.01	
RT5002	Rh	npn,Mesa,si	120mc	3	175	20	60	0.01	
RT5003	Rh	npn,Mesa,si	120mc	3	175	20	100	0.01	
RT5004	Rh	npn,Mesa,si	120mc	3	175	20	100	.1	–
2N696	FA	npn,DM,si	150mc	2	175	.0133	40	.01	
2N697	FA	npn,DM,si	150mc	2	175	.0133	40	.01	
2N717	FA	npn,DM,si	150mc	1.5	175	.010	40	.01	
2N718	FA	npn,DM,si	150mc	1.5	175	.010	40	.01	
2N1613	FA	npn,DP,si	150mc	3	200	.0172	40	.0008	
2N1409	PSI	npn,MS,si	175mc	2.8	150	0.024	30	10	7
2N1410	PSI	npn,MS,si	175mc	2.8	150	0.024	45	10	7
2N698	FA	npn,DM,si	180mc	2	175	.0133	80	.01	–
2N699	FA	npn,DM,si	180mc	2	175	.0133	80	.01	–
2N719	FA	npn,DM,si	180mc	1.5	175	.010	80	.01	
2N720	FA	npn,DM,si	180mc	1.5	175	.010	80	.01	
2N268A	CL	pnp,AJ,ge	–	14	90	1.5	80	2	–
2N252	FA	npn,DM,si	–	2	175	.0133	20	.1	
2N1253	FA	npn,DM,si	–	2	175	.0133	20	.1	

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DATA CHART

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	V_c V	I_{co} ma	Powr Gain db	Powr Out W	Switching Rise Time μsec	Switching Stor. Time μsec	Remarks	Type No.
	300	10	–	–	5	1		WX1016F
	100	50	–	–	–	–		2N1041
	80	100						OC28
	60	100						OC29
	60	100						OC35
	80	100						
	80	1.5	–		15	–		2N418
	45	0.5	–	–	15	–		2N420
	70	1.5	–	–	15	–		2N420A
	40	0.5	–		15	–		2N637
	70	2	–		15	–		2N637A
	80	2	–		15	–	CL	2N637B
	40	0.5	–		15	–		2N638
	70	2	–		15	–		2N638A
	80	2	–		15	–		2N638B
	40	0.2	–	–	12	12.5	RCA	2N456
	60	0.6	–	–	12	12.5	RCA	2N457
17	40	25					Infinite Heat Sink	2N671
17	25	75			0.5	0.4	Infinite Heat Sink	2N673
17	75	100					Infinite Heat Sink	2N675
	40	10	–	–	0.5	1	US,MIL only	GA52830
	40	10	–	–	0.5	1	US,MIL only	GA53242
	40	10	–	–	0.5	1	US,MIL only	GF45017
45	60	.001	–	–	0.7	0.2		2N547
45	30	.001	–	–	0.7	0.2		2N548
45	60	.0004	–	–	0.7	0.2		2N549
45	30	.0004	–	–	0.7	0.2		2N550
45	60	.001	–	–	1.2	0.3		2N551
45	30	.001	–	–	1.2	0.3		2N552
45	60	.001	–	–	0.7	0.2		2N1116
45	60	.0004	–	–	0.7	0.2		2N1117
57	60	20	–	–	0.25	0.5		2N1250
7	45	20	–	–	0.25	0.5		ST401
3	60	20	–	–	0.25	0.5		ST402
3	45	20	–	–	0.25	0.5		ST403
45	60	0.07	–	–	0.3	0.1		2N545
45	30	0.05	–	–	0.3	0.1		2N546
57	60	10	–	–	0.25	0.5		2N1212
57	60	10	–	–	0.25	0.5		2N1208
57	45	20	–	–	0.25	0.5		2N1209
	130	.3	–	–				2N1046A
	130	.3						2N1046B
	60	.1	–	–	0.05	0.05	US, MIL	2N1072
	40	0.01	–	–	0.08	0.03	T1, IND	2N696
	40	0.01	–	–	0.08	0.03	T1, IND	2N697
01	60	0.01			0.11	0.14		2N730
01	60	0.01			0.11	0.14		2N731
33	30	0.01			.08			2N1131
33	30	0.01			0.08			2N1132
	60	0.01			0.1	0.15		RT5001
	60	0.01			0.1	0.2		RT5002
	100	0.01			0.1	0.15		RT5003
	100	.1	–		0.1	0.2		RT5004
33	40	.01			.08		PSI, HO	2N696
33	40	.01			.08		PSI, HO	2N697
0	40	.01			.08		TO-18	2N717
0	40	.01			.08		TO-18	2N718
72	40	.0008					TO-5	2N1613
24	30	10	7	1	.06	.1	Power gain F =70mc	2N1409
24	45	10	7	1	.042	.17	IND	2N1410
33	80	.01	–	–	.08			2N698
33	80	.01	–	–	.08			2N699
0	80	.01			.08			2N719
0	80	.01			.08			2N720
	80	2	–	–	–		BE	2N268A
33	20	.1			.08	.05	IND	2N252
33	20	.1			.08	.05	IND	2N1253

TRANSISTORS–1960

Low

Type No.	Mfg.	Type	$f_{\alpha e}$ MC	Max. Rating: W_c (mw)	T_j C	mw/°C	V_c V
2N327A	RA	pnp,FA,si	0.2	385	160	–	40
2N619	RA	npn,FA,si	0.2	385	160	–	40
2N1034	RA	pnp,FA,si	0.2	250	160	–	40
2N1074	RA	npn,FA,si	0.2	250	160	–	40
2N1037	RA	pnp,FA,ge	0.25	250	160	–	35
2N328A	RA	pnp,FA,si	0.3	385	160	–	35
2N620	RA	npn,FA,si	0.3	385	160	–	35
2N1035	RA	pnp,FA,si	0.3	250	160	–	35
2N1075	RA	npn,FA,si	0.3	250	160	–	35
2N1077	RA	npn,FA,si	0.3	385	160	–	30
2N1036	RA	pnp,FA,si	0.4	250	160	–	30
2N329A	RA	pnp,FA,si	0.5	385	160	–	30
2N621	RA	npn,FA,si	0.5	385	160	–	30
2N1057	GE	pnp,AJ,ge	0.5	240	100	4	45
2N1076	RA	npn,FA,si	0.5	250	160	–	30
2N670	PH	pnp,AJ,ge	0.7	300	85	5.0	40
2N674	PH	pnp,AJ,ge	0.7	300	85	5.0	75
2N1228	HU	pnp,FJ,si	0.8	250	200	–	15
2N1229	HU	pnp,FJ,si	0.8	250	200	–	15
1234	HU	pnp,AJ,si	0.8	400	160	3	110
1244	HU	pnp,AJ,si	0.8	1000	160	7.4	110
2N327A	HU	pnp,AJ,si	1.0	385	160	3	50
2N328A	HU	pnp,AJ,si	1.0	385	160	3	50
2N329A	HU	pnp,AJ,si	1.0	385	160	3	50
2N331	RCA	pnp,AJ,ge	1.0	200	85	3	30
2N1008	BE	pnp,AJ,ge	1.0	400	85	.15	20
2N1008A	BE	pnp,AJ,ge	1.0	400	85	.15	40
2N1008B	BE	pnp,AJ,ge	1.0	400	85	.15	60
2N1056	GE	pnp,AJ,ge	1.0	240	100	4	50
2N1176	BE	pnp,AJ,ge	1.0	300	85	0.4	15
2N1176A	BE	pnp,AJ,ge	1.0	300	85	0.4	40
2N1176B	BE	pnp,AJ,ge	1.0	300	85	0.4	60
2N1230	HU	pnp,FJ,si	1.0	250	200	–	35
2N1231	HU	pnp,FJ,si	1.0	250	200	–	35
2N1232	HU	pnp,FJ,si	1.0	250	200	–	65
2N1233	HU	pnp,FJ,si	1.0	250	200	–	65
1232	HU	pnp,AJ,si	1.0	400	160	3	65
1233	HU	pnp,AJ,si	1.0	400	160	3	65
1242	HU	pnp,AJ,si	1.0	1000	160	7.4	65
1243	HU	pnp,AJ,si	1.0	1000	160	7.4	65
2N1234	HU	pnp,FJ,si	1.2	250	200	–	110
1228	HU	pnp,AJ,si	1.2	400	160	3	15
1229	HU	pnp,AJ,si	1.2	400	160	3	15
1230	HU	pnp,AJ,si	1.2	400	160	3	35
1231	HU	pnp,AJ,si	1.2	400	160	3	35
1238	HU	pnp,AJ,si	1.2	1000	160	7.4	15
1239	HU	pnp,AJ,si	1.2	1000	160	7.4	15
1240	HU	pnp,AJ,si	1.2	1000	160	7.4	35
1241	HU	pnp,AJ,si	1.2	1000	160	7.4	35
2N312	SY	npn,AJ,ge	1.5	100	85	1.66	15
2N519	IND	pnp,AJ,ge	1.5	150	85	2.5	15
2N519A	IND	pnp,AJ,ge	1.5	150	85	2.5	25
B-1154A	BE	pnp,AJ,ge	1.5	400	100	.15	60
B-1154	BE	pnp,AJ,ge	1.5	400	100	.15	40
2N1125	PH	pnp,AJ,ge	1.6	300	85	5	40
2N536	PH	pnp,AJ,ge	2.0	50	85	0.83	20
2N679	SY	npn,AJ,ge	2.0	150	85	2.5	20
2N1223	GT	pnp,AJ,si	2.0	150	150	1.2	40
OC80	AMP	pnp,PADT,ge	2.0	550	75	–	32
2N438	SY	npn,AJ,ge	2.5	100	85	1.6	30
2N356	RCA	npn,AJ,ge	3	100	85	–	20
2N356A	GT	npn,AJ,ge	3	150	100	2	40
2N1220	GT	pnp,AJ,si	3	150	150	1.2	30
2N1353	IND	pnp,AJ,ge	3.5	200	85	3.33	15
2N385A	SY	npn,AJ,ge	4	150	100	2	40

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...teristics: 'co .a	C_{co} $\mu\mu$
5	70
5	35
5	70
5	35
5	70
5	70
5	35
5	70
5	35
5	35
5	70
5	70
5	35
16	40
5	35
25	–
10	100
50	100
50	100
10	95
10	95
10	95
10	95
10	–
16	–
5	–
5	–
7	–
25	40
10	–
12	–
15	–
50	100
50	100
50	100
50	100
10	95
10	95
10	95
10	95
50	100
10	95
10	95
10	95
10	95
10	95
10	95
10	95
10	95
15	–
2	14
1	14
15	20
10	20
20	–
4	–
25	–
50	15
10	
10	–
5	–
3	14
50	9
3.5	12
40	–

DATA CHART

...cteristics I_{co} μa	C_{coe} μμf	Switching: Rise Time μsec	Switching: Stor. Time μsec	Remarks	Type No.
5	70	–	–	GT	2N327A
5	35	–	–		2N619
5	70	–	–		2N1034
5	35	–	–		2N1074
5	70	–	–		2N1037
5	70	–	–	GT	2N328A
5	35	–	–		2N620
5	70	–	–		2N1035
5	35	–	–		2N1075
5	35	–	–		2N1077
5	70	–	–		2N1036
5	70	–	–		2N329A
5	35	–	–		2N621
16	40	–	–		2N1057
5	35	–	–		2N1076
25	–	–	–	Pulse Amp	2N670
10	100	–	–		2N674
50	100	–	–		2N1228
50	100	–	–		2N1229
10	95	–	–	TO-5 Package	1234
10	95			coaxial package	1244
10	95			TO-5 package	2N327A
10	95			TO-5 package	2N328A
10	–	95			2N329A
16	–	–	–	BE, US	2N331
5	–	–	–		2N1008
5	–	–	–		2N1008A
7	–	–	–		2N1008B
25	40	–	–	neon indicator	2N1056
10	–	–	–		2N1176
12	–	–	–		2N1176A
15	–	–	–		2N1176B
50	100	–	–		2N1230
50	100	–	–		2N1231
50	100	–	–		2N1232
50	100	–	–		2N1233
10	95				1232
10	95			TO-5 package	1233
10	95			coaxial package	1242
10	95			coaxial package	1243
50	100	–	–		2N1234
10	95			TO-5 package	1228
10	95			TO-5 package	1229
10	95			TO-5 package	1230
10	95			TO-5 package	1231
10	95			coaxial package	1238
10	95			coaxial package	1239
10	95			coaxial package	1240
10	95			coaxial package	1241
15	–	1.5	2		2N312
2	14	–	–	US, CR	2N519
1	14	1.3	0.7	US, CR	2N519A
15	20	1.5	–		B-1154A
10	20	1.5	–		B-1154
20	–	–	–		2N1125
4	–	–	–		2N536
25	–	5	5		2N679
50	15	–	–		2N1223
10					OC80
10	–	0.7			2N438
5	–	1.0	0.3	GT, SY, CR	2N356
3	14	1.5	0.3	CR	2N356A
50	9	–	–		2N1220
2.5	12	.6	.4		2N1353
40	–	–	–		2N385A

TRANSISTORS–19

Low ... continued

Type No.	Mfg.	Type	$f_{\alpha e}$ MC	Max. Ratings W_c (mw)	T_j C	mw/°C	I_{co} μa	C μ
2N425	MO	pnp,AJ,ge	4	150	85	2.5	2.0	
2N1027	SSD	pnp,AJ,si	4	150	150	1.2	25	
2N1028	SSD	pnp,AJ,si	4	150	150	1.1	25	
2N1605	SY	npn,AJ,ge	4	150	100	2	20	
CK25	RA	pnp,FA,ge	4	80	85	–	2	
2N395	GE	pnp,AJ,ge	4.5	200	100	3.3	6	
2N520	IND	pnp,AJ,ge	4.5	150	85	2.5	1	
2N520A	IND	pnp,AJ,ge	4.5	150	85	2.5	1	1
2N1302	TI	npn,AJ,ge	4.5	150	100	2.5	6	2
2N1303	TI	pnp,AJ,ge	4.5	150	100	2.5	6	2
2N1354	IND	pnp,AJ,ge	4.5	200	85	3.33	2.5	1
2N123	SY	pnp,AJ,ge	5	100	85	1.66	.6	
2N315	GT	pnp,AJ,ge	5	100	85	2	1	1
2N315A	GT	pnp,AJ,ge	5	150	100	2	1	1
2N396A	SY	pnp,AJ,ge	5	150	100	2	6	–
2N414	SY	pnp,AJ,ge	5	150	85	2.5	5	–
2N439	SY	npn,AJ,ge	5	100	85	1.66	10	–
2N450	GE	pnp,AJ,ge	5	150	85	2.5	6	2
2N576	SY	npn,AJ,ge	5	200	100	2.6	20	–
2N578	RCA	pnp,AJ,ge	5	120	85	–	6	–
2N585	RCA	npn,AJ,ge	5	120	85	–	8	–
2N658	RA	pnp,FA,ge	5	150	85	–	2.5	1
2N1012	GT	npn,AJ,ge	5	150	100	2	5	10
2N1123	PH	pnp,AJ,ge	5	750	100	10	10	15
2N1348	IND	pnp,AJ,ge	5	200	85	3.33	5	12
GT1658	GT	npn,AJ,ge	5	150	100	2	3	10
2N377	SY	npn,AJ,ge	6	150	100	2	10	–
2N357	RCA	npn,AJ,ge	6	100	85	2	5	–
2N357A	GT	npn,AJ,ge	6	150	100	2	3	14
2N426	MO	pnp,AJ,ge	6	150	85	2.5	2	14
2N1343	IND	pnp,AJ,ge	6	150	85	2.5	3	12
CK26	RA	pnp,FA,ge	6	80	85	–	2	14
2N100	SY	npn,AJ,ge	7	150	100	2	15	–
2N1090	RCA	npn,AJ,ge	7	120	85	–	8	–
2N1114	SY	npn,AJ,ge	7	150	100	2	30	–
2N1219	GT	pnp,AJ,si	7	150	150	1.2	50	7
GT123	GT	pnp,AJ,ge	7	150	150	2	3	15
2N123	GE	pnp,AJ,ge	8	150	85	2.5	6	15
2N388	GT	npn,AJ,ge	8	150	100	2	5	10
2N396	GE	pnp,AJ,ge	8	200	100	3.3	6	12
2N576A	SY	npn,AJ,ge	8	200	100	2.6	40	–
2N579	RCA	pnp,AJ,ge	8	120	85	–	6	–
2N581	RCA	pnp,AJ,ge	8	80	85	–	6	–
2N358	GT	npn,AJ,ge	9	100	85	2	3	14
2N583	RCA	pnp,AJ,ge	8	80	85	–	6	–
2N597	PH	pnp,AJ,ge	8	250	100	3.3	5	15
2N662	RA	pnp,FA,ge	8	150	85	–	2.5	12
2N1280	IND	pnp,AJ,ge	8	200	85	3.33	5	10
2N1284	IND	pnp,AJ,ge	8	150	85	2.5	2	15
2N1304	TI	npn,AJ,ge	8	150	100	2.5	6	20
2N1305	TI	pnp,AJ,ge	8	150	100	2.5	6	20
2N1347	IND	pnp,AJ,ge	8	150	85	2.5	2.5	12
2N1350	IND	pnp,AJ,ge	8	200	85	3.33	10	12
2N1351	IND	pnp,AJ,ge	8	200	85	3.33	5	12
2N1355	IND	pnp,AJ,ge	8	200	85	3.33	2.5	12
2N1356	IND	pnp,AJ,ge	8	200	100	2.66	[illegible]	12
2N1478	PH	pnp,AJ,ge	8	250	100	3.3	5	15
2N167	GE	pnp,GJ,ge	9	65	85	1.1	[illegible]	2.5
2N358A	GT	npn,AJ,ge	9	150	100	2	[illegible]	14
2N394	GE	pnp,AJ,ge	9	150	85	2.5	[illegible]	12

...ow (continued)

...ings C	...acteristics I_{co} µa	C_{coe} µµf	Switching Rise Time µsec	Stor. Time µsec	Remarks	Type No.
5	2.0	14	1.0	0.3	US,SY,RA,IND,CR	2N425
2	25	–	–	–		2N1027
1	25	7	–	–		2N1028
	20	–				2N1605
	2	14	0.5	0.3		CK25
3	6	12	0.55	0.5	CR	2N395
5	1	14	–	–	US, CR, SY	2N520
5	1	14	0.9	0.7	US, CR	2N520A
5	6	20	.70	.50	TO-5, US, CR	2N1302
5	6	20	.40	.90	CR	2N1303
13	2.5	12	.55	.5		2N1354
66	.6		–	–		2N123
2	1	14	1.0	0.2	IND, US, CR	2N315
2	1	14	0.9	0.4	IND, US, CR	2N315A
2	6	–				2N396A
.5	5	–				2N414
66	10	–	0.5	0.7	CR	2N439
.5	6	20	–	–		2N450
.6	20	–	2	1		2N576
–	6	–	0.85	0.33	IND, US, CR	2N578
–	8	–	0.35	0.25	SY, CR	2N585
–	2.5	12	–	–	CR	2N658
2	5	10	0.1	0.1	CR	2N1012
10	10	15	–	–		2N1123
.33	5	12				2N1348
2	3	10				GT1658
2	10	–	2.5	0.7	CR	2N377
2	5	–	0.6	0.3	GT, SY, CR	2N357
2	3	14	0.5	0.5	CR	2N357A
2.5	2	14	1.0	0.3	US, RA, SY, TR, CR	2N426
2.5	3	12	1.0			2N1343
–	2	14	0.5	0.3		CK26
2	15	–				2N100
–	8	–	0.25	0.20	CR	2N1090
2	30	–	–	–		2N1114
1.2	50	7	–	–		2N1219
2	3	15	0.9	0.5		GT123
2.5	6	15	0.45	0.90	SY	2N123
2	5	10	0.6	0.4	SY, CR	2N388
3.3	6	12	0.4	0.6	TI, GT, SY, CR	2N396
2.6	40	–	2	1		2N576A
–	6	–	0.36	0.33	IND, US, CR	2N579
–	6	–	0.20	0.20	US, IND, CR	2N581
2	3	14	0.4	0.5	SY, CR	2N358
–	6	–	0.20	0.20		2N583
3.3	5	15	–	–	CR	2N597
–	2.5	12	–	–		2N662
3.33	5	10	1.0			2N1280
2.5	2	15	.45	.9		2N1284
2.5	6	20	.45	.50	TO-5, SY, CR	2N1304
2.5	6	20	.28	.80	TO-5, CR	2N1305
2.5	2.5	12				2N1347
3.33	10	12				2N1350
3.33	5	12				2N1351
3.33	2.5	12	.4	.6		2N1355
2.66	2.5	12	.4	.6		2N1356
3.3	5	15	–	–		2N1478
1.1	5	2.5	0.4	0.7	USAF 2N167-MIL	2N167*
2	3	14	0.4	0.4	CR	2N358A
2.5	6	12	–	–	CR	2N394

What you should know about Analog Computers

Judging from the literature, most discussion of analog computers turns on form rather than function.

Every computer manufacturer, including Donner, is ready to tell you all about their designs, right down to the last microvolt. Few spend their literary effort in telling you how to use them and what kind of problems are amenable to analog computer solution. Not too strangely, this is what you, the prospective user, wanted to find out in the first place.

The Donner 3400 Desk-top Computer functions as a compact, versatile electrical model of a dynamic system.

HOW AN ELECTRONIC ANALOG COMPUTER SOLVES PROBLEMS

A mathematical expression which defines the dynamic behavior of a particular physical system also describes the behavior of all other analogous systems. A general purpose analog computer can be programmed to behave as one of these analogous systems. So programmed, it can be used to explore the characteristics of the system or to "solve" the describing equations. Typical problems range all the way from explaining the laws of classical and modern physics to the physiological relations of life itself. Here are some of the fields where analog computers are in use: antenna design, medical research, cybernetics, electron trajectories, nuclear reactor design, fluid mechanics, heat transfer analysis, aerodynamics, meteorology, classical and nuclear physics, chemical kinetics, petroleum, engineering, servo system analysis, auto- and cross-correlation, and economic forecasting.

Assembly of Donner 3100 series high accuracy medium size analog computers in quantity lots provides the user with more value at lower cost. Complete Donner 3100 Computer Consoles start at just under $11,000.

Basic computing elements in an electronic analog computer are dc amplifiers, precision components (resistors, capacitors, and potentiometers), and non-linear accessories (multipliers, function generators, and transport delay simulators).

By interconnecting the computing elements at a patchboard, varying voltage amplitudes can be integrated, summed, differentiated, multiplied, divided, altered in non-linear fashion, and otherwise operated on as directed by a mathematical equation. The answer, which appears as a varying voltage, can be visually observed on a voltmeter or an oscilloscope and permanently recorded by any one of several plotting devices.

The analog computer user can take an equation, change the coefficients at will, and get whole sets of solutions with amazing ease and speed. He can get these results to accuracies of 0.1% or better for a very modest investment. Small Donner computers begin at just over $1,000.

ANALOG OR DIGITAL

The chief advantages of the analog technique are speed, economy, and flexibility. With the analog computer, you get a genuine insight into the response of the system to both internal and external stimuli. No other approach can bring the investigator into such intimate contact with the system.

Digital computers sometimes provide more accurate results, but they seldom give the user the same knowledge because they are at best only machines that compound arithmetic information. Unlike digital computers, analog computers actually behave just like the simulated systems.

TWO NEW PUBLICATIONS PROVIDE MORE INFORMATION

If you are interested in learning more about the application of analog computers, copies of Donner Tech Notes #1 and #2 are available from your nearby Donner engineering representative or directly from the factory. Tech Note #1 is titled "How to Simulate a Non-Linear Control System with an Analog Computer;" Tech Note #2, "How to Use and Program Analog Computers."

Donner Scientific specializes in the manufacture of accurate fixed and general purpose analog systems designed to analyze, measure, and control dynamic inputs. Complete technical information and informed applications assistance can be obtained from your nearby Donner engineering representative or writing Dept. 36.

