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1988

THE MAGAZINE FOR THE ELECTRONICS ACTIVIST!

THE GADGETEER'S GIZMO BUYER'S GUIDE

Two-Wheeler Intercom
A no-noise chit-chat channel for cyclists

Tame the DOS Tiger
Take command of your DOS system by understanding what it can do!

IQ-Test
This is the month to fool those who would do unto you!

Solar-Powered "Indy"
America snatches the sun cup by winning the first international solar race across Australia

The Zeta Blocker
Out of the lab and into hearing aids—A computer that you can stick in your ear!

BarCode Goes Video
Programming VCR's is a snap when the player comes with a light pen

Sweet Heart of a project

Let an LED timing circuit and your handicraft deliver a loving message to the someone you care about!

A GERNSBACK PUBLICATION

Thyristors' Finer Family Members
Triac, Diac, SCS, UJT, SUS and PUT may be just alphabet soup to you—that's why you need to read this issue!

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Hands-on Electronics®

INCLUDING 10-PAGE GIZMO

Volume 5, No. 4

APRIL 1988

CONSTRUCTION

FEATURES

HANDS-ON REPORTS

SPECIAL COLUMNS

DEPARTMENTS

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Saxon on Scanners—page 94

Hands-on Electronics®

The Magazine for the Electronics Activist!

Never look back!

In the publishing business many of us never look back, because we are so concerned about the future. It takes only common sense to realize that if you are not ready for tomorrow, some one else will beat you out.

I'm not prone to look back, but this morning that is exactly what I did. The work on our April 1988 issue was almost done and I decided to review it. I found that I began to read anew that which I had read before. I was delightfully surprized by the professional work my associate editors performed in sculpturing the finished issue.

Our feature article "Racing with the Sun" is a winner. It tells of a solar-car race in Australia that was won by a U.S. car. Another article on a computer chip noise blocker for hearing aides reveals a giant step in a field that was practically void of advancement for several years. Another story talks about using bar codes with VCR's, making programming easier. Those features reveal the progress made by the electronics industry to improve our life style now and in the future.

The issue goes on to cover in detail more on Thyristors, a subject continued from the previous issue. The host of varied semiconductor types discussed in this issue can stagger the mind.

Also, we "Tame the DOS Tiger" once and for all by starting at the base roots of the computer and instruct the neophyte in controlling his disk-operating system. Read it, even if you are an old hand at it. You'd be surprized.

No, I'm not going through the entire issue, but I do want to share my enthusiasm for the articles you will find in it. There will be several that will get you excited, and I'll admit that there will be one or two that won't. It is difficult to edit a magazine for everyone to enjoy completely, but you can help. Why not drop a short note to me stating which article you like the best and which one you cared for the least. With enough letters to survey, I can better understand what you want and you can then help me look to the future.

Julian S. Martin, KA2GUN
Editor

P.S. My college football coach said, "Never look back, they may be catching up to you." Well, he never edited a magazine!

STAFF

Volume 5, No. 4

April 1988

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Gernsback Publications, Inc.
500-B Bi-County Boulevard
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516/293-3000
President: Larry Steckler
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310 Madison Ave. Suite 1804
New York, NY 10017
212-/953-2121

Composition by
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Cover photo by
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Hands-on Electronics, (ISSN 0743-2968) Published monthly by Gernsback Publications, Inc., 500-B Bi-County Boulevard, Farmingdale, NY 11735. Second-Class postage paid at Farmingdale, NY and at additional mailing offices. One-year, twelve issues, subscription rate U.S. and possessions $28.00, Canada $33.00, all other countries $35.50. Subscription orders payable in U.S. funds only, International Postal Money Order or check drawn on a U.S. bank. U.S. single copy price $2.50.

Postmaster: Please send address changes to **Hands-On Electronics,** Subscription Dept., P.O. Box 338, Mount Morris, IL 61054-9932.

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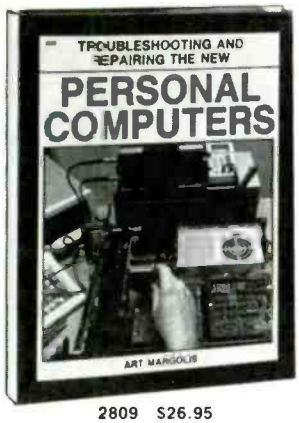

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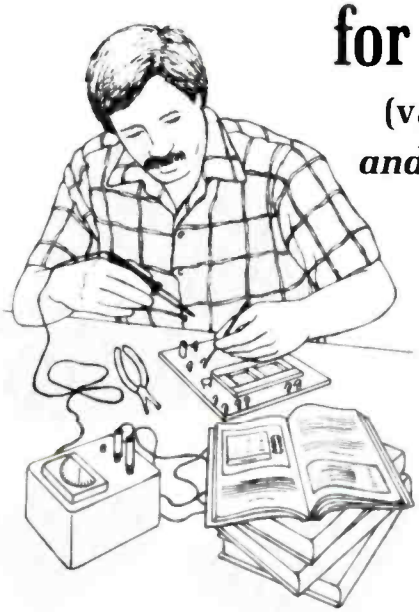

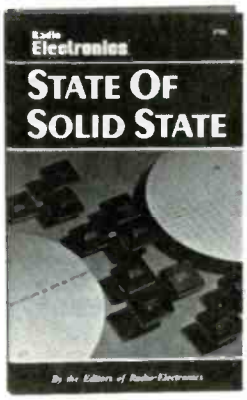

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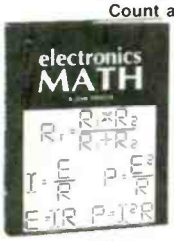

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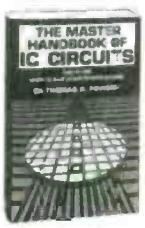

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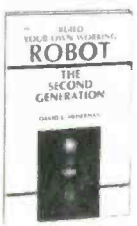

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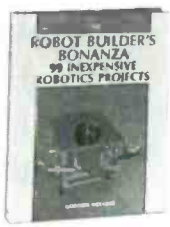

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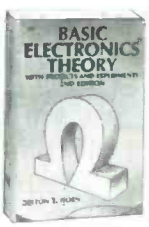

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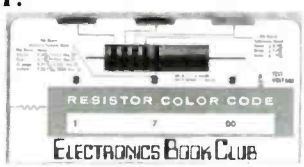

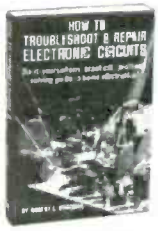

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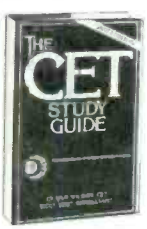

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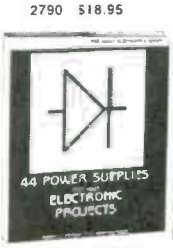

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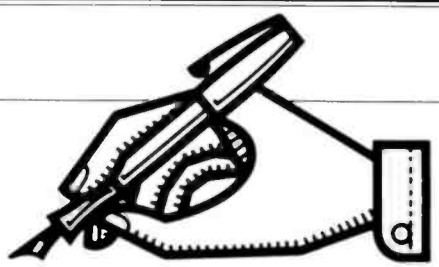

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Give Me More

I need some information, I hope you can help me. I picked up your magazine and found it very enjoyable, as well as useful reading. However, could you recommend a few professional publications geared to a technicians viewpoint, and toward the TV and/or communications technician.

I also need a source for tools and equipment. Please send any information at the address below.

Your help is greatly appreciated.
—G.E.T., Midland, TX

We try not to let things get way too technical in these pages. We assume most people want to relax with a stimulating-enough hobby such as electronics. If you want a real hardcore tech mag with lots of theory and big projects, try our sister publication **Radio Electronics**.

In these pages and R-E you will find lots of equipment advertisers and product reviews. (Are you sure you read our magazine?)

Sea-sure

Reguarding your story of the boarding and the arrest of those aboard the "Pirate Radio" vessel off New York. While your writer did a pretty good job of covering the story there was failure to mention some very interesting legal points.

The ship was registered under the Honduran flag. Did the U.S. authorities obtain permission from the Honduran Government to board? The U.S. Coast Guard claims the authority was granted by congress way back when to board any vessel on a voyage entering or leaving an American port. That brings us to a very interesting point of law.

Along about May 1978 the United States Supreme Court ruled that congress lacks the authority to empower an agency to conduct warrentless searches. (See Marshall v. Barlow's Inc. 436 US307, 56LEd 2d 305, 98 SCt 1816 76-1143. and Marshall v. Gibson's, 76-1526) And, since one cannot convey what one does not have, any attempt to convey such power by the congress was moot.

Now it would also seem, although I can't find where it had been argued, that if congress lacked authority in 1978, that it never had that authority in the first place and any previous attempts to convey was also moot, even though the issue has not been properly challenged in court.

Points of law may appear out of place in a radio story, however radio signals observe few civil boundarys while apparently civil law enforcement can be limited and controled by the courts.
—O.G.S., North Bend, OR

The wisdom of Solomon would be sorely tested on this matter. The complications in the piracy affair has confounded some of the best maritime legal minds around. The plain truth is there are no easy ways to determine where the duty of certain federal agencies begin and end. Unfortunately, the questions raised in this case are likely not to be resolved since the case may never be brought to court.

Curved Logic

I was monkeying around with some algebra concerning parabolic curves. According to the ARRL Handbook parabolic antenna are described by the formula:

$$y^2 = 4FX$$

If you make F = x then the formula becomes:

$$y^2 = 4X^2$$

and if you choose a y value to represent the radius of the dish, say a 3 meter dish, then

$$r = y = 1.5 \text{ meters}$$

and point X (or F for that matter) has a value of .75. That places the focus point in the plane described by the rim of the parabola. Any number of parabolic curves can now be generated by making point (F,0) not equal to point (x,0) yielding $F^*X = 1.5^2/4$ while holding the radius and thus the capture area constant. As manufacturers of dishes do not place the focus in the rim plane but rather at a point further from the dish, what is the relationship between F and X or, how is the point (F,0) derived?

I have been a reader of your magazine for years and I have seen many imitators come and go, proving yours is the best. I am sure you will keep up the standards you have set.
—S.F.B., Calgary, Alberta, Canada

You really know how to put the pressure on. There are a few different reasons why dishes are designed with a focal point beyond the rim plane. The most practical being that a feed horn cannot receive signals at 90°s or greater to its central axis. The attenuating cylindrical fins will eliminate any signal coming in at such an odd angle, thus making the large area near the rim of the dish useless.

Keeping Sharp

This regards page 87 of your January 1988 issue of **Hands-On Electronics**. I have noted that you show the manufacturer as "Sony" for the VC-D800U. Please be advised that Sharp Electronics Corporation, my employer, is the actual manufacturer of the featured product.
—P.D., Charlotte, NC

Sorry, the editor on that story got so

(Continued on page 101)

CABLE EQUIPMENT PRICES SLASHED WHILE YOU WAIT!

Call Aunt Matilda at **Pacific Cable Co., Inc.**, and get a pleasant surprise: Instant price cuts even on our own cut-to-the-bone prices!

Here's how: Just supply her (or one of our other operators) with anybody else's published prices (even wholesale, if you're a dealer) for the unit you want; and if their price beats our published price, we'll match it—or even beat it! Simple as that.

Of course, you'll have to look far and wide to beat our prices (see below) and we're betting that Aunt Matilda will seldom need her "little hatchet" and can partake of her cherished afternoon nap. Which is fine with us—she makes us nervous with that thing!

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NEW PRODUCTS

Pro Audio Headphones

The K260 Professional dynamic headphone is designed to accurately reproduce a wide range of frequencies. Capable of handling higher sound pressure levels than previous AKG headphones, the K260 will be appropriate for studio tracking and high-volume reference monitoring, as well as general listening situations.

The K260's special polycarbonate foil diaphragm has a lower resonance frequency, allowing full bass response down to 10 Hz, while maintaining a well defined, airy treble up to 20 Hz. Power-handling capabilities have been increased to provide clean reproduction at even the loudest volumes.

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The large openings of the K260's circumanual ear pieces make the outside shell acoustically transparent, and the sound more spacious. Its headband is self-adjusting for every head shape. The leatherette ear cushions are easy to remove and wash, and between the capsule and the ear is a comfortable fabric-covered acoustic-foam pad.

The K260 Professional headphone weighs only 9 oz. with cable, and has a net price of $160.00.

Some specifications: dynamic transducer; circumanual earphone; frequency range of 10–20,000 Hz; 600 ohms/system impedance; earphone pressure of 2.5N; THD less than 1% to DIN 45500; power-handling capability up to 200 mW to DIN 45500; Y cable, 3-m (10-ft) long.

For more information, contact: AKG Acoustics, Inc., 77 Selleck Street, Stamford, CT 06902.

Jumper Boxes

These Jumper Boxes enable assembly of custom RS-232 interfaces. A small PC board provides the solder pads for each line from both 25-pin connectors. There are 20 jumper wires included to provide the means to make null modems, pin reversers, etc. It also is equipped to tap signals from the RS-232 line. Plastic covers are included with the Jumper Boxes that are snapped over the board after assembly is completed. The covers have removable squares that allow a cable to be easily brought out.

The three model Jumper Boxes from B & B are as follows: Model 232 MFMB-RS-232 Jumper Box, with one female and one male connector; Model 232MMJB-RS-232 Jumper Box with two male connectors; Model 232FFJB - RS-232 Jumper Box with two female connectors. Because B & B is also the manufacturer as well as designer, they are able to sell these Jumper Boxes for $15.95 each.

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For a completely illustrated and descriptive brochure of products, communicate with B & B Electronics and request their new catalog. They will fill any request for brochure or product. Write or call B & B Electronics, 1500 Boyce Memorial Drive, PO Box 1040, Ottawa, IL 61350; Tel. 815/434-0846.

Lightning Protector

Multi-user computer systems are increasingly used in all industries. While providing greater throughput, complex arrangements of equipment are vulnerable to problems caused by the dangerous coupling of high-voltage surges and spikes into data lines, as those lines are being run through areas susceptible to such threats.

The Model 26 is designed to accommodate induced transients caused by lightning as well as other sources of transient pickup, and provide a low impedance to the frame ground of the equipment.

The Model 26 contains gas tubes and avalanche diodes adequately coupled to protect pins 2, 3, 7 and 20 of the RS-232 interface. The surge is diverted to Pin 1, frame ground. The Model 26-1 has a male DB-25 connector as the input, exposed line, and a female DB-25 for attaching to a DEC terminal. On the terminal side, pins 6, 8 and 20 are connected together.

The Model 26-2 is the same as the 26-1 except for the sexes of the DB-25 connectors which conform to the industry standard.

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The Model 26 is packaged in a small plastic enclosure whose size is 2 × 2-¼ × ⅝. The Model 26-½ sells for $45. Either unit is available from stock from Telebyte Technology Inc., 270 E. Pulaski Road, Greenlawn, NY 11740; Tel. 516/423-3232 or 800/835-3298.

dbX Schotz Tuner

Intended for audiophiles, the dbX TX1 tuner incorporates automatic circuits for reducing noise from weak FM stations, and brings improved frequency response to AM programs.

The TX1 constantly monitors the FM signal for signs of noise, which is normally concentrated in the higher frequencies. When noise is detected, the circuit blends together the high frequencies of the two stereo channels, reducing noise to an inaudible level. Since the Schotz blending is carried out dynamically, it is only activated when absolutely necessary. Mid frequencies, the main carriers of stereo information, remain relatively unaffected.

As an aid in tuning difficult FM stations despite strong nearby interfering stations, the TX1 automatically selects a narrower IF bandwidth than normal (for greater selectivity and better adjacent-channel rejection) or permits it by the press of a button.

Stereo signal-to-noise ratio is at 79 dB (A-weighted). The capture ratio is a mere 1.5 dB. FM tuning sensitivity is also low. Stereo separation (at 1 kHz) is 56 dB.

For accurate tuning, the dbX TX1 uses digital frequency synthesis. With FM, tuning steps are 100 kHz; with AM, 10 kHz. Six station presets are available to the user, for FM and for AM. In case the TX1 is unplugged, or if there is a power outage, the TX1 maintains the preset memory for up to two weeks.

Large readouts show FM and AM mode, station frequency, stereo or mono operation, and manually chosen narrow IF mode. An LED signal-strength meter aids manual tuning and antenna orientation. Other LEDs indicate selection of Schotz, interstation-muting defeat, and station presets.

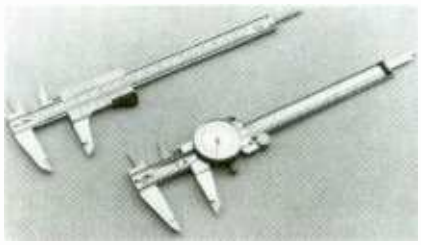
The TX1 FM/AM tuner is available

CIRCLE 74 ON FREE INFORMATION CARD

through dbX dealers, and the suggested reta il price is $600. For more information contact dbX, PO Box 100C, Newton, MA 02195.

Precision Calipers

These quality, stainless-steel instruments feature precision ground and lapped measuring surfaces. The dual-system Vernier Caliper has a measuring range of 0–6-in., a 0–150-mm metric capacity, and is stress-relieved to provide velvet-smooth action. Easy-to-read, etched graduations in .001 in./.05 mm, plus thumblock make the Vernier Caliper by Acu-min a must for most any precision measuring task.



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The Dial Caliper is also stress-relieved and crafted from stainless steel. An adjustable dial indicator with fine line indicating hand and thumbwheel make it ideal for extremely accurate measuring applications. Graduations in .001-in. are clearly etched in the recessed face of the measuring bar.

Both calipers come complete with operating instructions, and are packaged in handsome, fitted cases. In addition, both instruments are guaranteed for long term performance, accuracy and durability.

The suggested retail prices for the Vernier and dial calipers are $42.95 and $61.50 respectively. For further information contact Moody Tools, Inc., 42-60 Crompton Avenue, PO Box 230, East Greenwich, RI 02818; Tel. 401/885-0911.

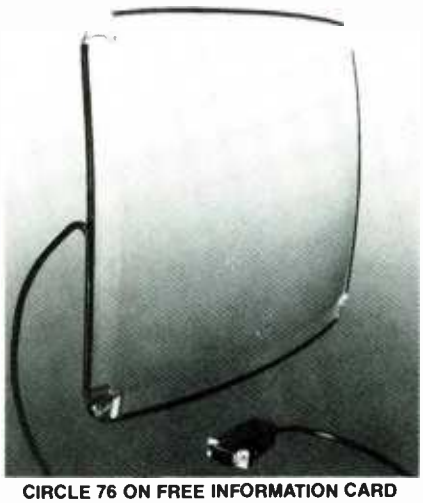
Loud Correction

Thank you very much for the write up on our Kappa series loudspeakers in your November 1987 edition. However, the retail prices printed are incorrect. Could you please issue a correction as follows: 7 Kappa $659 each; 8 Kappa $949 each; 9 Kappa $1,349 each. [*Consider it done—Ed.*] *(turn page)*

NEW PRODUCTS

Touchscreens

This touchscreen senses touch pressure as well as the touch location. That is a significant development because until now, touchscreens have been unable to take advantage of software written for other popular input devices such as the mouse, lightpen, and digitizer.



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The Elographics touchscreens allow various levels of finger pressure to be used to "pick up" a cursor, "drag" it over touch zones without activating them, and "click" it (activate a given command) by pressing a bit harder. In addition, this unique pressure-sensing ability can be used, for example, to control scrolling speed or the flow rate of a material in a process-control application.

The screens are made of completely transparent glass. There are no semi-transparent conductive surfaces between the eyes of the user and the images on the computer display.

Elographics has named the touchscreen technology *trace* for *T*ransparent *R*eflective *A*rray *C*oordinate *E*ntry. Unlike one other transparent touchscreen technology, infrared, Trace touchscreens require no special display frame (bezel) and have no parallax problems. In contrast to infrared light, acoustic signals can follow the curved surface of a display.

The company provides serial (RS232) or bus controllers, and menu-driven, general-purpose application-authoring software called TAG (Touchscreen Application Generator). TAG uses a *what-you-see-is-what-you-get* approach to building touchscreen displays. Up to 128 color combinations are available, in addition to a variety of video attributes.

IntelliTouch screens are available from Elographics, made to order to fit displays from 5 to 19 inches in size. The prices for the 13- and 19-inch displays are $800 and $960 respectively, and come with the controller and device-driver software.

For more information contact Elographics, Inc., 105 Randolph Road, Oak Ridge, TN 37830; Tel. 615-482-4100.

"That might explain your reception!"

Ultra-Small Modem

Modern data communication networks employing various forms of multiplexers often require tail-circuit short-haul modems to support local wiring schemes. Many multiplexer manufacturers pack the RS-232 inputs so close that ordinary short-haul modems

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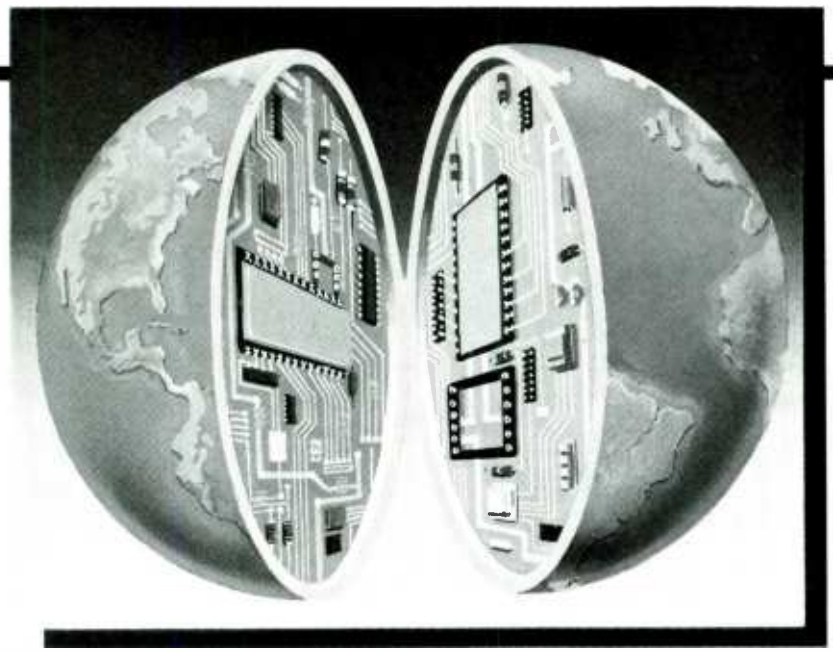
cannot be directly installed. To solve that growing problem Telebyte Technology has introduced the Model 81-140, low profile, short-haul modem.

The Model 81 is a full-duplex, 4-wire (two twisted pair), asynchronous, short-haul modem that operates up to 19,200 baud. At that speed the Model 81 will support link distances of 1 mile; longer distances are accommodated at reduced transmission rates, e.g. 2 miles at 9600 baud.

The Model 81 incorporates a DTE/DCE switch and a male DB-25 con-

(Continued on page 12)



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Today's world is the world of electronics. But to be a part of it, you need the right kind of training, the kind you get from CIE, the kind that can take you to a fast growing career in business, medicine, science, government, aerospace, communications, and more.

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To find out more, mail in the coupon below. Or, if you prefer, call toll-free **1-800-321-2155 (in Ohio, 1-800-523-9109).** We'll send you a copy of CIE's school catalog and a complete package of enrollment information. For your convenience, we'll try to have a representative contact you to answer your questions.

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NEW PRODUCTS

(Continued from page 8)

nector to allow interfacing with both terminals and computers. The Model 81 also "steals" its operating power from the interface to which it is attached.

The thickness of the Model 81-140 has been fixed at 0.7 inches in order that the modems can be mounted on ¾-in. centers. The size of the unit is 3.5 × 2.2 × 0.7-in. The Model 81-140's sell for $68 each. The units are available from Telebyte Technology Inc., 270 E. Pulaski Road, Greenlawn, NY 11740; Tel. 516/423-3232 or 800/835-3298.

Remove Dust From CDs

Compact-disc manufacturers recommend that when compact discs become soiled by fingerprints, dust or dirt they can be wiped with a clean lint-free, soft, dry, cloth. No solvent or abrasive cleaner should ever be used on compact discs.

Wipe-free, a dry, lint-free, antistatic cloth has been developed to clean compact discs according to those exact specifications.

It is a soft, lint-free, untreated cloth that removes both dust and static electricity. Its secret is a unique carbonized

CIRCLE 78 ON FREE INFORMATION CARD

thread woven right into the cloth. The carbon attracts dust and dissipates static as you wipe gently. Wipe-free uses no liquids at all in the disc-cleaning process.

It solves may of the drawbacks of other anti-static products at a fraction of the cost. It contains no silicon or other chemicals, so it will not leave a chemical residue on compact discs or any other surfaces. Wipe-free is not radioactive like some other products.

Most antistatic products are made of brushed fiber which produce lint, but Wipe-free is made of a monofilament, lint-free, nonabrasive material. Its antistatic properties are woven right into the cloth, making it impossible for Wipe-free to lose those properties.

Wipe-free is also perfect for cleaning your records, camera equipment, copying machines, picture frames, computer monitors, TV screens, furniture, and even your finest antiques and collectibles. In fact, Wipe-free is a perfect product for removing duct from virtually any surface.

Further information may be obtained from Argraph Corporation, 111 Asia Place, Carstadt, NJ 07072.

16-Channel UHF Portable

Now there are wideband, frequency-synthesized, two-way, FM portable radios (Model 70-254) that cover up to 30 MHz, at full-rated specifications, without retuning. The E²PROM-controlled portables can be programmed by an authorized technician for up to 16 chan-

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nels from 406 to 430, 450 to 480 or 480 to 512 MHz. Units equipped with the standard rechargeable battery pack are rated at 5 watts RF output, switchable to 2 watts.

They have built-in programmable tone-coded squelch, DTMF signaling and channel scanning capability. Controlled from a front key-panel, the radios can scan 20 channels per second with choice of priority and carrier, CTCSS or open-channel canning. A mode-lock key on the panel keeps the portable configured as the user sets it up. The units have die-cast chassis with metal back-plates and weather-resistant seals.

Options include a 1000-mA-hr battery pack, chargers, a speaker-microphone, belt clips, cases, and a variety of signaling formats.

For more information contact Midland LMR, Marketing Department, 1690 N. Topping, Kansas City, MO 64120; Tel. 800/643-5263 ext. 1690.

Cordless-Phone Interface

Wouldn't it be fun to remotely operate your HF transceiver that's in your ham shack from your living room as you relax watching the evening news? Or how about remotely operating your HF rig while raking leaves or shoveling snow?

MFJ's cordless-phone interface lets you use your cordless phone and the microphone input and speaker output of your transceiver into the MFJ-630 cor-

CIRCLE 80 ON FREE INFORMATION CARD

dless phone interface. Then with your cordless phone you can operate your rig using VOX anywhere within range of your cordless phone.

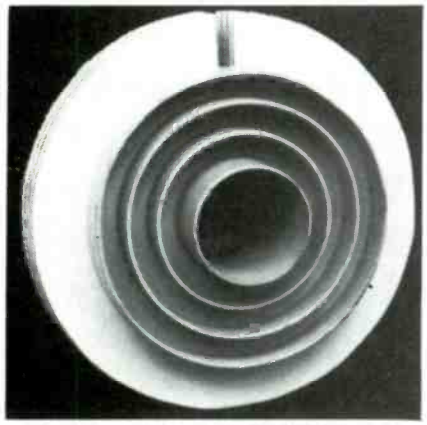
You can have remote operation for your HF transceiver for $39.95 plus $4.00 shipping and handling. For additional information contact MFJ Enterprises, Inc., at PO Box 494, Mississippi State, MS 39762; Tel. 800/647-1800 or 601/323-5869.

Feedhorn TI Reducer

Feedhorn TI reducer, model 6072, helps suppress terrestrial interference that arrives from either the forward or back sector and enters the feedhorn side lobes.

Model 6072 is a ring of special microwave absorber material which rests on the rear of the scalar feedhorn. The ring extends an inch and a half beyond the outer edge of the feedhorn. Model 6072 is custom cut after the customer provides the scalar ring's outside diameter and the outside diameter of the feedhorn throat. A measurement sheet illustrating the dimensions needed is available from the company.

"Bad news! The earth company that made your kit went out of business."



CIRCLE 81 ON FREE INFORMATION CARD

Price is $45 and delivery is two weeks. The feedhorn TI reducer may also be rented for $8 a month. For more information contact Microwave Filter Company, Inc., 6743 Kinne St., E. Syracuse, NY 13057; Tel. 800/448-1666 or collect 315/437-3953 for New York, Hawaii, Alaska, and Canadian residents.

Accurate Soldering System

Two soldering systems that provide accurate temperature control and reliable performance at a cost of less than $75 (suggested list) are now available.

Both units offer variable, closed-loop temperature control over a range of 400°F to 800°F. Easily calibrated at the station without assembly, the CMOS-safe systems are fully grounded from tip to plug and meet military specifications. Temperature stability at idle is less than ±10°F, tip potential is less than 2 mV RMS, and tip-to-ground resistance is less than 2.0 ohms.

Two versions are available to meet different soldering needs. Ungar's *UTC-100* system is equipped with a macro iron for heavier ground planes, while the *UTC-200* unit has a micro iron for fine lead spacings. Both feature burn-resistant cords and replaceable, long-life ceramic heaters.

CIRCLE 82 ON FREE INFORMATION CARD

Available through electronics distributors, the Ungar soldering systems are UL-listed and carry a one-year limited warranty on the power base. For further information, contact Ungar, Division of Eldon Industries, Inc., 100 West Manville Street, Compton, CA 90220; Tel. 213/774-5950; or Eldon Industries of Canada, Inc., 500 Esna Park Drive, Markham, Ontario, Canada L3R 1H5; Tel. 416/475-9407.

Scope With Automatic Setup

The PaceSetters are "smart" oscilloscopes that allow quick, convenient, and accurate measurements. The 2246A offers store/recall that stores up to 20 test setups for later use.

Both oscilloscopes feature auto setup of the front panel. Time/voltage measurements are convenient as well. The 2245A has cursors and a CRT readout for easy reading and measurement of

NEW PRODUCTS

CIRCLE 83 ON FREE INFORMATION CARD

time/voltage data. The 2246A goes one step further with "smart" cursors that automatically follow changes in the voltage, trigger, and ground level of the displayed waveform. That means easy setup of single-shot triggering, peak-voltage and DC measurements.

Both scopes offer 100 MHz capabilities that can make high-speed measurements from four channels, two of which are optimized for logic signals. They have horizontal and vertical accuracy of 2% and a sensitivity of 2 mV for capturing low-level signals.

The 2246A scope provides easy interpretation of burst waveforms via gated voltage measurements. When in the gated mode, the selected portion of the waveform is highlighted and the gated voltage value appears on the CRT with a digital readout.

All measurements on the 2246A are accessed through pop-up menus.

For further information on these products, write Tectronix, PO Box 1700, Beaverton, OR 97077; Tel. 800/TEK-WIDE.

Limited Edition CB

The professional-class 40-channel CB transceiver, model 77-250G, has 24-KT. gold covered knobs and special gold lettering accents on both the radio and the microphone. The limited edition also features new high-intensity amber readouts and an all black, high-tech face..

In addition, an all new transmitter with high-level modulation provides outstanding talk power. A tuned, dual-gate MOSFET, RF amplifier improves signal-to-noise ratio for excellent sensitivity. A highly selective, dual-conversion, superheterodyne receiver with crystal and ceramic filtering offers superb adjacent-channel rejection.

CIRCLE 84 ON FREE INFORMATION CARD

The unit also features ETR frequency control for pinpoint channel accuracy; switchable ANL to eliminate reception background noise; a switchable Dynamic Noise Filter to cut high-level engine noise; seven-stage, multi-colored S/RF/Modulation/SWR electronic metering; variable microphone gain control; variable RF-gain control; an SWR calibration system to monitor antenna performance; instant channel 9 and 19-memory access; and a slide-in, slide-out mounting system with 30° vertical and horizontal adjustment capability.

The Gold Power Max is a limited edition for 1988. Suggested retail price is $279.95. For more information about Midland's Model 77-250G, contact Midland International, Consumer Communications Division, 1690 North Topping, Kansas City, MO 64120.

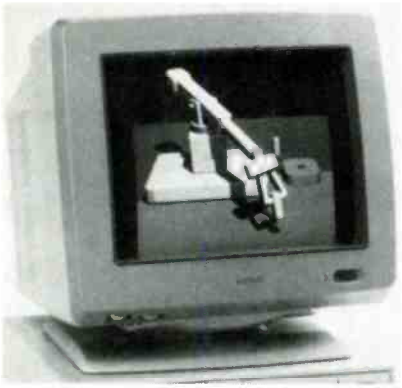
Frequency-Scanning Monitor

Spectrasync 1437 has been designed to fully support the IBM Personal System/2, IBM PC XT/AT and compatibles, and the Apple Macintosh II. High resolution graphics are provided using IBM CGA, EGA, PGC, VGA and MCGA graphic standards. The monitor will accept TTL digital or analog video inputs.

With its 14-in. diagonal, etched nonglare 0.31-mm CRT, the Spectrasync 1437 provides graphics resolution of up to 800 pixels × 600 lines. Seven switchable text colors are available via a combination of three RGB pushbuttons. When all three buttons are in the off mode, a monochrome display with gray shades results.

A mode switch is provided at the rear of the unit for selection of the input from the analog or digital connector. Two video sources from a digital output controller and analog controller can be connected to the monitor and selected by the mode switch. The mode switch allows the choice of a TTL 8-, 16-, or 64-color mode to best suit the installed graphics card.

Suggested retail price for the new Spectrasync 1437 Color Monitor with Fullscreen capability is $849. Suggested retail price for an optional tilt/swivel base is $29. Additional cables



CIRCLE 85 ON FREE INFORMATION CARD

for multiple video or computer installations are $19.

For further information on the Spectrasync 1437, contact Idek America, Inc., 204 S. Olive St., Rolla, MO 65401; Tel. 314/364-7500.

Graphic Equalizer

The Blaupunkt BEA 108E is a seven-band, electronic equalizer with a built-in, four-channel amplifier rated for 25 watts per channel maximum output. The seven-band graphic equalizer uses active electronic circuitry for ±12-dB control of each band with low noise and distortion and a smooth, zero-level frequency response. Band adjustment is by means of a unique touch-sensitive transreflective LCD activation and display panel. Those dual-function devices have color-coded bar-graph displays which indicate the output level of each band.

The BEA 108E has a gain-adjustable, preamp level, subwoofer output that rolls off above 80 Hz. Other features include front/rear fader control, defeatable sensor tone, dimmer switch, eight-

CIRCLE 86 ON FREE INFORMATION CARD

pin IEC preamp input and speaker-level input. Specifications: frequency response, 20–40,000 Hz; distortion less than 0.03% THD; and signal to noise ratio greater than 85 dB.

The BEA 108E carries a suggested retail price of $299.95. For more information contact Blaupunkt, PO Box 4601, North Suburban, IL 60198.

AC-Line Tamer

The PCLT VA sizes are particularly well-suited for protecting file servers for microcomputer networking systems. Typical VA requirements for this application fall into the 750–1200 VA range.

Personal Computer Line Tamers provide complete power conditioning. They remove spikes, transients, common-and transverse-mode noise, provide line isolation, and protect against surges, brownouts and overvoltages.

Output is 120-VAC with wall outlet input ranges from 95–132 VAC with regulation of ±5%. Noise rejection is 120 dB common mode; 60 dB transverse-mode. Spike attenuation is 250:1. All models meet ANSI Std. C62-41 for surge suppression.

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The units have six rear-panel plug receptacles, a six-foot power cord and a front-panel power switch.

Suggested list price for the 800 VA unit is $439 for the 1000 VA unit, $489; and for the 1200 VA unit, $549.

For complete information on Personal Computer Line Tamers, contact Shape Magnetronics, Inc., 901 DuPage Avenue, Lombard, IL 60148; Tel. 800/367-5811. ■

"Well of course, Harry, ZEEBEE4 occasionally makes a mistake or two. After all, it's only human!"

A Science Brief: *By J. Sienkiewicz*

BIGGER THAN A GALAXY

A sky watcher with the aid of computers discovers the largest known structure in the Universe!

AN ASTRONOMER HAS FOUND EVIDENCE that our own Milky Way galaxy is part of a flat, oblong *supercluster complex* that encompasses millions of galaxies and stretches one-tenth the distance across the observable universe. The evidence for the Supercluster Complex, 100 times more massive than any previously known structure, would suggest that, on this immense scale, galaxies are not randomly distributed throughout the cosmos, but are instead clustered in space in a way that is not anticipated by current conventional theories of galaxy formation.

The assumption by astronomers was that galaxies were distributed fairly uniformly in the universe. That prediction was postulated in early versions of the *Big-Bang* theory, whereby the big bang generated matter more than 10-billion years ago, flung out that matter randomly, and that material eventually congealed into stars and galaxies.

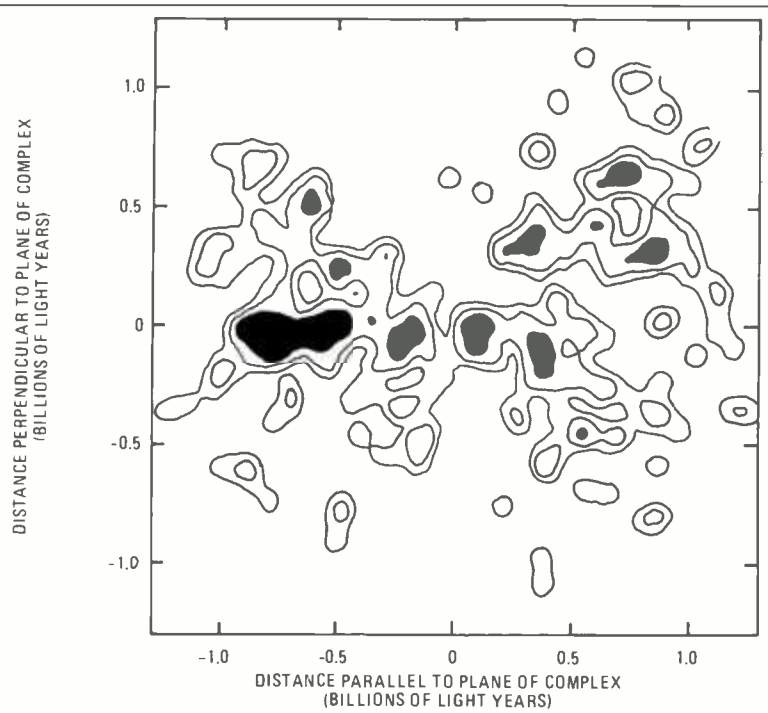
Now, our sky watchers are beginning to see and recognize vast chains of galaxies, celestial structures so extensive and enigmatic that they defy understanding in terms of current cosmology theory.

The Supercluster Complex, an immense conglomeration of galaxies, is about one-billion light-years long and 150-million light-years across, according to its discoverer, Brent Tully of the University of Hawaii's Institute for Astronomy, in Honolulu.

Recently, astronomers have observed that galaxies tend to cluster in filamentary and sheet-like structures. Astronomers have suspected for decades that a large fraction of the brightest, relatively nearby galaxies, along with our own Milky Way, lie in a structure that is flat.

In searching for the edge of that feature, known as the *Local Supercluster*,

(Continued on page 97)

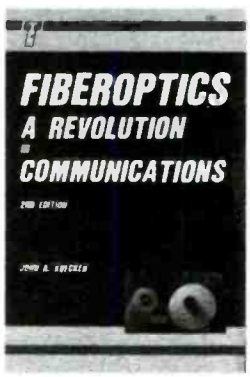


Supercomputer map of galaxy clusters in a spherical portion of the universe centered on planet earth. The black regions aligned horizontally across the center of the map indicate the densest part of the *Pisces Cetus Supercluster Complex*, the largest known structure in the universe. View is edge-on to the plane of the Complex. The wedges emanating from the center indicate regions of the universe obscured by dust in the Milky Way—our home galaxy.

BOOKSHELF

Fiberoptics—A Revolution in Communications—2nd Edition By John A. Kuecken

When the first edition of *Fiberoptics* was written, this exciting high technology showed great promise, but few practical uses had emerged. Now, fiberoptic cable offers such high performance at low cost, and in such a small space, that it is rapidly making conventional, bulky, copper-wire cable obsolete. *Fiberoptics* has been revised and updated to include the very latest information available in this expanding field.



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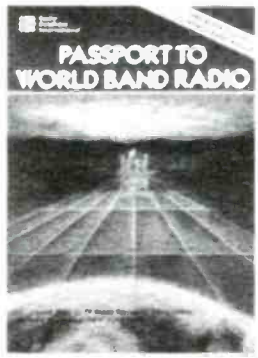
Sophisticated subject matter is conveyed clearly and simply, using many helpful examples and analogies rather than complicated mathematics. The author has also included computer-program listings for the Apple II+, which allow readers to generate models of many concepts such as waves, vectors, and attenuation curves, that are difficult to visualize from the raw math.

Engineers, technicians, electronics hobbyists, and students will find a wealth of information here—on wave propagation, detectors, fiberoptic wave-guiding, speech digitizing, and the new transatlantic fiberoptic cable from AT&T that is revolutionizing international communications.

Fiberoptics—A Revolution in Communications—2nd Edition (order No. 2786) contains 352 pages and sells for $28.95, hardbound only. The book is available from TAB Professional and Reference Books, a Division of TAB Books, Inc., P.O. Box 40, Blue Ridge Summit, PA 17214; or telephone 717/794-2191.

Passport to World Band Radio Edited By Lawrence Magne

New, affordable world-and radios have made tuning in the world as easy as using a Touch-Tone phone. With 1,100 channels and hundreds of stations broadcasting around the clock, finding the right station is a challenge. Unique Worldscan listings in *Passport To World Band Radio* now make it easy to tell what stations can be heard at which times, from the tiniest station in Nepal to the largest broadcasters in Europe.