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TRANSISTORS–1960

Low Level

Type No.	Mfg.	Type	$f_{\alpha e}$ MC	Max. Ratings W_c (mw)	T_j C	mw/°C	V_c V
2N1198	GE	npn,RG,ge	9	65	85	1.1	25
OC141	AMP	npn,PADT,ge	9	100	75	–	20
2N440	SY	npn,AJ,ge	10	100	85	1.66	15
2N518	GE	pnp,AJ,ge	10	150	85	2.5	12
2N521	IND	pnp,AJ,ge	10	150	85	2.5	15
2N521A	IND	pnp,AJ,ge	10	150	85	2.5	25
2N598	PH	pnp,AJ,ge	10	250	100	3.3	35
2N600	PH	pnp,AJ,ge	10	750	100	10	35
2N659	RA	pnp,FA,ge	10	150	85	–	14
2N745	RA	npn,MS,si	10	150	175	0.75	45
2N1281	IND	pnp,AJ,ge	10	200	85	3.33	16
2N1349	IND	pnp,AJ,ge	10	200	85	3.33	40
2N427	GT	pnp,AJ,ge	11	150	100	2	30
CK27	RA	pnp,FA,ge	11	80	85	–	15
2N269	RCA	pnp,AJ,ge	12	120	85	–	25
2N316	GT	pnp,AJ,ge	12	100	85	2	30
2N316A	GT	pnp,AJ,ge	12	150	100	2	30
2N397	GE	pnp,AJ,ge	12	200	100	3.3	15
2N404	RCA	pnp,AJ,ge	12	120	85	–	25
2N635	GE	npn,AJ,ge	12	150	85	2.5	20
2N1306	TI	npn,AJ,ge	12	150	100	2.5	25
2N1307	TI	pnp,AJ,ge	12	150	100	2.5	30
2N1313	IND	pnp,AJ,ge	12	175	85	–	30
2N1344	IND	pnp,AJ,ge	12	150	85	2.5	15
2N1345	IND	pnp,AJ,ge	12	150	85	2.5	10
2N1346	IND	pnp,AJ,ge	12	150	85	2.5	12
2N1357	IND	pnp,AJ,ge	12	200	85	3.33	30
2N1091	RCA	npn,AJ,ge	13	120	85	–	25
2N580	RCA	pnp,AJ,ge	15	120	85	–	[illegible]
2N660	RA	pnp,FA,ge	15	150	85	–	[illegible]
2N1282	IND	pnp,AJ,ge	15	200	85	3.33	[illegible]
2N1316	IND	pnp,AJ,ge	15	200	85	3.33	[illegible]
2N1317	IND	pnp,AJ,ge	15	200	85	3.33	[illegible]
2N1318	IND	pnp,AJ,ge	15	200	85	3.33	[illegible]
2N428	GT	pnp,AJ,ge	17	150	100	2	[illegible]
2N636	GE	npn,AJ,ge	17	150	85	2.5	[illegible]
CK28	RA	pnp,FA,ge	17	80	85	–	[illegible]
2N522	IND	pnp,AJ,ge	18	150	85	2.5	[illegible]
2N522A	IND	pnp,AJ,ge	18	150	85	2.5	[illegible]
2N582	RCA	pnp,AJ,ge	18	120	85	–	[illegible]
2N584	RCA	pnp,AJ,ge	18	120	85	–	[illegible]
2N599	PH	pnp,AJ,ge	18	250	100	3.3	[illegible]
2N601	PH	pnp,AJ,ge	18	750	100	10.0	[illegible]
2N317	GT	pnp,AJ,ge	20	100	85	2	[illegible]
2N317A	GT	pnp,AJ,ge	20	150	100	2	[illegible]
2N337	TI	npn,GD,si	20	125	200	1.0	[illegible]
2N417	IND	pnp,AJ,ge	20	200	85	3	[illegible]
2N661	RA	pnp,FA,ge	20	150	85		[illegible]
2N746	RA	npn,MS,si	20	150	175	0.75	[illegible]
2N1017	RA	pnp,FA,ge	20	150	85	–	[illegible]
2N1308	TI	npn,AJ,ge	20	150	100	2.5	[illegible]
2N1309	TI	pnp,AJ,ge	20	150	100	2.5	[illegible]
2N523	IND	pnp,AJ,ge	24	150	85	2.5	[illegible]
2N523A	IND	pnp,AJ,ge	24	150	85	2.5	[illegible]
2N496	PH	pnp,SB,si	25	150	140	1.3	[illegible]
2N747	RA	npn,MS,si	25	150	175	0.75	[illegible]
2N748	RA	npn,MS,si	25	150	175	0.75	[illegible]
2N1386	RA	npn,MS,si	25	300	175	0.5	[illegible]
2N1387	RA	npn,MS,si	25	300	175	0.5	[illegible]
2N1205	TR	npn,GR,si	27	150	150	–	[illegible]
2N338	TI	npn,GD,si	30	125	200	1.0	[illegible]
2N643	RCA	pnp,DR,ge	*30	120	85	–	[illegible]

DATA CHART

(continued)

I$_{co}$ μa	C$_{coe}$ μμf	Switching: Rise Time μsec	Switching: Stor. Time μsec	Remarks	Type No.
1.5	2.5	0.4	0.7		2N1198
0.8					OC141
10	–	0.3	0.7	GT	2N440
6	12	0.8	0.9		2N518
1	14	–	–	US, CR	2N521
1	14	0.2	0.5	US, CR	2N521A
10	15	–	–	CR	2N598
10	15	–	–		2N600
2.5	12	–	–	CR	2N659
10	3				2N745
5	10	.9			2N1281
5	12				2N1349
2	14	0.43	0.3	MO, IND, RA, US	2N427
2	14	0.4	0.3		CK27
5	–	0.17	0.20		2N269
1	14	0.4	0.4	IND, US, CR	2N316
1	14	0.4	0.4	IND, US, CR	2N316A
6	12	0.3	0.7	TI, CR	2N397
5	–	0.17	0.20	GE, RA, GT, SY, US	2N404
5	–	–	–	CR	2N635
6	20	.22	.50	TO-5, SY, CR	2N1306
6	20	.20	.80	TO-5, CR	2N1307
-	14				2N1313
5	12	.7	.3		2N1344
3	14	.3	.4		2N1345
2.5	14	.3	.4		2N1346
2.5	12	.3	.7		2N1357
8	–	0.20	0.17		2N1091
5	–	0.16	0.29	IND, US	2N580
2.5	12	–	–		2N660
5	10	.8			2N1282
2	14				2N1316
3	14				2N1317
4	14				2N1318
2	14	0.43	0.3	SY, MO, RA, IND, US	2N428
5	–	–	–	CR	2N636
20	14	0.4	0.3		CK28
1	14	–	–	US	2N522
1	14	0.2	0.5	US, CR	2N522A
5	–	0.15	0.17	IND, CR, SY	2N582
5	–	0.15	0.17	US	2N584
10	15	–	–		2N599
10	15	–	–		2N601
1	14	0.3	0.4	US, IND, CR	2N317
1	14	0.3	0.4	IND, US, CR	2N317A
1	1.4	0.02	0.02	TR, GE, RA	2N337
2	12	–	–	CR	2N417
5	12	–	–	CR	2N661
10	3				2N746
2	12	–	–	US	2N1017
6	20	.22	.50	TO-5, SY, CR	2N1308
6	20	.15	.70	TO-5, CR	2N1309
1	14	–	–	US, CR	2N523
1	14	0.1	0.4	US, CR	2N523A
0	6	–	–		2N496
	5				2N747
	5				2N748
	5				2N1386
	5				2N1387
	3.5	–	–		2N1205
	1.4	0.06	0.02	GE, TR, RA	2N338
	–	0.03	0.06	gain bandwidth product*	2N643

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2N1647	20	25	80V.	1.7 @ 1A.	2 @ 1A.
2N1648	20	25	120V.	1.7 @ 1A.	2 @ 1A.
2N1649	20	46	80V.	1.7 @ 1A.	2 @ 1A.
2N1650	20	46	120V.	1.7 @ 1A.	2 @ 1A.

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HIGH POWER TRANSISTORS

- **Available in two package styles — 11/16" hex stud mount and square flange**

For regulated power supplies and amplifier output stages — replaces 2N1015-16, 2N424, 2N389, 2N1487-90 — with low R_{cs} (typical .8 ohms), good Beta linearity, high cut-off frequencies, and high voltage.

Type	Maximum Power Dissipation @ 100°C (Watts)	Maximum Collector Current (amps)	Maximum Collector Voltage (Volts)	Maximum Saturation Resistance (ohms)	Maximum DC Input Voltage (Volts)	DC Beta @ 2 amps	
						Min.	Max.
2N1616 2N1210	30	5	60	1 @ 2A.	3 @ 2A.	15	75
2N1617 2N1211	30	5	80	1 @ 2A.	3 @ 2A.	15	75
2N1618 2N1620	30	5	100	1 @ 2A.	3 @ 2A.	15	75

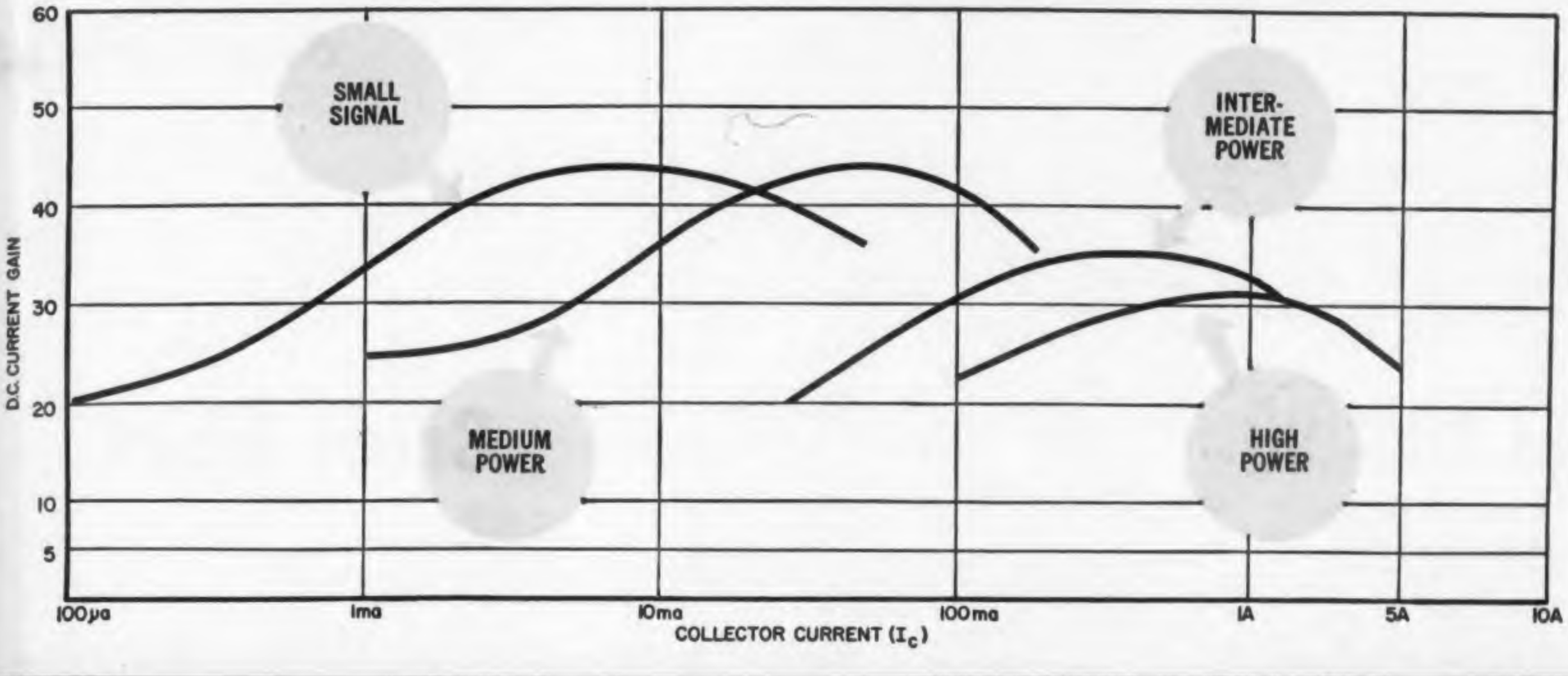
WRITE FOR BULLETIN #TE-1355R

With these new transistors, Transitron offers improved performance and outstanding features in all power ratings from 100 microamps to 5 amps. Each functions in a wide operating range — permitting use of fewer types, simplifying equipment manufacture. All provide the ruggedness and reliability of mesa silicon construction. All are available now, at prices competitive with lower-performance devices.

COMPUTER DESIGNERS ATTENTION

Watch for announcement of Transitron's revolutionary new switching device — coming next month and at WESCON show!

Booth 2638-39



HIGH CUT-OFF FREQUENCIES, LOW R_{CS} AND BETA LINEARITY

SMALL SIGNAL TRANSISTORS

For low level high voltage switching and amplification. Replaces 2N332-2N343 with higher cut-off frequencies (30mc), lower R_{cs}, smaller sized TO-18 package, and higher voltages.

SMALL SIGNAL TO-18						
Type	Maximum Collector Voltage	Minimum DC Beta I_c 500μa	Minimum DC Beta I_c 5ma	Minimum DC Beta I_c 50ma	Maximum Power Dissipation @ 25°C Ambient (mw)	Typical Saturation Resistance (ohms)
ST1504	60	15	20	20	300	40
ST1505	100	15	20	20	300	50

WRITE FOR BULLETIN /TE-1353T

MEDIUM POWER TRANSISTORS

- Collector lead isolated from case — greatly simplifying heat dissipation measures and increasing reliability
- Include highest standard voltage ratings available (to 125V) — for extra safety margin against overloads.

To replace 2N332-343, with improved high frequency characteristics, good Beta linearity, and low R_{cs}.

Type	Maximum Collector Voltage (volts)	Minimum Beta I_c 1ma AC	Minimum Beta I_c 5ma AC	Minimum Beta I_c 50ma DC	Maximum Power Dissipation (Watts) @ 25°C Case	Maximum Saturation Resistance (ohms)
•2N339A†	60	15	25	20	1	50
•2N340A	85	15	25	20	1	70
•2N341A†	125	15	25	20	1	70
••2N1054	125	20(DC) @ 200ma			5	20
•••2N696	60	20(DC) @ 150ma			2	10
••••2N697	60	40(DC) @ 150ma			2	10

† Electrical equivalents available in TO-5 package as 2N1206 and 2N1207

• WRITE FOR BULLETIN /TE-1355J1 •• WRITE FOR BULLETIN /TE-1366E-2
••• WRITE FOR BULLETIN /TE-1355B-3 •••• WRITE FOR BULLETIN /TE-1366B-4

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CIRCLE 81 ON READER-SERVICE CARD

Low Level *(continued)*

Type No.	Mfg.	Type	$f_{\alpha e}$ MC	Max. Ratings: W_c (mw)	T_j C	mw/°C	V_c V	I_c ma	Characteristics: h_{fe} or h_{FE}	I_{co} μa	C_{coe} μμf	Switching: Rise Time μsec	Stor. Time μsec	Remarks	Type No.
2N1122	PH	pnp,MA,ge	40	25	85	0.63	12	50	35	5.0	6.0	–	–	SPR	2N1122
2N1122A	PH	pnp,MA,ge	40	25	85	0.63	15	50	35	5.0	6.0	–	–	SPR	2N1122A
2N644	RCA	pnp,DR,ge	•50	120	85	–	30	100	45	10	–	0.015	0.004	gain bandwidth product*	2N644
ST3030	TR	npn,DJ,si	50	100	150	0.8	15	–	–	50	4	.04	.07		ST3030
2N1254	HU	pnp,MS,si	55	250	160	1.8	15	–	25	30	8	.015	.015	TO-5 package	2N1254
2N1256	HU	pnp,MS,si	55	250	160	1.8	30	–	25	30	8			TO-5 package	2N1256
2N1258	HU	pnp,MS,si	55	250	160	1.8	50	–	25	30	8			TO-5 package	2N1258
2N240	PH	pnp,SB,ge	60	30	85	0.5	6	15	30	0.7	2.9	–	–	SPR	2N240
2N560	WE	npn,DD,si	60	600	150	.25	60	100	20	.1	8	.06	.05	US, MIL only	2N560
2N645	RCA	pnp,DR,ge	*70	120	85	–	30	100	45	10	–	0.01	0.002	gain bandwidth product*	2N645
OC46	AMP	pnp,PADT,ge	73	83	75	–	20	125	< 80	< 3					OC46
OC139	AMP	npn,PADT,ge	73.5	100	75	–	20	250	45	0.8					OC139
OC140	AMP	npn,PADT,ge	74.5	100	75	–	20	250	75	0.8					OC140
2N1255	HU	pnp,MS,si	75	250	160	1.8	15	–	55	30	8			TO-5 package	2N1255
2N1257	HU	pnp,MS,si	75	250	160	1.8	30	–	55	30	8			TO-5 package	2N1257
2N1259	HU	pnp,MS,si	75	250	160	1.8	50	–	55	30	8			TO-5 package	2N1259
OC47	AMP	pnp,PADT,ge	75.5	83	75	–	20	125	<200	<3					OC47
2N1411	PH	pnp,MA,si	85	25	85	0.41	5	50	75	0.5	3				2N1411
2N702	TI	npn,DJ,si	100	150	175	2	20	50		0.5	–	–	–	1 @ 70 mc	2N702
2N1420	RH	npn,MS,si	120	2W	175	13.2	60	500	200	.1	20	.08	.06		2N1420
2N1507	RH	npn,MS,si	120	2W	175	13.2	60	500	200	.1	20	.08	.06		2N1507
2N1139	TR	npn,GR,si	140	500	175	–	15	–	45	1.0	9	0.1	0.05		2N1139
2N501	PH	pnp,MD,ge	250	25	85	0.63	15	50	–	1.0	1.5	0.013	0.007	SPR	2N501
2N501A	PH	pnp,MD,ge	250	25	100	0.45	15	50	–	1.0	1.5	0.013	0.007	SPR	2N501A
2N706	TI	npn,MS,si	250	1000	175	6.67	25	–	30	1	3	.01	.01	hfe = 15 min.	2N706
2N1199	PH	npn,SADT,si	250	100	150	0.8	20	100	25	0.7	1.5	.07	.02		2N1199
2N705	TI	pnp,DJ,ge	300	300	100	4	15	50		.3	–	0.03	0.075	MO, SY	2N705
2N710	TI	pnp,MS,ge	300	300	100	4	15	50	40	0.3	35	.06	.075	TO-18,saturated,SY	2N710
2N711	TI	pnp,MS,ge	300	300	100	4	12	50	30	0.3	4	.07	.1	TO-18,saturated	2N711
2N706	FA	npn,DM,si	750	1000	175	6.7	20	–	45	.005		.02		TO-18 IND, RH	2N706
2N707	FA	npn,DM,si	400	1000	175	6.7	28	–	12	.005	–	.02		TO-18	2N707
2N559	WE	pnp,DG,ge	750	150	100	.5	15	50	25	3	–	.002	.003	US, MIL only	2N559
2N1385	TI	pnp,MS,ge	750	750	100	8	25	100	30	5	1.3	.001	.001	TO-5, non saturated	2N1385
2N377A	SY	npn,AJ,ge	–	150	100	2	40	200	20–60	40		tr + td = 2.5 μsec (max)			2N377A
2N388A	SY	npn,AJ,ge	–	150	100	2	25	200	60–180	40	–	tr + td = 1 μsec (max)			2N388A
2N398	RCA	pnp,AJ,ge	–	100	85	–	105	100	60	14	–	–	–	CR	2N398
2N438A	SY	npn,AJ,ge	–	150	85	2.5	25	200	15 min	10	–	0.7			2N438A
2N439A	SY	npn,AJ,ge	–	150	85	2.5	25	200	30 min	10	–	0.5			2N439A
2N440A	SY	npn,AJ,ge	–	200	85	3.3	25	200	40	10	–	0.3			2N440A
2N556	SY	npn,AJ,ge	–	100	85	1.66	20	200		25	–	3.5	2	tr = 3.5 μs max. to = 2.0 μs max.	2N556
2N557	SY	npn,AJ,ge	–	100	85	1.66	20	200		25	–	6.5	2.5		2N557
2N558	SY	npn,AJ,ge	–	100	85	1.66	15	200		15	–	3.5	2		2N558
2N586	RCA	pnp,AJ,ge	–	250	85	–	45	250	55	16	–	–	–		2N586
2N587	SY	npn,AJ,ge	–	150	85	2.5	30	200		50	–	2	2		2N587
2N725	SY	pnp,DM,ge	–	150	100	2	15	50	20	3	–	0.1		Very high speed medium power	2N725
2N1119	PH	pnp,SAT,si	–	150	140	1.3	10	50	16	–	6.0				2N1119
2N1213	RCA	pnp,MS, ge	–	75	85	–	25	100	–	5		.015	.05		2N1213
2N1214	RCA	pnp,MS, ge	–	75	85		25	100		5		.015	.05		2N1214
2N1215	RCA	pnp,MS,ge	–	75	85		25	100		5		.015	.05		2N1215
2N1216	RCA	pnp,MS,ge	–	75	85		25	100		5		.015	.05		2N1216
2N1299	SY	npn,AJ,ge	–	150	100	2	40	200	35–110	.1	–	Rise & Fall time = 1.5 μsec			2N1299
2N1427	PH	pnp,MA,si	–	25	85	0.41	6	50	25	0.3	3.5				2N1427
2N1472	PH	npn,SADT,si	–	100	150	0.8	25	100	35	0.5	1.0				2N1472
2N1473	SY	npn,AJ,ge	–	200	75	4	40	400	25–80	100	–				2N1473
2N1499	PH	pnp,MD,ge	–	25	85	0.63	20	50	35	1	1.5	25	–		2N1499
2N1500	PH	pnp,MD,ge	–	50	100	0.68	15	50	50	1	1.5	13	7		2N1500

Cross Index

2N356A	LL	2N446	HF	2N546	HL
2N357	LL,HF	2N446A	HF	2N547	HL
2N357A	LL	2N447	HF	2N548	HL
2N358	LL,HF	2N447A	HF	2N549	HL
2N358A	LL	2N448	HF	2N550	HL
2N359	A	2N449	HF	2N551	HL
2N360	A	2N450	LL	2N552	HL
2N362	A	2N456	HL	2N553	P
2N363	A	2N457	HL	2N556	LL
2N368	A	2N458	HL	2N557	LL
2N369	A	2N459	HL	2N558	LL
2N370	HF	2N460	A	2N559	LL
2N371	HF	2N461	A	2N560	LL
2N372	HF	2N463	P	2N561	P
2N373	HF	2N464	A	2N564	A
2N374	HF	2N465	A	2N566	A
2N375	HL	2N466	SP,A	2N568	A
2N376	P	2N469A	SP	2N570	A
2N376A	P	2N472A	A	2N572	A
2N377	LL,HF	2N473	HF	2N574	P
2N377A	LL	2N474	HF	2N574A	P
2N378	HL	2N475	HF	2N575	P
2N378A	LL	2N475A	A	2N575A	P
2N379	HL	2N478	HF	2N576	LL
2N380	HL	2N479	HF	2N576A	LL
2N381	HL	2N480	HF	2N578	LL
2N382	A	2N480A	A	2N579	LL
2N383	A	2N481	HF	2N580	LL
2N384	HF	2N482	HF	2N581	LL,HF
2N385	HF	2N484	HF	2N582	LL,HF
2N385A	LL	2N485	HF	2N583	LL
2N386	HL	2N486	HF	2N584	LL
2N387	HL	2N495	HF	2N585	LL
2N388	LL,HF	2N496	HF	2N586	LL
2N389	P	2N497	P,HF	2N587	LL
2N392	P	2N498	P,HF	2N588	HF
2N393	HF	2N499	HF	2N591	A
2N394	LL	2N501	LL	2N592	A
2N395	LL,HF	2N501A	LL	2N593	A
2N396	LL,HF	2N502	HF	2N594	A
2N396A	LL	2N502A	HF	2N595	A
2N397	LL,HF	2N503	HF	2N596	A
2N398	LL	2N508	A	2N597	LL
2N399	P	2N511	P	2N598	LL
2N400	P	2N511A	HL	2N599	LL
2N400A	LL	2N511B	HL	2N600	LL
2N401	P	2N512	P,HL	2N601	LL
2N402	A	2N512A	P,HL	2N602	HF
2N403	A	2N512B	P,HF	2N603	HF
2N405	A	2N513	HL	2N604	HF
2N406	A	2N513A	HL	2N609	A
2N407	A	2N513B	HL	2N610	A
2N408	A	2N514	HL	2N611	A
2N409	HF	2N514A	HL	2N612	A
2N410	HF	2N514B	HL	2N613	A
2N411	HF	2N515	HF	2N614	HF
2N412	HF	2N516	HF	2N615	HF
2N413	HF	2N517	HF	2N616	HF
2N413A	HF	2N518	LL	2N617	HF
2N414	LL,HF	2N519	LL,HF	2N618	HL
2N414A	HF	2N519A	HF	2N619	LL
2N414B	HF	2N520	LL	2N620	LL
2N415	HF	2N520A	LL,HF	2N621	LL
2N416	HF	2N521	LL	2N624	HF
2N417	LL,HF	2N521A	LL	2N627	P
2N418	HL	2N522	LL	2N628	P
2N419	P	2N522A	LL,HF	2N629	P
2N420	HL	2N523	LL	2N630	P
2N420A	HL	2N523A	P,HF	2N631	A
2N422	A	2N524	A	2N632	A
2N424	P	2N525	A	2N633	A
2N425	LL	2N526	A	2N634	HF
2N426	LL	2N527	A	2N635	LL,HF
2N427	LL	2N528	HF	2N636	HF
2N428	LL	2N534	A	2N637	HL
2N438	LL,HF	2N535	A	2N637A	HL
2N438A	HF	2N535A	A	2N637B	HL
2N439	LL,HF	2N535B	A	2N638	HL
2N439A	HF	2N536	LL	2N638A	HL
2N440	LL,HF	2N537	HF	2N638B	HL
2N440A	HF	2N538	P	2N639	P
2N441	P	2N539	P	2N639A	P
2N442	P	2N540	P	2N639B	P
2N443	P	2N541	HF	2N640	HF
2N444	HF	2N542	HF	2N641	HF
2N444A	HF	2N543	HF	2N642	HF
2N445	HF	2N543A	A	2N643	LL
2N445A	HF	2N544	HF	2N644	LL
		2N545	HL	2N645	LL

2N647	A
2N649	A
2N650	A
2N650A	A
2N651	A
2N651A	A
2N652A	A
2N653	A
2N654	A
2N655	A
2N656	P,HF
2N657	P,HF
2N658	LL
2N659	LL
2N660	LL
2N661	LL
2N662	LL
2N665	P
2N669	P
2N670	LL
2N671	HL
2N673	HL
2N674	LL
2N675	HL
2N679	LL
2N695	HF
2N696	HF,HL
2N697	HF,HL
2N698	HF,HL
2N699	HF,HL
2N702	LL
2N705	LL
2N706	LL,HF
2N707	LL
2N710	LL,HF
2N711	LL
2N715	HF
2N716	HF
2N717	HL
2N718	HL
2N719	HL
2N720	HL
2N725	LL
2N728	HF
2N729	HF
2N730	HL
2N731	HL
2N734	A
2N735	A
2N736	A
2N741	HF
2N742	A
2N745	LL
2N746	LL
2N747	LL
2N748	LL
2N749	HF
2N750	HF
2N751	HF
2N1008	A,LL
2N1008A	LL
2N1008B	LL
2N1009	A
2N1011	P,HL
2N1012	LL
2N1014	P
2N1017	LL
2N1018	A
2N1021	P
2N1022	P
2N1023	HF
2N1024	HF
2N1025	HF
2N1026	HF
2N1027	LL
2N1028	LL
2N1031	P
2N1031A	P
2N1031B	P
2N1031C	P
2N1032	P
2N1032A	P
2N1032B	P
2N1032C	P
2N1034	LL
2N1035	LL
2N1036	LL
2N1037	LL
2N1038	HL
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CTP1112	P
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CTP1736	P
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GA53242	HL
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GK16A	HF
GT74	A
GT81	A
GT109	A
GT123	LL
GT327A	A
GT328A	A
GT1624	Sp
H3A	P
H4A	P
H45	P
LT11	P
LT12	P
LT13	P
LT14	P
LT15	P
OC22	HL
OC23	HL
OC24	HL
OC29	HL
OC30	P
OC35	HL
OC36	HL
OC44	HF
OC45	HF
OC46	LL
OC47	LL
OC53	A
OC54	A
OC55	A
OC56	A
OC59	A
OC60	A
OC74	A
OC75	A
OC79	A
OC80	LL
OC139	LL
OC140	LL
OC141	LL
OC170	HF
OC171	HF
OC200	A
OC201	A
OCP70	A

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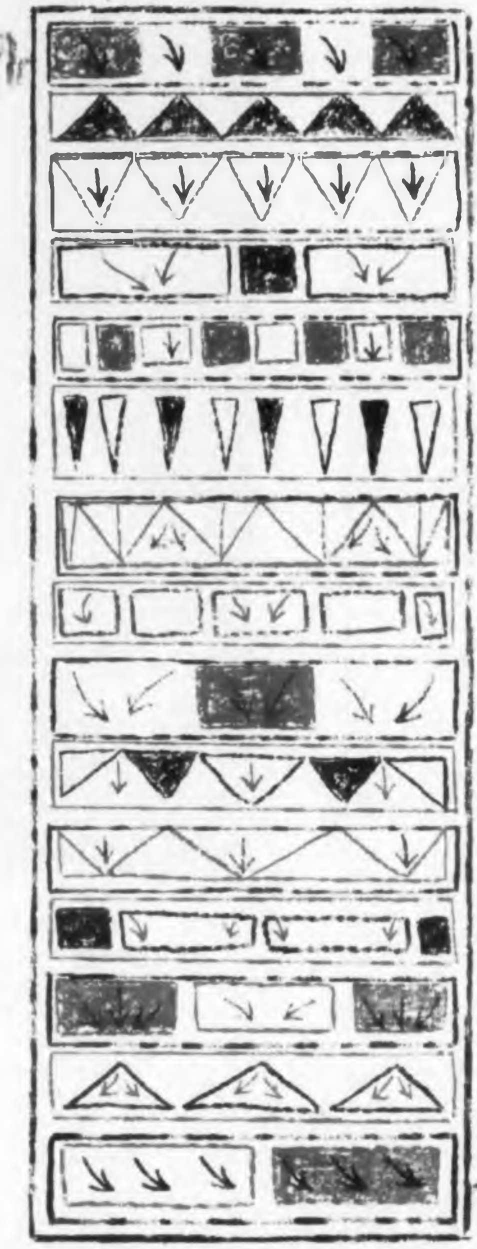
Part 3

Pulse Code Modulation Terminal And Repeater Methods



R. L. Carbrey
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Murray Hill, N.J.

Because coded pulses can be regenerated, the design of repeaters for PCM systems is an important part of the system design. In this third and concluding part of this series Bob Carbrey details regenerative repeater operation and design Part 1 of the series appeared in ED, June 8, p 52 and Part 2 in ED, June 22, p 66.