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In its 400 pages, *Passport To World Band Radio* encompasses a wide variety of information, including: A basic introduction to world-band radio with more than a dozen articles and program tips on getting the most out of the world-band radio listening, a buyer's guide to dozens of high-tech portable and tabletop world-band radios, from $100 to more than $1000, with comparative ratings. The entire world-band radio spectrum is arranged in one handy volume: From *Radio Afghanistan* to England's BBC, from *Radio France* to the *Zimbabwe Broadcasting Corporation*, a con-

venient cross-index of major stations listed alphabetically by country, with *at-a-glance* schedules.

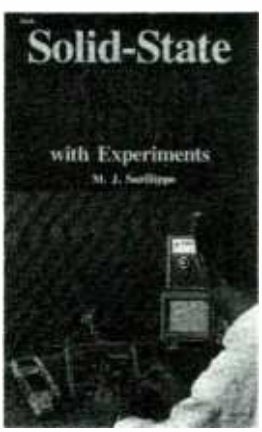
Passport To World Band Radio was prepared by a team of experts, headed by Editor-In-Chief Lawrence Magne.

Passport To World Band Radio is available from bookstores, world-band radio suppliers and the publisher, International Broadcasting Services, Ltd. To order directly, send $14.95 (plus $1.95 for shipping and handling) to: International Broadcasting Services, Ltd., Box 300D, Penn's Park, PA 18943.

Solid-state Electronics Theory with Experiments By M. J. Sanfilippo

Anyone who wants a good introduction to solid-state technology should read *Solid-state Electronics Theory*. Its pragmatic rather than mathematics approach makes it understandable to everyone. The projects at the end of each chapter reinforce concepts and allow readers to experiment with the solid-state applications described in the text by building actual circuits.

Author Sanfilippo presents instruction in semiconductor theory, and describes some simple solid-state devices; such as the PN junction diode and the basic transistor. The author focuses on how to test those devices and design circuits using them. The text is formatted to ensure that readers build a firm understanding of each concept before progressing to more complex topics.



CIRCLE 98 ON FREE INFORMATION CARD

A wide range of subjects are covered in *Solid-state Electronics Theory*, including topics like GaAsFETs, state-of-the-art devices popularly used in high-frequency applications, special-purpose diodes, testing procedures for bipolar transistor devices, techniques for preventing static damage during testing or handling, op-amps, oscillators, and pulse circuits; programmable and switching power supplies, integrated circuits, and much more!

Solid-state Electronics Theory (order No. 2926) contains 336 pages and costs $16.60. It is available from TAB Books, Inc., P.O. Box 40, Blue Ridge Summit, PA 17214, or telephone 717/794-2191.

How to Design Electronic Projects By R.A. Penfold

Information on various standard circuit building blocks is freely available from manufacturers' catalogues, books, and magazines, but there is little information available to the amateur electronics hobbyist on how to combine and integrate the various circuit parts into a complete working project.

CIRCLE 97 ON FREE INFORMATION CARD

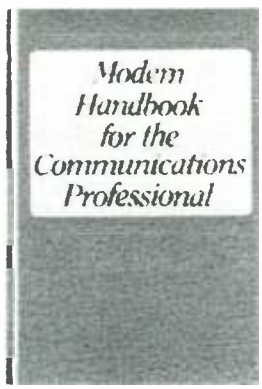
The aim of *How to Design Electronic Projects* is to do just that, by helping the reader put together projects from standard circuit building blocks with the minimum of trial and error, and without resorting to any advanced mathematics. Hints on designing circuit blocks to meet your own special requirements, where no usable stock designs are available, are also included.

The subject is tackled by taking a series of simple practical examples, analyzing exactly what each circuit must do, exploring possible methods of achieving each circuit action, and then working out practical designs including component values. Thus, a number of useful circuits are provided, as well as project design advice.

How to Design Electronic Projects costs $5.75, plus $1.75 (S/H). The book is available from Electronics Technology Today, P.O. Box 240, Massapequa, NY 11762. The text contains 101 pages.

Modem Handbook for the Communications Professional By Cass Lewart

Written by an electrical engineer in the computer and data-communications fields, *Modem Handbook for the Communications Professional* describes and compares features of modems used both in the personal computing and commercial markets. The book addresses both the engineer and the manager by not just listing what is available, but by explaining the significance of each modem feature.



CIRCLE 88 ON FREE INFORMATION CARD

Modem Handbook for the Communications Professional is the ideal self-contained reference guide for managers, supervisors, technical staff members, engineers, and all other communications professionals within its 310 pages.

Modem Handbook for the Communications Professional sells for $34.95, from Elsevier, 52 Vanderbilt Avenue, New York, NY, 10017, or telephone 212/370-5520.

"That was the only way I could get it to scroll."

Now from NRI comes the first course of its kind . . . anywhere!

Learn to use, program, and service today's digital electronic music equipment as you build your own computer-controlled music center

Now NRI puts you at the heart of the most exciting application of digital technology to date! With NRI's new at-home training in Electronic Music Technology, you get hands-on experience with the equipment that's revolutionizing the music industry—Atari ST Series computer with built-in MIDI ports, Casio CZ101 digital synthesizer with advanced MIDI capabilities, and ingenious MIDI software that links computer keyboard to synthesizer keyboard—all yours to train with and keep.

This year, over $1.5 *billion* worth of digital electronic music instruments—keyboards, guitars, drum machines, and related equipment—will be sold in the U.S. alone. Who's buying this new-tech equipment? Not just progressive musicians and professional recording technicians, but also thousands of people who have never touched a musical instrument before. And there's good reason why.

Something called MIDI (Musical Instrument Digital Interface) has suddenly transformed musical instruments into the ultimate computer peripherals . . . and opened up a whole new world of opportunity for the person who knows how to use, program, and service this extraordinary new digital equipment.

Now NRI's breakthrough Electronic Music Technology course puts you at the forefront of this booming new technology with exclusive hands-on training built around a MIDI-equipped computer, MIDI synthesizer, and MIDI software you keep.

Dynamic New Technology Opens Up New Career Opportunities for You

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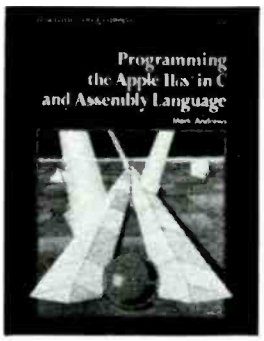
Programming the Apple IIGS in C and Assembly Language
By Mark Andrews

With the help that *Programming the Apple IIGS in C and Assembly Language*, the computer buff can take advantage of the added power, speed, graphics, and sound capabilities of the IIGS—the revolutionary upgrade to the highly successful Apple IIe computer.



CIRCLE 95 ON FREE INFORMATION CARD

The book is the single source for programmers who want to know how to program the Apple IIGS in C and how to integrate assembly language to *supercharge* their programs. The text begins with basic programming and an overall look at the Apple IIGS, and continues with intermediate and advanced programming techniques, complete with useful type-and-run programs.

Topics covered include: Introducing the Apple IIGS, programming in Assembly Language, programming in C, the 65816 microprocessor, architecture of the Apple IIGS, the Apple programmer's workshop C compiler, the Apple IIGS toolbox, Apple IIGS graphics, and Apple IIGS sound synthesizer.

Programming the Apple IIGS in C and Assembly Language (order No. 22599) contains 400 pages and retails for $18.95. It is available at bookstores, computer stores, and electronics distributors, or direct from the publisher, Howard W. Sams & Company, by calling 1-800/428-SAMS

Amplifiers Simplified with 40 Projects
By Delton T. Horn

Virtually every electronics system includes some form of amplifier circuit. *Amplifiers Simplified with 40 Projects* gives the electronics experimenter the practical information needed in order to amplify audio, radio, and video signals. Forty projects and experiments guide readers through the circuits involved with inverting and non-inverting amplifiers, a ceramic cartridge phono amplifier and tape recorder, and high-power amplifiers.

CIRCLE 98 ON FREE INFORMATION CARD

The text discusses problems associated with amplifiers, such as oscillation, distortion and clipping, and noise, along with how to avoid or correct those problems. Finally, voltage-controlled amplifiers and some of the most interesting and important amplifier integrated circuits are considered: the LM380 audio amplifier IC, the LM381 low-noise dual preamplifier, the LM377-379 power amplifiers, the ICL8063 power-transistor driver/RF amplifier, the HA2400 programmable amplifier, RF amplifiers, and video amplifiers.

Amplifiers Simplified with 40 Projects (order No. 2885) has 210 pages and costs $10.60 from TAB Books, Inc., P.O. Box 40, Blue Ridge Summit, PA 17214, or telephone 717/794-2191.

DOS, the Complete Reference
By Kris Jamsat

DOS, the Complete Reference has the answers to *all* of your questions on DOS through version 3.X. Now you don't have to waste computing time over baffling PC-DOS and MS-DOS commands or functions.

This essential resource is for every PC- and MS-DOS user, whether you need an overview of the disk operating system or a reference for advanced programming and disk management techniques.

Each chapter begins with a discussion of specific applications followed by a list of commands used in each. All commands are presented in the same clear, concise format: description, syntax, discussion of arguments or options, and examples.

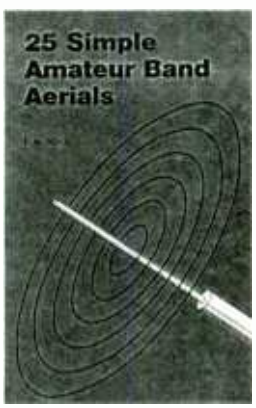
The text provides comprehensive coverage of basic DOS commands, disk management via DOS subdirectories, advanced DOS commands, EDLIN, the DOS line editor, customization of your system via CONFIG.SYS, and Microsoft windows. *DOS, the Complete Reference* includes a complete DOS reference section with DOS syntax charts, and a complete reference section on DOS error messages.

CIRCLE 96 ON FREE INFORMATION CARD

DOS, the Complete Reference has 1046 pages and sells for $24.95. It is available from Osborne/McGraw-Hill, 2600 10th St., Berkeley, CA 94710, or telephone 415/548-2805.

25 Simple Amateur Band Aerials By E. M. Noll

This concise book describes how to build 25 amateur-band aerials (antennas) that are simple and inexpensive to construct, and perform well. The designs start with the simple dipole and proceed to beam, triangle, and even a mini-rhombic made from four TV masts and about 400 feet of wire.



CIRCLE 97 ON FREE INFORMATION CARD

After the aerial discussion in *25 Simple Amateur Band Aerials*, you will find a complete set of dimension tables that will help you to spot an aerial on a particular frequency. Dimensions are given for various style aerials and other data needed for spacing and cutting phasing lengths. Also included are dimensions for the new WARC bands.

Costing $5.00 (plus $1.00 for postage and handling), *25 Simple Amateur Band Aerials* contains 63 pages and is available from Electronics Technology Today, P.O. Box 240, Massapequa, NY, 11762.

Lasers—The Light Fantastic —2nd Edition By Clayton L. Hallmark and Delton T. Horn

Used extensively in medicine, by the armed forces, and in every facet of industry, the laser is one of the most important advances of modern science. Lasers have such a huge range of actual and potential applications, a knowledge of lasers and related devices is crucial to many persons from a variety of fields. *Lasers—The Light Fantastic—2nd Edition* provides the detailed, practical introduction to laser development, theory, hardware, and applications that so many people want.

CIRCLE 98 ON FREE INFORMATION CARD

Author Delton Horn added to the text new, updated chapters on recent technology and more emphasis on laser applications for electronics hobbyists and general science enthusiasts. Readers who want to experiment with lasers will find the guidance they need here—including actual schematic diagrams and information on obtaining the necessary materials at low cost. Safety procedures are also covered, including advice on protective equipment, eye exposure, beam termination, and the biological effects of laser radiation.

For non-technical readers, complete introductory material is provided, ex-

BOOKSHELF

plaining in understandable terms the physics and electromagnetics involved with laser technology and applications. Every kind of laser is explained, from the first ruby laser to gas, injection, and semiconductor lasers. Finally, a handy appendix and useful glossary of terms round out the coverage.

Lasers—The Light Fantastic—2nd Edition (order No. 2905) has 298 pages and sells for $12.60 in paperback form. The book is published by TAB Books, Inc., P.O. Box 40, Blue Ridge Summit, PA 17214, or telephone 717/794-2191.

IBM PC Advanced Troubleshooting and Repair By Robert Brenner

Author Brenner shares his service/repair expertise with readers of his new text, *IBM PC Advanced Troubleshooting and Repair*, and he provides more sophisticated data than his earlier text, the *IBM PC Troubleshooting and Repair Guide*. The new 300-page book compliments the circuit-tested ComputerFact service data with its descriptive text and expanded circuit explanations.

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IBM PC Advanced Troubleshooting and Repair text may be used in courses in microcomputer maintenance and repair, featuring step-by-step troubleshooting methods and detailed circuit descriptions. The text details PC operation and gives instructions on how to use test equipment. Troubleshooting programs help locate failures, while numerous oscilloscope-screen photos and drawings help to identify problems.

Topics covered include: System overview, detailed system operation, troubleshooting techniques, preliminary service checks, and detailed circuit troubleshooting/analysis.

IBM PC Advanced Troubleshooting and Repair (order No. 22590) is published by Howard W. Sams & Company and retails for $24.95. It is available at bookstores, computer stores, and electronics distributors, or direct from the publisher by calling 1-800-428-SAMS.

Using dBASE III Plus By Edward Jones

Osborne top-selling title Using dBASE III has now been revised to include Ashton-Tates powerful upgrade dBASE III Plus. With Author Jones' expertise, you'll be in full command of all the new features this enhanced database software offers. *Using dBASE III Plus* helps you design, create and display a dBASE III

CIRCLE 96 ON FREE INFORMATION CARD

Plus database, devise entry forms with the dBASE III Plus Screen Painter, generate reports, use query files, plug into dBASE III Plus networking, install dBASE III Plus on a hard disk, conduct data searches, and manipulate pull-down menus.

Using dBASE III Plus is a thorough and practical handbook that offers both beginners and experienced dBASE III users essential information needed to master Ashton-Tates software.

Edward Jones is a consultant specializing in microcomputer applications and database design. He has developed customized applications in dBASE for a number of clients including the Lawyer's Committee for Civil Rights, the Edison Electric Institute, and the American Industrial Arts Students' Association.

Using dBASE III Plus is a 516 page book costing $18.95, and is available from Osborne/McGraw-Hill, 2600 10th St., Berkeley, CA 94710. Telephone orders call 415/548-2805. ■

HANDS-ON REPORT

Panasonic Bar-Code Programmable VCR.

The marriage of two technologies takes the hassle out of programming your home video system.

THIS MORNING YOU MAY HAVE PURCHASED a box of chocolate-chip cookies, a box of cubed sugar, and a container of milk. The checkout clerk passed those products over a star-shaped window in the counter top, a beep sounded for each product, and the price for each flashed on an electronic display.

Here, the check-out clerk was using bar-coded grocery items to list the items you purchased with prices, then totalled the prices, and made subtractions from the store's inventory. So what's new? Using the same technology, Panasonic has developed a hand-held, pen-like scanner, which simplifies programming a VCR. The new adaptation of bar-code technology makes programming a video recorder as simple as drawing a line or buying a box of cookies.

Putting Bar Codes to Work

Using the scanner and bar-code sheet, we programmed the Panasonic PV-4722 VCR without any confusion on the very first try. The sheet included with the Panasonic's Bar-code VCR (they have three—the PV-4722, PV-4761 and PV-S4764) offers coded selections for television channel, date, and times. To access that information, and load it into the VCR's program memory, we draw an invisible line over the corresponding codes with the scanner. A tone sounds as each code is registered.

After the appropriate time on, time off, channel, and date have been selected, the information is transferred directly to the VCR by pointing the scanner at the deck and pressing the transmit button. The recorder receives the information and sounds a set of tones for confirmation.

The viewer also gets visual confirmation as the list of all programs to be recorded—up to a maximum of eight selections—can be viewed directly on the full-screen television display.

While the quickness and simplicity of bar-code video technology will benefit all VCR users, consumers who have not been able to program their home decks will find bar coding especially helpful. Senior citizens and children are two groups that are sure to find the new bar-code technology particularly beneficial.

How It Took Off!

The inspiration for joining bar codes and video came several years ago at a consumer electronics trade show. Anthony Jasionowski, Manager, Matsushita Technology Center, noticed the display of a child's educational toy which took advantage of bar codes. The toy had a very simple, low-cost, bar-code reader, and he was impressed that even a child could use it. From there, his idea went up the corporate ladder and came down as a product with bar-code programming incorporated in a VCR.

Here is the Panasonic PV-4722 Bar-Code Programmable VCR, its remote control, and Bar-Code scanner. Two other Panasonic models are step-up units that include additional features at increased price.

Programming their VCR to record favorite shows is easy for this mother and daughter, because they're using a Panasonic Bar Code programmable home video deck. With a pen-like scanner, function sheet and their Bar Code VCR, programming is as simple as drawing a line. With the whisk of a scanner over a bar-code sheet, Panasonic has made programming a VCR a goof-proof process.

That technological breakthrough, the *Interleaved 2 of 5 Bar Code* system, is fast becoming the industry standard. Currently, Magnavox, Cannon, and Panasonic's American sister company, Quasar, market products using that bar-code system.

Bar-code programmable VCRs entered the Japanese consumer market in the fall of 1986, and those decks now enjoy tremendous popularity there. Panasonic introduced its first bar-code model, the PV-4722, to American consumers in the second half of 1987. Two additional decks, the PV-4761 and the S-VHS (super-VHS) format PV-S4764, became available near year's end.

Bar-code programming moved into the video mainstream, when *Cable Guide* magazine introduced an Editor's Choice page of movie listings, which included a bar code adjacent to each selection. Readers had only to scan the codes directly from the pages of *Cable Guide* to program their VCRs.

More on the PV-4722

Along with bar-code programming, the PV-4722 features Panasonic's newly designed *Hi-Tech 4* double-azimuth configuration, four-head system.

The HI-Tech 4 sampling method reads twice as much information as previous Panasonic four-head systems. With its *double-fine slow* feature, every field of information is read, as opposed to every other field, so the stepping effect is eliminated from slow motion.

The PV-4722 also offers *on-screen display* for programming confirmation. When a specific operation mode is selected, it automatically appears on the television screen. On-screen display can also recall the current time, tape-speed/counter, and current operation with the touch of the FUNCTION MODE DISPLAY button.

The PV-4722's *omnisearch* function offers playback speed of 7× in the SP (Standard Play) mode and 21× in the SLP (Super Long Play—400-line horizontal resolution) mode. With *search lock*, an extra-quick search can be maintained until a particular scene is located. The suggested retail price for the PV-4722 is $525.00. For more information on the Panasonic PV-4722 featuring bar coding, circle No. 40 on the Free Information Card.

How good is the Panasonic PV-4722 Bar Code video deck? Without the bar-code feature, the VCR is a quality component worthy of consideration for purchase. With the bar-code feature tossed in, the PV-4722 is a winner. Once you have used it for programming, you'll wonder how you ever got along without it! ■

Hands·on Electronics®
APRIL 1988

RACING WITH THE SUN

The source of all Earthly power provides the drive for the world's solar-powered distance and speed record holder—Sunraycer.

By Philip McKnight

THE GREEN FLAG DROPPED AND the world's first solar-powered automobile race was on! Grand adventure and high technology characterized the Pentax World Solar Challenge for some 25 teams from seven nations. The starter's flag began the 1,950-mile race across the continent of Australia last November, sending the solar-powered cars down Stuart Highway.

Racing cars powered solely and directly from the sun's energy were in a race that lasted six days—a severe test of the technology, talents, and stamina of drivers, crews, designers, and engineers. The race course runs from Darwin on Australia's north coast to Adelaide on the south, through a range of extreme climate, terrain, and road conditions. A well known, world-class entry, General Motors' *Sunraycer*, took the lead and went the distance, never to be overtaken, as it sped to the checkered flag. At the race's end, the nearest competitor was 600 miles behind, as Sunraycer crossed the finish line near Adelaide, South Australia around 11:30 A.M., Friday, November 6 1987.

More Than a Race

General Motors and most other competitors entered the race as a practical technical project, to develop and demonstrate technology in lightweight structures and materials, low-speed aerodynamics, high-efficiency batteries, lightweight motors, and power electronics, as well as solar cells and panels, and many other technical considerations. After all, the solar-powered family car of the future may spawn from that race.

What a Car!