ONE OF THE most important advantages of pulse code transmission is that the pulses can be recreated at the receiving end. Thus, all noise and distortion can be eliminated, resulting in a signal generally as clean as the original.

In the process of transmitting coded signals over long lines, the repeaters can be designed to amplify and recreate, or regenerate, these pulses.

Regenerative repeaters have been successfully operated with bit rates ranging from ordinary telegraph to several hundred megabits per second. Ordinary exchange area telephone pairs, coaxial cable, microwave radio, and waveguides have been used as transmission media.

Normal repeater functions are shown in block form in Fig. 13. When pulses are sent over a transmission medium that does not have a flat pass band, the pulses are "smeared out in time" so that some frequency components of a given pulse appear in the following time slots. A particularly severe example is shown in Fig. 14 which shows what happens to a code group sent over 3000 feet of exchange area telephone cable at a 10-megabit rate. After appropriate low-frequency loss has been inserted by a simple equalizer, the combination appears as shown at 14c. If flat band loss were the only consideration, the equalizer could just as well be located at the output. The equalizer would be used at the output if crosstalk into other systems from the pulse system were controlling. When it is located at the input, however, any noise picked up in the link is also attenuated.

Fig. 15a shows a 2-mc interfering sine wave added to the binary signal as it appears before the equalizer. The interference is about 8 db greater than the signal transition due to a change from pulse to space or space to pulse. The resulting output after the amplifier and equalizer is shown in Fig. 15b. The signal is about 1 db greater than the 2-mc interference.

With simple sine wave timing added as shown in 15c, some variation in the regenerated signal is apparent as shown in 15d. This is adequate unless the following noise is severe. Usually very little equalization is needed for microwave and coaxial transmission circuits.

The ideal regenerative repeater would be one in which no linear amplification is used. However, linear amplification is used in repeaters because most decision circuits do not have sufficient

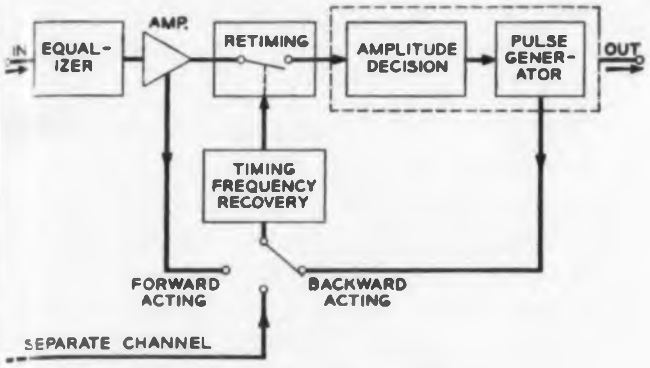
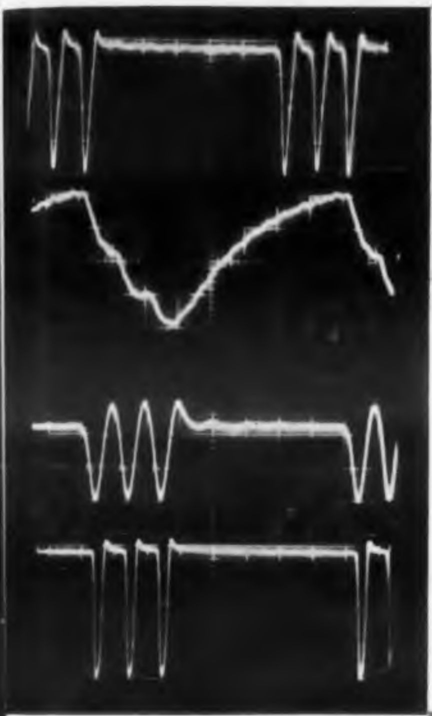


Fig. 13. PCM repeater functions.



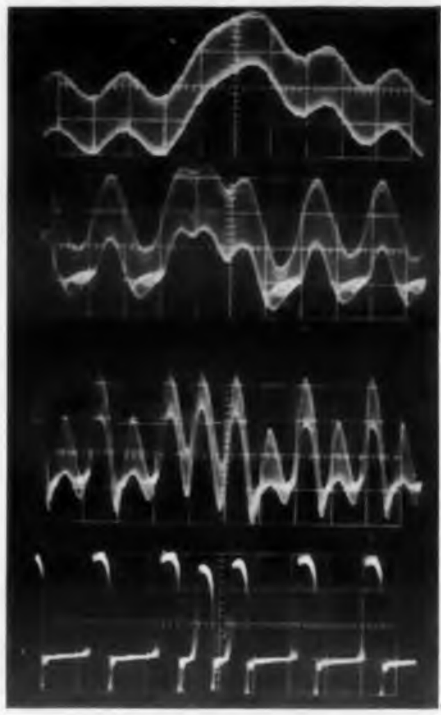
a. 10101 input to cable pair

b. Unequalized output of 3000 ft pair showing effect of line distortion

c. Equalized output of repeater amplifier

d. Regenerated output pulses

Fig. 14. Example of how severe noise can cause a "time shift" in a pulse train.



a. Cable pair output with 2 mc interference added. Interference approx. 8 db above space to pulse transition of signal

b. Same signal and interference after equalizer and amplifier

c. Same as (b) with 10 mc sine-wave timing added

d. Regenerated output pulses for input shown at (a).

Fig. 15. Effect of 2 mc interference added to a pulse train and the way the pulses are regenerated.

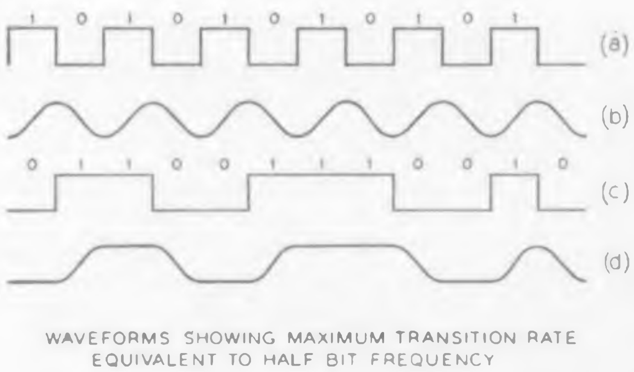


Fig. 16. Putting two or more bits through a system in sequence (c) does not require additional bandwidth over single bit sequence (a). Cosine wave (d) resulting from passing (c) through an appropriate filter results in fewer transitions per second than cosine wave (b), the resultant of (a) passing through an appropriate filter.

ensitivity and stability to be triggered correctly om signals which are still far enough above the oise to be easily distinguished. Amplifiers provide a part or all of the gain necessary to make p for the loss of the preceding transmission link nd permit repeaters to be spaced further apart.

The amplifier band should be kept only wide nough to prevent excessive intersymbol interrence due to cutoff at the high end, and excesve low frequency "droop" due to cutoff at the w end. Wider bands than this just permit more oise to get through to the decision circuit. The ver-all combination of transmission line amplifier nd equalizer for the 10-megabit signals of Figs. 4 and 15, for example was already down 6 db at mc. At 10 mc it was down 18 db.

Nyquist showed that $2B$ bits per second could theoretically be transmitted over a system of bandwidth B even in the presence of noise. Although a discussion of Nyquist's theorem,[20] is beyond the scope of this article, some insight into how this can be done may be gained from a study of Fig. 16.

A sequence of alternate pulses and spaces, 16a, passing through an appropriate filter band appears as a raised cosine wave of half the bit frequency, 16b. This represents the maximum possible number of transitions from one level to the other. If two or more like bits are put in sequence as shown at 16c, then there are actually fewer transitions per second; so no more high-frequency bandwidth is necessary.

A transmission bandwidth of at least 28,000 cps per channel would be required to transmit the 56,000 bits per second resulting from coding a 4000-cps speech band as seven digit PCM. If this seems wasteful of bandwidth, it should be recalled that regeneration makes possible use of bandwidth which could not be used for analog signals because of excess distortion and noise.

Timing Methods

The next function shown in Fig. 13 is that of retiming. Ideally the switch should gate a very narrow sample of the input signal through to the decision circuit at the center of each bit interval. This provides the maximum protection against excursion of the bits either forward or backward in time. Fig. 17c shows the result of gating both a noise-free pulse and one with the limiting time perturbation as shown at 17a. The timing pulses

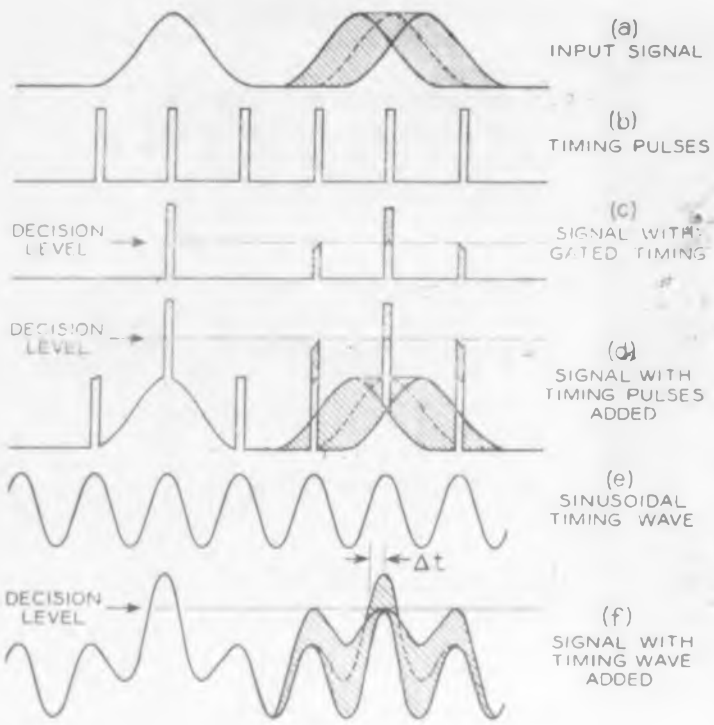


Fig. 17. Result of gating both a noise-free pulse and one with limiting time perturbation (a). Effect of adding timing pulses (d) is shown (f).

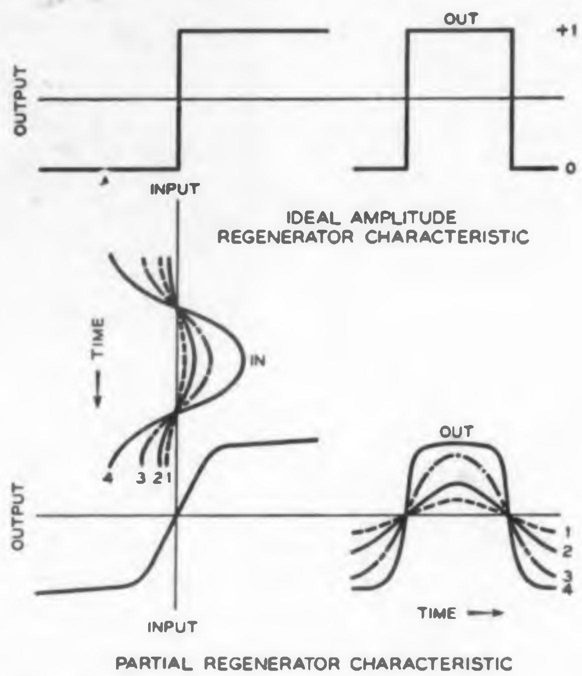


Fig. 18. Ideal regenerator characteristic (top) compared to the close approximation (bottom) that can be obtained by cascading enough clipping-tape amplifier stages.

are shown at 17b. This is a very desirable type of signal to apply to a regenerative trigger circuit.

Two other retiming techniques are frequently used in order to keep the complexity of a repeater to a minimum. These are negative pedestal timing and additive timing. In these, the timing pulses are essentially added to the signal wave as in Fig. 17d. This eliminates both the gate circuit components and the loss through the gate. With negative pedestal timing,[21] the peaks of the pulses are held at zero. The space interval between pulses holds the signal down below the trigger level thus preventing operation except during the pulse.

If the timing pulse magnitude changes or even drops to zero, the amplitude threshold will still be at the center of the binary signal. As a result, the timing pulses need not be controlled precisely, and backward acting timing recovery circuits can start without difficulty. The negative pedestal must be added in after the last ac coupling and its power must be comparable to that of the signal.

When the timing wave is added before the last ac coupling, the dc reference is lost, and simple additive timing results. The amplitude threshold will vary as the timing signal varies. With this method, the timing signal can be added at the input of the signal amplifier; so that very little timing signal is required. This is particularly useful where a number of repeaters are driven in parallel at each repeater point. Isolation can be provided between repeaters by attenuation in the timing input circuits.

Generating the idealized pulses of Fig. 17b is not easy to do. Even simple sine wave timing can be used, however, as shown in 17e and 17f. The timing and signal waves are shown at equal magnitudes with a resulting timing variation, Δt, remaining. This is a form of partial timing regeneration, and the following repeater should clean the timing up almost entirely.

Amplitude Decision

The input-output characteristic of an ideal amplitude regenerator is shown in Fig. 18a. For all input amplitudes below threshold, the output is zero, and for all amplitudes above this the output is a unit height pulse such as that shown to the right. As with most ideal characteristics this one, too, is difficult to obtain. It can be approximated as closely as the designer wishes (subject to dc stability and bandwidth limitations) by cascading enough clipping type amplifier stages which successively amplify the center region and limit the upper and lower extremes.

This is really a process of cascading partial regenerator characteristics such as that shown at 18b. Fig. 19a is a functional diagram of a partial regenerator stage. Diode *A* limits the positive swing as soon as the forward breakdown voltage is exceeded. Diode *B* limits when the negative swing exceeds its forward breakdown. Four such circuits in cascade are shown in Fig. 19b.

When high-level interference is not likely to occur between repeater sections, considerable economy will result by simply using a single section at each repeater thus spreading the regeneration out along the transmission medium. The effect of either the local or spread out cascaded regeneration is indicated by the waveforms in Fig. 18. A low level signal such as Curve *1* shown on the input axis between the two characteristics would simply be amplified as it passed through the first repeater stage. The output is shown to the right of partial regenerator characteristic.

At the next repeater this amplified signal appears as input Curve *2* which is further amplified. At the input to the third repeater in the string it would appear as Curve *3* which is already large enough to show some upper and lower level limiting action. The resulting input to the fourth repeater produces a full height pulse.

Pulse amplification and stretching will be required after the clipping operation unless the clipping is done at high level and unless a long signal sample is taken. Repeaters using diode limiting in a hybrid T waveguide section have been used at the Bell Laboratories Holmdel Laboratory to directly regenerate microwave pulses

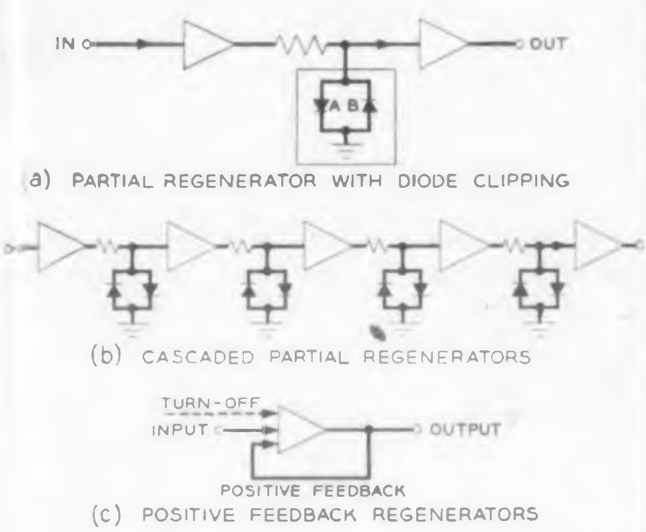


Fig. 19. Partial regenerator (a) shown cascaded (b). Positive feedback can be used as at (c).

a rate of more than 320 megabits per second.[22]

Positive Feedback Regenerators

Positive feedback trigger circuits such as blocking oscillators and the various types of multivibrators accomplish the effect of cascading a large number of stages in a much more economical manner. The output is simply fed back to the input as indicated in 19c where it is amplified again. The process continues until self-limiting occurs. These circuits provide amplification as well as pulse stretching and can be triggered from a short input sample. Unlike the simple clipping amplifiers, however, some form of "turnoff" must be provided in order to bring the circuit back out of the limiting condition.

When control pulses are used to do this, they have to be relatively high power. This is particularly true of transistor circuits which are driven into saturation. The pulse length can be controlled relatively precisely because both turn-on and turn-off are specified.

When internal time constants are used to terminate the pulse, as in a blocking oscillator, no turn-off power is required. The pulse usually must be shorter than the full digit interval in order to allow time for recovery to a stable decision threshold. The duration is subject to somewhat greater variation. Monostable blocking oscillators or negative resistance circuits are probably the most economical of components since they can be built with one active element.

Timing Recovery Control

The regenerative repeater timing frequency must be slave in both frequency and phase to the signals which are sent out from the transmitter. The frequency can be taken from a separate channel or recovered from the pulse signals themselves

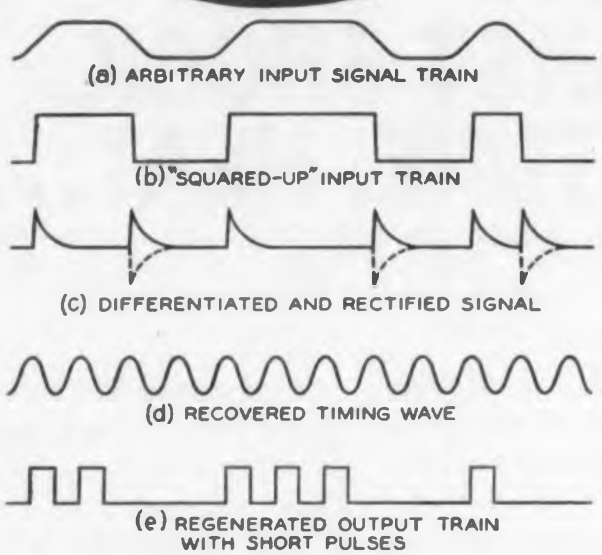


Fig. 20. Squaring up of input signal (b) is followed by differentiation (c), adding timing wave (d) resulting in regenerated output.

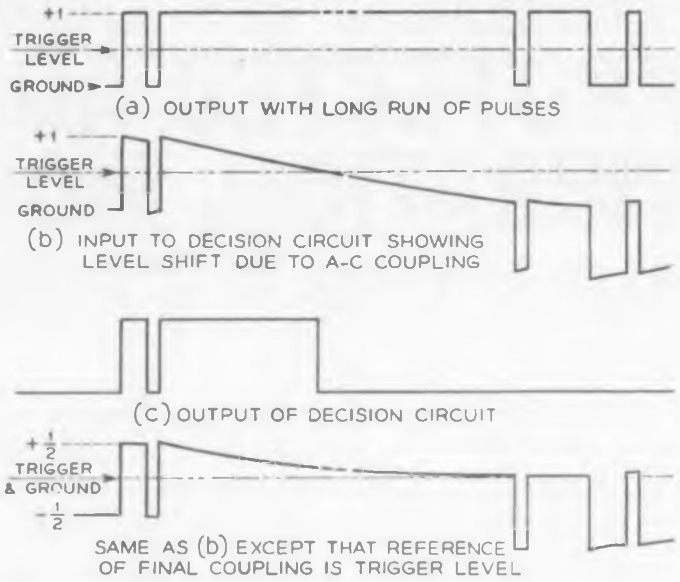


Fig. 21. Loss of regenerators margin due to duty factor variation.

as indicated by the switch of Fig. 13.

When separate channel timing is used, a frequency which is either the fundamental bit frequency or a submultiple of it is sent over the same route as the signals. It is subject to the same delay variations as the signal; so it presumably will remain in the correct phase relationship to cause the retiming operation to occur at the midpoint of the binary signals. Noise should be small because a narrow band repeater can be used. It is, however, subject to crosstalk from the system itself which is right in the band. Regenerative type timing repeaters will help minimize the timing signal variations.

The major advantage of a separate channel timing circuit is that the timing information is always the same and the problem is simply one of separating it from the noise. A disadvantage is that a separate transmission path and repeater circuit must be used which, with very little addition, could be used to transmit a full channel of data. Failure can occur as a result of loss of either the timing or the signal path.

A narrow band filter can be used to extract timing information directly from the binary signal train. The filter "averages out" the frequency and phase. Although the timing wave will follow the slow or permanent changes, the broadband of noise will not perturb it.

If the bandwidth of the input amplifier and transmission circuit is kept to a minimum, such as indicated in Fig. 16, there is very little fundamental bit frequency in the input signal train. The most common practice in forward acting timing is to "square-up" the input signal, differentiate the result, and then rectify it as shown in Fig. 20. After rectification all transitions will add in phase with the bit rate timing frequency. The timing frequency recovery circuit must have a sufficiently high Q to bridge any gaps due to long runs of all pulses or all spaces. A local slave oscillator can be used to provide a source of fixed magnitude signal.

The variation of input signal sequences may cause shifts in either magnitude or phase of the recovered timing wave. This is the principal problem for timing circuits which depend on the pulse train for timing information. Although the pattern effect is small in a single repeater, it may accumulate in a large number of repeaters because the same pattern appears at each one.[23,24,25]

It is important to note that accumulated low-frequency timing variation will not reduce the signal-to-noise margin due to pulse-to-pulse jitter and distortion. Even though the timing wave variation accumulates through a long chain of repeaters to the point where it is slowly wandering forth and back through many cycles of phase shift with respect to absolute reference, the pulses from which the timing wave is derived are also accumulating a corresponding slow wander.

The penalty, if any, occurs in the demodulation process. If the effective filter bandwidth is sufficiently small, any disturbance for a time separation multiplex signal should be inaudible.

"Squaring-up" the input signals is really a form of partial regeneration with the retiming omitted. With backward acting timing the actual regenerated signal is used as a source of timing frequency. If the pulses occupy the full time interval as shown in Fig. 16a, the same differentiation process would have to be used as with the forward acting case. When the pulses are shorter than a full bit interval, as with a monostable type regenerator, every pulse will contribute to the recovered timing wave. See Fig. 20e.

Backward acting timing depends for control on the slight changes in firing time which occur when either the signal or timing is not in the proper position. A perfect timing control pulse would always cause the regenerator to fire at the same time. Therefore, a timing pulse with a finite rise time should be used. Because the regenerated pulses are used as a source of timing frequency, it is always necessary to design backward acting circuits so that pulses will be produced even though the timing wave disappears.

With either forward or backward acting timing, very long runs of pulses and very long runs of spaces should be avoided, if possible, in any type of repeater. In almost any ac coupled repeater, the duty factor variations cause shifts of the effective decision threshold which reduce the signal-to-noise margin to the point where errors are likely to occur long before the timing goes out. Even with dc coupling, the operating points and decision levels tend to shift with severe change in duty factor. For example, fixed and stray capacity charge, heating, I_{co}, base or grid currents, etc. may shift.

Duty Factor Variation

Fig. 21 illustrates the effect of using ac coupled circuits in regenerative repeaters with baseband signals. Ac coupling is usually desirable both for stability and gain where impedance transformation can be used and for coupling between balanced transmission lines and unbalanced circuits.

A long run of pulses, Fig. 21a, is equivalent to a step function. If the run is long compared with the low frequency cut-off, the pulse train will decay back to the coupling reference potential as indicated in 21b. Single time constant is shown. The result will be spaces where pulses should be as in 21c. Even if the run does not last long enough to cause an error directly, the decay will reduce the signal to noise margin. If the circuit is arranged so that the final ac coupling reference is the decision threshold as indicated in 21d, the pulses will at least decay no further than the decision level. In this case a long run of spaces is put in equal jeopardy.

The effective decision level for a pulse train will shift around due to simple variations of duty factor. The long run of all pulses or all spaces is simply the limiting case. The most obvious solution to this problem is to use dc restoration, but there are two limitations. Spaces must be pro-

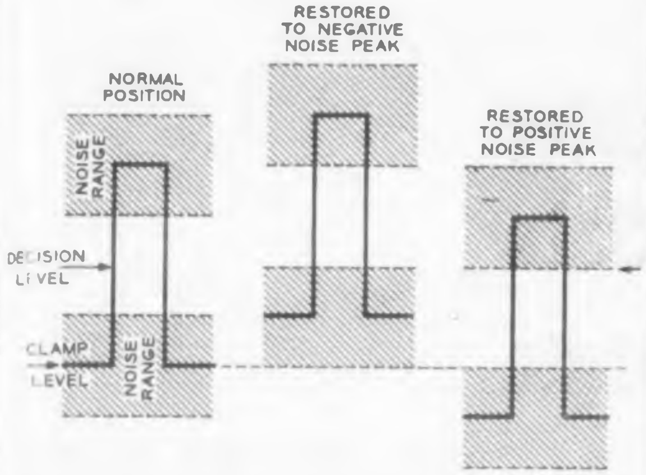


Fig. 22. Reduction of signal-to-noise margin due to dc restoration.

duced frequently enough to insure adequate restoration, and the signal-to-noise margin is cut in half because restoration is to the sum of signal and noise as indicated in Fig. 22a.

L. R. Wrathall[21] showed that quantized feedback could be used to correct for the duty factor variation. Because the pulses have a fixed shape, they will cause a known low frequency "tail" to appear in going through one or more ac coupled circuits. The decay is really the summation of the tails from a large number of pulses.

With quantized feedback, an equal and opposite set of tails is generated to cancel the original ones by feeding back a part of the short regenerated pulse energy through the same or equivalent time constants. Quantized feedback is very effective, but the balance is subject to variation with general magnitude. In high speed circuits delay variations from the input to the ouput create problems.

Proposals for eliminating or reducing the dc or converting the ordinary binary pulse train to a more favorable one have been made by a number of workers in the field. ■ ■

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Silicon Controlled Rectifier Automatically Sets Initial Multivibrator State

Robert Alan Mammano
U. S. Naval Ordnance Test Station*
China Lake, Calif.

A naval officer as well as an engineer, Robert Mammano has been working on semi-conductor applications in missile programing systems. The module he's holding contains the circuit he describes in this article.

A SIMPLE, silicon controlled rectifier (SCR) circuit can be used to automatically fix, or set, the initial turn-on state of a bistable multivibrator.

When power is applied to a bistable multi, it is entirely arbitrary which side of the flip-flop will conduct initially. There will usually be enough unbalance in a flip-flop stage so that it will turn on in the same state. However, this turn-on characteristic is hard to predict and is also unreliable. The SCR circuit described here, sets the initial turn-on state and then allows the multi to be triggered in a balanced, normal manner.

Positive Base Voltage Can Be Used to Set Bistable Multi

A bistable multivibrator, which uses base turn-off triggering with negative input pulses, is shown in Fig. 1. This multi can be set by putting a positive voltage on one base and saturating the transistor. This voltage can be introduced with the manually operated switch shown in Fig. 2. The positive voltage is applied to the transistor base when the switch is in the *SET* position. When moved to the *OPERATE* position, the set flip-flop can operate normally. The value of R is determined from the number of flip-flops to be controlled. An approximate value of R is found from the equation

$$R = \frac{E - I_b R_b}{n I_b}$$

where n is the number of multi stages and I_b is the base current which is required to saturate the transistor.

This system works quite well. It reliably sets the flip-flops and when switched to allow them to count, no triggering transients are developed. If, at a later time, it is desired to reset the stages, the switch is returned to the *SET* position. The obvious disadvantage of this system, however, is the need for a manually operated switch.

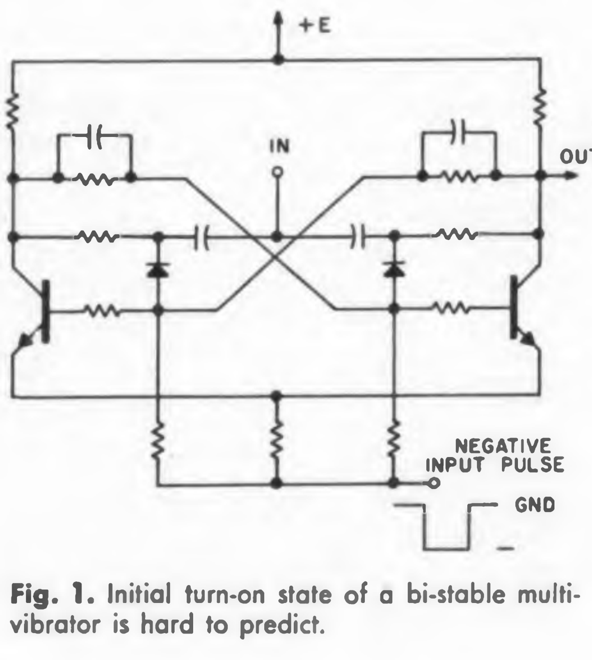


Fig. 1. Initial turn-on state of a bi-stable multivibrator is hard to predict.

Pulse-Gated SCR Automatically Sets Initial Multi State

For remote or automatic operation, the manual switch is replaced by a silicon controlled rectifier, Fig. 3. The rectifier's open and closed states correspond to the *SET* and *OPERATE* positions of the manual switch. A 3A31 controlled switch made by Solid State Products, Inc. is highly suited for this application. It requires very little firing current (20 μa), has a low maximum holding current (less than 2 ma), and is packaged in a standard TO-9 transistor case.

Initially the SCR is open. When the circuit is energized, current flows into the base of the tran-

*Now with Aeronautical Tactical Weapons Div., Santa Ana, Calif.

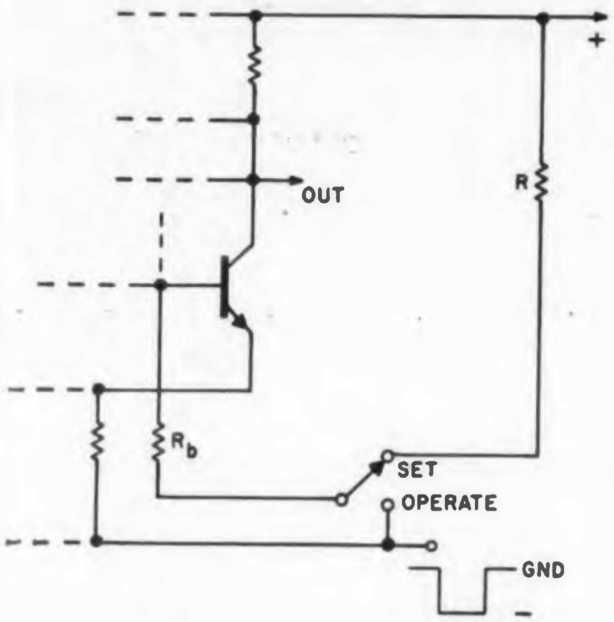


Fig. 2. Multi can be set by applying a positive voltage, through the manually operated switch, to the base of one transistor. The voltage is removed by moving the switch to the *OPERATE* position.

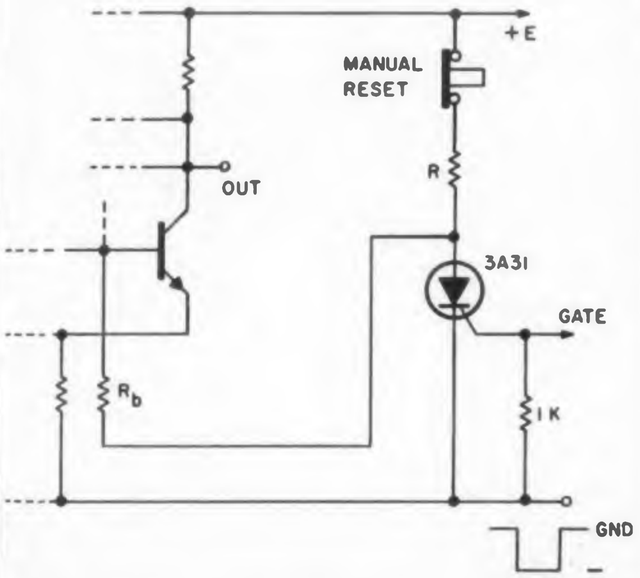


Fig. 3. The manually operated switch is replaced by a silicon controlled rectifier. Multivibrator can now be set electrically.

sistor as in the manually operated case. However, when a positive signal is applied to the rectifier gate, it switches closed and the anode voltage is equal to the saturation voltage of the SCR. For the 3A31 unit this voltage is less than 1 v. This is close enough to ground potential to allow the flip-flops to operate in their normal manner. Thus, by applying a position gating pulse to the SCR, we have effectively moved the manually operated switch of Fig. 2 to the *OPERATE* position.

If it is desired to reset the flip-flop, the SCR may be turned off by either manually or electrically reducing the anode current below the holding value.

There are a few points to be considered if the circuit of Fig. 3 is to be used effectively. First,

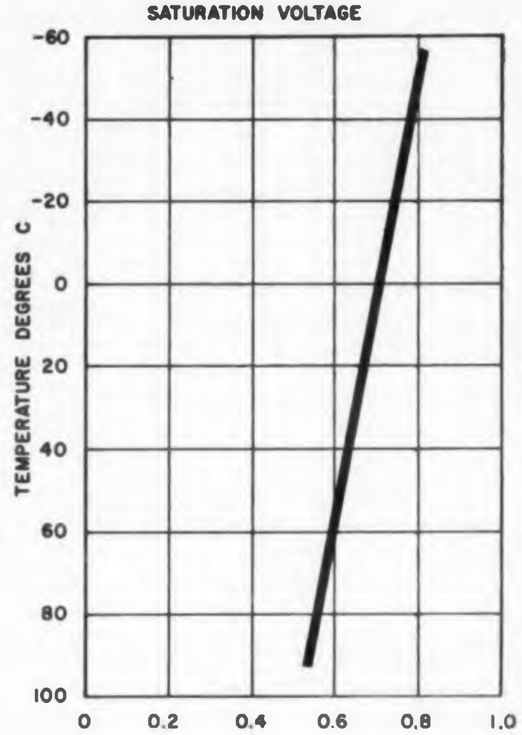


Fig. 4. Saturation voltage of switched controlled rectifier varies with temperature.

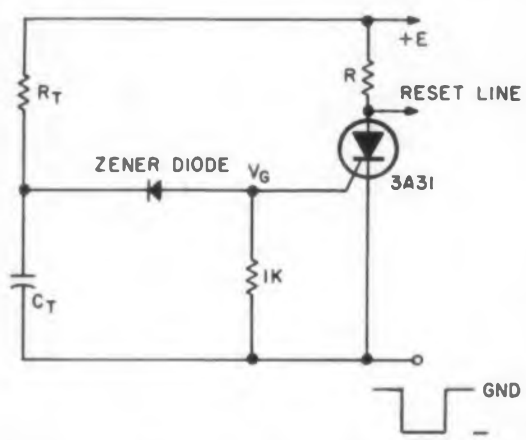


Fig. 5. With an RC charging circuit, the gating (switching) voltage for the SCR is obtained from the B+ supply.

the value of R has a maximum value determined by the holding current of the SCR. With a maximum holding current of about 2 ma, R would be limited to about 7 or 8 K. For most transistors this would normally not offer much restriction.

Second, instead of going directly to ground, the base resistor now goes to the saturation voltage of the rectifiers. In normal saturated flip-flop design, the off npn transistor has a negative V_{BE}. This negative voltage should be large enough so that when it is increased by the saturation voltage of the SCR, it is still negative.

Another problem is that the saturation voltage of the SCR varies with both temperature and current. A plot of the variation of this voltage with temperature is given in Fig. 4. Because of this

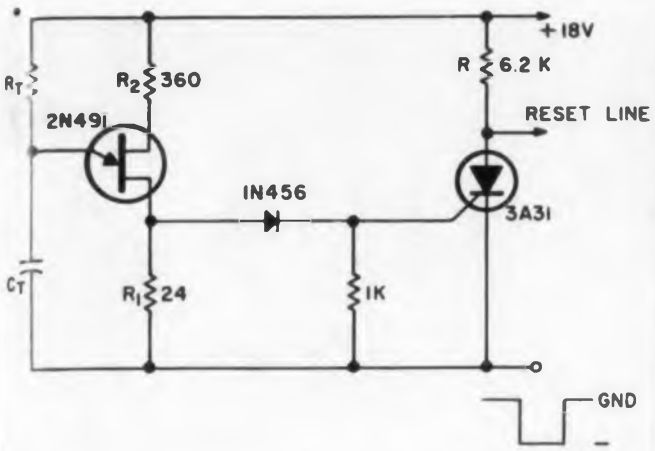


Fig. 6. For greater time delays in gating the SCR, a unijunction transistor is added.

variation it may be necessary to check the operation of the circuit at low operating temperatures.

RC Delay Switches SCR Without Separate Gating Pulse

The SCR can also be triggered, after an adjustable time delay, directly from the power source. There are two techniques for this. With each, the separate gating pulse for switching the rectifier is no longer required.

For short delays, an RC charging circuit and a Zener diode are used as shown in Fig. 5. In this circuit, V_G must be about 1 v to fire the SCR, R_T must be selected so that when the capacitor is charged, the voltage divider of R_T, the Zener voltage, and the 1 K biasing resistor allow V_G to equal 1 v. For times longer than a few seconds, C will have to be quite large. For delays of less than 1 sec, the Zener diode could be omitted.

The other method uses a unijunction transistor to provide the time delay as shown in Fig. 6. Here the delay can be made as much as a minute, and is fairly stable over changing environmental conditions. The time delay is given approximately by the equation:

$$T = R_T C_T \, ln \frac{1}{1\text{-}k}$$

where k is the stand-off ratio of the unijunction transistor. To keep the steady state voltage well below the gate firing voltage of the SCR, R_1 is limited to about 24 ohms. The diode is included to avoid, after the switch has fired, the paralleling effect of the 24-ohm resistor. If the gate-to-cathode resistance is lowered, the value of holding current will increase.

This circuit was experimentally built for a 10-sec delay. It performed satisfactorily with a timing tolerance of 5 per cent over the temperature range of −50 C to +100 C. Higher temperatures could be obtained with a sacrifice in holding current by changing the biasing of the controlled rectifier. ■ ■

Automated coordinatograph extracts cartographic data from aerial photograph. Flexowriter at left prints out coordinates of objects observed through viewing microscope. Operation is controlled from panel atop the electronics cabinet. Robert Conroy (left) and C. W. Hargens, both of the Franklin Institute Laboratories, Philadelphia, demonstrate the machine.

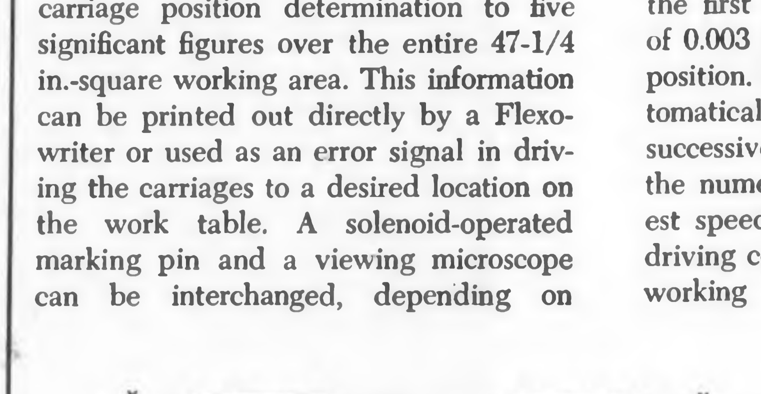
Point Plotter Gives a 0.0015-In. Accuracy

NUMERICAL control techniques and digital position encoders are employed in a newly developed, automated point plotter that has a claimed accuracy of 0.0015 in. The instrument is being manufactured by the Aero Service Co., 210 E. Courtland St., Philadelphia, Pa., and is an automated version of the Swiss-made Haag-Streit coordinatograph—a manual plotter widely used in printed circuit layouts, data plotting and other precision drafting applications.

The automated instrument employs two servo-driven carriages mounted on the X and Y rails of the basic Haag-Streit machine. Carriage positions are measured by two Datex double-disc, contact-type digital encoders having a resolution of 0.001 in. Their accuracy permits carriage position determination to five significant figures over the entire 47-1/4 in.-square working area. This information can be printed out directly by a Flexowriter or used as an error signal in driving the carriages to a desired location on the work table. A solenoid-operated marking pin and a viewing microscope can be interchanged, depending on whether a point is to be marked on or read off the work table.

When driving the carriages to a desired position by a manual or punched tape input, each decimal digit of the input is examined sequentially and compared against carriage location as derived from the encoders. The most significant decimal digit is compared first and an "increase" or "decrease" circuit is closed to the servo drives. When coincidence is reached, the next significant digit is examined and nulled. This process continues automatically until complete coincidence of all X and Y digits is reached. The marking solenoid is then energized.

A separate carriage speed is used in zeroing each decimal position. These speeds range from a maximum of 3 ips for the first significant digit to a minimum of 0.003 ips for the thousandths decimal position. Speed changing is performed automatically, a decade at a time, as each successive digit reaches coincidence with the numerical command. The four highest speeds are implemented by various driving combinations of two servo motors working through a differential and



Logic and control system of the automated coordinatograph. Input Programer directs Flexowriter input to appropriate X and Y channels. Tape Translator converts 8-digit binary code to decimal code for use in Comparator. Encoder Translator receives binary-coded cyclic decimal information from position encoders and converts it into decimal code. Both decimal codes are then fed to the Decimal Comparator which drives the carriages accordingly.

coupled to the carriage by a steel tape. A gear-head motor and lead screw at the encoder provide the 0.003 ips drive.

Connections to the encoder heads and servo motors are through Mylar-insulated printed circuit cables. Two 30-conductor cables are required for each carriage.

Semiconductor And Relay Logic Used

The logic and control circuits, housed in a separate cabinet, employ relay and semiconducting computing elements throughout. All-digital logic and the absence of tubes eliminate drift. Pulse counting is avoided; the logic circuit is static and directly coupled at all times. Binary-to-decimal conversion is through transistor-buffered relay trees and odd-even complementing circuits. Numerical comparisons and decisions are made by diode matrices.

The coordinate origin can be shifted at will; carriage position with respect to the origin is indicated on the control panel by projection-type numbers.

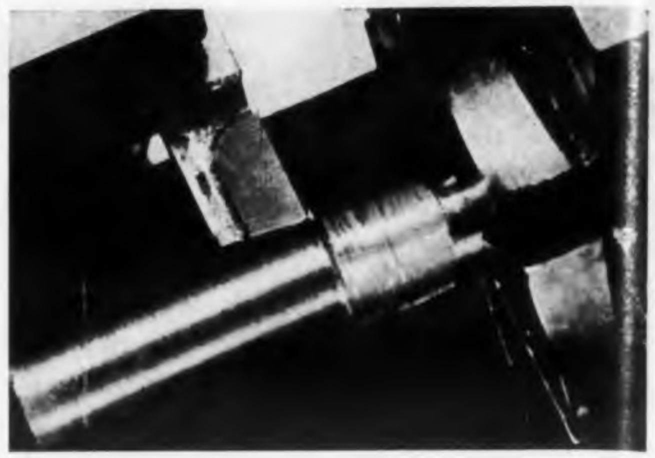
A series of points can be marked one at a time or programed automatically by a punched tape input to the Flexowriter. The coordinatograph can mark or locate successive points at 0.001-in. intervals. When operated in this manner, the instrument serves as a highly accurate but slow curve tracer.

Closed Circuit TV Available

The reverse of this operation (such as locating objects in an aerial photograph or determining values from a data curve) can be performed to the same close tolerances as the plotting function. This operation generally requires two men—one at the control console and an observer at the work table. An optional closed-circuit TV system will be made available to expedite viewing and control. Full benefit of the coordinatograph's 0.0015-in. accuracy of course requires that reading or plotting be done on glass, metal and other dimensionally stable materials.

The automated coordinatograph was designed by C. W. Hargens of the Franklin Institute Laboratories, Philadelphia. The instrument, including Flexowriter and control console, is priced at $34,750. The closed circuit TV system, specially designed for mounting on the carriages, is approximately $6,500 additional. Delivery is from 90 to 120 days.

For more data, turn to the Reader Service card and circle number 250.



Machining of tungsten and other refractory materials is now possible at significantly lower temperatures as a result of the development of large crystals of these metals and compounds.

Large, Single Crystals

And Metallic

Type Available "As Grown" Single

NEW MATERIALS that lend themselves to the solution of a variety of problems encountered in high-temperature electronics are now available. The materials take the shape of large single crystals and are grown from metals and metallic compounds by an arc fusion process.

Made by the Linde Co., a division of Union Carbide Corp., 270 Park Ave., New York 17, N.Y., the crystals have the following claimed advantages:

- Purity.
- Homogeneity.
- Absence of grain boundaries and porosity.
- Controlled crystallographic orientation.

	Material	Largest Diameter (In.)	Maximum Length (In.)
METALS	Tungsten	5/8	12
	Molybdenum	3/4	12
	Vanadium	3/4	12
	Columbium	3/8	12
	Tantalum	5/8	12
COMPOUNDS	Titanium Monoxide	3/8	2
	Titanium Sesquioxide	1/4	1/2
	Titanium Carbide	3/8	3/4
	Molybdenum Disilicide	1/4	1/2

The new large single crystals are produced by the arc fusion process in individual furnaces like the one pictured here.

Of Metals Compounds Grown

Crystals of Refractory Materials

The high purity and non-porosity of tungsten crystal suggests applications as electrical contact points in vacuum switches, lead-ins to vacuum equipment, and other places where outgassing is a problem, according to Dr. C. R. Castor of the Linde Company's Crystal Products Dept. He adds, "the high purity of these crystals also results in low, cold emission, making them of value in several electronic applications."

Some of the non-metal crystals hold promise as semiconductors. Titanium diboride, for instance, is a high-temperature semiconductor.

At present, the company has available in stock nine refractory materials as grown in single crystal form. These are: (metals) tungsten, molybdenum, vanadium, columbium, tantalum; (compounds) titanium carbide, titanium monoxide, titanium sesquioxide, molybdenum disilicide. Other crystals will be available shortly.

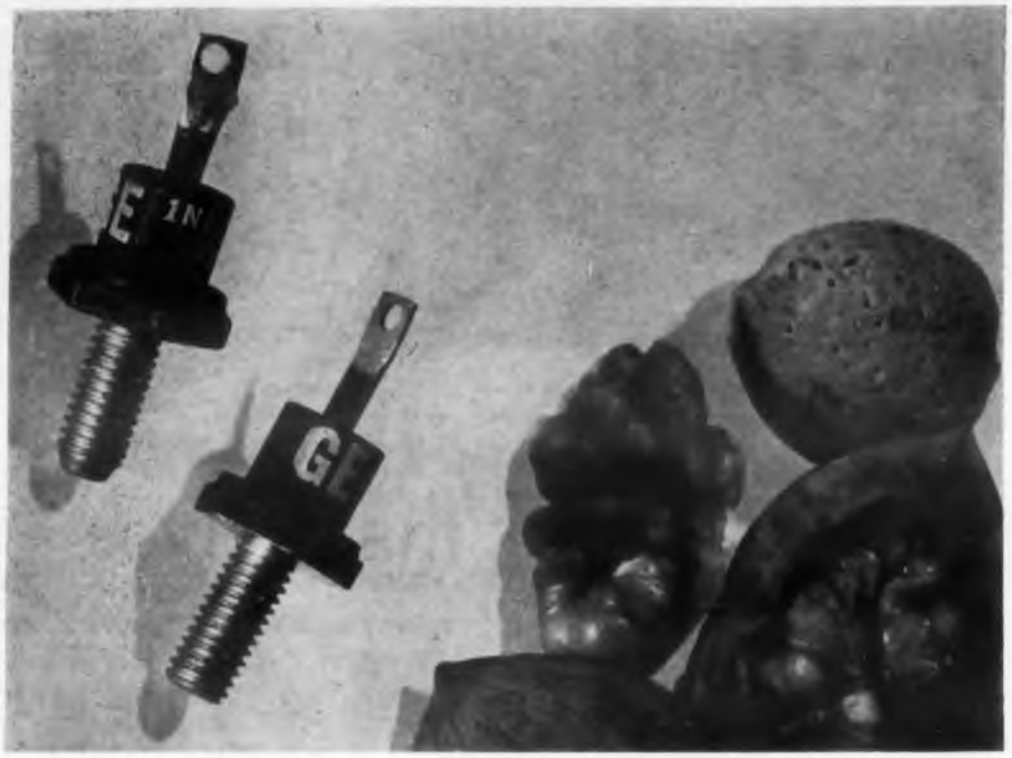
These single crystals can be formed and worked at temperatures significantly lower than those normally associated with the refractory group, says Linde. Threads, for example, can be tapped into bolts made from single crystal tungsten without cracking.

The crystals come either in "as grown" cylindrical form, as swaged or in fabricated shapes. Special sample packages for laboratory investigation of properties have been prepared for both the metal and non-metal crystals. These packages are priced at $90 each. The cost of large single crystals depends on a number of variables.

For more information on these crystals, turn to the Reader Service Card and circle 251.

NEW PRODUCTS

Covering all new products that might generally be specified by an electronics engineer engaged in the design of original equipment.



Silicon Rectifiers Designed For 2 to 8 Amp Range — 257

Designed for rectifier applications in the 2- to 8-amp range, these 16 silicon units have piv ratings between 50 to 600 v. Both positive and negative polarity rectifiers are available. All the units, JEDEC numbers 1N1341A through 1N1348A and 1N134RA through 1N1348RA, feature all hard-solder design for maximum thermal fatigue free operation. They have a junction operating and storage temperature range from —65 to +200 C.

General Electric Co., Semiconductor Products Dept., Dept. ED, Syracuse, N.Y.

Price & Availability: *In medium size quantities, the units are priced from $2.40 each to $15.15 each. No extra charge for reverse polarity units.*

Laboratory Kit Fabricates Micromodules And Circuits — 255

This do-it-yourself laboratory kit enables engineers to design and fabricate micromodules and electronic circuits with packing densities of several hundred thousand parts per cubic foot. Ten feet of workbench and a tank of nitrogen are all the additional equipment required. The micromodule is a series of tiny ceramic wafers with microminiature components applied to them. The kits start with the completed wafers and include all equipment to build and test up to 10 modules.

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

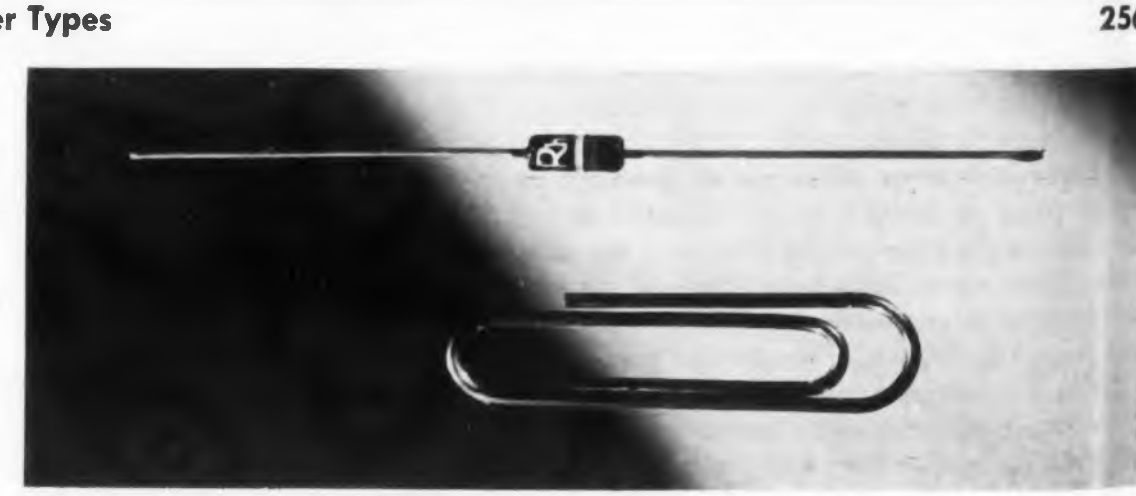
Price: $800 per unit.