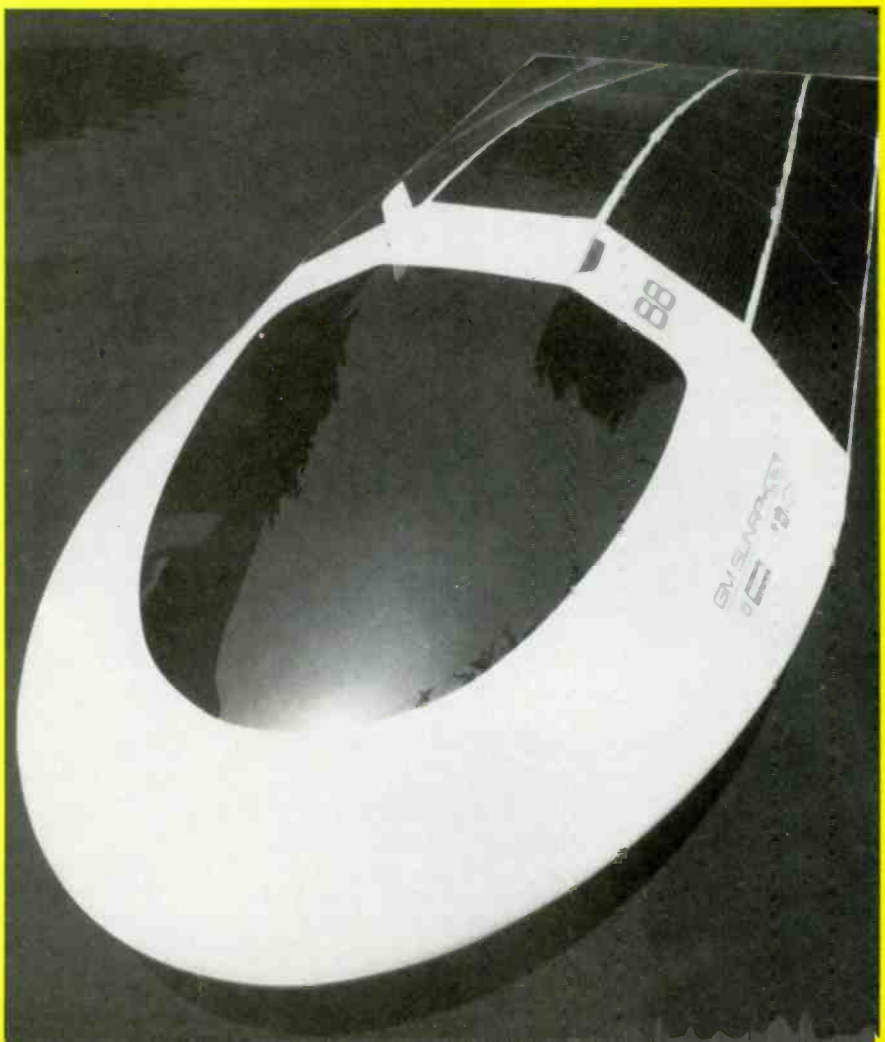
The Sunraycer, a one-seat, four-wheeled vehicle designed and built especially for the Australian transcontinental race, derives its drive power from 7,200 solar cells mounted on 90 square-feet of the car's aerodynamically-engineered, domed surface.

Electrical energy from the solar cells flows to a special high-efficiency Magnequench electric motor designed by GM Research Laboratories, and to rechargeable silver zinc batteries used for supplemental power. The electrical motor powers the left rear wheel through a chain drive.

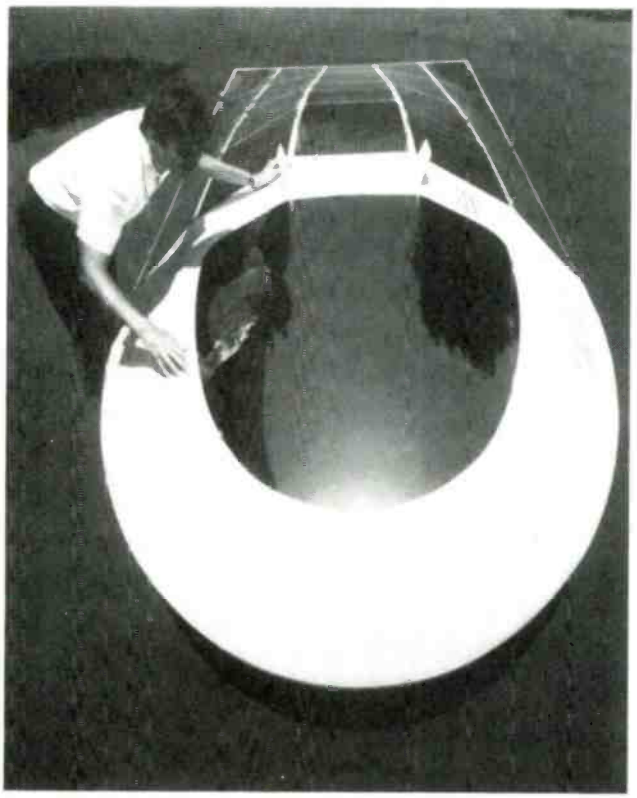
The vehicle weighs 360 pounds, and will race at a gross weight of 547 pounds, including the driver's weight ballasted to 187 pounds according to race rules. It is 19.7-feet long, 6.6-feet wide, and 3.3-feet high. The Sunraycer is built on an aluminum-tube space-frame, with a body of lightweight, honeycombed, sandwich material, and runs on 17-inch bicycle-type tires.

Its teardrop shape and special design features give it extremely low aerodynamic drag and good stability in cross winds. The Sunraycer's canopy is gold plated to reflect 90 percent of visible light and 98 percent of infrared radiation. That keeps its cockpit within a few degrees of the outside temperature when the race runs through areas of very-hot climate.

Because the race is run on Australia's Stuart Highway, a two-lane asphalt road, the Sunraycer complies with international vehicle regulations. It is reg-



istered in California with license number "GM SUN 88." The plate will be fitted inside a clear plastic aerodynamic fin located on the underside of the trailing edge of the car. The number 88 was chosen because: 1988 is Australia's bi-centennial year, and 1988 is GM's 80th anniversary.



A racer's view of the Sunraycer. Dr. Alex Brooks, one of the many contributing designers of the car, inspects the gold-plated canopy that reflects 98% of the sun's unwanted heat.

The Race

Competitors race from precisely 8 A.M. to 5 P.M. each day, camping overnight wherever they find themselves at the end of the day's run. Each team was required to be self-sufficient, carrying in its support vehicles all of the food, water, camping gear, and maintenance equipment it will need through the race.

The 1,950-mile race across the barren continent began on November 1 in Darwin on the North Coast with the racing teams from competitors, which included Ford, Volvo, and Mitsubishi, who entered or partially sponsored solar-powered vehicles. Other vehicle sponsors ranged from Australian Geographic, the Massachusetts Institute of Technology (M.I.T.) in Cambridge, MA, and Crowder College in Missouri.

A loser's view of the Sunraycer "easing on down the road." Two protuberances on top give it an "out-of-space" appearance, but they serve to stabilized the racer in strong cross winds.

The vehicle performed flawlessly over its six-day trek through the middle of the Australian Outback with tire changes representing the only delay in its winning effort. The vehicle achieved an average race speed of approximately 40 *mph* for the five and one-half day journey.

The Pentax World Solar Challenge is organized by Energy Promotions, an Australian organization. The winner receives a special trophy, but there are no cash awards.

Aerodynamics

Designed by a team of engineers from AeroVironment, Inc., and General Motors, the aerodynamics of Sunraycer give it a teardrop shape. The goal has been to achieve extremely low aerodynamic drag, with low side forces during cross winds, while still providing a suitable surface for the solar cells, and adequate space for the driver.

The shape was refined by use of an advanced computer program called VSAERO, developed by the National Aeronautics and Space Administration (NASA). The car's final configuration minimizes overall up or down aerodynamic forces on the Sunraycer at high speeds. Tests of a one-quarter scale model at the 10-foot GALCIT wind tunnel at California Institute of Technology (Caltech) exhibited the lowest drag coefficient ever measured at Caltech for a road vehicle.

Prior to the first racing outing of the Sunraycer in GM's quest to enter the *Guiness Book of Records*, the car was unveiled to the press by GM Chairman of the Board Roger B. Smith at the GM Technical Center in Warren, MI. Driver Molly Brennen handles the controls in the Sunraycer's cockpit during the demonstration. On September 17, 1987 she set a new land record for solar powered vehicles at 35.22 *mph*.

Results of the wind-tunnel tests on the vehicle helped the team to fine tune the aerodynamics with the addition of a small vertical fin, called a *strake*. Mounted on top of the vehicle just above the driver's head, the strake helps keep the car on the road by reducing upward lift in a cross wind. Six ventral fins located under the rear edge of the vehicle also reduce the effect of cross winds on vehicle stability and control.

Aerodynamics was also a consideration in designing the wheels for the vehicle. To reduce aerodynamic drag the spokes are covered with plastic disks.

Light-Weight Structure

The chassis of the Sunraycer is a welded aluminum-tube spaceframe. A spaceframe is like a cage and is inherently lightweight. The chassis frame weighs 15 pounds, yet it supports a vehicle weighing 547 pounds, including a driver, electric motor, solar panel, batteries, and electronic components. Many recent types of race cars use spaceframe construction.

The body is made like a sandwich of Kevlar/Nomex/Kevlar. The center portion of the sandwich (made of Nomex) looks like a slice of honeycomb. The honeycomb structure gives the body great strength and rigidity with very low weight (3 ounces per square foot).

With temperatures reaching 120-degrees Fahrenheit, the gold-plated canopy plays a vital role in protecting the driver from the intense radiation of the Australian sun. Since the car is only driven during the day, the 10 percent of visible light available to the driver is sufficient. By blocking the infrared rays, the canopy helps to keep the driver relatively cool and therefore, allows him or her to remain in the car longer, requiring fewer stops. Unlike your family wheels, this auto has no air conditioning.

Even the seat is designed to keep the driver cool. Made like a sling or hammock, the nylon mesh allows air to circulate around the driver, helping to remove excess heat from the driver's body. Like the driver and passenger safety restraints in your car, the driver is held securely in place by a lap belt as well as shoulder and leg harnesses that are attached to the frame of the car. Safety is an important factor even in medium-speed races with relatively low-traffic density on the Australian highway.

Scientists using computer-aided-design (CAD) technology resort to space age computer programs to design the Sunraycer's teardrop shell. Their design achieved an extremely low aerodynamic drag, with low side forces during cross winds, while providing a large surface for the solar cells and space for the driver.

Technicians prepare to position and shape the composite honeycomb material (Nomex—a DuPont product) used in body construction of the Sunraycer's 19.7-feet long, 6.6-feet wide, and 3.3-feet high outer shell. The honeycomb structure gives the body strength and rigidity, and weighs only 3 ounces per square foot.

Solar Array

The source of power for all the Solar Challenge racers is, of course, the sun. Sunraycer uses 7,200 of the K7 solar cells built by Hughes Aircraft Company's Spectrolab subsidiary. They're the same type cells used on Hughes-built communications satellites, such as the AUSSAT satellite for Australia. Each cell, measuring 2 by 6 centimeters and .2 millimeters thick (about the thickness of a business card), has a nominal efficiency of 16.5 percent in converting the sun's rays to electricity.

Hughes' Space and Communications Group designed and built the curved solar array, which is 2 by 4 meters. The cells are connected in series and arranged in 20 strings of 360 cells each. Although the intensity of the sun's rays and the temperature of the environment affect the output, the panel typically operates at 150 volts, providing 1,000 watts of peak electrical power at noon.

Batteries

An indirect source of power is the batteries. Sunraycer uses 68 rechargeable silver-zinc cells, each providing 1.5 volts and 25 ampere-hours, producing a total of 120 volts. The batteries were designed and assembled by Hughes' Space and Communications Group. At a total weigh of 60 pounds, which is one-fifth the weight of a lead-acid battery with the same capacity, the silver-zinc cells can operate at high temperatures. And at high rates of charging, they have an energy recovery efficiency of 75 percent.

Battery power is used early and late in the day to supplement the reduced solar power available during those times. The batteries are recharged by the solar panel during the two-hour periods just after sunrise and before sunset. The batteries can also be used to provide additional short-term power for acceleration and for hill climbing.

Power Electronics

Connecting the solar array to the batteries are the peak-power *trackers*. The trackers are custom-built direct-current-to-direct-current converters that optimize the voltage level on the solar array for maximum power. Each peak-power tracker is connected to two parallel strings of solar cells and delivers the maximum available solar power to the battery.

Ten trackers are needed for the entire array. The use of multiple trackers allows the solar array to be curved for better aerodynamics without losing solar power. Each peak-power tracker weights 10 ounces and has an efficiency rating of 98.4 percent.

Connecting the power source to the accelerator and DC motor are the motor-drive electronics. Those circuits allow the driver to select cruise control, charge and discharge the battery, and provide automatic regenerative braking, which allows the drive motor to run as a generator and feed power back to the battery, thus slowing the car.

The motor-drive electronics controlled delivery of pulsed DC current to the commutatorless motor provides the desired torque output. The system is a three-phase, pulse-width modulated, motor-drive circuit. Twenty power MOSFETs (metal-oxide, silicon, field-effect transistors) are used in each of the three phases, giving an efficiency of 98 percent.

The Magnequench Motor

Sunraycer was powered by a new electric motor, especially designed to be powered by the solar cells in the vehicle. Using recently-developed super-strength, rare earth, iron-based permanent magnets, called Magnequench III, the motor's efficiency rating was stepped up to 92 percent, which is about 30 to 40 percent more efficient than comparable-sized, commercially-available electric motors.

The specs on the motor are impressive: weight, 8.1 pounds; power, 2 horsepower continuously at 4,000 *rpm*. At the end of Sunraycer's power train is a chain drive connecting the motor to the left rear wheel with a 4:1 ratio. The motor design offered high-torque capability for short periods. That's important to the Sunraycer for pulling off the shoulder of a road or in hill-climbing.

A critical construction step was to bond the solar cells to the Sunraycer's body. 7,200 solar cells are mounted on 90 square feet of the aerodynamic, domed surface.The work was performed at Hughes Aircraft Co. facilities in California.

FACTS ON THE PENTAX WORLD SOLAR CHALLENGER

The Pentax World Solar Challenger is the first international race across a continent for solar-powered cars. Twenty-five cars entered, from seven nations. All vehicles are powered entirely by the sun. Storage batteries can be used, but charged only by the vehicle's on-board solar system.

The race course runs from Darwin to Adelaide; 1,950 miles from the top of the Australian continent to the bottom. The race started on November 1, 1987. The course traverses a wide range of extreme climate, terrain, and road conditions such that the conditions would not be advantageous to one type of car.

Contestants race exactly nine hours each day. Each team must be completely self-sufficient and carry all supplies for its vehicles and crew. The drivers camp overnight wherever their vehicle stops that evening.

Some of the Magnequench motor features are revolutionary. In part, the high efficiency is due to the DC motor not having any brushes, hence the absence of the attending friction and electrical power loss at a commutator due to heating and arcing.

We know that opposite poles of magnets attract and like poles repel, thus goes the armature round; but to do it more efficiently, new designs are required. The Magnequench motor has larger pole areas (arcuates), more flux, less current eddies; therefore, less power loss due to excessive currents in the motor. Stationary outside-the-shell windings are better cooled, thereby reducing internal resistance. Special low-friction bearings from GM's New Departure Hyatt Division were equally important in conserving energy for productive work.

Flat steel laminations found in transformers and motor magnetic cores reduce the eddie currents that are induced by the surrounding windings. GM developed special thin laminations to reduce such iron magnetization loss.

The motor's high-power density (horse-power per unit weight) was kept low by the motor's light weight. The motor design was optimized using computer programs developed at GM's Research Laboratories. One simple weight-saving innovation was hollow-shaft construction—weight reduction with no loss of shaft strength.

The Making of Magnequench Magnets

Named after the processing technology, which instantly cools (quenches) a stream of molten metal contacting a spinning wheel in an oxygen-free environment, *Magnequench* combines basic elements neodymium, iron, and boron into an unusual alloy. Quenched at the decreasing rate of one-million degrees centigrade per second, the rapid solidification process creates magnetic metallic ribbon-flakes in the first step of a patented process as unique as the product itself.

Depending on subsequent processing, magnetic properties ranging two to ten times greater than similar ferrite magnets are possible. That enables engineers and designers to reduce the size and weight of any device powered by an electric motor made with Magnequench magnets.

The Race Before the Race

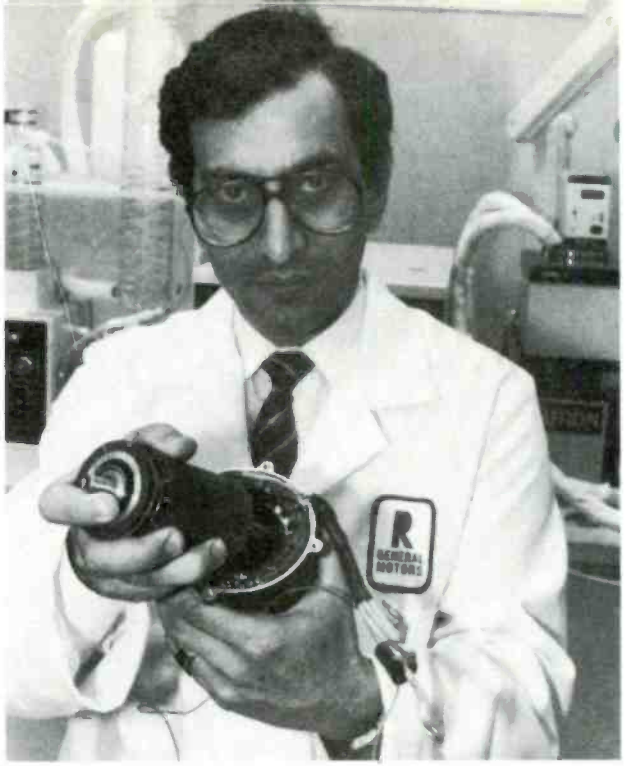
Prior to September 17, 1987 and the Downunder Australian

race, the *Guinness Book of World Records* listed the world speed record for a solar-powered vehicle at 24.74 *mph*. The book states, "The highest speed attained under IHPVA (International Human Powered Vehicle Association) rules by a solely solar-powered vehicle is 24.74 *mph* at Bellflower, California on July 1, 1984 by *Sunrunner*, designed by Joel Davidson and Greg Johanson of Photovoltaic Power Systems."

Sunraycer went after that record, and on that eventful Thursday at the GM Desert Proving Ground in Mesa, Arizona, it entered the record book!

The Proving Ground's five-mile circular test track is designed to cancel out variances in wind and minute elevation changes that can be used to advantage in record runs. Sunraycer made a flying start and crossed the start line at nearly full solar speed. It drove around the full five-mile circle several times, ending its run at the starting line.

Sunraycer established a new world speed record of 35.22 miles per hour for a land vehicle powered solely by direct energy from the sun. The record was set under cloudy conditions permitting only about one-half of the normal sun power. The record was certified by the United States Auto Club and the International Human Powered Vehicle Association. No batteries were used to set that record for direct solar power. Sunraycer can attain higher speeds when its solar-charged batteries are used for supplemental power.



Dr. Nady Boules holds the very-efficient Magnequench DC motor that powers the Sunraycer. Designed by GM Research Laboratories in Warren, MI, the mighty motor weighs only 8.1 pounds and delivers 2 horsepower continuously at 4,000 *rpm*.

To get into the *Guinness Book of World Records*, the United States Auto Club (USAC) and the International Human Powered Vehicle Association (IHPVA) sanctioned and certified the speed for each lap run, and certified other test conditions, including the track and the vehicle. Record run documentation will then be submitted to the *Guinness Book of World Records*.

A Word From the Chairman of the Board

GM's Chairman Roger B. Smith says Sunraycer "is a prime example of how General Motors is using teamwork and leading-edge technology to prepare for success in the ultra-competitive international marketplace." He described the World Solar Challenge as "one lap in the race to create the future."

"I am extremely proud of the GM people involved in this project, for their commitment and ability to apply disciplines from many different areas to create a winning team effort," said Mr. Smith. "This victory is yet another example of how GM teamwork and technology are multiplying the power of people to create even better GM cars and trucks of the future."

A leading force in the development of the Sunraycer project is the Hughes Aircraft Company, a subsidiary of GM Hughes Electronics Company. The Hughes people were responsible for the solar cells, solar panel, and batteries in the Sunraycer, and their working expertise in areas like microelectronics, optics, materials science and communications, will have an equally positive effect on future GM products.

Several other GM divisions played key roles in the Sunraycer's success. The General Motors Research Laboratories built the drive motor, using revolutionary high-efficiency Magnaquench magnets from Delco Remy.

(Continued on page 106)

INSIDE THE GM SUNRAYCER

The GM Sunraycer is a one-seat racing car designed and built specifically for this event by a General Motors team. Its dimensions are: 19.7-feet long, 6.6-feet wide, and 3.3-feet high. The car weighs 360 pounds; the gross weight with driver is 547 pounds. The dimensions are limited by race regulations. The estimated top speed is more than 45 miles-per-hour under pure solar power, and more than 60 miles-per hour with on-board battery.

The car's construction consists of aluminum tube spaceframe very much like that used in aircraft and a body of light-weight honeycomb sandwich materials. A solar array nestles on its top surface covering an area of 90 square feet with 7,200 solar cells; same type as used in communications satellites.

The solar array produces 150-volts DC at 1-kilowatt peak power. The storage batteries are silver-zinc type with 68 cells with 25 ampere-hours each, providing a voltage of 120-volts DC. The weight is 60 pounds.