Diode Combines Feature Of General And Computer Types — 256

The type 1N661A, all-purpose silicon diode combines the low leakage specifications of the best general purpose types with the switching speed of the best computer types. At 200 v, the unit has a maximum reverse leakage of 0.025 μa at 25 C, 1 μa at 100 C, and 5 μa at 150 C. Recovery time is 0.3 μsec to 400 K under the switching conditions of +30 ma to —35 v in the JAN 256 circuit. Sealed in a standard glass package, the unit is certified to MIL-S-19500B.

Rheem Semiconductor Corp., Dept. ED, 350 Ellis St., Mountain View, Calif.

Price & Availability: *$2.74 at 100 quantity level; immediately available from stock in production quantities.*



Miniature Power Supply Delivers 20,000 V — 258

These plug-in power supplies, actuated by sources as small as a 1.5-v penlight cell or a 1.3-v mercury cell, deliver voltages as high as 20,000 v. They can stand the shock and acceleration found in missiles. Designated Varia-Volt, three models are available. Inputs range from 1.5 to 6 v at 4 to 65 ma; outputs from 800 to 20,000 v dc.

Victory Electronics, Inc., Dept. ED, 50 Bond St., Westbury, L.I., N.Y.

Price: Prices start at $93.80 each.

Coaxial Cable Operates At 1,500 F — 259

Model 323 coaxial cable operates at temperatures as high as 1,500 F. It uses a specially processed silica dielectric, copper conductors, and a protective stainless steel sheath. It can only be supplied with type C, N, TNC or BNC rf connectors capable of operating at 500 F or with special connectors that operate at 1,000 F. It is normally supplied with a 50 ±2 ohm characteristic impedance; other impedances are available.

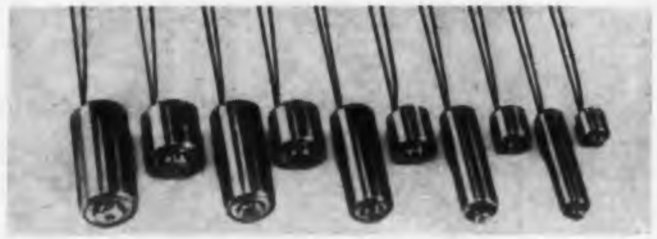
Thomas A. Edison Industries, McGraw-Edison Co., Dept. ED, West Orange, N.J.

Availability: Samples available in 8 to 10 weeks.

NEW PRODUCTS

Miniature Solenoids 509

Come in five types



Series ME solenoids are offered in five standard types ranging from 1/2 to 1 in. in diameter, have high-temperature insulation, and can be push or pull types. Various mounting arrangements can be furnished. The units are for dc applications and are made with ratings to 125 v.

Anderson Controls, Inc., Dept. ED, 9959 Pacific Ave., Franklin Park, Ill.

Silicon Rectifier Stacks 510

Current ratings are 2 to 35 amp

For all basic circuit configurations, these preassembled silicon rectifier stacks have piv ratings from 50 to 600 v and current ratings from 2 to 35 amp. Sizes are 2 x 2 in., 2 x 3 in., and 5 x 5 in., all 0.064 in. thick.

Vickers, Inc., Dept. ED, 1815 Locust St., St. Louis 3, Mo.

Availability: Delivery time is two weeks on all standard units.

Ferrite Isolators 507

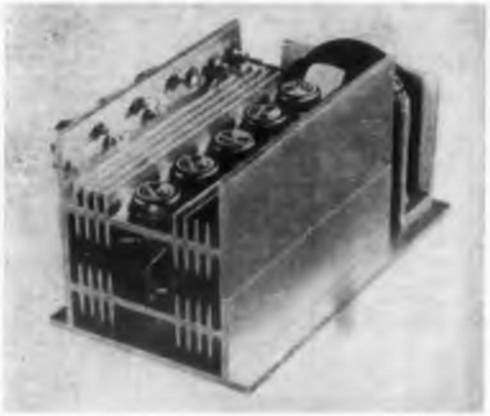
Five units cover 2 to 11 kmc

These ferrite isolators consist of coaxial construction with permanent magnet transverse field and ferrite sections built in. Five models are offered. Model C992100-402 covers 2 to 3 kmc; model C992100-404, 2 to 4 kmc; model C992100-403, 3 to 4 kmc; model C993100-401, 4 to 8 kmc; and model C994100-402, 7 to 11 kmc. The vswr is 10 w for all units. Type N female terminations are used.

Kearfott Div., Dept. ED, 14844 Oxnard St., Van Nuys, Calif.

Heat Sink 512

Dissipates 200 w with a rise of 12 C



This heat sink dissipates hundreds of watts with temperature rises of a few degrees, using forced convection or a few watts of power with natural convection. With a 6.75-in. stacked structure and 120 cfm of blower-supplied air at 0 pressure, 200 w are dissipated with a temperature rise of 12 C. Thermal resistance is 0.06 C per w.

The Delbert Blinn Co., Dept. ED, P.O. Box 757, Pomona, Calif.

Price: The extrusion is offered in 5-ft lengths at the price of $10 per ft for up to 25 ft. For 25 to 100 ft, price is $9 per ft.

Torque Tester 436

Static and dynamic characteristics measured

Model 67-M2 torque tester can measure the static and dynamic characteristics of such devices as ball bearings, gyro motors, meter measurements, torsion wires and dampers. The tester has an air bearing that offers low friction and stiff support in both radial and axial directions for the device under test. Measurements are made by summing torque about the air supported shaft. The maximum axial load is 1 lb and the readout accuracy is 0.1%. The adjustment resolution of the alignment fixture is 20 millionths of an inch. Maximum calibration torque is 5000 dyne cm.

Dynamics Research Corp., Dept. ED, 38 Montvale Ave., Stoneham, Mass.

Price & Availability: Made on order only; $19,958 per unit.

Tantalum Capacitors 515

Operate from —80 to +125 C

These capacitors are offered in type ST-12 with an uninsulated case and type ST-13 with an insulated case. Temperature range is —80 to +125 C. Voltage ratings are 6, 10, 15, 20, and 35 v dc for operation at +85 C and 4, 7, 10, 13, and 23 v dc for operation at +125 C. A semiconductor electrolyte is used. Designated Aerotan, the units meet the requirements of the proposed specification MIL-C-26655A.

Aerovox Corp., Dept. ED, New Bedford, Mass.

General Purpose Relay 505

Has built-in neon lamp

Type KRP-N general-purpose relay, equipped with a built-in indicator lamp, can be furnished for 6 to 110 v dc or 6 to 230 v ac operation. Silver contacts rated at 5 amp and silver-cadmium contacts rated at 10 amp are used for both units. Contact arrangements are up to 3 pdt. Overall dimensions are 2 x 1-13/32 x 1-13/32 in.

Potter & Brumfield, Dept. ED, Princeton, Ind.

Micromodule Socket 514

For printed-circuit boards

Designed to mount on a printed-circuit board, this socket makes it possible to remove and replace the RCA micromodule with the same ease as replacing a tube. Micromodules may be mounted on 0.4-in. centers. The insulating material is

DIALL FS-5 and the contacts are heat-treated, beryllium copper, heavily silver plated.

Jettron Products, Inc., Dept. ED, 56 Route 10, Hanover, N.J.

silicon diodes and rectifiers

GALLIUM ARSENIDE VARACTOR

Type	Case Type	Min Breakdown Voltage—v	Junction Capacitance @ 0 volts bias μμf	Min Q @ 3 Kmc	Min Cut-off Frequency Kmc
XD-500	FF	−6	0.1 min 1.0 max	20 @ −2 volts 30 @ −6 volts	60 @ −2v

POWER REGULATORS AND DOUBLE ANODE CLIPPERS

Available with either anode or cathode to stud

Type	Case Type	Zener Voltage @ 25°C	I_z ma	Power Diss @ 50°C w	Reverse Current LI_b 25°C μa @ −5v	Reverse Current LI_b 25°C μa @ −10v	Max Z_z @ 25°C @ I_z Ohms	Typ Temp Coef %/°C
1N2498†	R	10	500	10	40	—	2	0.06
1N2499†	R	11	500	10	30	—	2	0.06
1N2500†	R	12	500	10	25	—	2	0.06
1N1816†	R	13	500	10	25	—	2	0.07
1N1817†	R	15	500	10	15	—	2	0.07
1N1818†	R	16	500	10	10	—	3	0.07
1N1819†	R	18	500	10	10	—	3	0.07
1N1820†	R	20	250	10	—	10	3	0.08
1N1821†	R	22	250	10	—	10	3	0.08
1N1822†	R	24	250	10	—	10	3	0.08
1N1823†	R	27	250	10	—	10	3	0.08
1N1824†	R	30	250	10	—	10	4	0.08
1N1825†	R	33	150	10	—	10	4	0.08
1N1826†	R	36	150	10	—	10	5	0.09
1N1827†	R	39	150	10	—	10	5	0.09
1N1828†	R	43	150	10	—	10	6	0.09
1N1829†	R	47	150	10	—	10	7	0.09
1N1830†	R	51	150	10	—	10	8	0.10
1N1831†	R	56	150	10	—	10	9	0.10
1N1832†	R	62	50	10	—	10	12	0.10
1N1833†	R	68	50	10	—	10	14	0.10
1N1834†	R	75	50	10	—	10	20	0.11
1N1835†	R	82	50	10	—	10	22	0.11
1N1836†	R	91	50	10	—	10	35	0.12
1N2008†	R	100	50	10	—	10	40	0.12
1N2009†	R	110	50	10	—	10	47	0.12
1N2010†	R	120	50	10	—	10	56	0.12
1N2011†	R	130	50	10	—	10	65	0.12
1N2012†	R	150	50	10	—	10	82	0.12

†Suffix A (± 5% Tolerance)

Units 1N1816 through 1N1836 (A & RA) meet Mil specification MIL-E-1/1258 (Navy) and are available with USN prefix.

PHOTO DEVICE

Type	Case Type	Bias Voltage v max	Dark Current @ 25°C ±50v max μa	Dark Current @ 100°C ±50v max μa	*Typ Light Current @ 25°C @ ±10v μa	*Typ Sensitivity @ 10v μa/mw/cm²
1N2175	CC	50	0.5	100	200	22.3

* Light current measured in terms of radiation. Radiation = 9 mw/cm² in a frequency bandwidth of 0.7 to 1 micron.

STABISTORS

Type	Case Type	I_F ma	PIV Volts	V_F Volts at 1 ma	V_F Volts at 100 ma	LI_b μa at −2v at 25°C
G 129	N	250	10	0.56±10%	1	0.1
G 130	N	150	6	0.64±10%	1	0.1

SILICON RECTIFIERS—ECONOMY PACKAGE

Type	Case Type	PIV	I_o ma 25°C	I_o ma 100°C	Recurrent Peak Current @ 25°C a	DC Forward Voltage Drop @ 25°C v @ ma	Max Reverse Current @ 25°C μa @ v
1N2069	W	200	750	500	6	1.2 @ 500	10 @ 200
1N2070	W	400	750	500	6	1.2 @ 500	10 @ 400
1N2071	W	600	750	500	6	1.2 @ 500	10 @ 600

SILICON RECTIFIERS

Type	Case Type	Mounting	PIV v 25°C	PIV v 150°C	Io ma 25°C	Io ma 150°C	Recurrent Peak Current −65°C to +150°C ma	E_b @ 25°C v@a	LI_b @ PIV @ 25°C μa
1N588	O	Axial	1500	1000	25	10	150	10@10ma	50
1N589	O	Axial	1500	1000	50	25	250	8@50ma	50
1N1130	P	Cathode Stud	1500	1000	300	150	1 a	15@0.3	50
1N1131	P	Anode Stud	1500	1000	300	150	1 a	15@0.3	50
1N570	BB	plug in	1500	1000	37.5*	25*	1.2a@25°C*	10@50ma*	50
1N538	Q	Axial	200	200	750	250	2.5a@25°C	1@0.5	10
JAN 1N538	Q	Axial	200	200	750	250	2.5a@25°C	1@0.5	10
1N539	Q	Axial	300	300	750	250	2.5a@25°C	1@0.5	10
1N540	Q	Axial	400	400	750	250	2.5a@25°C	1@0.5	10
JAN 1N540	Q	Axial	400	400	750	250	2.5a@25°C	1@0.5	10
1N547	Q	Axial	600	600	750	250	2.5a@25°C	1@0.5	10
JAN 1N547	Q	Axial	600	600	750	250	2.5a@25°C	1@0.5	10
1N1095	Q	Axial	500	500	750	250	6a@25°C	1@0.5	10
1N1096	Q	Axial	600	600	750	250	6a@25°C	1@0.5	10
1N253†	R	Cathode Stud	100	100	3 a	1a@135°C	10a@50°C	1.1@1	10
JAN 1N253†	R	Cathode Stud	100	100	3 a	1a@135°C	10a@50°C	1.1@1	10
1N254†	R	Cathode Stud	200	200	3 a	0.4a@135°C	10a@50°C	1.1@1	10
JAN 1N254†	R	Cathode Stud	200	200	3 a	0.4a@135°C	10a@50°C	1.1@1	10
1N255†	R	Cathode Stud	400	200	3 a	0.4a@135°C	10a@50°C	1.1@1	10
JAN 1N255†	R	Cathode Stud	400	200	3 a	0.4a@135°C	10a@50°C	1.1@1	10
1N256†	R	Cathode Stud	600	200	3 a	0.2a@135°C	10a@50°C	1.1@1	10
JAN 1N256†	R	Cathode Stud	600	200	3 a	0.2a@135°C	10a@50°C	1.1@1	10
1N1124†	R	Cathode Stud	200	200	3 a	1 a	10a@50°C	1.1@1	10
1N1125†	R	Cathode Stud	300	300	3 a	1 a	10a@50°C	1.1@1	10
1N1126†	R	Cathode Stud	400	400	3 a	1 a	10a@50°C	1.1@1	10
1N1127†	R	Cathode Stud	500	500	3 a	1 a	10a@50°C	1.1@1	10
1N1128†	R	Cathode Stud	600	600	3 a	1 a	10a@50°C	1.1@1	10
1N1614†	R	Cathode Stud	200	200	15 a	5 a	50a@50°C	1.5@10	10
1N1615†	R	Cathode Stud	400	400	15 a	5 a	50a@50°C	1.5@10	10
1N1616†	R	Cathode Stud	600	600	15 a	5 a	50a@50°C	1.5@10	10

* For each half-wave section
† R Suffix denotes anode to stud configuration, i. e. 1N1124R

SILICON CONTROLLED RECTIFIERS

Type	Case Type	At 80°C Case Temp: Av Rect Fwd Current Amps	At 80°C Case Temp: Recurrent Peak Current Amps	Non-Recurrent Surge Current 1 Cycle at 60 cps Amps	Min Fwd Off Voltage* v	PIV	Min Breakdown Voltage v	Max Case Temp °C	Max Fwd Gate Current ma	Gate to Cathode PIV v	Max Fwd Voltage Drop @ Avg Rect. Fwd. Current @ 25°C Stud Temp v @ a	Gate Current Req to Fire ma Typ	Gate Current Req to Fire ma Max
2N1600	AA	3	10	25	50	50	60	150	100	5	2 @ 3 amps	1	10
2N1601	AA	3	10	25	100	100	120	150	100	5	2 @ 3 amps	1	10
2N1602	AA	3	10	25	200	200	240	150	100	5	2 @ 3 amps	1	10
2N1603	AA	3	10	25	300	300	360	150	100	5	2 @ 3 amps	1	10
2N1604	AA	3	10	25	400	400	480	150	100	5	2 @ 3 amps	1	10
2N1595	X	1	3	15	50	50	60	150	100	5	2 @ 1 amp	1	10
2N1596	X	1	3	15	100	100	120	150	100	5	2 @ 1 amp	1	10
2N1597	X	1	3	15	200	200	240	150	100	5	2 @ 1 amp	1	10
2N1598	X	1	3	15	300	300	360	150	100	5	2 @ 1 amp	1	10
2N1599	X	1	3	15	400	400	480	150	100	5	2 @ 1 amp	1	10
TI-010	X	1	3	15	50	50	60	150	100	5	See data sheet for switching information		
TI-025	X	1	3	15	50	50	60	150	100	5			
TI-050	X	1	3	15	50	50	60	150	100	5			

* Measured with 1K resistor gate to cathode

Pulse Receivers 508

Range is 45 to 10,750 mc

Models 301, 302, and 303 pulse receivers cover the range of 45 to 10,750 mc with sensitivities approaching those of superheterodyne equipment. For the range of 45 to 550 mc, stagger-tuned amplifiers are used. Above 550 mc, permanent magnet-focused traveling wave tubes are used. The receivers are offered in relay rack of aircraft packaging. Power requirements are 109 to 121 v at 50 to 800 or 360 to 800 cps.

Granger Associates, Dept. ED, 974 Commercial St., Palo Alto, Calif.

Parabolic Antenna 447

Surface tolerance is ±0.065 to ±0.125

Model 103 30-ft, parabolic antenna, for use in radio astronomy, radar tracking, and experimental test installations, has a surface tolerance of ±0.065 to ±0.125. A tolerance of ±0.08 can be furnished on special order. The f/d ratio is 0.417. Use above 10,000 mc is possible. The antenna can be mounted on the top or the side of a tower with azimuth and elevation adjustments, on el-az or equatorial pedestals, self-contained trailer mounts, or other types of mounts.

Antenna Systems, Inc., Dept. ED, Hingham, Mass.

◄CIRCLE 97 ON READER-SERVICE CARD

Power Supplies 513

For missile and airborne use

This line of dc power supplies is designed for missile and other airborne applications. Made to step up dc power, the units have precise regulation against line and load variation, even under severe changes in environmental conditions. Requirements of MIL-E-5272C are met. The units are solid state and are offered in 34 standard models, having outputs of 5 to 250 v.

Arnoux Corp., Dept. ED, 11924 W. Washington Blvd., Los Angeles 66, Calif.

Constant Voltage Transformer 516

Comes in 60- and 400-cps units

This sine-wave constant-voltage transformer is offered in both 60- and 400-cps units. With a line variation of 95 to 130 v, output remains constant to within ±1.5%. The unit can replace non-regulating transformers in step-up or step-down service. It is hermetically sealed for military application at high temperatures and has a current-limiting feature.

Freed Transformer Co., Inc., Dept. ED, 1718 Weirfield St., Brooklyn 27, N.Y.

DC Power Supply 451

For missile ground support use

Model M-1348 dc power supply with an output of 24 to 32 v at 100 amp is for missile ground support use. The unit has magnetic amplifier regulation with no vacuum tubes or moving or delicate parts. Silicon rectifiers provide resistance to high temperatures and adverse environmental conditions. Regulation is ±0.5% for line and load. Ripple is 0.5% rms based on an ac input of 208, 230, or 460 v ±5%, three-phase, 60 cps.

Perkin Engineering Corp., Dept. ED, El Segundo, Calif.

Polycrystalline Silicon Rods 572

For floating zone crystal growing

For floating zone crystal growing, these polycrystalline silicon rods are uniform in diameter, have a boron content of 1 ppb, and have a very high density. Standard diameters of the rods are 3/4 to 7/8 in. with tolerances of ± 0.005 in. Nominal length is 10 in. Diameters of 3/8 to 1 in. are available on special order.

Trancoa Chemical Corp., Dept. ED, Reading, Mass.

Price: $1 per gram.

High-Q Coating 697

For tuned circuits

Type 338-D high-temperature, high-Q coating is particularly suited for use with tuned circuits. One application is in the fabrication of miniature, in-line rf filters. The coating is supplied as a solvent solution that can be brushed, dipped, or sprayed. After a brief drying period, the coating is cured in an oven at 275 to 300 F for 2 hr. Besides having only a negligible effect on the frequency response of assembled units, this coating resists water, oils and solvents.

Plastic Associates, Dept. ED, 185 Mountain Road, Laguna Beach, Calif.

***Price & Availability:** Available for immediate delivery, the product is priced at $4.90 per lb.*

Polarized DC Motor 446

Operates without commutation

Operating without commutation, this polarized dc motor has a starting torque of 4 lb-in., a running torque of 8 lb-in., and a starting and running current of 85 ma at 28 v dc. The motor is useful in areas where there is a limited source of power. Free-arc-operating, the motor is activated by synchronized impulses and a sealed circuit that may be remotely located.

Diaphlex Div., Cook Electric Co., Dept. ED, 2700 N. Southport Ave., Chicago 14, Ill.

NEW PRODUCTS

Digital Demonstration Unit 395

For use to 100 kc

Providing continuously adjustable frequencies to 100 kc, this digital demonstration unit can be used as an aid to training personnel in the digital field. Patch cords on the control panel permit inter-connection of circuits to form an adder-subtractor, shift registers, binary counters, and binary-coded-decimal counters. Switches allow selection of continuous operation, single-pulse operation, or single cycles of addition or subtraction. The unit has a power supply and eight plug-in modules providing a total of 12 flip-flops.

Abacus, Inc., Dept. ED, 3040 Overland Ave., Los Angeles 34, Calif.

Cavity Filters 416

Center frequencies are 200 to 2400 mc

Having center frequencies ranging from 200 to 2400 mc, the ACF cavity filters allow for bandwidth adjustment, by means of a hex-screw, from 1.5% to 10% of center frequency. They have 2 to 9 cavities. Insertion losses are 0.5 to 3 db. The input and output impedances are normally 50 ohms; units with 75- or 93-ohm impedances can also be furnished. The units can be used as fixed-tuned pre-selectors or for harmonic suppression or selection on the output of fixed-frequency oscillators. Power rating is 100 w.

Telonic Engineering Corp., Dept. ED, Laguna Beach, Calif.

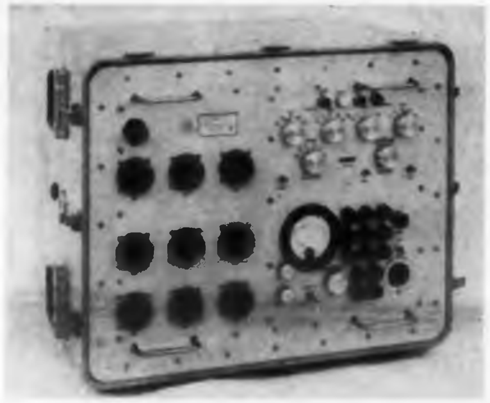
Price & Availability: Price ranges from $200 to $1000 ea; units are made on order and have a 30- to 45-day delivery time.

CIRCLE 102 ON READER-SERVICE CARD

CIRCLE 102 ON READER-SERVICE CARD

Cable Tester 361

Checks 150 simple circuits



Model 196 military cable tester checks 150 simple circuits, 75 main circuits with up to 75 branch circuits, and any intermediate combination of main and branch. It performs leakage and continuity tests simultaneously. Measurements are made on precision bridges. Continuity testing can be made from 0.3 to 10 ohms at 0.5 to 3 amp; high-pot testing can be made to 1000 v dc. An ohmmeter measures leakage resistance from 0 to 1000 meg. The equipment meets MIL-T-945A.

California Technical Industries, Div. of Textron, Inc., Dept. ED, 1421 Old Colony Road, Belmont, Calif.

Price & Availability: *$7000 ea; 60-day maximum delivery time.*

Klystron 351

Produces 2 megawatts

Type L-3270 klystron produces 2 megawatts peak rf power with a 100-mc bandwidth at the L-band. It has flat bandpass and linear phase shift characteristics over the bandwidth centered at 1300 mc. Minimum gain is 30 db. The klystron is suited for use as the output stage of radar systems where frequency diversity or precisely shaped pulses are required.

Litton Industries, Electron Tube Div., Dept. ED, 960 Industrial Road, San Carlos, Calif.

Availability: *Made to order, units can be furnished in 90 to 120 days.*

NEW PRODUCTS

Power Supply 354

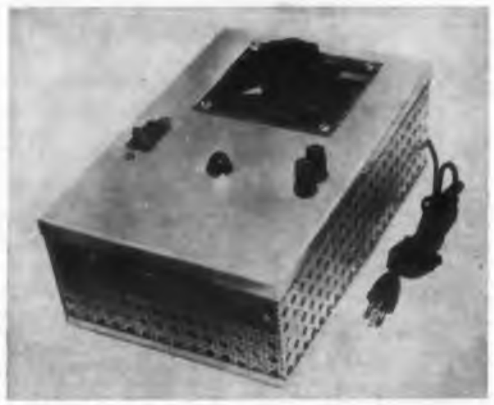
Provides 35 kv dc

Model PSC 30-5-1 power supply provides an output of 35 kv at 1 ma and 30 kv at 5 ma. Input is 115 v at 60 cps. Ripple is less than 0.5% per ma rms. The unit is portable, measuring 12 x 14 x 12 in. and weighing 60 lb.

Del Electronics Corp., Dept. ED, 521 Homestead Ave., Mt. Vernon, N.Y.

DC Power Supply 359

For laboratory applications



Designed for laboratory work such as circuit testing or transistor testing, this supply delivers 0 to 45 v at 0 to 2.5 amp. It plugs into a 60-cps, 95 to 130 v line. The output is stabilized to ±1% of setting. The unit can be supplied as a portable type or a rack mounting type.

Acme Electric Corp., Dept. ED, Cuba, N.Y.

Price & Availability: $131 for portable type; $152 for rack type. Delivery from stock.

Precision Switch 483

Total resistance is 0.7 milliohms

This precision instrument switch has a total resistance of 0.7 milliohms and remains constant to ±20 micro-ohms. It is for use on instruments that measure electrical potential and resistance.

The Ealing Corp., Dept. ED, 33 University Road, Cambridge 38, Mass.

Price & Availability: Price is $29 per unit when ordered in quantities of 1 to 11, and $25 per unit in quantities of 12 or more. Available from stock.

Static Inverter 403

Meets missile requirements

Built to meet missile requirements, this 90-w, single-phase static inverter performs over the temperature range of —65 to +180 F. Efficiency is 70%. It is suitable for any application requiring a 400-cps output in a small, lightweight package, and is able to provide power to mechanical tele-etering commutators or to gyros.

Kinetics Corp., Dept. ED, 410 S. Cedros Ave., Solana Beach, Calif.

Code Generator 353

Produces 43 characters

The Codamite transistorized code generator, measuring 6.25 x 5.25 x 2.25 in., produces 43 different code characters. Circuitry includes a ten-bit magnetic core memory to retain each character until transmitted. A speed control provides for rates of transmission from 5 to 40 words per min.

R. W. Johnson Co., Dept. ED, 9372 Hillview Road, Anaheim, Calif.

Price & Availability: $1275 ea; 60-day delivery time.

Waveguide Gages 417

For go/no-go operation

A go/no-go means of checking critical dimensions of standard waveguide transmission lines used in uhf, shf, and ehf instruments, the ID series gages cover from WR 975 (0.75 to 1.12 kmc) to WR 10 (75 to 110 kmc). Each gage is ground to a tolerance of 0.0002 in. The gages are offered in 24 sizes.