The DC motor is a 1.5-kilowatt, 2-HP Magnequench brushless device that weighs 8.1 pounds.

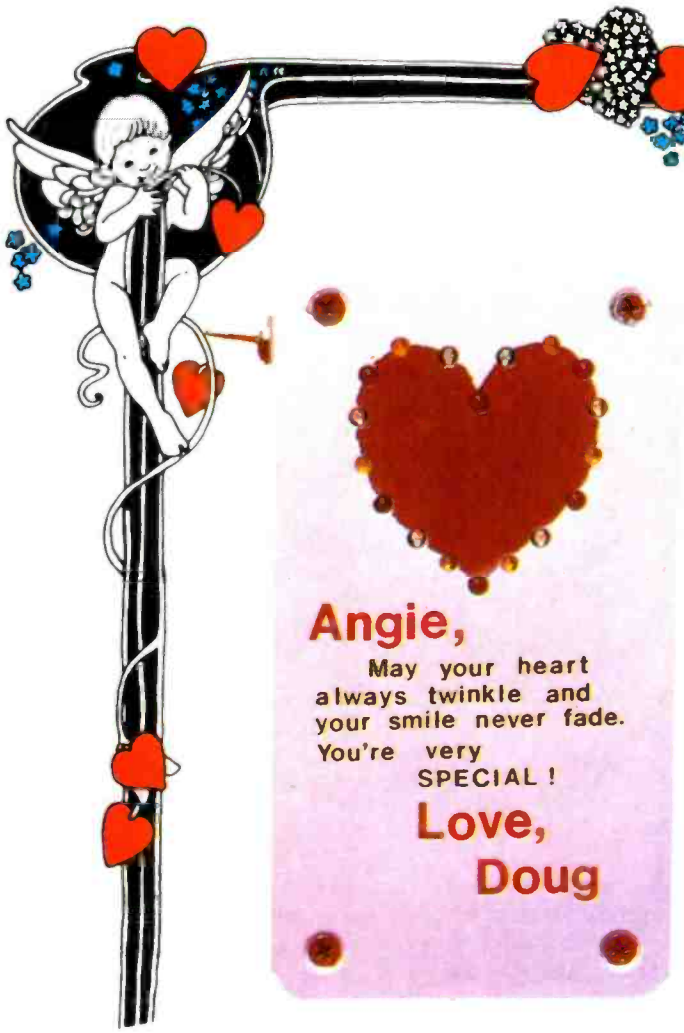
The tires are a throwback to the era of the brothers Wright. Bicycle-like in appearance, they have an external diameter of 17 inches and are 1-inch wide. Tire pressure is 90 psi. The spokes are covered by plastic discs to reduce aerodynamic drag.

The chassis is aluminum-tube frame with MacPherson struts in suspension in front and trailing arms in the rear.

Brakes consist of a primary system that is regenerative— energy is converted to electricity to charge the batteries. The secondary system is the common goof-proof hydraulic disk brakes on the front wheels. An emergency brake system uses a mechanical disk brake on right rear wheel.

Bicycle-type tires are 17-in. outside diameter by 1-in. and inflated to 90 psi.

Power drive performance: 0 to 40 *mph* in 20 seconds, maximum speed using the solar cells only— 45+ *mph*; maximum speed using solar cells and batteries—60+ *mph*. ■



THE ELECTRONIC GIFT

Brighten someone's life with this sweetheart of a project. It's easy to build for any holiday and keeps giving long afterward

By Douglas E. Pope

HERE'S AN ELECTRONIC PROJECT THAT IS RELATIVELY easy to build, allows the builder to be as creative as he wants to be, is fairly inexpensive, uses few components, and is fun to give to that "special someone". The heart of the circuit is a 74C925 four-digit counter with a seven-segment output driver. It is the most expensive component in the circuit, but it can be obtained for less than ten dollars from either Digi-Key Electronics or from Sintec Electronics.

The Driver

The design theory behind this circuit is a circuit that will drive a simple 7-segment LED display, and allow the display to count from one to nine continuously as long as power is applied to the circuit. But, instead of using a typical LED display, each of the seven segments is replaced with a T-1-¾ or a T-1 light-emitting diode (LED).

That enables us to arrange the LEDs in any shape or fashion we desire. Arrange them to create a heart (as shown), a Christmas tree, a fireworks display, a name or logo, or anything else that you can imagine. You are, however, limited to the number of LEDs that you may use. Using too many will cause an excessive drain on the power supply (9-volt battery) and, in certain instances, may cause the integrated circuits to burn out or overheat under the extra load.

In General

The project uses eighteen LEDs and does so without any complications. My "special someone," Angie, has put the electronic gift through countless hours of operation on the same battery that I installed upon its completion. So, if at all possible, stick to the same number of components as outlined.

Another limitation to be considered is the size of your project box. It must be large enough to accommodate the battery, circuit board, and the design of LEDs you create. The size of the project box that I used for this particular project sufficient room on the front for the heart design (which is about 1½" wide at the top) and the message I placed below the heart design, and of course provided space for the internal components.

The Counter

Let's start with the circuit itself. Layout is not critical. Figure 1 shows the lay-out that I used and it will yield a fairly compact board. You can, however, "breadboard" this project or design your own printed circuit board (PCB); whichever you prefer.

The main component, the 74C925 counter IC, is basically eight old-style ICs rolled into one package. It performs the job of four BCD (*B*inary *C*oded *D*ecimal) counter ICs and four BCD to seven segment driver/decoder ICs. In more common applications it would be used to drive a four-digit LED display.

Note that the 74C925 counter IC is a CMOS type integrated circuit and therefore it should be handled carefully. CMOS-type integrated circuits can be damaged by static electricity and/or improper soldering. By keeping the IC in conductive foam until it is soldered on to the PC board, and

by using a low-wattage soldering iron, you can usually ensure that the component will not be damaged while you construct your project.

The Timer

The other integrated circuit, U2, is an NE555 timer IC. It is connected to function as an astable timer, and will supply a continuous train of pulses to the counter IC, U1, as long as power is supplied to the circuit. The NE555 timer IC is a linear IC and, unlike U1, it does not require the special handling as do CMOS type ICs. A low-wattage soldering iron and reasonable handling are still recommended, though.

The frequency (or rate) at which the pulses are output from U2 is controlled by the potentiometer, R2. Varying the setting of R2 will cause LEDs 1–18 to flash at a faster or slower rate according to how it is adjusted.

Integrated circuit U1 has outputs for what would normally be the common outputs for the "one's," "ten's," "hundred's." and "thousands's" positions on a 4-digit LED display. Only one of those outputs are utilized in this circuit.

Connecting the base of Q1 to pin ten (the "one's" position display output) instead of pin nine on U1 will will allow faster flash rates.

In building the project as it is shown, you will use C1 as common for all eighteen LEDs, but you may modify the design and use C1 as common on a portion of the LEDs and use the conditioned output from pin 9 as a common on the remainder of LEDs. That will result in some of the LEDs flashing at a fast rate than the others.

The lettering really makes this project. Using transfers is quick and easy, but make sure the letters are well aligned.

LED Hook Up

By now, you're probably wondering how the eighteen LEDs were hooked-up to only seven outputs (A1–A7). Line A7 is not connected and A1 through A6 each have three LEDs wired in parallel to them, for a total of eighteen anode connections ($3 \times 6 = 18$). You may decide, however, to wire A1 through A6 to one LED each and then wire the remaining twelve LEDs in parallel to A7, or you can use any of numerous combinations to obtain various effects. Just remember to always wire the LEDs in parallel when you have two or more attached to the same output. Again, experimentation is the best way to find out which hook-up yields the flash and sequence pattern you desire. Figure 2 shows the hook-up arrangement that I used and you may use that fashion of wiring to simplify the construction of your project, or as a starting point if you wish to experiment.

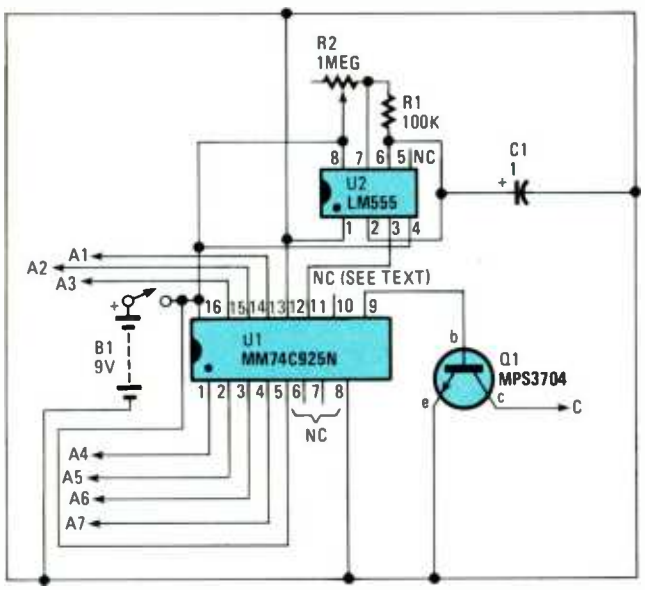


Fig. 1—The Arrows marked A1–A6 go to the anodes for the diodes in Fig. 1. Anode seven is not used in this project, but you may use it if you wish. Pin 10 can be connected to its own transistor, like pin 9, for slower flash rate.

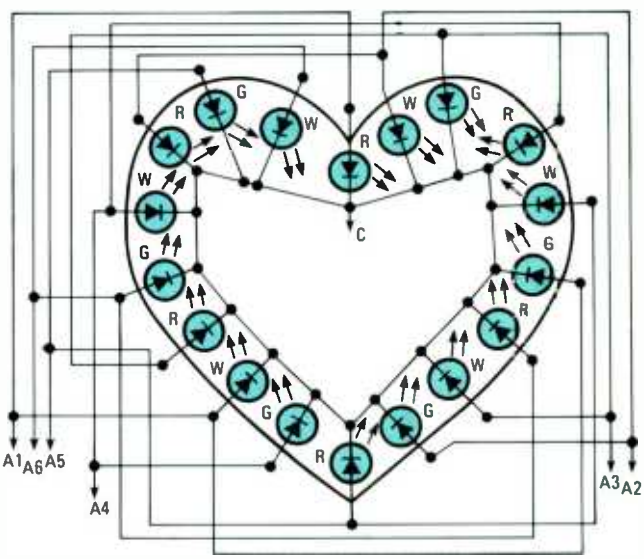
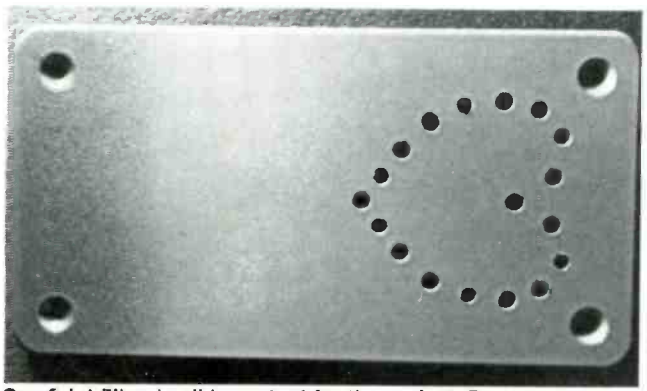


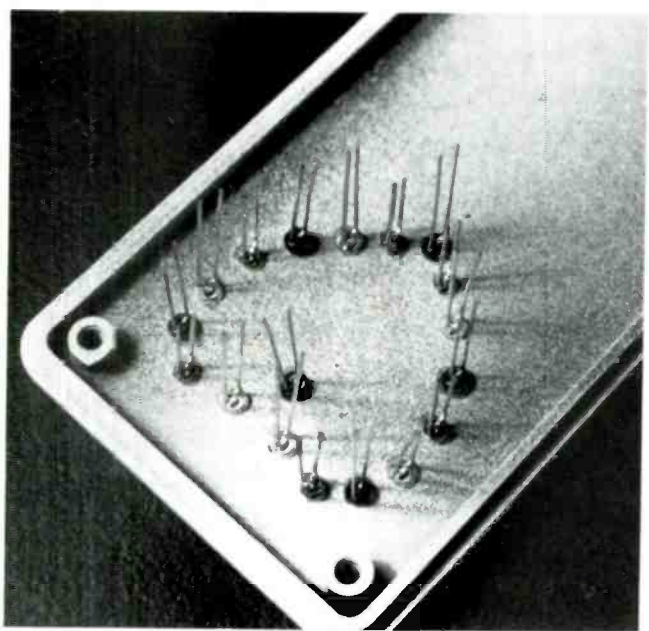
Fig. 2—Anode bus connections A1–A6 run to the connections in Fig. 1. The light-emitting diodes are denoted R for red, G for amber, and W for red with a clear lens.

Artwork

Now that we've covered the circuit, let's discuss the artwork and lettering on the outside of the project box. The first step is to mark and drill the holes for the on/off switch (S1) and the LEDs. Start by drawing your design on a piece of paper. Draw it the same size as it will be on your project box. Mark the desired locations of all LEDs on the paper and cut out the design. Tape the cut out design to the project box in the proper location. Select the correct size drill bit(s) and drill out the holes for the LEDs. After all holes are drilled, test fit the LEDs and the switch. If all holes are properly drilled, remove the switch and LEDs and lay them aside.



Careful drilling is all important for the project. Be sure to carefully remove all burs from the face before painting.



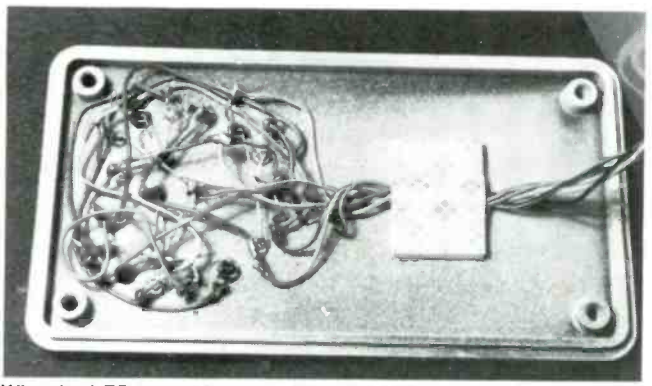
The LEDs can be held in place with epoxy, but be sure you get none on the lens or cover. placing all the anodes on the outside is a good way to keep from wiring them wrong.

Now you are ready to apply the first coat of paint. In the project I constructed, the design on the front of the project box and the cover screws were painted red and set aside to dry. The main part of the box was painted white and also set aside to dry. The paper cut-out of the design was transferred to a piece of wide masking tape. The design was then cut out of the masking tape to form a painting mask for the next step.

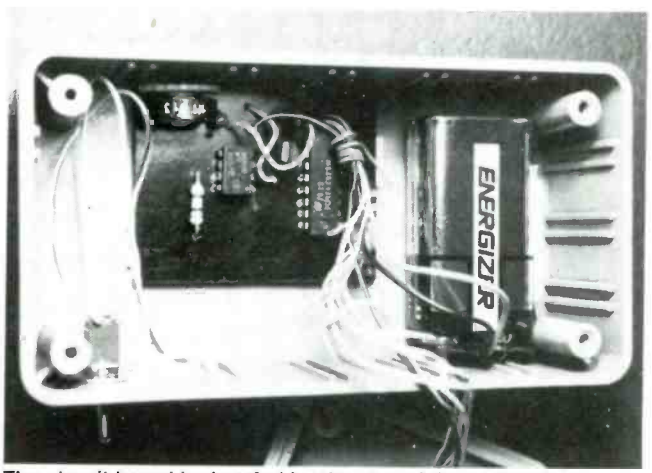
After the cover was thoroughly dry, the mask was applied inside of the outline formed by the holes that were previously drilled for the LEDs. The cover was then painted a second time with white spray paint and allowed to dry. After the cover had dried, the masking tape was removed; leaving red under the masking tape from the first coat of paint that was applied to the cover. That is how the red heart on a white background was obtained.

The Lettering

Next, the lettering was applied. The letters are dry, rub-on transfers that can be obtained at most office-supply stores. Various sizes, colors, and type styles are available. The lettering was applied below the heart design to form a message. Upon completion of the lettering, a coat of clear acrylic spray was applied to the entire project box. The clear acrylic spray paint can be obtained at most hardware or craft shops. This coat of acrylic adds durability to the paint on the project box, but even more important, it keeps the rub-on transfers



Wire the LED buses before wiring the LEDs to the circuit board. That will make lead identification easier. Color coded jumpers to the board will reduce the chance of error.



The circuit board is dwarfed by the size of the project box. That is because of the length of the message on the front. Be sure to select a box large enough for the artwork.

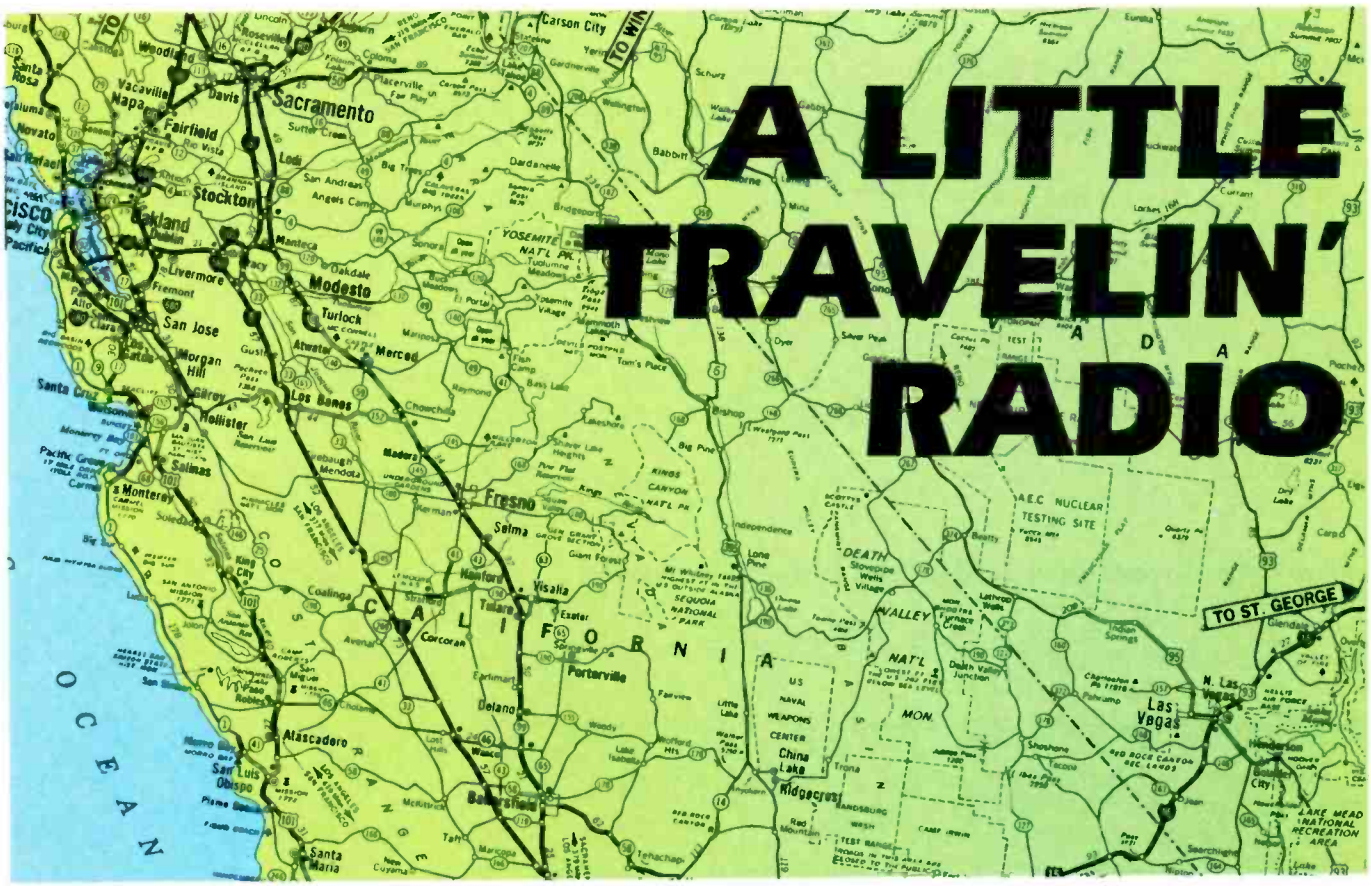
from peeling off during handling of the completed project. Be sure to apply all spray coatings evenly and according to label directions to avoid messy runs and to ensure proper drying times, etc.

Mounting the LEDs

Once the clear acrylic spray has dried (usually about 24 hours), you are ready to mount the LEDs. A small amount (one or two drops) of instant bonding glue on the side and near the base of each LED will ensure that it does not fall out of the hole once it is attached.

It will help simplify wiring of the LEDs if you will place all

(Continued on page 102)



A LITTLE TRAVELIN' RADIO

There's a world of radio out there of which few of us are even aware.

By Gerry L. Dexter

☐"WELCOME TO BLACK WATERS STATE FOREST. THE MAIN lodge and information center is located 2 miles into the forest on Route 4. The information center features a restaurant, snack bar, gift shop, visitor information office, telephones, restrooms and showers. This facility is open 24-hours per day. Trail maps, showing the routes of all hiking trails and campsites in the forest, are available for $1. Rules for campers are posted in the main reception area and in all designated camping areas...."

Messages like that one for an imaginary state forest are heard on the radio everyday. But you aren't likely to find them as part of the format on your local Top-40 or all talk radio station. Those kinds of messages are broadcast by *Traveler's Information Stations* (TIS), which operate with such low power that you'd have to be practically on their doorstep to hear what they have to say.

Take a Hike

Traveler's Information Stations are just about what their name implies. They provide information to visitors about national parks, campgrounds, monuments, and other specific tourist attractions, as well as information about parking and where to find what at major airports and other large installations, which might otherwise be difficult for a visitor to find his or her way around. Visit Los Angeles International Airport, Yellowstone, or Bryce Canyon National Parks, the Carlsbad Caverns, Chicago's Brookfield Zoo, or such cities as Columbus, Ohio, or Yakima, Washington, the Tacoma Dome or even little Foothill College in California and you'll find TIS's in daily operation.

The first use of radio broadcasts in a TIS-like manner was in 1968 at Yellowstone National Park in Wyoming, even though that type of broadcast service didn't yet officially exist. Yellowstone, because of its huge size and diversity probably had more reason to use such a service than many other tourist attractions. Indeed, today there are 26 TIS transmitters operating in various places within Yellowstone National Park.

The Federal Communications Commission didn't officially approve the TIS concept and begin to license stations until the summer of 1987. And, actually, it wasn't until the early 1980's that such stations really began to grow in number.

TIS installations may not operate with power exceeding 10 watts and can operate on only one of two frequencies—1610 kHz, just above the top of the AM radio dial; or 530 kHz, just below the bottom of the AM dial. Most assignments are on 1610 kHz, with 530 assigned only in situations where use of 1610 would present an interference problem; for example, where a local station's signal on 1610 would make the TIS signal difficult to pick up.

TIS's must be FCC-licensed and generally have an optimum reception range of only around seven miles. They can be licensed only to some sort of governmental body—the National Park Service, state government, city, township, airport authority, and so on. No commercials or entertainment material is allowed to be broadcast. The content of the broadcasts must be strictly informational (routes, operating hours,

This highway sign at Carlsbad Caverns National Park advises motorists to dial 1610 AM for information.

background information about a particular attraction, parking, instructions, weather information which might have an effect on the attraction and so on).

The solid-state TIS-type transmitters can be adjusted for any RF output between 2 and 10 watts. Most messages are pre-recorded and run on automatic 8-track cassette units or automatic digital record/playback units. A typical TIS station may simply run one message over and over, *ad infinitum*. Or, it may run several messages in a string, covering a variety of related subjects before repeating any, or it may pick and choose from a library of messages that are then aired as needed. Most systems are set up so that fresh messages can be recorded and gotten on the air quickly; that's an important factor in areas where sudden weather changes can make trails or roads treacherous.

Several companies, including Information Station Specialists of Zeeland, Michigan provide turnkey installation of TIS systems, even to the point of recording the desired messages. TIS stations can also be rented from such firms for use when a TIS service is required *only* for temporary use, such as at a state fair or other limited-time event.

There is a second type of TIS station with the same technical specifications, but a different purpose—*Highway Advisory Radio* (HAR).

Info to Cruise By

Highway Advisory Radio provides information about traffic conditions, weather that might cause driving conditions to get worse, detours, and so on.

The first Highway Advisory Radio station came on the air about a year after the first TIS. It was (and still is) run by the Illinois Department of Transportation, and was put to use on the Edens Expressway in Chicago during a period when major road work was causing detours and traffic delays. There are now six HAR stations in a co-ordinated system along the Chicago area expressway system. Overall, there are about 100 HAR stations in the United States.

Because HAR listeners are moving much faster than the average TIS listener, the messages on HAR stations must be considerably shorter or the motorist will be out of range before hearing the full message. As a result, HAR messages seldom run more than 60 seconds before repeating. Content can also include information about accidents (which might be holding up traffic), lane closures, and so on. Signs along the roadway, which you may have seen in your travels, inform the driver that he is coming within range of an HAR broadcast and indicates the frequency to which the radio in the car should be tuned.

The Chicago area HAR system receives continual informational input on the expressway's status from a computerized surveillance system. That data is automatically converted into a voice format and put out over the air in the area involved. Eventually the system will enable motorists to phone in and get HAR messages automatically, before leaving for their destinations.

In Oregon, five HAR stations operate from trailers so they can be moved to construction sites to notify motorists of construction ahead. Temporary telephone-line hook ups to the stations allow the stations to be controlled from distance via a touchtone phone.

The TIS facilities at Los Angeles International Airport operate on 530 AM, giving traffic reports, parking availability and airline locations—with many of the broadcasts aired live.

There are, however, question marks ahead for TIS and HAR stations. The planned expansion of the AM-broadcast band up to 1705 kHz in the coming decade means something will have to give and no one, including the FCC, seems to know the answers. If TIS's are moved above 1705 kHz, it will render them virtually useless to the to the public until such time as the majority of autos have car radios that can have the ability to tune that high.

Indeed, even now, TIS stations in some locations are facing potential interference from the 50 kW *Caribbean Beacon* a religious broadcaster operating on 1610 kHz from the island of Anguilla. Everyone assumes that TIS's will be preserved and protected, but how that will be achieved is still rather an open question.

Meantime, when you travel remember to keep an eye open for signs advising that traffic or visitor information is available on your car radio. There's a book that you'll find very helpful, too. It's called the *Traveler's Information Station—Highway Advisory Radio Guide for Tourists and Motorists*. Although published in Germany, it's available in the US from Gilfer Associates (PO Box 239, Park Ridge, NJ 07656, priced at $9.95).

If you are into DX'ing, you'll be glad to know that many of those stations do verify correct reception reports. The book mentioned above gives addresses.

Tuning in on, and keeping a log of, TIS and HAR stations that you manage to pick up can add some interest to a long, boring motor trip, as well as aiding you through heavy traffic areas, and making your visits to National Parks and the like more enjoyable than they might otherwise have been. ■

THE ZETA NOISE BLOCKER

Microcomputer technology reduces the biggest problem of hearing-aid wearers —background noise.

By Philip McKnight

I MET MY DAD AT A CLASSY CHICAGO LOOP RESTAURANT FOR lunch. We hadn't seen each other since last Christmas. I picked the place, because I wanted to impress him. I wanted to tell him how far I had gone in the business world since I graduated with an MBA. As I entered the restaurant a sudden fear struck me.

The cacophony of many diners talking, plates clinking, and other noises that added to the general din would prevent my father from hearing me. His hearing is impaired. Dad saw me and waved a hello from a table in the center of the room. I thought, "Oh, he's is in the center of the pandemonium. How will he hear me?"

I walked over, extended my hand and felt his warm handshake in return; and not thinking, I said in a normal voice, "Gee, Dad, you look great!"

He responded, "I feel great, son."

Dad heard every word I said. I couldn't believe it. He even heard the mumbling waiter and understood him. He heard as if his hearing was not impaired.

After a few minutes, I asked Dad if he had reversed his hearing loss.

He answered by telling me that no longer was a crowded room filled with noise a dreaded situation for him as it is for millions of hearing-aid wearers. For those individuals, background noise has been identified as the number one problem, one that often prevents them from communicating with the normal hearing world. Dad said he owed it all to the *Zeta Noise Blocker*. I didn't know what he was talking about, but my curiosity made me inquire, which eventually prompted me to write this article.

It's All in a Chip!

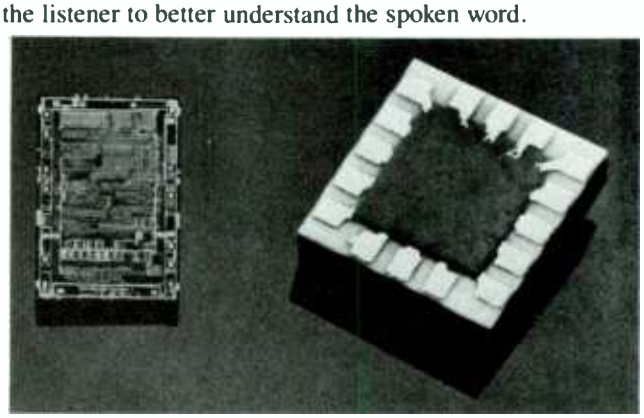
As it turned out, the Zeta Noise Blocker was a recently introduced hearing-aid component that was developed to tackle the noise problem. It may very well be the only application of a microcomputer in head-worn hearing aids. That microcomputer has the unique capabilities to distinguish between speech and noise, and to automatically adjust its multiple noise filters to selectively reduce noise at any frequency.

Speech vs. Noise

Many hearing-impaired persons have difficulty separating and hearing the different frequencies of sound. They also have trouble isolating and hearing frequencies that contain word cues versus frequencies, which contain noise. Moreover, in noisy surroundings, a hearing-impaired person's ability to identify where a particular sound originates is reduced. Those factors combine to make understanding speech in noisy surroundings difficult or impossible.

Hearing aids offer a critical benefit in that they provide amplification. However, since they amplify all sound, speech as well as noise, they can compound the problem of understanding speech in noisy environments.

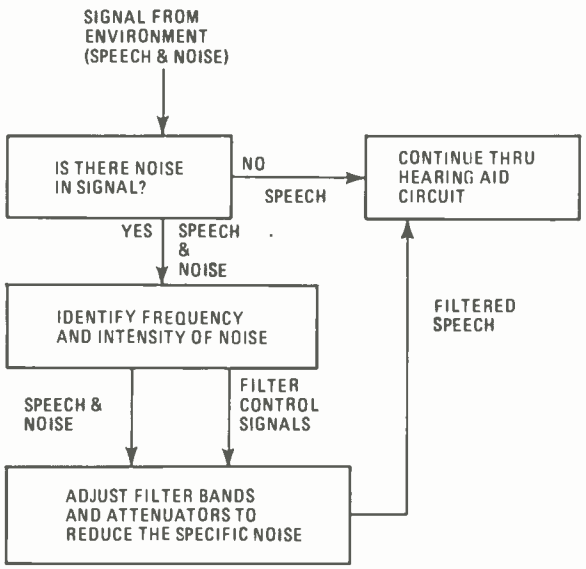
The Zeta Noise Blocker integrates a specially designed microprocessor (computer) to address the noise problem. The Zeta, which is built into hearing aids by manufacturers during production, operates as follows: 1. The Zeta continuously analyzes the environment for noise; 2. When noise is present, the Zeta identifies the frequency and intensity of the noise; and 3. The Zeta then automatically adjusts its multiple filters to reduce the specific noise, thereby enabling the listener to better understand the spoken word.



This magnified photograph of the Zeta integrated-circuit chip looks like just another industry product; and yet, the Zeta development has brought realism, improved understandability, and comfort to many hearing-impaired persons.

ZETA NOISE BLOCKER BASIC OPERATION

This basic logic diagram illustrates the paths that the audio signal takes through a hearing aid with built-in Zeta circuitry. The signal from the environment (speech and noise) is detected by the aid's miniature microphone and passed on the Zeta's decision-maker circuit. Here, the circuitry passes the signal straight through when no noise is present. In the event that noise is detected, the signal is directed to the noise identifier where the frequency and intensity of the noise is measured and control signals are sent to the filter bands and attenuators to preset them for optimum noise cancellation. The signal is filtered and speech is passed to the remaining hearing-aid amplifier circuit. Simple, yes; however, its development through the year was a monumental task capped with accomplishment and pride.



The Advantages of Zeta

Until the unique capabilities of the Zeta Noise Blocker were applied, no hearing device used the identification of noise as an activating cue. Traditional techniques for controlling noise are activated manually or by the overall volume of sound, irrespective of whether it is noise or speech. Additionally, such techniques are incapable of self-adapting to differing frequencies of noise.

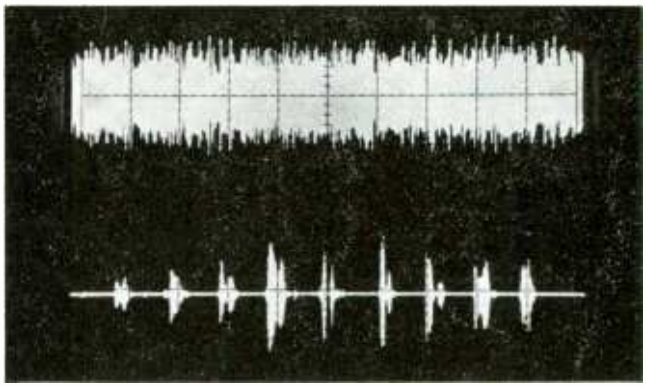
The self-adaptive technology in the Zeta gives it a number of advantages.

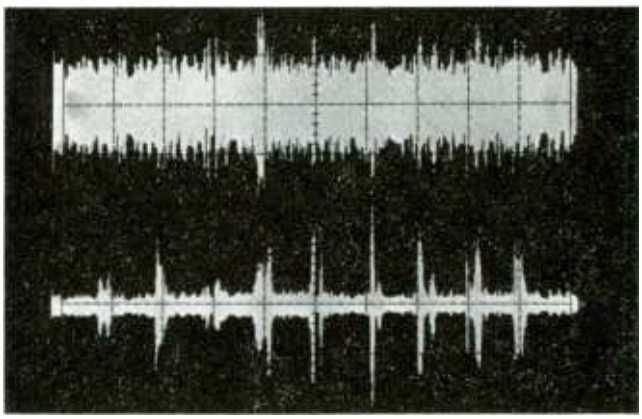
Transparency—Since the Zeta can discriminate between noise and speech, it does not interfere with the fidelity of the hearing aid in speech-only situations.

Better Sensitivity—When there is noise, the Zeta starts its filtering at low volumes, where noise first begins to impair the comprehension of the listener. Traditional techniques operate based upon the volume of the sound, not the presence of noise. Therefore, the activation threshold for those devices must be preset at a high enough level to limit unintended operation in speech-only situations with the result that the hearing-aid wearer may experience relatively loud noise before the device reacts.

Filtering Flexibility—Since the Zeta has multiple filters, it can address many types of noise (low frequency, high frequency, cocktail babble, etc.) rather than some predetermined frequency subset.

Filtering Precision—The ability to identify the noise type (frequency range) and to adjust its appropriate filters gives the Zeta precision in its filtering operation. Since noise and speech often occur together in the same frequencies, it is impossible to remove all noise, while preserving speech. The Zeta, however, uses the adjustability of its filters to provide accurate reduction of noise, while avoiding unnecessary reduction of speech.





The performance of the Zeta Noise Blocker is shown in these four traces of sound over time as shown on an oscilloscope. The top trace illustrates low-frequency noise, 400–600 Hz in frequency; the second, a person counting from two to ten; the third, a mixture of the first two traces, noise with speech; last, the same mixture as filtered through the Zeta Noise-Blocker, which reduces the noise and allows speech to be clearly heard.

Traditional noise-reduction devices are preset to specific frequencies. As that type of circuitry reduces all sound within a preset frequency range, it may filter important speech components unnecessarily. Conversely, the inability of those filter circuits to adjust to troublesome noise outside of their preset range may result in uncomfortable levels of noise to the impaired listener.

Greater Noise Reduction—The Zeta can deliver significantly more noise reduction than traditional techniques. Furthermore, a major portion of that reduction can be applied at the low levels of noise which bother hearing-impaired persons. *(Continued on page 103)*

TABLE 1—MEAN SPEECH DISCRIMINATION SCORES (%) IN PRESENCE OF BACKGROUND NOISE

Noise Type	Filter Off	Filter On
Low Frequency (600-800 Hz)	35	63
Cafeteria	33	60
Babble	33	57
High Frequency (2700-3500 Hz)	50	60

Data source: Presentation by Cindy Ellison, M.A., at the annual meeting of the Michigan Speech and Hearing Association (MISHA), March 21, 1987.

By James E. Tarchinski

IQ-TEST

Use our DOS look-alike program to have some April-first fun with your family, friends, or co-workers!

THERE IS ONLY ONE DAY OUT OF THE YEAR THAT I'M GLAD we don't get off from work: April first. Small practical jokes played on friends can be a lot of fun, especially at the office where such events tend to break up the day's routine. This year we are especially lucky because April Fool's Day falls on a Friday, that time of the week when almost everyone is in an agreeable mood.

In the Beginning

Last year, before anyone else was in my office, I installed the BASIC language program of Listing 1 on the department's IBM computer. Later in the day, when a co-worker tried to execute a DOS command, the computer responded with its catch-all error message "Bad command or file name." Bowing to human nature, the command was tried a second time, only now the computer responded with the much more aggressive "I said Bad Command or File Name!" The user was completely stunned, and might never have caught on to what was happening if I hadn't been laughing from halfway across the room.

Called IQ-TEST.BAS, the program makes the computer look like it is in the machine's disk operating system (DOS). All of the important keys act just like they do under DOS, but the error messages can be programmed by you. With a little creativity you can have a lot of fun with this short program.

Even if there are no PCs where you work, you can still use IQ-TEST.BAS. The next time you trade data files or software programs with a friend, just include this program on the floppy disk. When most people receive programs like this, especially programs with innocent looking names, they tend to run them first and list them out later. That gives IQ-TEST just enough time to give the unwary program runner a healthy dose of *computeri humorus*.

```
1000 ' IQ-TEST.BAS
1010 '(c) 1986 by James E. Tarchinski
1020 '
1030 '
1040 JOKE$="I said BAD COMMAND OR FILE NAME!"
1050 STAN$="Bad command or file name"
1060 PT$="A>"
1070 MAX.COUNT=2
1080 '
1090 SCREEN 0,0,0,0 : WIDTH 80 : CLS : KEY OFF
1100 '
1110 KEY 1,CHR$(213)
1120 KEY 2,"<"
1130 KEY 3,CHR$(214)
1140 KEY 4,">"
1150 KEY 5,"@"
1160 KEY 6,"^Z"
1170 KEY 7,"^@"
1180 KEY 8,CHR$(255)
1190 KEY 9,CHR$(255)
1200 KEY 10,CHR$(255)
1210 '
1220 LOCATE 1,1,1,6,7 : IOLD=2
1230 '
1240 PRINT PT$; : B1$="" : I=2
1250 '
1260 A$=INKEY$ : IF A$="" OR A$=CHR$(255) THEN GOTO 1260
1270 IF LEN(A$)>1 THEN 1260
1280 '
1290 IF A$=CHR$(214) AND I<3 THEN B1$=AOLD$:I=IOLD:PRINT B1$;:GOTO 1260
1300 IF A$=CHR$(214) AND I>2 THEN 1260
1310 '
1320 IF A$=CHR$(213) AND IOLD=2 THEN PRINT "Z"; : I=I+2 : GOTO 1260
1330 IF A$=CHR$(213) AND IOLD>I THEN A$=MID$(AOLD$,I-1,1)
1340 IF A$=CHR$(213) THEN 1260
1350 '
1360 IF A$<>CHR$(8) THEN GOTO 1420
1370   IF I<3 THEN GOTO 1260
1380   LOCATE ,I : PRINT " ";:LOCATE ,I : I=I-1
1390   K=LEN(B1$)-1 : IF K>0 THEN B1$=LEFT$(B1$,K) ELSE B1$=""
1400   GOTO 1260
1410 '
1420 IF A$<>CHR$(27) THEN 1470
1430   PRINT "\" : PRINT " ";
1440   B1$="" : I=2
1450   GOTO 1260
1460 '
1470 IF A$<>CHR$(13) THEN 1570
1480   PRINT
1490   IF B1$="A:" OR B1$="a:" THEN PT$="A:" : GOTO 1540
1500   IF B1$="B:" OR B1$="b:" THEN PT$="B:" : GOTO 1540
1510   IF B1$="C:" OR B1$="c:" THEN PT$="C:" : GOTO 1540
1520   COUNT=COUNT+1 : AOLD$=B1$ : IOLD=I
1530   IF COUNT=MAX.COUNT THEN PRINT JOKE$ ELSE PRINT STAN$
1540   PRINT
1550   GOTO 1240
1560 '
1570 I=I+1 : B1$=B1$+A$ : PRINT A$;
1580 GOTO 1260
```

Program Startup

In the first third of IQ-TEST, from line 1000 to line 1250, the program is initialized. Variables are set to their initial values, the screen is cleared and set up in 80 column mode, the function keys are each assigned appropriate string values, and the DOS prompt for the A-drive is displayed.

One character from the keyboard is read into the variable A$, by line 1260, through the use of the INKEY function. If no key is waiting to be read, or if the inputted character is equal to CHR$(255) (which would indicate that either F8, F9, or F10 had been pressed), the program jumps back to the beginning of line 1260 and the process is repeated.

Numeric and Function Keys

The next line, line 1270, is used to void two-character, INKEY$ inputs. Such inputs are caused by the numeric key pad when it is not in "number mode."

If the function key F3 is pressed, which the program would recognize by the fact that A$ would be equal to CHR$(213), then lines 1290 and 1300 provide the correct computer response. In this program, as in most versions of PC compatible DOS, F3 is used to retype the last command entered. That is true so long as no other character has been entered on the new line, in which case the pressing of F3 would be ignored.