Somerset Radiation Laboratory, Inc., Dept. ED, 192 Central Ave., Stirling, N.J.

Price & Availability: *$90 to $545 ea; stock delivery.*

Wideband Amplifier 397

Bandwidth is 10 to 90 mc

Model 1004 wideband amplifier, capable of amplifying sine waves, symmetrical signals, or fast pulses, has a bandwidth of 10 to 90 mc. Gain is 40 db and noise figure is better than 8.5 db at 85 mc. Amplifier delay is about 0.03 μsec. Input and output impedance is 300 ohms. A power supply is self-contained within the unit.

Community Engineering Corp., Dept. ED, P.O. Box 824, State College, Pa.

Price & Availability: *$195 ea; 45-day delivery.*

Dual-Channel Amplifier 414

For compensated-resolver applications

For compensated-resolver applications, this transistorized amplifier has a parallel summation input circuit that accepts up to five inputs per channel. Amplifiers and resistors are packaged separately; the dual amplifier plugs into the resistor package and is retained by captive screws. Voltage transfer accuracies can be maintained to an accuracy of 0.1% from —55 to +105 C. Ratios in the range of 0.1 to 10 can be obtained. The amplifier operates at 400 cps, signal frequency, and provides a 26-v rms output. Total power requirement is 45 v dc at 16 ma.

Reeves Instrument Corp., Dept. ED, Roosevelt Field, Garden City, N.Y.

Availability: Sample quantities are available from stock.

Pressure Transducers 415

Ranges extend to 100 psi

The 800 series pressure transducers use a free-edged, circular diaphragm of Ni-Span-C in the sensor to increase system accuracy. Full scale ranges are 1 to 100 psi; differential or absolute measurements can be made. Units are sensitive to less than 0.01% of full scale for a 0 to 1 atmosphere pressure range. Hysteresis effects are less than 0.03%. Temperature range is —55 to +100 C. The sensor stands 100% overpressure.

Rosemount Engineering Co., Dept. ED, 4900 W. 78th St., Minneapolis 24, Minn.

Price & Availability: Delivery time is 30 to 60 days. One of the units, for example, is priced at $290 ea.

Impulse Counter 477

Has decade cascade system

The Minichron 10 impulse counter counts timed pulses with a decade cascade system like that of abacus. A cascade of six ring counter decades counts each pulse of a 400-cps time base signal to pinpoint 16 different operations within a million count-time period of about 45 min. Programming can be changed in a few minutes and without disturbing associated wiring or connections. Operating on 22 to 35 v dc, the unit has current drain of 0.2 amp. Designed for programming missiles in flight, the unit can program sequence of events such as automated operations in testing, process control, or production.

The Victoreen Instrument Co., Dept. ED, 5 W. Mission Road, Alhambra, Calif.

NEW PRODUCTS

Wirewound Resistors 394

Exceed MIL-R-26c

The TO-RW series of wirewound resistors are made to exceed the requirements of MIL-R-26c with "V" characteristics. They use alloy terminals which match the thermal expansion of tube and enamel. Minimum wire size is 0.00175 in.

Tru-Ohm Products, Dept. ED, 2800 N. Milwaukee Ave., Chicago, Ill.

Availability: Delivery time is 10 days to two weeks.

Pushbutton Switches 479

For pulse and digital systems

Designed for pulse and digital electronic systems, these one-shot, switch-circuit, pushbutton assemblies generate a single square-wave pulse, synchronized with a clock pulse at each operation. Pulse frequencies are 4 to 500 kc. The assemblies can be used for manually loading magnetic drums, checking ring counters, resetting flip-flops, radar, telemetering, data reduction, industrial process control and other applications.

Micro Switch, Dept. ED, Chicago & Spring Streets, Freeport, Ill.

Price & Availability: $46 ea; about six weeks for delivery.

Ceramic Coil Forms 413

Have V-type thread

For use where high stability and uniformity of electrical properties are required, these V-threaded, ceramic coil forms are available in the ollowing sizes: 12-pitch, three-thread; 16-pitch, ive-thread; and 18-pitch, seven-thread. They are nade to stand shock and vibration. Silicone fibre-lass collars with silver-plated solder lugs are ssembled at both ends of the form's threaded ection.

United Products Co., Dept. ED, 165 Franklin Ave., Nutley, N.J.

rice & Availability: Price is $0.34 ea in quanti-ies of 1000. Delivery is from stock for limited uantities.

isk Cathodes 485

Miniature

These miniature disk cathodes with triangular le ceramic insulators provide a minimum heat s by reducing the area of contact between the ank and the ceramic. The temperature of the hode can be as high as 850 C. Shank diam-r is about 0.09 in. and length, 0.22 to 0.28 in. e disk cathodes can be furnished with a 0.365-0.40-in. OD ceramic.

Superior Tube Co., Dept. ED, 1521 German-wn Ave., Norristown, Pa.

ncoder 401

Position-to-digital type

odel 773 13-bit, position-to-digital encoder a resolution of 128 counts per input-shaft lution. Full scale capacity is 8192 counts; ac-cy is never less than the least significant digit. ting torque is less than 0.2 oz-in. and moment ert a is 0.048 oz-in.^{2} The unit weighs 7.6 oz. ibrascope Div. of General Precision, Inc., t. ED, 808 Western Ave., Glendale 1, Calif.

Before any lot of G-E silicon transistors may be delivered, a representative number of units are selected for each of the four restrictive life tests. These tests include operation at maximum power at 25°C ambient, operation at high temperatures and peak ratings, storage at 200°C, and shelf life at 25°C—all tests for 1000 hours. If the sample fails any one of these tests, the lot cannot be shipped.

Only General Electric silicon transistors (Series 2N332-2N338, including "A" and USN versions) are subjected to such rigorous restrictive testing. *And* we keep them pure inside — no grease or surface contaminants that degrade performance are permitted to enter. Write for a full report on the restrictive tests which G-E silicon transistors must pass *before* they're shipped to you. Section S2370, General Electric Co., Semiconductor Products Dept., Electronics Park, Syracuse, N. Y.

At factory-low prices from your General Electric Distributor.

GENERAL ELECTRIC

CIRCLE 113 ON READER-SERVICE CARD

NEW PRODUCTS

Monitor Receiver 368

Operates from 225 to 399.9 mc

Model 36 monitor receiver is offered in fm and am models. The fm unit is capable of receiving fm voice, frequency shift keying messages, telemetry, and digital transmissions. The unit is for various missile uses. The am model is designed for uhf aircraft traffic control, airport tower operations, am voice, am frequency division, and am-fm telemetry. The units are self-contained, integrating the power supply and the basic receiver. Input is 115 v at 60 cps.

Electronic Communications, Inc., Dept. ED, 1501-72nd St. N., St. Petersburg, Fla.
Availability: Units are built to customer specs.

Leak Detector 478

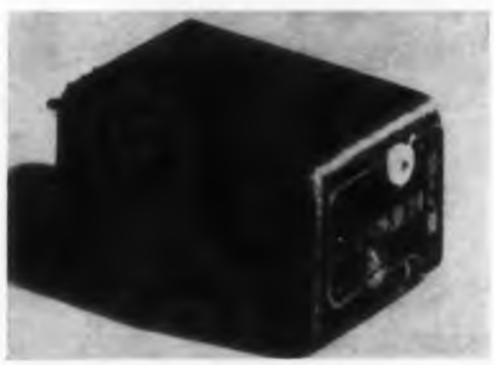
Spectrometer-type

Model 24-210B leak detector, a spectrometer-type unit, has a sensitivity such that it can detect one part of helium in 10,000,000 parts of air. A liquid-nitrogen cold trap removes condensable vapors before they can enter the analyzer section. Response time is less than 1 sec for 50% full-scale deflection of the leak-rate meter on the x1 scale. Attenuations are x1, x5, x10, x100, and x1000. Residual fluctuation and noise level are less than 2%, full-scale peak-to-peak. Input is 105 to 125 v ac.

Consolidated Electrodynamics Corp., Dept. ED, 360 Sierra Madre Villa, Pasadena, Calif.

Subcarrier Oscillator 398

For airborne applications



Model TS-56 voltage-controlled subcarrier oscillator converts information in the form of varying dc voltage amplitude into a frequency-modulated subcarrier signal suitable for transmission by wire or radio to distant receiver stations. Available in all standard RDB channels, the unit is for use in airborne applications. Input requirement is 6 v dc ±0.1% at about 12 ma. Input impedance is 1 meg and output impedance is 47 K. The output voltage is 2 v rms min.

Vector Manufacturing Co., Inc., Dept. ED, Keystone Road, Southampton, Pa.

DC Differential Amplifier 393

Input resistance is 500 meg

Model 2900 dc differential amplifier has over 500-meg input resistance, voltage gains of 2 to 50, and over-all linearity of 0.05%. A missile-grade mechanical chopper and a silicon-transistor carrier amplifier are used. Output voltage is ±5 v. Power consumption is 140 ma from an unregulated 28-v source. Construction is of cast magnesium alloy.

Dynamics Instrumentation Co., Dept. ED, 583 Monterey Pass Road, Monterey, Calif.

Price & Availability: Units will be in stock by Sept. 30, 1960. Price is $2700 ea for quantities of 1 to 99.

Trimmer Potentiometer 441

Value range is 10 to 100,000 ohms

Designated W-51, this subminiature trimmer potentiometer comes in resistance values from 10 to 100,000 ohms. It operates from −55 to 175 C, and withstands 20 g vibration, 30 g acceleration, and a shock of 100 g for 10 msec. It can be furnished with standard soldering lugs, printed circuit leads, flexible insulated wire leads, or side mounted solid leads. The component weighs about 5 g, and has case dimensions of 0.89 x 0.312 x 0.21 in.

Atohm Electronics, Dept. ED, 7648 San Fernando Road, Sun Valley, Calif.

Price & Availability: Delivery is from stock. Prices range from $5.10 to $7.50 for 1 to 24 units, depending on resistance value. All prices fob Sun Valley.

NEW PRODUCTS

Spring Motors 491

Provide constant torque

These constant-torque spring motors, using a wide band of spring material, have a long, tubular shape. The units are suitable for applications such as internal mounting in drums and instrument chart drives. The spring material shown is a flat strip of stainless steel, 0.0033 in. thick and 7-7/8 in. wide. It has been given a curvature by continuous heavy forming so that in the relaxed condition, it is a tightly wound roll of flat material. A constant torque of 6 lb-in. is developed through 50 revolutions of the output pulley at all positions of cable extensions.

Hunter Spring Co., Dept. ED, 1 Spring Ave., Lansdale, Pa.

Attenuators 434

Have range of 0 to 61.5 db

Four separate attenuators cover a range of 0 to 61.5 db in 0.5 db steps to an accuracy of 0.1 db. Insertion loss is less than 0.05 db with a power rating of 1 w. The frequency range is dc to 70 mc with characteristic impedances of 50, 75, 92, and 600 ohms.

Wayne Kerr Corp., Dept. ED, 1633 Race St., Philadelphia 3, Pa.

Price & Availability: Prices from $110 to $130. Available from stock to 4 weeks.

Synchronous Motor 482

Permanent magnet type

Type SS50 synchronous motor is a permanent magnet type ac motor for a wide range of applications requiring constant, 72 rpm synchronous, speed and dc stepping with instant starting, stopping, or reversing. Input is 120 v, 40 to 70 cycles, single-phase; 0.3 amp is maximum current at 60 cycles. Output speed at 60 cycles is 72 rpm, and torque is 50 oz-in. The unit uses class B insulation and is rated for 75 C temperature rise from 40 C maximum ambient under continuous duty. It provides speeds of approximately 16.6, 3.3, 0.67, 0.133, or 0.027 rpm, and weighs 3 lb.

The Superior Electric Co., Dept. ED, 83 Laurel St., Bristol, Conn.

Price & Availability: Price is $36 ea. Available from stock.

Power Supplies 365

Regulation is 0.1% or 0.5%

This line of ac to dc power supplies provides 0.1% regulation for line and load variations on units rated at 5 v and up, and a 0.5% regulation on units rated below 5 v. Response time is less than 100 μsec for 10% line transient or 50% load transient. Ripple is 0.02% or 5 mv rms. Temperature coefficient is 0.01% per deg C. Outputs are 2 to 305 v dc from 100 ma to 1 amp. The units are plug-in type and are built on heat-sink chassis.

Consolidated Avionics Corp., Dept. ED, 800 Shames Drive, Westbury, N.Y.

Price & Availability: $175 ea; from stock.

Laminate 432

Has 1,000,000 meg resistance

Textolite 11577, a self-extinguishing, epoxy, paper-base laminate has 1,000,000 meg resistance at 35 C and twice the impact and flexural strengths of XXXP standards. It stands cyanide plating solutions and provides good bonding strength between copper and laminate for increased circuit reliability. Peel strength after UL aging test, 1544 hr at 128 C, is 4 to 6 lb. Standard sheet sizes are 36 x 36 in. and 36 x 72 in. from 0.031 to 0.250 in. thick.

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

Price & Availability: Price is between $1.09 per sq ft and $5.76 per sq ft when ordered in quantities of 500 sq ft or more, depending on thickness of core material, thickness of copper and whether copper is on one or both sides.

NEW PRODUCTS

Cathode-Ray Tube 481

Has 7.5-in. diameter screen

Type 7BCP- magnetic focus and deflection cathode-ray tube is designed for flying spot scanner applications. It has a minimum useful screen diameter of 6-3/4 in., an over-all length of 18-3/8 ±4 in., and a spot size of 0.0035 in. average. Accelerator voltage is 37,000 v dc and screen current is 300 μa.

Allen B. Du Mont Labs., Inc., Electronics Tube Div., Dept. ED, 750 Bloomfield Ave., Clifton, N. J.

Price & Availability: Price is $300 ea. Delivery is 4 to 6 weeks.

Subcarrier Oscillator 396

Handles low-level signals

This solid-state subcarrier oscillator incorporates electronic commutation and a multi-input amplifier. Input signals vary from 50 mv full scale to 5 v full scale. Over-all system drift is ±0.5% over a 24-hr period. Signal linearity is ±0.5%. The basic input module has a volume of 8 cu in. and weighs about 8 oz; each additive plug-in has a volume of about 5 in. A 22-input unit occupies less than 30 cu in.

Solidtronics Div. of Electrosolids Corp., Dept. ED, 14751 Keswick St., Van Nuys, Calif.

Price & Availability: $200 to $650 ea; delivery is in six to 41 weeks.

Servo Amplifier 418

Temperature range is —55 to +150 C

Model A419 servo amplifier operates servo motors up to size 15 at 6 w output over the temperature range of —55 to +150 C. The self-contained power supply operates from 115 v at 400 cps. Input impedance is 10,000 ohms, nominal. Input signal is 25 v max and voltage gain is up to 2500.

Westamp, Inc., Dept. ED, 11277 Massachusetts Ave., Los Angeles 25, Calif.

***Price & Availability:** $450 to $550 ea in quantities of one to four. Made on order, units are delivered in eight weeks.*

Synchronous Motor 412

For low speed operation

The Hyspersyn motor drives a spindle in an automated machine tool. Two identical counter-rotating motors are contained in the housing; one is connected to the 60-cps line and the other to a variable-frequency power supply. If the variable frequency is 60 cps, the output shaft is stationary and opposes rotation with the full motor torque. An increase or decrease of the variable frequency begins to turn the shaft forward or reverse. With 60.6 cps applied the shaft speed is 18 rpm at 66 cps and the shaft speed is 180 rpm. Motors can be built with 1/50 to 1 hp.

Genisco, Inc., Dept. ED, Bekey Electric Div., Dept. ED, 2233 Federal Ave., Los Angeles 64, Calif.

***Availability:** Made on order.*

Glass Laminates 438

Thicknesses up to 2 in.

Glass silicone laminated plastic, Grade G-7, is available in sheets up to 2 in. thick. Made with a glass fabric reinforced with silicone binder, the laminate is claimed to have good dielectric loss factor and insulation resistance properties under humid conditions, and excellent heat and arc resistance. Thicknesses of not less than 1/4 in. and up to 2 in. are available in sheets measuring 24 x 36 in.

Synthane Corp., Dept. ED, Oaks, Pa.

***Price & Availability:** Made on order usually; delivery 5 to 6 days after order received. Prices range from $6.82 per lb when under 50 lb ordered to $6.50 per lb when over 300 lb and over ordered.*

NEW PRODUCTS

Sensitive Relays 502

Multiple-arm type

These multiple-arm, sensitive relays can be furnished with spst and spdt circuit arrangements and in several combinations. Series 50 ac coil windings are rated at 2.5 to 5 va. Series 60 dc coil windings are rated at 2 and 0.1 w. Standard contact material is silver or palladium. The magnetic circuit is substantially square.

F. A. Scherma Manufacturing Co., Inc., Dept. ED, 424 Broome St., New York 13, N.Y.

Gold-Finished Rivets 498

Are as small as 1/32 in. in diameter

Designed for electronic and instrument uses, these rivets have 24-carat gold shot-burnished finish and are offered in range of lengths varying in fractional increments of 1/32 in. and in a range of diameters down to 1/32 in. The head form is a modified brazier with low contour and minimum functional diameter for the stresses imposed. Non-magnetic brass is used with the alloy controlled for ease in setting and uniformity of the swaged or upset clinch.

Circon Component Corp., Dept. ED, Santa Barbara Municipal Airport, Goleta, Calif.

***Price & Availability:** $2.23 to $8.68 per 100; from stock.*

Insulating Materials 610

Have high dimensional stability

These insulating materials, designated 800 Rod, have high dimensional stability under high moisture conditions. The paper base type has a flexural strength of 28,000 psi and a tensile strength of 16,700 psi. The linen base type has a flexural strength of 26,000 psi and a tensile strength of 21,000 psi. The materials can be supplied in bulk form or fabricated to precise dimensions as specified by the user.

Spaulding Fibre Co., Inc., Dept. ED, 310 Wheeler St., Tonawanda, N.Y.

Availability: From stock.

Wirewound Potentiometers 389

Case length is 3/8 in.

Type APS 1/2 wirewound potentiometers have a case length of 3/8 in. and a diameter of 1/2 in. Capable of dissipating 2 w continuously, they are for use in industrial and military equipment where reliability is an important consideration. The units are made for bushing-type mounting and are furnished with terminals, wire leads, or printed-circuit pins. They have a sealed construction.

Waters Manufacturing, Inc., Dept. ED, Boston Post Road, Wayland, Mass.

Microwave Oscillators 591

Come in three models

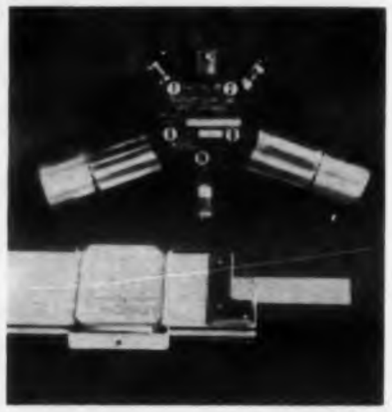
Three high-power sources have been added to the company's line of microwave oscillators. Model 814-S-31 covers a range from 3700 to 4300 mc and delivers 1 w. Models 814-C-31 and 814-C-32 are tunable over a range of 5900 to 6400 mc and 5400 to 5900 mc respectively, and deliver an output power of 1 and 1.5 w. All units have an incidental fm of less than 5 parts in 10^8, and stabilities of better than 1 part in 10^6 over a one-hour period.

Laboratory For Electronics, Inc., Dept. ED, 1079 Commonwealth Ave., Boston 15, Mass.

CIRCLE 127 ON READER-SERVICE CARD ➤

NEW PRODUCTS

Coaxial Latching Switch 499



Needs no holding power

This solenoid-actuated, coaxial, latching switch requires no holding power. The solenoids operate from 28 v dc, drawing 3.2 μa per hr and have a switching time of 10 msec. The 50-ohm switch is a make-before-break type, weighing 8.7 oz. Frequency range extends to 11 kmc. The device has the following characteristics at 7 kmc; vswr, 1.4; insertion loss, 0.4 db; and crosstalk, 30 db.

Transco Products, Inc., Dept. ED, 12210 Nebraska Ave., Los Angeles 25, Calif.

Availability: Delivery time is 45 to 60 days.

Environmental Test Chambers 429

Altitude up to 150,000 ft

This environmental test chamber has a temperature range of from —100 F to +1000 ±5 F. It produces high and low temperatures by convection, and by radiation from all six sides, thus reproducing high altitude conditions around the test specimen. The free test space measures 4 x 4 x 4 ft. Mechanical refrigeration capable of dissipating a heat load at the rate of 7500 w at —70 F is provided.

The American Research Corp., Dept. ED, Farmington, Conn.

Silver-Zinc Battery 475

Fits curved missile skin

Model P13A silver-zinc primary battery, shaped to fit curved missile skin, is a main power supply for missile equipment and instruments, guidance and control systems, telemetry equipment, and warhead arming. The 40 dry-charged cells are activated by an electrically ignited solid propellant gas generator. Output is 11 kw; current rating is 180 to 3,700 amp. The capacity of the 56-v battery is 7.5 amp-hr with a shorting time of 2.5 min. The activation signal is 115 v at 4 amp.

Cook Batteries, Dept. ED, 3850 Olive St., Denver, Colo.

Rotary Solenoid 399

For airborne and computer applications

This rotary solenoid is designed for computer, aircraft, and missile applications. It is offered in sizes as small as 3/4 in. in diameter. Linear force is translated into torque by means of roller bearings moving over precision cams. The output shaft has no linear motion. Units have a high accuracy, operate under environmental extremes, and will function for millions of cycles.

PSP Engineering Co., Dept. ED, 6058 Walker Ave., Maywood, Calif. **Booth 2229.**

Silicon Transistors 409

For industrial applications

This complete line of silicon transistors is for industrial applications. The 2N1586/J-503 and J-623 general-purpose units are for operation to 100 C, have 15, 30, and 60 v BV_{cbo} and BV_{ceo}, and guarantees beta spreads of 9:27, 25:75, and 70:210. The J-581 grown-junction, medium-power amplifier series has the same ratings with beta spreads of 10:30, 20:60, and 40:150. The J-460 series, for NOR logic circuitry, available in kits, have a 30-v BV_{cbo} at 50 μa, operate from —40 to +100 C, and have minimum dc betas of 3 to 50.

Texas Instruments, Inc., Dept. ED, P. O. Box 312, Dallas Tex. *Availability: Production quantities are immediately available.*

Servo Amplifiers 448

For open- or closed-loop systems

The Trans-mag line of servo amplifiers, using ac or dc inputs for 60 and 400 cps systems, are designed for open- or closed-loop servo systems. Semiconductors are used in the low power preamplifier stage. The units meet Mil specs. Applications are in military and industrial control such as in radar antenna positioning, inertial platforms, computers, and optical tracking.

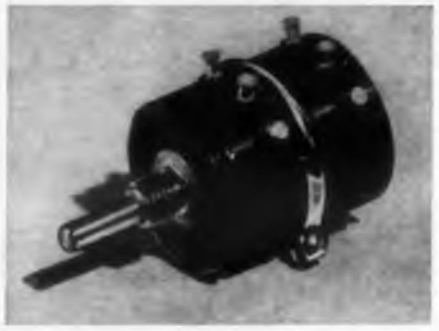
Magnetic Amplifiers, Inc., Dept. ED, 632 Tinton Ave., New York 55, N.Y.

CIRCLE 130 ON READER-SERVICE CARD ➤

NEW PRODUCTS

Trimmer Potentiometers 362

Have 100 to 25,000 ohms resistance



Type 118 7/8-in. trimmer potentiometers are offered in eight resistance values ranging from 100 to 25,000 ohms. The units are manufactured with 20 ppm resistance wire and can dissipate 1 w at 125 C for 2000 hr. Units meet MIL-STD-202A and NAS710.

Carter Manufacturing Corp., Dept. ED, 23 Washington St., Hudson, Mass.

Price & Availability: *$15 to $25 ea; stock to four weeks.*

Ultrasonic Cleaner 619

For large missile parts

Model BC-2500 ultrasonic cleaner, designed for cleaning large missile parts, is for use with automatic or semi-automatic washers and degreasers, manual washers, or for automatic plating. The frequency is adjustable from 36 to 40 kc. Input is 6 kw at 220 v or 440 v, 60 cps, single phase. Frequency output averages 3 kw. The unit measures 22 x 54 x 18 in. and weighs 350 lb. The fluid capacity of the tank is 75 gal.

Circo Ultrasonic Corp., Dept. ED, 51 Terminal Ave., Clark, N.J.

Power Meter 419

Reads from 30 μw to mw

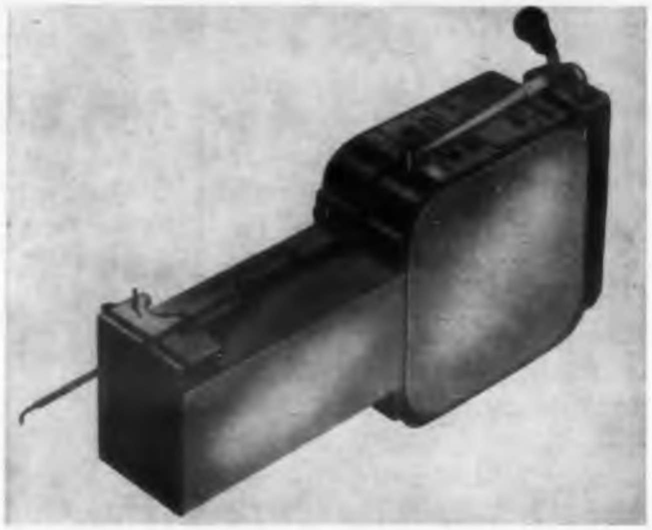
Model B832T temperature-compensated power meter measures cw or pulsed rf power in five full scale direct-reading ranges from 30 μw to 3 mw. Values can be read in mw or dbm. Readings are virtually drift free. The unit is transistorized and is energized by a self-contained, rechargeable nickel-cadmium battery. The charging circuit operates from 105 to 125 v ac at 50 to 400 cps. Use-to-charge ratio is 2:1.

FXR, Inc., Dept. ED, 26-12 Borough Place, Woodside 77, N.Y.

Price & Availability: *Price is $450 ea. A limited number of units can be furnished from stock.*

Pen Motor 366

For rectilinear ink or electric writing



Model OS-600 40-mm pen motor records signals from dc to 100 cycles and over. An interchangeable electric stylus is available for electric writing. Specifications of the unit with the firm's DA-101 compensated driver-amplifier are: current sensitivity, 28 ma per mm; linearity, dc to 120 cps, 3 db down; hysteresis, less than 1/4 mm. The motor weighs 1-1/2 lb and measures 1-3/16 x 2-1/2 x 5-1/8 in.