A similar type of decoding scheme is used to handle the pressing of F1. Line 1320 will print "Z" on the screen if IOLD = 2, that is, if only the return key was pressed the last time the computer waited for input. If IOLD is greater than the current value of I, then line 1330 will keep typing one character from the last command entered, just as in DOS.

Backspace, Escape, and Return

If the entered keystroke is not the backspace key, then line 1360 causes the program to skip ahead to line 1420. If the backspace key was pressed, line 1370 first checks to make certain there is something to backspace over. If so, line 1380 removes it from the string B1$. B1$ is the variable formed by concatenating all of the keys pressed since the last time the return key was pressed.

Escape-key presses are handled in the next section of the program, lines 1420–1450. As in DOS, the program prints a back-slash character and starts the input process over in Column 2 of the next line down.

The last special key that IQ-TEST tests for and decodes is the return key. After a return key hit, the program checks to see if the user simply wanted to change the default drive on the machine. That is handled by lines 1490–1510.

If the command was not a simple drive change, then line 1520 increments the value of COUNT and saves the old values of B1$ and I as the variables AOLD$ and IOLD$, respectively. If COUNT is now equal to MAX.COUNT, line 1530 will print JOKE$, otherwise it prints the standard DOS error code, STAN$.

All characters entered on the keyboard that have not already been dealt with by IQ-TEST will end up at line 1570. Here the value of I is incremented by one, the value of A$ is added to the end of B1$, and A$, is printed on the screen. The GOTO statement of line 1580 then jumps back to line 1260 to wait for the next character to be entered.

Program Modifications

As the listing currently stands, IQ-TEST will display the standard DOS error message, STAN$, the first time the user tries to execute a command. The second time, however, JOKE$ will be printed to the screen. You can modify either one of these strings by editing the appropriate line before you run the program or before you save it on a disk and mail it to a friend. Edit line 1040 to change JOKE$ or line 1050 to change STAN$.

In addition to changing the message of the joke string, you can change when the joke string will be printed during the program's execution. Remember that the variable COUNT is incremented each time a command is entered by the user. Line 1530 keeps comparing the value of COUNT with a maximum value, which is determined by line 1070. Change MAX.COUNT in line 1070 to whatever value you feel is appropriate—it is currently set for the second command entered, that is, MAX.COUNT = 2.

Because of the equal sign in line 1530, JOKE$ is only printed when COUNT is equal to MAX.COUNT. You may want to change this sign to a greater than or equal sign, ">=," so that the joke will be printed every time on or after the MAX.COUNT time through the loop.

Conclusion

While IQ-TEST.BAS can be a lot of fun, there are some individuals that you should probably avoid using this program on. People who, for one reason or another, just don't have the same sense of humor as "regular" folks do. A partial list of those people is given below for your safety.

1. Your boss.
2. People who tend to slam their fists on computers whenever the computer doesn't do what they expect it to.
3. People who spend more than 90% of their income on their gun or knife collection. ■

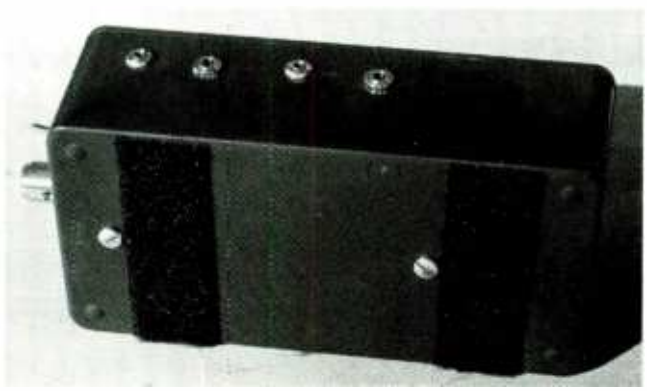
TWO-WHEELER COMMUNICATOR

When your out free-wheel'n it down the highway with a partner, how can you share the scenery if you can't talk to them? Build our communicator and keep in touch.

By Charles D. Rakes

IF YOU ARE A MOTORCYCLE ENTHUSIAST WHO LIKES TO take a friend on a spin to show off your machine, or to ride down the highway to escape the pressures of the day, then you know that making conversation at highway speeds must be limited to hands-on contact. The wind and engine noise bouncing around inside the safety helmet is just too great for voice communication. To the rescue comes our **Hands-on Electronics** *Two Wheeler Communicator* that brings friendly conversation back to the twosome cycle riders.

Our communicator is a self-contained, battery-operated, portable electronic intercom, that can be put together in a couple of evenings for less than the cost of a speeding ticket. The construction and placement of the communicator's pick-up mike, and the voice actuated circuitry hold the secret to the communicator's successful operation as a noise-resistant intercom.



Using velcro fasteners are the least permanent, most secure way to attach the unit to your bike. Position the unit where it will not be crushed if you lay the bike down.

How the Communicator Works

See the circuit diagram in Fig. 1. The communicator consists of two identical voice-activated audio amplifier circuits with their input and output circuits crisscrossed to form a duplex talking system.

An electret mike element is connected to the input of opamp U1-a, and the values of R3 and R9 set the amp's gain to 4.5. The audio output of amp U1-a is fed through pot R23, to the input of a high gain threshold amplifier circuit, opamp U1-b. The amplifier's threshold level is set to .6 volts by diode D1. Diode D2 sets the amplifier up to produce a high-level positive output while suppressing the negative waveform. Diode D3 receives that positive audio signal and turns on Q1 to activate the audio switching transistor Q2.

The audio at the output of amp U1-a also goes to the input of the headphone power amp U2, through C15 and R15. The audio-switching transistor, Q2, connects to the junction of R15 and R25 to turn the audio on and off. The threshold triggering level for the mike's audio is set by R23. The attack or turn-on time for the audio-switching circuit is very fast, and the hold, or on-time is determined by the value of C5 and R17, and is about 3 seconds with the component values given.

Building the Communicator

The majority of the components are mounted on a compact PC board measuring 2-¾ × 3-¼-in. (see Fig. 2). If the overall size is not too critical, the old standby construction method of perfboard and pins will do okay, but keep all leads as short as

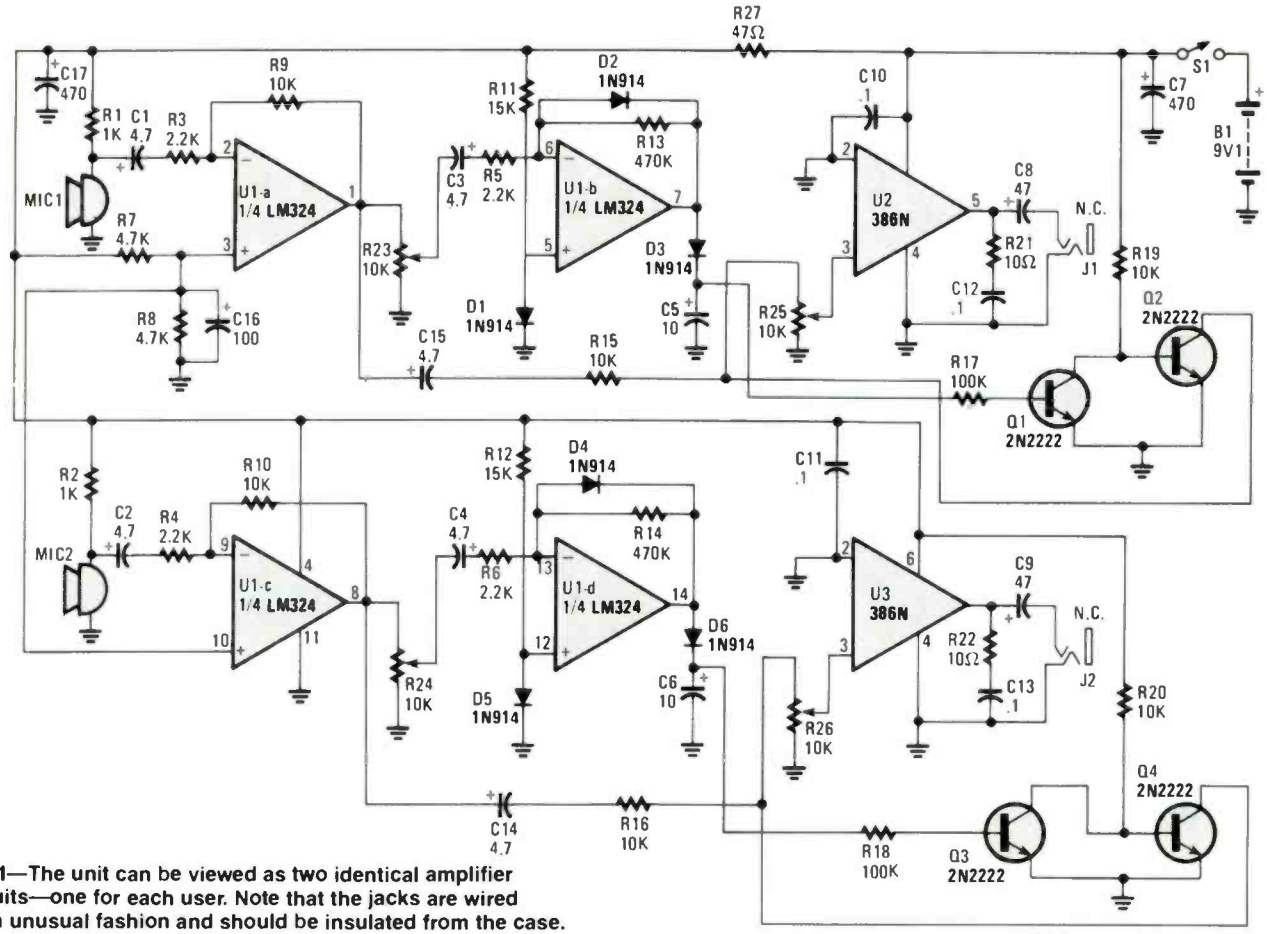


Fig. 1—The unit can be viewed as two identical amplifier circuits—one for each user. Note that the jacks are wired in an unusual fashion and should be insulated from the case.

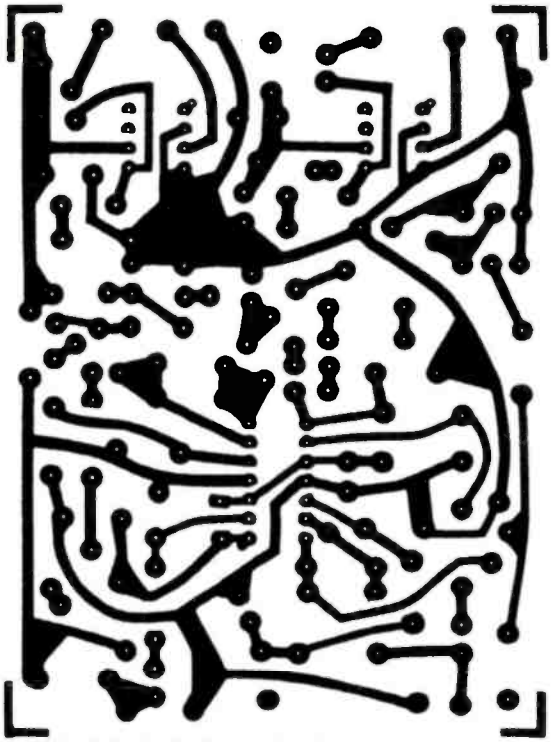
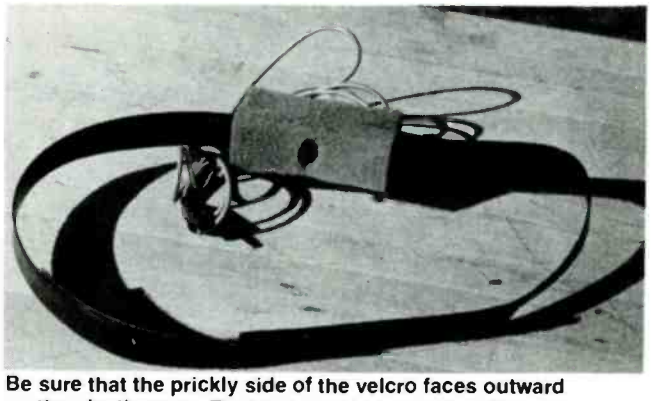


Fig. 2—This full-sized printed-circuit board pattern will help you keep things compact. After all, you wouldn't want a big ugly project box on your bike, would you?

possible and follow the same general layout as shown for the PC board.



Be sure that the prickly side of the velcro faces outward on the plastic strap. That means you must place its soft counterpart facing inward. Here they are shown interlocked.

Take the time to check and double check the polarity of each of the electrolytic capacitors, the diode bands, and the transistor and IC leads, to correspond with the schematic diagram and board layout drawing, before soldering any component in place. You can avoid a simple error that could cause a heap of grief at check-out time.

The circuit board, controls, and jacks are all mounted in the plastic cabinet. Two ½-in. spacers support the circuit board at one end leaving enough room at the other end of the cabinet to hold a 9-volt battery pack made up of 6 AA cells.

The two headphone jacks are wired to place the two earphone elements of a stereo headset in series to lighten the load on the amp and batteries. That is accomplished by connecting the tip and short ring to the circuit, while leaving the long or common ring unconnected.

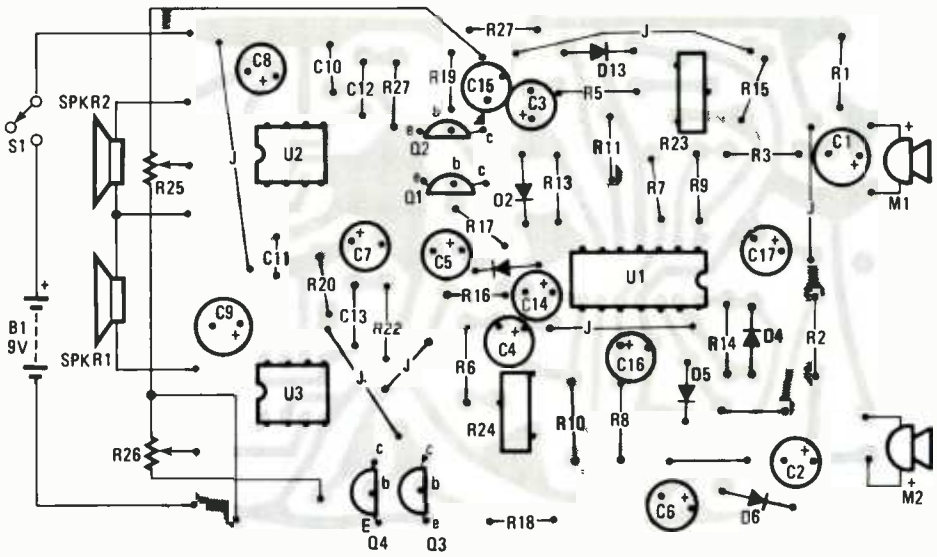


Fig. 3—When wiring the off-board components remember that speakers one and two are connected through stereo jacks. Remember that R25 and R26 are two parts of a stereo pot.

PARTS LIST FOR THE TWO-WHEELER COMMUNICATOR

SEMICONDUCTORS

D1–D5—1N914 small-signal silicon diode
Q1–Q4—2N2222 general-purpose NPN transistor
U1—LM324 quad-opamp integrated circuit
U2, U3—386N .4-watt audio amplifier integrated circuit

CAPACITORS

(All capacitors are 16-WVDC electrolytic units except where otherwise noted.)
C1–C4, C14, C15—4.7-μF
C5, C6—10-μF
C7, C17—470-μF
C8, C9—47-μF
C10–C13—.1-μF, 100-WVDC mylar capacitor
C16—100-μF

RESISTORS

(All fixed resistors are 1/4-watt, 5% tolerance units except were noted.)
R1, R2—1000-ohm
R3–R6—2200-ohm
R7, R8—4700-ohm
R9, R10, R15, R16, R19, R20—10,000-ohm
R11, R12—15,000-ohm
R13, R14—470,000-ohm
R17, R18—100,000-ohm
R21, R22—10-ohm
R23, R24—10,000-ohm mini trim pot
R25, R26—2 single, or 1 dual mini 10,000-ohm pot
R27—47-ohm ¼-watt resistor

ADDITIONAL PARTS AND MATERIALS

B1—6 AA 1.5-volt batteries and holder
J1, J2—Mini stereo jack (see text)
J3, J4—Mini mono jack
M1, M2—electret mike element
S1—SPST mini toggle switch

Plastic case, 12-ft. small shielded mike cable, foam rubber material, plastic belting, 2-½-inch spacers, Velcro material, battery snap hardware, solder etc.

The following can be ordered from: Krystal Kits, PO Box 445, Bentonville, AR 72712. PC Board $14.95 pp.. PC Board and all the components that mount on the board $29.95. That does not include the cabinet, mikes, S1, R25, R26, jacks, headphones, battery holder, battery clip, hardware, etc.

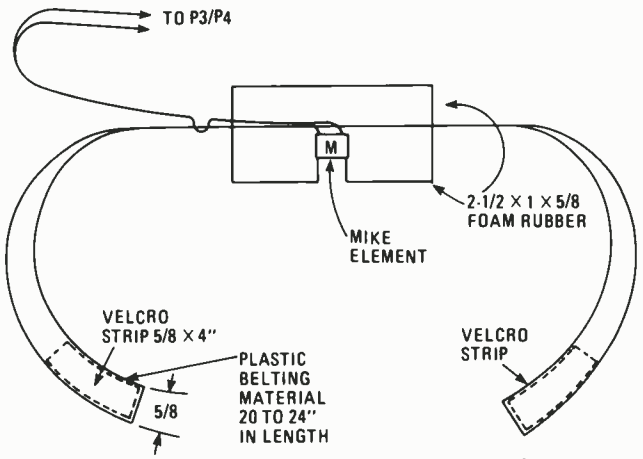


Fig. 4—The little loop of wire to the left of the mike is threaded through the strap to secure the wire. Be sure that the velcro strips are on the correct sides on the strap.

Fabricating the Mikes

The first step to take is to determine if you want to use a throat mike, or a lip or chin mike. The only difference that makes in building the mike is in the length of the belting material used. If you want to use a throat mike just take a length of plastic ⅝-in. belting material and go around your neck with a 4-in. overlap. Velcro material will go on each end of the belting material to keep the mike snugly in place.

If a lip/chin mike is desired, and I've found in many instances that the following mike arrangement works the best: place the belting material around your neck and chin and overlap by 4-in. In either arrangement the remaining mike construction is the same.

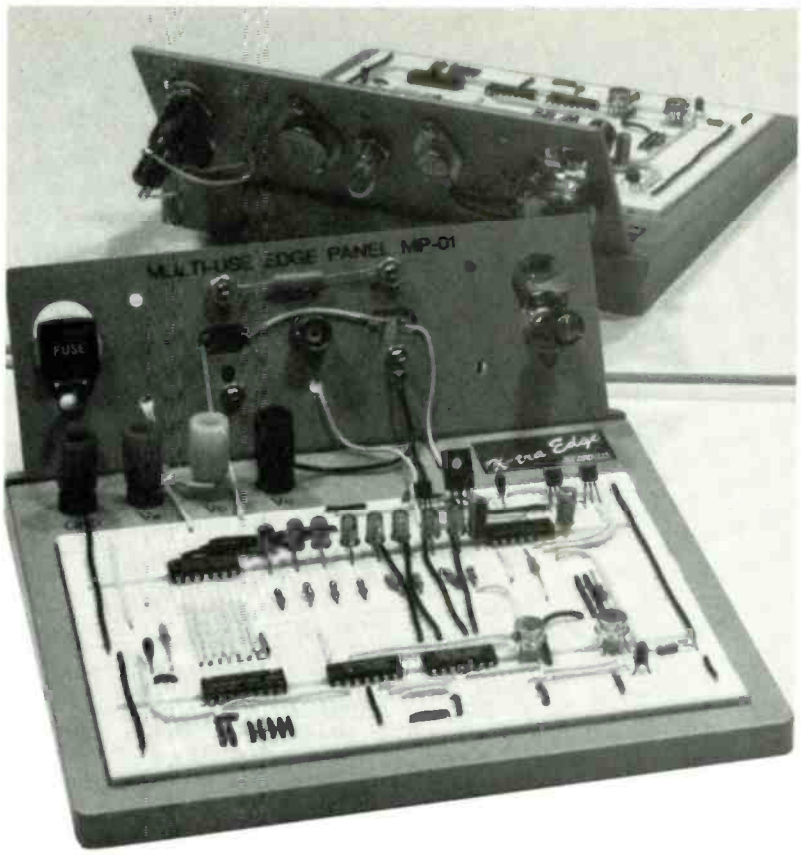
After the belt length has been determined and cut to size, locate the center of the belt and punch or drill a 1/16-in. hole at that location. Take a 3 to 4-ft length of mini shielded mike cable and run one end through the hole. Connect that end, with care, to the electret mike element. Drill another small hole 1-¼ in. from the first, and in the center of the belting material. Run the shielded cable through that hole and position the back of the mike element squarely on the belt. Silicon-rubber it in place.