Cohu Electronics, Inc., MASSA Div., Dept. ED, 5 Fottler Road, Hingham, Mass.

Price & Availability: *Price is $175 in single quantities; immediate delivery available from stock.*

Power Supplies 433

Outputs are up to 150 kv at 50 ma

These dc power supplies provide output voltages up to 150 kv at 50 ma. Output voltage and current are indicated on separate 4.5-in., wide-view rectangular meters. The bench type cabinet may be supplied in units with outputs up to 45 kv; mobile cabinets are used in models up to 120 kv; the caster-mounted console houses the larger supplies.

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

Price & Availability: *Prices range from $497.50 to $5480. Some available from stock, others require 6-8 weeks after receipt of order.*

NEW PRODUCTS

Telephone Type Relay 501

Coil resistance is 10 K

Series TW medium power telephone type relay is available with contact arrangements up to 4 pdt. In voltages from 6 to 220 v ac and dc, 3/16-in. diam contacts made of fine silver and gold flashed are rated at 5 amp at 115 v, and 60 cps, noninductive. Coil resistance is 10 K as standard, higher on request. Applications include: communications equipment, computers, industrial programing devices, and other applications requiring a small, fast-acting multi-contact relay.

Line Electric Co., Dept. ED, 229 River St., Orange, N.J.

Price & Availability: *Price is $5.50 to $8.05. Delivered in 8 weeks.*

Schering Bridge 400

Available as a cable-tester

This Schering bridge is offered as a general purpose bridge and as a cable test bridge. Units measure the power factor and capacitance of insulating materials. The general purpose bridge has a range of 0.0000025 to 1 μf; the cable test bridge, from 0.0000025 to 2 μf. Capacitance accuracy is ±0.2%.

Industrial Instruments, Inc., Dept. ED, 89 Commercial Road, Cedar Grove, N.J.

Price & Availability: *$6950 ea; 70-day delivery time.*

Shield-Bezel Assemblies 355

For CRT use

This series of CRT bezel assemblies includes complete assemblies for 3, 5, and 7-in. curved and flat-faced tubes. Assemblies consist of cast aluminum and/or molded plastic bezel, scale-calibrated reticule, colored light filter, molded rubber shock cushion, and mounting hardware. Bezels are non-reflecting, black baked enamel throughout.

Jan Hardware Manufacturing Co., Inc., Dept. ED, 38-01 Queens Blvd., Long Island City 1, N.Y.

Waveguide Switches 420

Range is 3.95 to 40 kmc

Series 641 waveguide switches cover the range of 3.95 to 40 kmc. Each switch operates over the full waveguide bandwidth. They can be operated manually or driven by a 28 v dc solenoid actuator. Maximum vswr is 1.1; minimum isolation is 60 db for 3.95 to 26.5 kmc and 50 db for 26.5 to 40 kmc.

FXR, Inc., Dept. ED, 26-12 Borough Place, Woodside 77, N.Y.

Price & Availability: *Manually-operated units are from $225 for X-band type to $350 for H-band type. Electrically-operated units are from $250 for X-band to $400 for H-band. Delivery is in 30 to 90 days.*

Digital Readout System 439

For quality control, statistical testing

Having applications in high-volume, high-speed testing operations for quality control and statistical testing, this digital readout system consists of the firm's universal testing instrument equipped with encoders, memory storage units and associated assemblies. Through binary decimal code, the system converts information normally presented in graphic form directly into automatic printing digital form. Specific characteristics of materials to be evaluated are preselected and their values are sorted in magnetic memory units during the test. The values are automatically printed out after the test.

Instron Engineering Corp., Dept. ED, 2500 Washington St., Canton, Mass.

Price & Availability: *Made on order only; delivered 120 days order received. Price depends on the number and kind of parameters to be printed in digital form.*

DESIGN DECISIONS

Featuring the clever and unusual in packaging, appearance design and circuitry in electronic equipment.

Pen Recorder Drives Slotted Line For Accurate VSWR Plots

THE USUAL way to measure the vswr of coaxial microwave components involves connecting them to a slotted line, then carefully reading vswr for many discrete positions of the slotted-line probe. With luck, these readings can be closely duplicated on a second run.

A simpler and faster technique, and one which makes for more accurate measurements is one devised by engineers at General Radio Co. in West Concord, Mass. They chain-drive the probe carriage on a slotted line directly from a G-R Graphic Level Recorder.

They can thus plot vswr directly on paper and can repeat measurements to within 0.1 per cent. By making separate runs for the line alone and for the line with a component to be tested, they can cancel the vswr introduced by the line.

Graphic recorder plots vswr of components connected to chain-driven slotted line.

CIC

PRECISION FILM POTS

AVAILABLE FROM STOCK!

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

LINEAR SINGLE TURN FILM POTENTIOMETERS

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

SINE-COSINE SINGLE TURN FILM POTENTIOMETERS

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

LINEAR MOTION FILM POTENTIOMETERS

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

Write or call in your order! Potentiometers will be in your plant within 24 hours.

CIC COMPUTER INSTRUMENTS CORPORATION

90 MADISON AVE., HEMPSTEAD, L. I., N. Y.

CIRCLE 143 ON READER-SERVICE CARD

WHY GAMBLE?

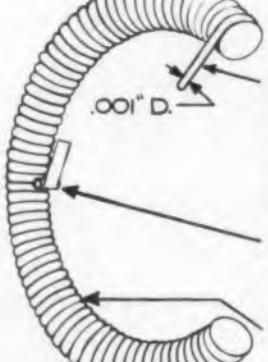
RELIABILITY

is a NATURAL...

WITH CIC PRECISION FILM POTS!

HERE'S WHY!

WIRE-WOUND... THE HARD WAY

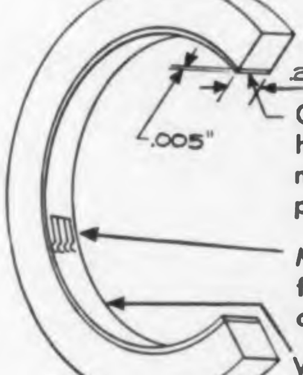


All current carried by a single fragile hair-like wire. Cutting *any* one turn causes no-warning, catastrophic failure—for 2,000 turns, 2,000 chances for element failure!

Single bar contact wiper — one microscopic dust particle can cause an open — 1:1 odds on failure!

In one traverse wiper must make switch-like contact to *each* turn for continuity — for 2,000 turns, 2,000 chances for opens!

FILM POT... THE EASY WAY



Current carried by broad band of hard carbon film with an *infinite* number of current paths — *ZERO* probability of element failure!

Multiple fingered wiper — each finger with different natural frequency — odds on opens 1:16!

Wiper rides on continuous film, glass smooth, self-lubricating carbon — *ZERO* probability of opens!

Precision film potentiometers are *inherently* four million times more reliable than wire-wound types! Write for our Tech Note "Reliability Factors in Precision Potentiometers" for the whole story.

FIRST IN FILM POTS

CIC COMPUTER INSTRUMENTS CORPORATION

92 MADISON AVENUE, HEMPSTEAD, L. I., N. Y.

CIRCLE 144 ON READER-SERVICE CARD

NEW LITERATURE

Slip Ring Assemblies 260

This 28-page catalog describes the company's line of seven standard slip ring assemblies with ring envelope diameters from 1 through 10-1/2 in. Custom assemblies are also described and illustrated. Breeze Corp., Inc., 700 Liberty Ave., Union, N.J.

Converting to Solid State 261

State-of-the-art advancements on new systems and components are graphically presented in this 42-page brochure, "Solid State Conversions." Among the categories discussed are: Voltage Level Sensing Systems—Ac; Voltage Level Sensing Systems—DC; Static Inverters; Power Supplies; Ice Detection Systems, and Solid State Components. The booklet intends to show how size reduction and environmental range extension are possible by using solid state techniques. Cook Electric Co., Diaphlex Div., 2700 Southport Ave., Chicago 14, Ill.

Metal Tubing 262

Bulletin No. 42, 12 pages, is a selection guide to metal tubing. It briefly summarizes the important properties of 84 tubing analyses in seven groups: carbon steels, stainless steels, alloy steels, nickel and nickel alloys, copper base alloys, glass sealing alloys and reactive metals. Alloys are described in tabular style which provides AISI type number, available form, characteristics and applications. Superior Tube Co., 1521 Germantown Ave., Norristown, Pa.

Carbon Film Resistors 263

This 12-page catalog describes the company's line of carbon film resistors. In addition to specifications, the catalog contains three histograms on the four basic types of resistors. In graph form, these show the results of continuing temperature cycling, load life and moisture tests. Electra Manufacturing Co., 4051 Broadway, Kansas City, Mo.

CIRCLE 147 ON READER-SERVICE CARD

Elastometers 264

Bulletin No. 902, six pages, contains a chart that covers physical and chemical properties, processing properties, and environmental resistance of ten general elastometer types. Some of the types covered are: silicone rubbers, styrene butadiene rubber and fluorinated elastomers. Lord Manufacturing Co., Erie, Pa.

Heating Element 265

The Electro-Mesh heating element is described in this 16-page catalog. Complete technical data includes physical properties and thermal characteristics, as well as a visual description of the varied components now being used in the aircraft, missile and space age fields. Electrofilm, Inc., 7116 Laurel Canyon Blvd., N. Hollywood, Calif.

Fractional Horsepower Motors 266

Characteristics of the full line of fractional horsepower Form G general purpose motors appear in this 12-page brochure. Capacitor-start, split-phase, permanent-split capacitor, shaded-pole and polyphase motors are included. Sixteen different kinds of motors are shown in NEMA frame sizes 48 through 56. General Electric Co., Schenectady 5, N.Y.

Industrial Alloy Transistors 267

Industrial alloy transistors types 2N650A, 2N651A and 2N652A are described in this six-page technical data sheet. Results of acceptance tests are given in table form; performance curves are included for collector characteristics, current versus base drive voltage and current gain versus collector current. Motorola Semiconductor, 5005 E. McDowell Road, Phoenix, Ariz.

Servometer-Amplifier 268

Type R1040-6 servometer-amplifier is described in this four-page bulletin, No. 910-4B. Specifications include resistance and capacitance balance, temperature characteristics, frequency response, and output indication. Associated equipment described in the bulletin includes a stick force, a rudder force and a wheel force dynamometer. Radiation, Inc., Melbourne, Fla.

NEW LITERATURE

Memory Core Tester 269

Type 2101 automatic memory core tester is described in this four-page folder. The folder contains block diagrams of sensing and decision circuitry, four different programs of current driving pulses, and examples of test accept and reject criteria. Digital Equipment Corp., Maynard, Mass.

Filters and Toroids 270

This four-page illustrated catalog lists various toroid types and shows typical performance curves. A new standard line of encapsulated toroids is described and illustrated, and information is given on how to specify size, style, types of leads and mountings by a system of designators. The catalog has a section on the ordering of filters, with a listing of requirements under eight general groups which cover the information necessary to develop suitable characteristics. Barker & Williamson, Inc., Canal St. & Beaver Dam Road, Bristol, Pa.

Time Delay Relays 271

This 1960 catalog on thermal time delay relays contains separate sheets describing different models. Dimension drawings are given for each model in addition to complete specifications. Schematics also show delay, ignition timer, sequence operation, and rapid reset-no operation typical circuit applications. Thermal Controls, Inc., 43 River Road, N. Arlington, N.J.

Ceramic Insulated Wire 272

Entitled "Secon Ceramic Insulated Wire For Use in High Temperature and Nuclear Environments," this brochure outlines many of the pitfalls which must be avoided if components are to operate successfully at temperatures in the 800 to 1200 F range. Part I covers the physical and electrical properties of the insulation. The next section contains data on conductors for use under various conditions. The last section is concerned with potting, sealing and termination. Secon Metals Corp., 7 Intervale St., White Plains, N.Y.

Decimal Scalers 273

Series SC-750 transistorized decimal scalers are described in this data sheet, No. D-750, two pages. A photograph and block diagram of the equipment are included. Specifications cover resolution, count storage, input pulse requirements, gating modes and threshold control. Eldorado Electronics, 2821 Tenth St., Berkeley 10, Calif.

Patent Preparation 274

Entitled "Preparing for Patent-Hood," this 19-page booklet tells you what to do with your invention idea; when to talk with a patent attorney; importance of dates and a verifier; about the patent office; applications handling; revising claims; claims and patents; economic importance of patents; and foreign patents. CGS Laboratories, Inc., Trak Electronics Co., Wilton, Conn.

Transistor Servo Amplifiers 275

One of these two four-page bulletins describes standard and stock lines of transistor servo amplifiers of miniature size and a stock line of magnetic control amplifiers for controlling silicon control rectifiers. The other bulletin describes the toroidal winding, inductor and magnetic amplifier facilities of the company. Magnetico Inc., 6 Richter Court, E. Northport, Long Island, N.Y.

Rare Earth Elements 276

Complete technical information about various chemicals, metals and alloys of the rare earth group of elements, thorium, scandium and yttrium, appears in this eight-page bulletin. In addition to potential uses, it describes manufacture and lists detailed properties and chemical analyses of more than 50 products. Vitro Chemical Co., 342 Madison Ave., New York 17, N.Y.

Digital Readout System 277

Brochure No. 7 describes the company's dynamic digital readout system. The six-page brochure contains a block diagram of the system. Included in the summary of specifications are data on the digital equipment, slope and maximum load detectors, power requirements, and accessories. Instron Engineering Corp., 2500 Washington St., Canton, Mass.

Speed Detecting Governors 278

Three types of housed speed detecting governors, as well as smaller components for original equipment, are described in this one-page bulletin, No. 264. In addition, operating principles of the detectors are covered. Torq Engineered Products, Inc., 32 W. Monroe St., Bedford, Ohio.

Transistor Adaptors 279

Five transistor adaptors, type Q-601, are described in two-page illustrated bulletin No. WK-Q-601. Brief specifications, purpose, and design features are included in the bulletin. Wayne Kerr Corp., 1633 Race St., Philadelphia 3, Pa.

IDEAS FOR DESIGN

Get $10.00 plus a by-line for the time it takes you to jot down your clever design idea. Payment is made when the idea is accepted for publication.

Special Potting Method Provides Waterproof Seal Around Teflon Wire

Potting around Teflon-covered wire and cables can be made permanently watertight and highly resistant to shock impact by pre-treating the wire with an etching compound called Tetra-Etch. Introduced recently by W. L. Gore & Associates, Inc., Tetra-Etch reacts with fluorocarbon resin to produce a carbonaceous film on the treated surface. This film then serves as a medium for tightly bonding the potting compound to the Teflon.

The accompanying photos illustrate the steps involved in attaching and potting plug assemblies to flat, multiple-conductor ribbon cable.

After the cable ends have been slit between conductors and stripped of insulation, they are dipped in the etchant, Fig. 1, for approximately 2 min. After the wires are removed from the etchant, they're wiped off with a damp cloth or flushed with water. The etched area will show a definite change of color to light brown. As a final preparatory step, all surfaces are wiped with acetone.

Next, the wire ends are tinned and all leads are soldered into the plug. After soldering, all surfaces are wiped clean with MEK solvent (methyl ethyl ketone) to make certain they're

Fig. 1. After the cable is slit, it is immersed in the etchant for about 2 min; then residue is removed with water and all surfaces are wiped with acetone. Carbonaceous film formed on the Teflon is the key to tight bonding.

Fig. 2. Primer is brushed on sparingly, then allowed to dry for several minutes. Duct seal is applied to all areas where uncured resin might leak out.

completely free of possible contaminants such as grease, oils and sealants.

Now the assembly is ready for priming as in Fig. 2. A thin coat of 3-M Scotchcast resin No. XR-5001 is brushed sparingly on all surfaces to be potted, then allowed to dry for several minutes. In preparation for potting, the unit is placed in a mechanical fixture to assure rigid clamping during the resin cure. At the same time, duct seal is applied to all areas where uncured resin might possibly leak out.

Finally, the unit is potted as in Fig. 3. Depending upon specific requirements, Scotchcast No. 212 or No. 1120 can be used.

Potted Unit Withstands Wear and Tear

That the resulting assembly will stand up to surprisingly rough treatment was demonstrated in tests run on the first plug-and-cable unit potted in this manner.

After potting and curing was completed on the back of the plug, the front was closed off tightly with duct seal. Then the entire assembly was submerged in 2 ft of water, with only the extreme opposite end of the cable extending above the surface. After the unit had soaked for an entire week, all adjacent wires were tested with a 500-v dc megger; no measurable leakage could be detected from wire to wire, or from any wire to the water.

Next, the potted assembly was subjected to severe manhandling. Each wire was pulled and wiggled many times by several people. The entire

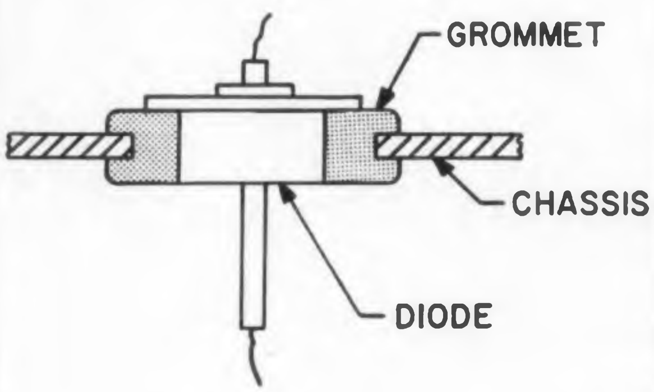
Fig. 3. Finally, the unit is potted. Mechanical fixture assures rigid clamping during subsequent resin cure under heat lamps.

cable was bent, twisted and pulled. Following this mechanical abuse, the plug was again soaked for a full week—this time in a solution of borax and water to decrease surface tension and increase conductivity. And once again, results of the 500-v megger test were completely negative, with no measurable leakage.

Harry D. Wintle, Manager Electrical Engineering Dept., Kollmorgen Optical Corp., Northampton, Mass.

Hold Onto Your Hat With a Rubber Grommet

"Top hat" type diodes can be securely mounted atop a chassis by using a rubber grommet as



shown in the figure. The amount of holding force can be changed by varying the diameter of the hole in which the grommet is fixed. Using the grommet, mounting gear is held to an absolute minimum.

J. C. Mueller, Mechanical Design Engineer, Crosley-Avco, Cincinnati, Ohio.

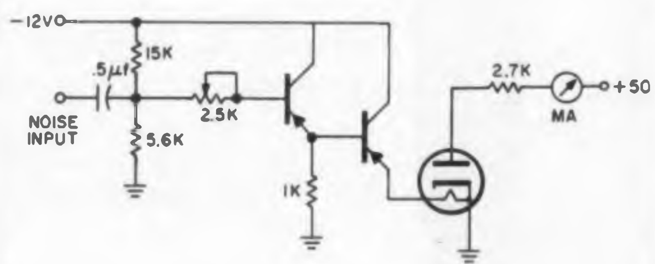
Heat-Sensitive Diode Calibrates RMS Meter For Noise Voltage Readings

A temperature-limited diode can be used to recalibrate a standard rms meter to give correct readings of noise. This recalibration is necessary because an rms meter is designed to measure pure sinusoids only. The waveform of a noise signal is decidedly nonsinusoidal.

The calibrating device works on the principle that the current through a temperature-limited diode is a function of the heat generated in its filament. Since the heat generated is proportional to the rms voltage applied, the current through the diode is also a function of its rms filament voltage. Thus, if a noise voltage is applied to the diode filament, its plate current will be a measure of the rms value of the voltage.

Known Sine Wave Signal Calibrates Meter

The calibrating circuit shown in the figure uses a low impedance amplifier to drive the diode's



filament. The rms voltmeter can be calibrated by the following procedure.

A known sine wave signal is applied to the input of the amplifier. The current through the diode and the deflection of the rms meter is noted. A sample of the noise to be measured is next applied and adjusted to give the same current reading as recorded for the sine wave. The noise voltage is then measured on the meter. The ratio of the sine wave voltage reading to the noise voltage reading is the calibrating factor. That is, the quantity the rms meter readings must be multiplied by this factor to give the correct rms noise voltage value.

Gwynn M. Reel, Design Specialist, Airborne Electronics, Martin-Orlando, Orlando, Fla.

PATENTS

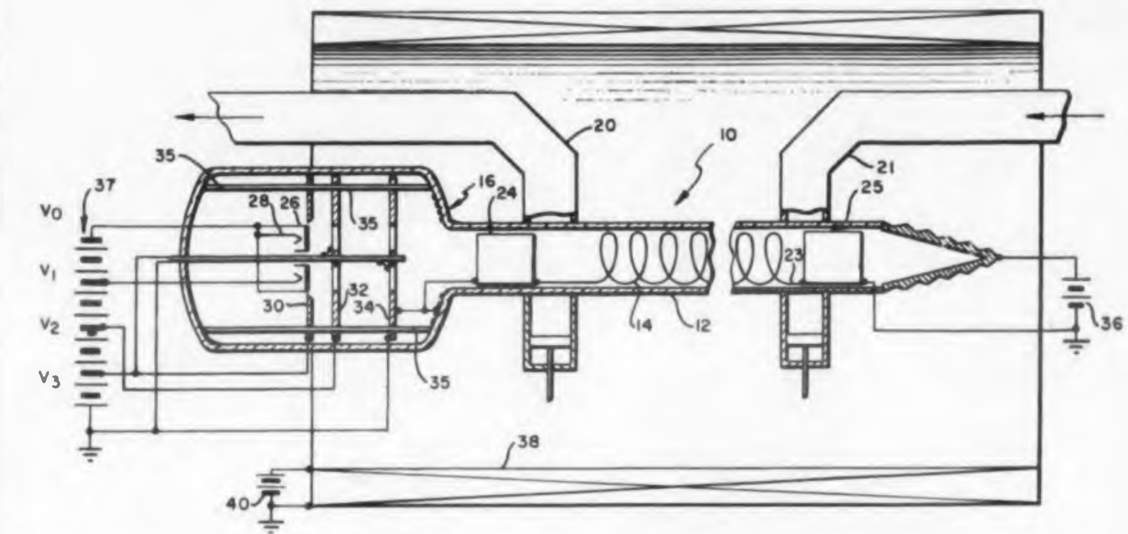
Benjamin Bernstein

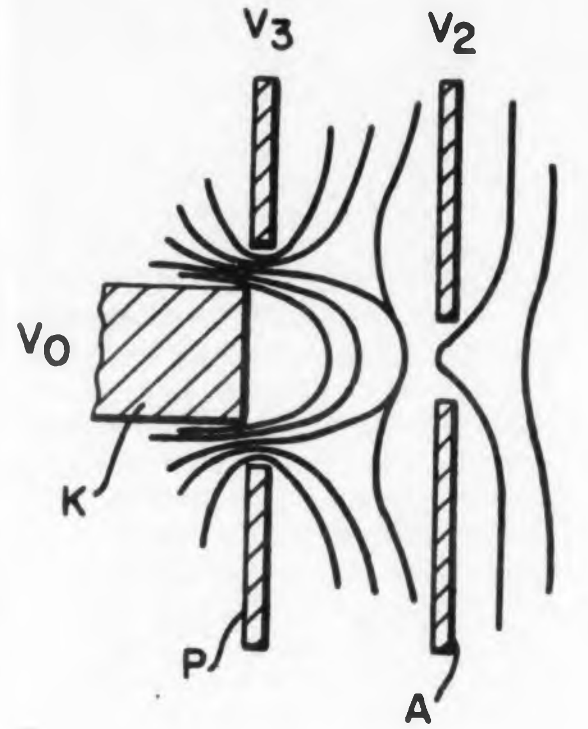
Low Noise TWT

Patent No. 2,936,393. M. R. Currie and D. C. Forster (Assigned to Hughes Aircraft Co).

A low-noise electron gun is achieved by accelerating and decelerating the electron beam in the immediate vicinity of the emissive cathode. A beam-forming electrode at a higher potential than the anode is inserted next to the cathode. This causes a saddle point to develop there. The potential profile along the tube axis is initially accelerating. However, this condition is then followed by a long drift region. It is believed that the cross-over at the cathode increases the emission from the edges of the cathode. This factor ultimately contributes to the low noise figure.

A TWT having an electron gun





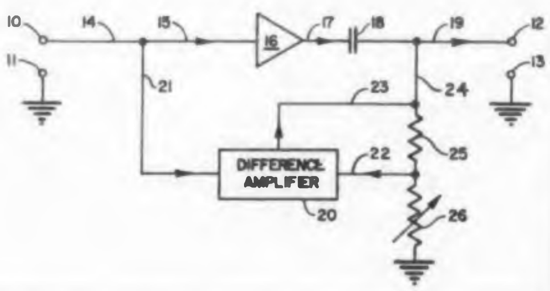
mounted in a strong solenoid focusing coil *38* is shown. The field shaping ring *30 (p)* is at potential V_3 which is higher than the potential on the first accelerator *32 (A)*. The resultant potential profile includes the desired cross-over in the cathode region.

Wide-Band Amplifiers

Patent No. 2,935,696. C. F. Ault (Assigned to A. B. DuMont Labs).

A wide-band amplifier is obtained by placing a dc amplifier in shunt with the load of an ac amplifier. To operate correctly in the low frequency range a dc difference amplifier is used.

The signal to be amplified is applied to terminals *10* and *11*. The ac amplifier is coupled to the voltage divided load consisting of capacitor *18* and resistors *25* and *26*. Within the flat frequency response range of amplifier *16*, the dc amplifier *20* has equal inputs. The dc unit's contribution to the load is zero. At lower frequencies, the inputs to the difference amplifier become unequal. The resultant output is essentially the amplified signal produced by this amplifier.



BOOKS

Direct Conversion of Heat to Electricity

Joseph Kaye and John A. Welsh, John Wiley & Sons, Inc., 440 Park Ave. S., New York 16, N. Y., 220 p, $8.75.

An edited collection of papers issued at an MIT seminar, this volume is one of the first published sources of reference material in the field of direct conversion of heat to electricity. The papers were presented at a special summer program titled "Direct Conversion of Heat to Electricity," that took place July 6 to 17, 1959. At the time they represented the latest advances in research.

The book has been divided into five general sections. These include fundamental discussions in thermoelectric energy conversion (the thermocouple), thermionic energy conversion (the vacuum tube and the gaseous tube), magneto-hydrodynamic conversion (separating the positive and negative charges in a gas), and fuel cells (the separation of positive and negative charges during a chemical reaction). Also presented are examples of practical applications and problems associated with each type of conversion scheme.

Transistor Projects

Compiled by the staff of Gernsback Library, Gernsback Library, Inc., 154 W. 14th St., New York 11, N.Y., 160 pp, $2.90.

Strictly a practical book, this volume passes very lightly over transistor theory and gets right down to detailing a large variety of transistor construction projects. Outlined are projects on radios, instruments and accessories, and miscellaneous devices such as a remote transistor ear, an electronic compass, and an electronic counter.

An Introduction To Statistical Communication Theory

David Middleton, McGraw-Hill Book Co., 330 W. 42nd St., New York 36, N. Y., 1140 pp, $25.00.

Broadly speaking, statistical communication theory may be described as a theory which applies probability concepts and statistical methods to the random phenomena (messages, signals, and noise) that influence and control the design, operation and evaluation of communication systems. Although the specific treatment in this book is directed toward electronic and electrical systems, such as radio, radar, etc., the general methods and philosophy described are applicable in other areas of communication science, as well.

According to the author, this is the first text to appear on the subject of statistical communication theory as distinct from special works on information theory, noise, and stochastic processes. It offers a systematic approach to the functional design of optimal communication systems, including evaluation and comparison with suboptimum systems. Sufficient development of the mathematical techniques required for the solution of advanced problems is included.

The book is divided into four main parts. Part I introduces and describes some of the statistical techniques required in the analysis of communication systems and concludes with an introductory chapter on information theory. Part 2 considers the random noise processes and some of the processes derived from it, and gives a short account of the physical models of shot and thermal noise. Part 3 is concerned mainly with various nonlinear operations that are common in transmission and reception, such as modulation and demodulation, and the calculation of signal-to-noise ratios. Linear measurement, filtering, and prediction and more general distribution problems, the results of which are needed in the general analysis of Part 4, are also examined here. Finally, Part 4 gives a detailed development of a statistical communication theory for the basic single-link communication system consisting of message or signal source, transmitter, medium of propagation (or channel), and receiver and decision-making elements.

REPORT BRIEFS

Asynchronous Logic Networks

The systems considered are asynchronous, dc-level sequential switching circuits. They do not have clock pulses, and the signals are represented, not by pulses, but by variables that can assume values in either of two non-overlapping ranges. The analysis of these circuits is discussed, with emphasis on the problem of choosing state variables. A relationship is established between the number of rows of a reduced flow matrix and the feedback index of the associated circuit. The major portion of the research is devoted to a study of the effects of stray delays on the operation of sequential switching circuits. *A Study Of Asynchronous Logical Feed Back Networks, Stephen H. Unger, Research Laboratory of Electronics, MIT, Cambridge, Mass., 26 April 1957, 47 pp, Microfilm $3.30, Photostat $7.80. Order PB 145436 from Library of Congress, Washington 25, D.C.*

Voice Data Processing

The system programing, the results of a feasibility study, and the design and development of transistorized plug-in modules for a digital Voice Data Processing System are presented. This system, being fabricated to support the development of a speech bandwidth compression technique, is a special purpose computer operating from a 400-kc clock. Several operational modes are provided to enable use of the Voice Data Processing System as a data accumulating and sorting device and then as a complete communication system simulator. The mathematical design analysis and the description of the operational evaluation tests for one of the circuit modules are included as appendices. *Voice Data Processing System, L. P. Schoene, Melpar, Inc., Falls Church, Va., 15 Oct. 1959, 121 pp, Microfilm $6.30, Photocopy $19.80. Order PB 144797 from Library of Congress, Washington 25, D.C.*

Supersonic Delay Lines

Structural features of supersonic delay lines, together with some investigations bearing on their acoustic and electrical properties, are described. The lines were designed specifically for laboratory use as signal storage devices for an MTI (Moving Target Indication) system and have delays of the order of 0.5 to 1.6 ms. *Supersonic Delay Lines, Herbert Shapiro, Office of Scientific Research and Development, Washington, D.C. 15 March 1946, 46 pp, Microfilm $3.30, Photostat $7.80. Order PB 137822 from Library of Congress, Washington 25, D.C.*

LETTERS

Patent Law Point Clarified

Dear Sir:

In the ELECTRONIC DESIGN issue of April 27, 1960, there is an article entitled "Delayed Patent Application . . . What You Can Lose." The article's second paragraph contains an erroneous statement, which reads:

"Under the patent law an inventor is not entitled to a patent if his invention was known or used by others in this or a foreign country before the invention by the patent applicant."

The patent law under 35 U.S.C. 102 states that: "A person shall be entitled to a patent unless the invention was known or used by others in this country, or patented or described in a printed publication in this or a foreign country, before the invention thereof by the applicant for patent."

As you can readily see, the author of the quoted article leads one to believe that foreign knowledge or use is an anticipation. However, only domestic knowledge or use, or a foreign patent or printed publication, is an anticipation.

Sincerely,
R. R. Skolnick
Patent Administrator
Ford Instrument Co.
Long Island City, N. Y.

Load Lines Simplify but Equations Don't

In your otherwise well written article "Load Lines Simplify Transistor Amplifier Analysis," a few errors have sneaked in: On page 22 of your March 2nd issue, the equation

$$i_1 = \frac{v_1 - i_1 r_{in} + (B+1) R_e}{R_b}$$

should read

$$i_1 = \frac{v_1 - i_1 r_{in} - (B+1) R_e i_1}{R_b}$$

The next equation

$$i_1 = \frac{v_1 - i_1 [r_m + (B+1) R_e]}{R_b}$$

should read

$$i_1 = \frac{v_1 - i_1 [r_{in} + (B+1) R_e]}{R_b}$$

Adam A. Jorgensen
Stromberg Carlson Co.
Rochester, N. Y.

YOUR CAREER
ENGINEER-IMPROVEMENT COURSES AND SEMINARS

Below are courses and seminars intended to provide the engineer with a better knowledge of various specialties. Our grouping includes several different types of meetings. National Courses—those held on consecutive days and intended to draw attendees from all geographical areas; One-Day Seminars—one-day intensive seminars which move from city to city; and Regional Lectures—regional symposia or lecture series which generally run one night a week for several weeks.

National Courses

Modulation Theory and Systems, Aug. 1-12, Massachusetts Institute of Techonology

This program on "Modulation Theory and Systems" is planned particularly for practicing communications engineers with an active interest in communication systems and techniques. Emphasis will be on theory and methodology, rather than current practice. Familiarity with Fourier techniques and an understanding of the basic concepts of probability and noise theory will be assumed. The program, which will run from August 1-12, requires a $300 tuition payable upon notification of admission. Academic credit is not offered. For information, contact Professor Elie J. Baghdady of the Department of Electrical Engineering, Massachusetts Institute of Technology, Cambridge, Mass.

PAPER DEADLINES

Convention Program Chairmen have issued the following deadlines to authors wishing to have their papers considered for presentation.

July 30: Deadline for 50-200 word abstracts of papers for the **Conference on Reliability of Semiconductor Devices** to be held Jan. 12-13, 1961, at the Western Union Auditorium, 60 Hudson St., New York, N.Y. Papers are requested to cover the following: transistors, diodes and rectifiers made of germanium, silicon and other semiconductor material. The papers should be basically empirical in nature, covering observation of the devices alone, or the devices in circuitry and systems, under various conditions of operation and/or storage. A concise description of device structure and fabrication should be included. All material included in the papers must be unclassified. Send titles, abstracts and papers to: *Mr. John E. Shwop, Chairman, Program Committee, U. S. Army Signal Supply Agency, 225 S. 18th St., Philadelphia 3, Pa., ATTN: Production Development Div., 15th Floor.*

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Employment History

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Direct your ingenuity to the design of circuits forming integral parts of CW range measuring equipment and the integration of complex timing and coding circuitry for earth satellites. You will also establish and supervise test programs, direct the testing of setups, component parts, circuits and complete ranging systems, supervise and monitor electrical and environmental testing for qualification. Familiarity with transistor switching circuitry is required.

RANGE DESIGN ENGINEERS
Challenging assignments can be yours in the production of installation criteria, specifications, instructions and drawings required to implement advanced radar, telemetry, data processing, computing and communications systems.

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If your experience includes low-frequency phase measurements, tracking or radar, openings exist at PHILCO WDL for engineers to design, develop and insure fabrication of specialized test equipment.

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CIRCLE 904 ON CAREER INQUIRY FORM

CAREER OPPORTUNITIES BROCHURES

Cornell Aeronautical Laboratory

Under the general guidance of Cornell University, the Cornell Aeronautical Laboratory seeks to advance and enlarge scientific and engineering knowledge and to serve the aircraft industry, education and the public at large. The intent of the brochure "A Community of Science" is to profile for the prospective employe some of the men who would be his associates, to depict the technical areas he would work in and to describe the research facilities and equipment that would be at his disposal as a member of C.A.L.'s staff.

In the Physics Div., the Electronics Dept. has a broad program which includes navigation, communications, computers, traffic control, and radar. Scientific activities in the Applied Physics Dept. center in the fields of atmospheric and radiophysics, nucleonics, solid state and surface physics, and instrumentation.

Theoretical and experimental research into fundamental and applied aerodynamics, gasdynamics, and propulsion is the prime responsibility of the Aerodynamics Div. The Materials Dept. of this division is involved in a search for new materials to withstand the high temperature and stresses imposed by supersonic and hypersonic flight.

Under the Full Scale Div., the Flight Research Dept. serves primarily as an independent research group on flight projects requiring full-scale aircraft operations; the Vehicle Dynamics Dept. studies the problems of the design of many vehicle types, including submarines, seaplanes, and track-layers.

The brochure also includes career profiles of four men, representative of C.A.L.'s technical staff, opportunities available in the education program, salary and benefits and a description of the Buffalo community in which the laboratory is located. *For further information write: Personnel Manager, Cornell Aeronautical Laboratory, Inc., 4455 Genesee St., Buffalo 21, N.Y.*

computer programmer and don't know it?

Many men who have training in engineering and the sciences are now going into computer programming. They find that it makes full use of their special analytical and logical talents, often not fully tapped in their present work.

In the 60's and beyond, the electronic computer will become more and more an important factor in the operations of business, industry, science and government. Computer programmers, the men who direct the computers, will play a vital role in this progress.

One of the most important qualifications for this work is the ability to analyze complex problems and to deduce from them meaningful and useful answers.

A computer programmer takes a problem—it may be in engineering, science, marketing, or in any of dozens of other fields—analyzes it, and phrases it in a mathematical-logical language that the computer can "understand." Then the computer goes to work with its prodigious speed and accuracy.

If you qualify as a computer programmer, you will be given an intensive training course in machine language, stored program equipment, problem-solving techniques, and program writing.

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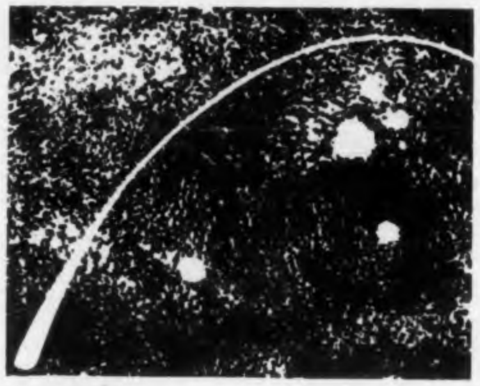

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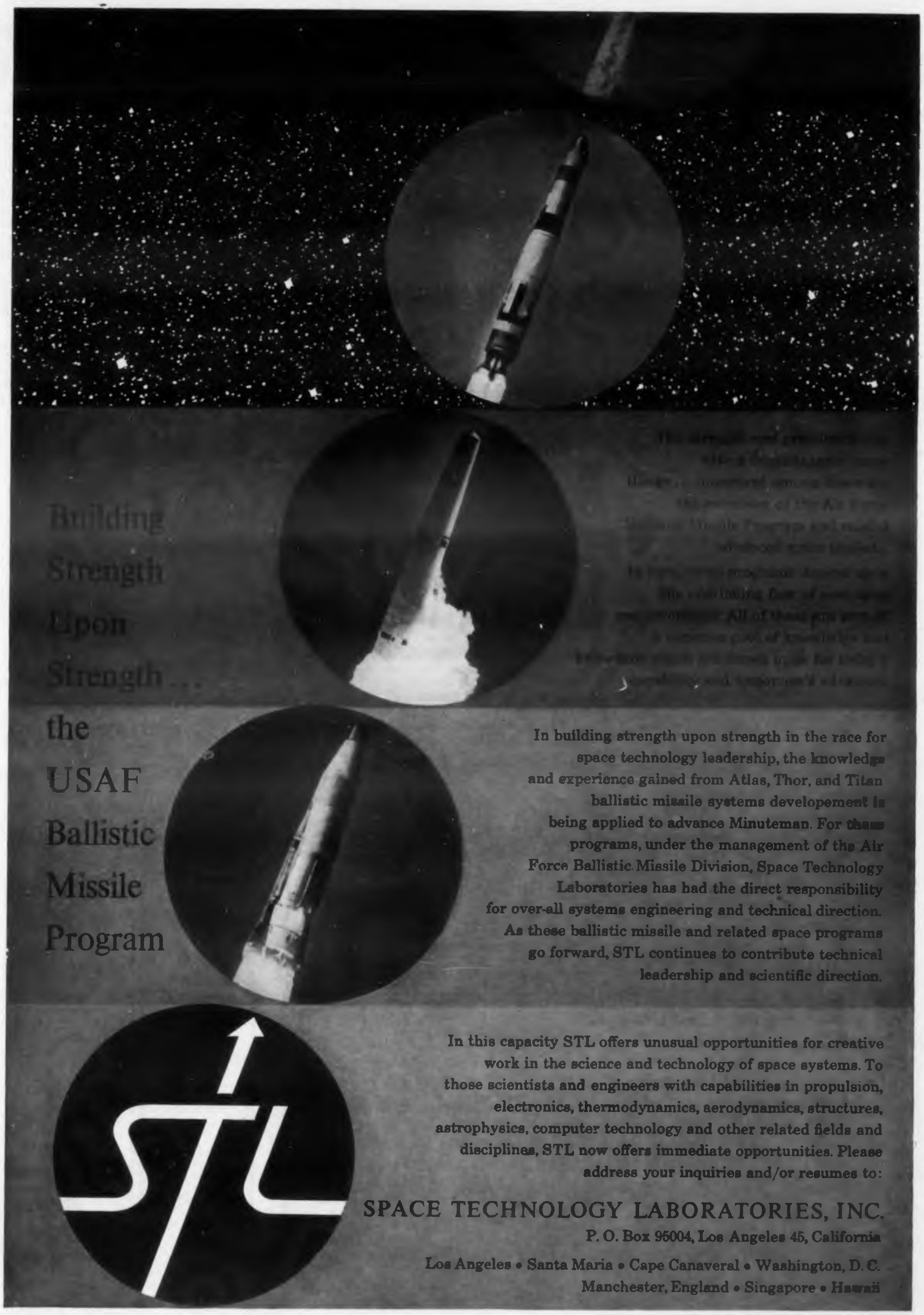

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ELECTRONIC DESIGN is growing and seeks additional engineers to fill new editorial spots.

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These men like working where their efforts are rewarded . . . they like the idea of working for a young company that offers engineers career opportunities with excellent advancement potential.

are you one of these men?

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Salary: To $8,000, depending on individual qualifications.

TO APPLY, **Circle #908 on Career Inquiry Form on page 159**

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The average Electronics Engineer will earn approximately $516,000 in his lifetime ($12,000 average annual income over a period of 43 years), or over *one-half million dollars!* Yet most engineers still choose their jobs after only the most cursory survey of available positions.

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Sure it makes sense! A man can't risk $50,000 or more without using the best help he can get. So send your resume direct, or circle No. 912 on Career Inquiry Form. For your free Bulletin each month listing America's best electronics jobs, circle No. 899 on Reader Service Card.

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CIRCLE 898 ON READER-SERVICE CARD

ADVERTISERS' INDEX

JULY 6, 1960

DRAFTING TRENDS

This versatile, easy-to-handle, adjustable triangle is made of yellow-tinted optical-grade acrylic plastic. A clean-cut oval track fitted with metal knurled knob assures ease of operation and lasting tight fit.

New combination protractor-triangle speeds up drafting

Architects, Engineers, Builders, Field Surveyors, Mathematicians—anyone who develops solutions to measurement problems indirectly to determine a wanted measurement graphically or mathematically—will find the Trig-Matk Adjustable Triangle a handy tool. It eliminates much of the graphic work necessary in estimating results or in checking for correct answers.

Versatility with accuracy

Basically, the new POST Trig-Matk Adjustable Triangle is a mathematician's tool—accurate to two decimal places.

It combines the functions of a protractor and a triangle into a simple unit, with two fundamental trigonometric relationships of a right triangle. The Trig-Matk provides accuracy within 1% in problems dealing with any of the six trigonometric ratios of the sides of a right triangle.

The adjustable protractor has three sets of graduations. One set is graduated in half degrees, labeled *Degrees*, and permits the use of the Trig-Matk as a protractor setting for determining any angle from 0 to 90 degrees.

The second set of graduations, labeled *Slope*, shows directly the *Secant* trigonometric ratio of the angle indicated on the degree scale. The third scale, labeled *Rise*, indicates directly the *Tangent* trigonometric ratio shown on the degree scale.

Examples

This new tool has a host of drafting and engineering applications. Highway designers find the Trig-Matk very useful when making cross sections of roadways at ground level or below. By

An indicated angle of 40 degrees on the Trig-Matk (1589) shows directly that the Rise is 8.4 to the base of 10.

setting the *Slope* scale to the degree desired, road-curve grades are automatically determined. The protractor can be used to determine the angle of highway ingress and egress lanes.

Structural Engineers will find the Trig-Matk Adjustable Triangle a simple tool, eliminating the use of both a scale and individual triangles. In addition to the time saved, many of the errors usually associated with the older method are avoided. The Trig-Matk design eliminates the need of frequent reference to handbooks for information on various bevels.

Two Bases

The Trig-Matk No. 1589-12 has a 12" base for handy calculations in feet and inches. Number 1589-10 has a base of 10 for decimal calculations.

Keep posted on all the latest trends in drafting. Consult your local POST dealer, or write to Frederick Post Co., 3644 North Avondale Ave., Chicago 18, Ill.

POST

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CIRCLE 183 ON READER-SERVICE CARD

Advertiser	Page

UNPRECEDENTED EFFICIENCIES IN HARMONIC GENERATION...

11 kMc input @ 500 mw

33 kMc output @ 5 to 20 mw

Nine new examples of Microwave Associates' capabilities in the design of harmonic generators are available now. These models feature exceptionally high output power with conversion losses well below existing devices.

New designs incorporating solid state elements can be used to eliminate costly klystrons, DC bias supplies and high voltage power supplies. All units feature broadband fixed-tuned operation, filters eliminating unwanted harmonics, and versatile coaxial, waveguide and strip transmission line packaging. These models are typical examples of our progress to date . . . presently we are working for even greater efficiencies and performance. Additional models in development converting 1 watt at 2000 Mc to 100 mw or more, at 4000 and 6000 Mc, to be announced soon.

Your specific application problems are of prime interest to us. Our Applications Engineers would welcome the opportunity to design harmonic generators to meet your specifications.

SPECIFICATIONS

	INPUT				OUTPUT				
Model	Connector Type UG-	Frequency Input kMc/s	Band	mw input	Connector Type UG-	Frequency Output kMc/s	Band	Conversion Loss (max.)	Output mw
MA796	23/U	0.26 — 0.28	P	20	23/U	1.30 — 1.43	L	13db	1
MA797	23/U	1.30 — 1.43	L	100	23/U	5.22 — 5.72	C	15db	3
MA798A	39/U	9.0±150Mc	X	500	596/U	18.0±300Mc	K	17db	10
MA798B	39/U	10.0±150Mc	X	500	596/U	20.0±300Mc	K	17db	10
MA798C	39/U	11.0±150Mc	X	500	596/U	22.0±300Mc	K	17db	10
MA798D	39/U	12.0±150Mc	X	500	596/U	24.0±300Mc	K	17db	10
MA799A	39/U	9.0±100Mc	X	500	600/U	27.0±300Mc	Ka	20db	5
MA799B	39/U	10.0±100Mc	X	500	600/U	30.0±300Mc	Ka	20db	5
MA799C	39/U	11.0±100Mc	X	500	600/U	33.0±300Mc	Ka	20db	5

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IMPULSE
A DIGEST OF NEW DEVELOPMENTS IN ELECTRONICS AND AUTOMATION

PUBLISHED BY **ROME CABLE DIV. OF ALCOA**, ROME, N. Y.
PIONEERS IN INSTRUMENTATION CABLE ENGINEERING

NOW HEAR THIS. Japanese hearing aids now coming into the U.S. market could mean real competition, since some units are priced as low as $29.95. This compares with $100 average price for U.S.-made aids. Recently published figures indicate that between 300 and 360 thousand hearing aids were sold here last year. Yet the Japanese, in planning their market strategy, estimate that some 15,000,000 Americans have some hearing difficulty. Despite the difference between current sales and this figure, it definitely looks like an expanding market. Manufacturers of electronic components are particularly interested in the trend toward the binaural eyeglass-type aid, since it uses separate microphones, amplifiers and earphones for each ear and, therefore, requires twice as many components as used by conventional-type aids.

UP 30 PER CENT. Shipments of electronic components jumped more than 30 per cent from 1958 to 1959 to reach a new all-time record. A Commerce Department report spells out all the details, gives quantities and values by major category, and breaks totals down into military and non-military use. If you'd like a copy, write to the Commerce Department and ask for BD-60-64.

ELECTRONIC VOLLEYBALL. Ways of knocking out unfriendly ICBM's without shooting them down are being looked into with great interest by the Pentagon. Among the more dramatic is a plan to supply missiles with extra energy at the height of their flight in space and, thus, cause them to overshoot their intended target by a very comfortable margin. Only a small amount of energy would be needed. But the big problem is how to apply it. The whole problem of anti-missile killing mechanisms of all kinds is coming in for more attention these days. The Advanced Research Projects Agency is increasing funds for this purpose to $9 million for 1961. It's a wide-open field and it looks like anybody and everybody is invited to participate.

NEW WAY TO SPARK. A major electronics firm in this country is developing a revolutionary automobile system that would use microwave energy as the igniting agent. In this system, a microwave pulser, wave guides and timing pickup would replace the traditional ignition coil and condenser, distributor and timing drive, high-voltage wires and spark plugs.

CABLEMAN'S CORNER. The old adage "Don't put the cart before the horse" was never so true as it is in these days of automation and instrumentation. With all the intricate pieces of equipment being designed these days, it is important that careful consideration be given to the wire and cable that may be employed in any system. Often forgotten is the unromantic aspect of the connecting links of the system. Cables are the arteries through which must flow the power and informational pulses necessary for reliable performance.

Don't take a chance on being able to obtain a cable that will fit into what is left. Many times, important characteristics such as conductor size, insulating walls, protective sheaths, flexibility and flex-life have to be sacrificed. Don't sacrifice reliability in your cables for an existing space or connector fittings.

For 100% reliability in multi-conductor cables, call on a cable specialist—and call on him as soon as possible. Phone Rome 3000, or write: Rome Cable Division of Alcoa, Dept. 1170, Rome, New York.

These news items represent a digest of information found in many of the publications and periodicals of the electronics industry or related industries. They appear in brief here for easy and concentrated reading. Further information on each can be found in the original source material. Sources will be forwarded on request.

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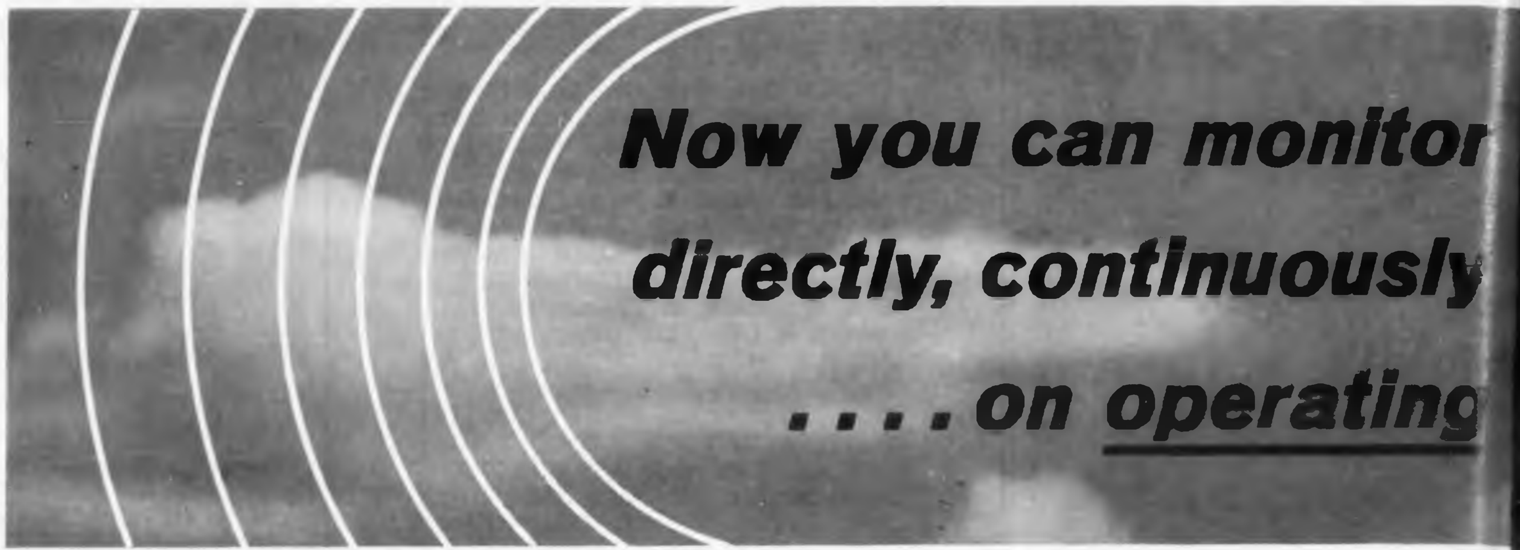

All-New, Transistorized hp 344AR Noise Figure Meter

The new hp 344AR Noise Figure Meter assures you that your radar is continuously operating at peak performance, and you are enjoying maximum range. The instrument's fast meter response lets you optimize or adjust the system during operation or maintenance. Model 344AR is designed for the utmost in dependability—it is militarized, transistorized, very compact and very rugged.

With this new 5¼" high instrument system noise figure is measured on a time-shared basis with the radar scan. The unit has high sensitivity to minimize signal and transmitter losses; the noise source may be decoupled 20 db from the main transmitter line. Two alarm functions give visible and electrical indication when an allowable noise figure is exceeded, or a noise source malfunctions.

High voltage on antenna slip rings is eliminated with a remote noise source modulator operated with low voltage triggers. Other features include quick, easy front panel calibration, and remote metering and alarms if desired.

FREE APPLICATION NOTES INCLUDE CONSIDERATIONS FOR AUTOMATIC MEASUREMENT OF NOISE FIGURE ON A CONTINUOUS BASIS

Write hp direct for Application Note 43—"Continuous Monitoring of Radar Noise Frequency". Discussion includes description of hp 344AR and its application to radar systems.

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