Cut two pieces of foam rubber to a 2-½ × 1-⅝-in. size, see Fig. 4. Take one of the foam rubber pieces and punch a ⅜-in.

(Continued on page 106)

HANDS-ON REPORT

X-TRA EDGE SOLDERLESS BREADBOARD



Finally! A solderless breadboard that accommodates major hardware

REGARDLESS OF HOW SIMPLE OR FANcy they might be, when you come down to the real nitty-gritty, most solderless breadboards are nothing more than a frame having several rows of tiny sockets designed for the No. 20–29 wire leads of small-signal transistors, IC's, resistors, capacitors, and other Munchkin-size components.

Unfortunately, most projects also include potentiometers, switches, jacks, perhaps a power transistor, lamps, rheostats, and a host of hardware that can't fit into tiny holes. Usually, you're on your own when it comes to the larger hardware. More often than not, they are left hanging off the end of the breadboard...usually shorting each other's connections.

Thinking Big

But now there's a solderless breadboard—*X-tra Edge Solderless Breadboard*—that finally puts the *cart behind the horse*. In this instance, it's a universal *edge panel* that simply slips in and mounts behind the solderless breadboard.

"What is a universal edge panel?," you ask. As shown in the photographs, it's simply a plastic (insulated) mounting strip having geometric cut-outs—meaning oddly-shaped holes that can accommodate a broad range of small and large components. In a sense, they are "universal" mounting cut-outs.

Although there are four different sizes of *X-tra Edge* breadboards, all of which use different size edge panels, the cut-outs are the same—they are simply spaced farther apart. Only the breadboard terminals themselves, which we'll cover later, have different capacities for component connections.

Each edge panel has an ice-cream-cone-shaped cutout at each end that can accommodate components with round shaft having diameters from 0.15- to 0.72-in. As shown, they'll hold anything from miniature potentiometers to full- and super-size toggle switches.

Moving in from both ends, there are holes for mounting TO-220 heatsinks, buzzers, sensors, etc.

Again moving inward, there are another pair of cut-outs designed for power transistors in TO-3 and 66 cases, and for stud rectifiers, triacs, SCR's, etc., in TO-48, 59, 61, 63, and 111 case styles.

Finally, dead center we have a cut-out that will handle the preceding lineup of rectifiers, Triacs, and SCR's, as well as BNC connectors and switches.

And if there are no cut-outs to handle your favorite kind of components, you can always drill your own mounting holes.

This is just a sample of the oddball shapes that can be mounted on the edge panel. From left to right, a miniature potentiometer, slug-tuned RF coil, wirewound rheostat, power transistor, and automobile-dashboard toggle switch.

Four Posts

The base section, the part with the breadboard tie points, has four insu-

(Continued on page 98)

GIZMO

APRIL 1988 **WHAT'S NEW IN ELECTRONIC DO-DADS**

CIRCLE 52 ON FREE INFORMATION CARD

Under Its Spell

WORD WHIZ (WW-93). Manufactured by: Franklin Computer, Rt. 73/ Haddonfield Rd., Pennsauken, NJ 08110. Price: $69.95. SPELLING ACE (SA-98). Price: $69.95. SPELLMASTER (SA-103). Price: $99. LANGUAGE MASTER (LM-2000). Price: $299.

Critics of electronic calculators routinely conjure up a future in which people will be unable to perform simple arithmetic exercises, a worldwide atrophy of mathmetical skills. Those same observers are likely to view *Franklin Computer*'s expanding line of linguistic computers with much the same alarm.

In reality, those impressively portable word machines are more likely to increase English language vocabulary skill, rather than render their users speechless. Certainly, they have great appeal to word buffs, especially as they're capable of playing word-based games.

The *Word Whiz*, aimed at youngsters, is the most basic model in the product line. With a vocabulary of 60,000 words, including selected proper nouns and common abbreviations, the *Whiz* is a phonetic spelling corrector, able to find the correct word working from approximate spellings. The user keys in how he or she thinks the word is spelled on the hand-held unit's typewriter-style keyboard and presses "Enter." If the original attempt at spelling the word is too far off, the display will show, "Sorry, can't help."

Otherwise, the *Word Whiz* displays, one at a time, possible spellings for the word based on its sound. Users scroll the list up or down to display the several possible correctly spelled words. If the user has accurately spelled the word in entering it, an asterisk verifies its spelling. If still uncertain, the user can press the question-mark key, and the unit will display a list of similar words.

The *Word Whiz* also has what *Franklin* calls a "prefix feature." That allows the user to enter just the first few letters of a word, with the unit displaying multiple words beginning with those letters. For example, if trying to spell "hippopotamus," the user keys in "hip," and presses the hyphen key. The display will show, in alphabetical order, words beginning with those three letters, including "hippopotamus." *Word Whiz* also offers a guide to hyphenation. If a user types in "topnotch," the display will bring up "top-notch."

All of this is done by a unit measuring 6-1/2-in. wide, 4-in. tall and 1-in. deep at its highest point. As a computer it's rated at 128K bytes of ROM (contained in a single megabit chip) and 2K bytes of RAM. Power is supplied by four "AAA" batteries.

As a game player, *Word Whiz* is programmed for "Hangman" (a word game very much like the one played on televi-

sion's "Wheel of Fortune"). Players can select the length of the word to be guessed and the number of wrong guesses allowed. To enter the game playing mode, a hyphen followed by "H," for "Hangman" is keyed in.

Similarly, to play the more difficult anagram, in which words made up of the letters in a selected word are discovered, a hyphen, followed by "A" is entered. Besides randomly generating a word to be used in the game, the *Whiz* indicates how many words can be spelled using the same letters, counting down as correct words are selected and entered.

Finally, the *Word Whiz* can also generate "coded messages." *Franklin* boasts that its "encryption is so good that a State Department license is required for export." Using either "Franklin" or a user-selected word as a "key word," in its coding functions, a message typed into the unit will appear on the screen as an apparent jumble of letters. With knowledge of the key word, that same collection of random letters, typed into the unit will appear on the screen as the message originally encoded.

Playing with the *Word Whiz* might well enliven a youngster's interest in words and language. Its "prefix feature," is much like an exercise used by generations of English teachers while its phonetic approach to spelling could help a child begin to understand relationships between different words. That the information is accessible without all the paraphernalia of learning—paper, pencils and books—could also be a big plus in that it allows concentration on the information itself.

On the market for a little over a year, the *Spelling Ace* has a vocabulary of 80,000 words, proper nouns and abbreviations. It shares all of the *Word Whiz*'s capabilities and adds one of its own. Besides the "prefix feature," the *Ace* can supply missing letters within words. Most useful for crossword-puzzle players, that feature allows the user to type in question marks for the unknown letters, with the display showing the complete word or list of possible words.

The *Spellmaster* uses the same 80,000-entry vocabulary as the *Spelling Ace* but utilizes a more sophisticated program. It can be used to play both single and two-player versions of "Hangman" and anagrams and functions as a "word-list builder" for both Scrabble and Jumbleword. It can also generate lottery numbers randomly and can an electronic version of dice. Sold with a carrying case and batteries, the *Spellmaster* includes a built-in index of games and their rules. *Franklin* maintains that unit is so "easy to use the owner can throw away the manual." Somebody must have followed the company's advice because the demonstration model we used came *sans* instructions.

The *Langauge Master* is the top of the *Franklin* spelling computer line. In addition to the phonetic spelling capabilities of the lesser models, here is an actual dictionary, with definitions for over 80,000 entries. It also incorporates a 30,000 word thesaurus, furnishing alternate words with the same meanings.

A user keys in a word. If a misspelled word is entered, the *Langauge Master* provides a list of up to 26 correctly spelled words, based on the computers "judgment" of what word the user is trying to spell. Once correct spelling is established, a definition appears on the *LM*'s four-line, 160-character display.

The definition gives the root word, the part of speech of the root, different forms of the root, syllable division, and a concise explanation of word meaning. *Franklin* rightly emphasizes that the *LM* as well as its other language computers are supplemental resources, not meant to replace standard dictionaries. The concise nature of the defintions is one reason for that caution. Even in four lines, some of the nuances of meaning can't be covered.

If the word for which a definition is given appears in the *LM* thesaurus, a small "t" on the upper right of the display directs the users to that second function. Pressing the "T" brings up the thesaurus. Entries for words in the thesaurus give part of speech, a set of definitions for each sense or meaning of the word for which there are synonyms, and the synonymous words.

(Continued on page 10)

Son Of Sony

MY FIRST SONY CASSETTE RECORDER (TCM-4000). Manufactured by: Sony Corp. of America, 9 W. 57th St., New York, NY 10019. Price: $44.95. MY FIRST SONY RADIO CASSETTE-RECORDER (CFM-2000). Price: $59.95. MY FIRST SONY WALKIE-TALKIE HEADSET (ICB-1000). Price: $49.95. MY FIRST SONY WALKMAN (WM-3000). Price: $34.95.

Consumer electronics for the youngest of the younger set is experiencing a big trend in current marketing. At the American International Toy Fair two years ago, the products were dubbed "kidtronics," and Fisher-Price and California's Worlds of Wonder emerged as among the concept's leading exponents. At least in the U.S. market, Sony joined the kidtronics parade a little later. Given the brand's enormous role in establishing contemporary consumer-electronics trends, it's at least interesting to see how products have been altered or redesigned for the *My First Sony* line.

Whether kids need to be introduced to audio-visual products via scaled-down versions of the adult item is another question. Contemporary kids from toddlers up take to electronics with a sometimes astounding precociousness.

Not surprisingly, *My First Sony Walkman* has been the most popular of those products for the pint-sized. Walkman makes the relationship between those kid-targeted items and Sony "Sports" line of audio/visual products clear. Both use the same bright yellow housing plastic and durability features.

This Walkman includes at least one feature, however, which marks it as kid-oriented. The four-track, stereo, tape player with headphones is fitted with a "volume limiter:" a switch, which allows parents to control maximum decibel levels, protecting the offspring's hearing and the parent's sanity. As with its *My First Sony* counterparts, it's lightweight (8.8 oz. without the batteries) and features rubber fittings to help protect against rough use. An automatic power shut-off helps limit the drain on the unit's two "AA" batteries.

If the *Walkman* is recognizable as a juvenile version of a grown-up product, the *My First Sony Walkie Talkie* veers off into clearly-defined kids' territory. Sold in sets of two, the bright-red headset features a plastic-tipped rubber antenna and flexibly-mounted, electret condenser-microphone. A single 9-volt battery fits into the left earpiece along with the system's single 1-inch speaker. A simple control (off, low, and high) is mounted on the right side of the microphone.

The kids' communication toys of our childhood tended toward the faint and barely heard. In contrast, these *Walkie Talkies* provide surprisingly strong, static-free transmission and reception. Sony claims an obstruction-free transmission distance of 1,000 feet. They also seem to be an inducement to lots of excited, high-decibel enjoyment. Power output is rated at 5 mW. An LED power indicator rounds out the simple rig's features.

Gizmo is published by Gernsback Publications, Inc., 500-B Bi-County Blvd., Farmingdale, New York 11735. Contributors to this issue of Gizmo are Larry Brady, Eric Lacitis, Bruce R. Olson, and John Swenson.

CIRCLE 53 ON FREE INFORMATION CARD

The product group's *Radio Cassette-Corder* combines AM/FM radio reception with a tape player/recorder featuring a built-in microphone and one-button recording. The plastic eject mechanism immediately struck us as a bit on the fragile side for the still-learning hands of early childhood.

At first, the "eject" function of the supplied demonstration model didn't work. The cassette door had to be pried open. But after a couple of cassette changes, the mechanism began operating correctly. More serious: With a handle that practically invites swinging, we noticed that a semi-hearty swing sent batteries and cassette flying. That may have reflected wear-and-tear on this particular unit, but how well will the design take the more physical play style of childhood?

The radio/recorder selection switch seems liable to stub small thumbs. It also might have made more sense to color the volume control differently from the section of the case it's mounted on. But the remaining controls are big, easy-to-manipulate, brightly colored buttons. The radio's non-extending antenna did a reasonable job of pulling in stations indoors and performed better outside. Power is supplied by four "C" batteries.

Its audio performance would have thrilled portable-radio owners of 20 years ago, although as a childhood introduction to mobile listening, only a few toddler audiophiles will notice its limitations.

The *My First Sony Cassette Recorder* seems a clear echo of company products in the Japanese market. The tot-size portable combines a tape system with a simple microphone and amplifier powered by four "C" batteries. It can be used as a tape deck, or a PA system, or, with cassette in play, kids (or adults) can sing along with the recorded music.

The red-yellow-and-blue body is topped by a curved handle onto which the microphone can be fastened. The childhood possibilities of that combo are pretty varied. Kids of a certain age love to sing along with the radio, a *My First Sony Cassette Recorder* can be an imagined awakening to real musical involvement.

If the products are meant for kids, Sony realizes that parents will be making the buying decision. The product boxes carry the notation "recommended for children four years and older." To some of us oldsters, knowing your way around a tape deck at age four might seem that you're somewhat gifted. We suspect that the marketing whizzes of *My First Sony* have estimated the age of electronic consent accurately.

It's another question entirely, but we have to wonder if a generation that seems to know its way around home electronics about the time it gives up the bottle will take kindly to kids' versions of already familiar audio toys. Many of us, for example, have been in homes where a youngster handles the VCR programming that mom or dad finds way beyond them. It's a fair guess that some parents who buy *My First Sony* products are going to spend more time with those bright-colored, simplified units than their kids ever will.—*G.A.*

VHS Virtuosity

PANASONIC OMNIMOVIE VHS CAMCORDER (PV-320). Manufactured by: Panasonic Co., One Panasonic Way, Secaucus, NJ ZIP 07094. Price: $1,550.

Taking the VHS camcorder plunge confronts consumers with a selection between competing brands based on differences which often appear minor. The current generation shares impressive spec sheets and much of the same technology. Record and playback come within hailing distance of foolproof operation, while price most often varies in response to retailers' promotions.

Competition, however, is the name of the game and each of the camcorder marketeers struggles to give their unit some unique attribute or characteristic that will make it stand out from the pack. *Panasonic* in its introduction of new camcorders last fall appears to have incorporated the newest technology available, including

CIRCLE 54 ON FREE INFORMATION CARD

charge-coupled-device image capture and a *rotary flying* erase head for its standard *Omnimovie VHS Camcorder* (PV-320).

A new high-speed shutter mode is said to eliminate the still-picture blurring usually seen with fast-action recording. A "fade" function and sophisticated audio- and video-editing features are also incorporated into the design of the PV-320. *Panasonic* designers seem also to have rethought the role of the humble battery-charge stand, reconfiguring it into something more central to the camcorder's functions.

Although more compact, we did find the *Omnimovie* a tad heavier than the Minolta V-1400 that we tested recently. Its record control was a little confining, although all the controls seemed scaled down as if to fit on the camcorder's more compact body.

In a variety of standard situations (a shadowy living room, twilight, and bright sun outdoors, a dim restaurant), the PV-320's performance was most impressive. *Panasonic* claims that the camcorder is capable of recording "using the light of a single candle;" and based on our limited test we wouldn't disagree. Unfortunately, our only experience with the fast-shutter feature was discovering that mistakenly engaged, it reduced footage to shadowy ghosts.

A standby switch conserves battery life during recording sessions. Although the information is buried in the paragraph at the beginning of the operating instructions' "features" table, the unit's rechargeable battery is apparently good for up to 2 hours and 40 minutes of continuous recording.

In designing the battery-recharge stand, *Panasonic* uses the PV-320 as an audio/video center for camcorder playback functions. VHF connections for television and video/audio out for VCR dubbing and camcorder editing both connection to the *Omnimovie* via the recharger/adaptor. In the present modification, we suspect, *Panasonic* has taken an idea from professional video camera design.

Playback controls are grouped under a sliding door on the camcorder's top. The cover acts as a control; when it's pushed over the playback function buttons it automatically sets the unit to "camera." Open, it pushes the switch to "VCR." Those who like to plan ahead should be forewarned that the PV-320's date function is only valid through New Year's Eve, 1999.

Editing, using a VCR to supply new footage to be added or just taping a new audio track, appears to be an *Omnimovie* specialty. Those new "flying erase heads" do make for cleaner edits, while the PV-320's "fade," "edit," and "dub" controls are all aimed at making cleaner, more professional video available to the home entertainment enthusiast.

The *Omnimovie* was found to be very useful for what the operating instructions call "re-recording (video/audio dubbing)." Those instructions, as always, are coupled with a tasteful (and repetitive) reminder that "the unauthorized exchanging and/or copying of copyrighted recordings may be copyright infringement."

Acknowledging home-video reality, the PV-320 instruction booklet devotes nearly as much space to telling the user what to record as to how to record. With point-and-shoot simplicity nearly achieved, the problem becomes making good use of that extraordinary technology. Careful study of the operating instruction's "using your VHS movie" guide should be enough to get the enthusiastic camcorder newcomer up and taping.

It's a little early in the consumer camcorder game to come to any definitive judgment about the dominance of any particular VHS model. Judging from VCR development of the past decade, that clear-cut equipment advantage may never come about. With Super VHS and digital video still at the starting gate, even further performance improvement for non-professional video recording may be in the works. In the meantime, units like the *Panasonic Omnimovie VHS* set an impressive pace.—*G.A.*

TAG Sale

LAZER TAG STARLYTE. Manufactured by: Worlds of Wonder, Inc., 4209 Technology Dr., Freemont, CA 94538. Price: $29.95. LAZER TAG STARSENSOR. Price: $19.95. LAZER TAG STARBASE. Price: $49.95.

A press release issued during the Christmas buying season, headlined the increased popularity of electronic toys and games. "High technology, video interactive, and other types of electronic toys are leading the list of top-selling toys this holiday season," it claimed, based on a poll of toy retailers.

Although issued in behalf of another manufacturer, we're sure that at least part of that increasing market share is due to the heavily promoted *Lazer Tag*, a constellation of game products from *Worlds of Wonder*. The foundation for all of it is the *Starlyte*. While it may look like a futuristic pistol and has drawn harsh criticism as a toy weapon, the company is careful to label it a "hand unit that emits a directed beam of safe, infrared light." Other promotional material calls it a "portable energy unit."

However labeled, the *Starlyte*—measuring about 13-inches in length—is outfitted with a pistol-grip handle and sports a nifty red racing stripe around its sides. There's a sighting lens which displays an impressive ring of red light when the "portable energy unit" emits its "directed beam of safe, infrared light."

There's an audio switch to turn off the unit's electronic weeps and beeps as well as an adjustment that controls the circumference of the infrared beam. A compartment in the rear should be of some interest to parents who'll be expected to keep the energy unit fueled. Into it are loaded the six "AA" batteries necessary to the *Starlyte's functions. But what would a Lazer Tag* portable energy unit be without an "electronic device that registers the tags'?"

Enter the *Starsensor*. Looking like a cross between a tail light and a left-over prop from *Star Wars* (the movie, not the defense project), this item is to be worn on front of the *Lazer Tag* "Starbelt" (sold as part of a $39.95 game kit which also includes a *Starlyte* and the *Starsensor*) or the "Starvest," available separately for $19.95. Failing those accessories, a swatch of Velcro fastened onto any garment would hold the *Starsensor* in place.

By now you've gotten the picture. The *Starlyte* sends forth its infrared beam, accompanied by much science-fiction-inspired audio/visual imagery (including realistic "decay" of the pretend Lazer signal). A direct hit to the *Starsensor* sets off a "stuttered electronic tone." A semi-circle of LEDs keep track of the number of "tags" completed. With the "sixth and final tag,' the *Starsensor* emits a game-over sound while the LEDs flash in unison." All of that pre-programmed sound and fury requires only a single 9-volt battery.

The company also offers a unit in solitary pursuit of *Lazer Tag*, the *Starbase*—to our thinking, the jewel in the crown of the *Worlds of Wonder* special-effects department. Looking like half the spaceships that have come down the Hollywood pike in the past four decades, the *Starbase* makes up for its inanimate nature by being loud and flashy. A "control panel" allows for some variation in play.

Standing 6-inches tall, that six-legged, black and silver electronic opponent can send out a "protective shield" and fire infrared beams back at *Lazer Tag* players. Both functions are activated randomly.

Players can also select "time" or "tag" determined games. "Time" puts a minute limit to the game, while "tag" requires a particular number of tags be made to triumph. The *Starbase* features an LED counter which keeps track of tags as well

as a "game start" button. "Beeps," "sirens," "alarms" and "a Lazer-like sound" [sic] are among the audio effects in the *Starbase* arsenal. This powerhouse of distraction requires a half-dozen "C" batteries.

In addition to the toys and accessories GIZMO looked at, there's a *"Starhelmet"* ($39.95), a *"Starcap"* ($24.95) a two-way *"Startalk"* radio ($24.95) and a *"Starscope"* ($9.95), which fastens to the *Starlyte* scope and "emits a targeted visible light more than 25 feet away." For the real fanatic, there's the *Starlyte* "Pro" ($44.99 to $49.99), a "larger even more sophisticated version" of the game's "hand-held energy unit." For the total lifestyle, there are licensed *Lazer Tag* arenas which provide futuristic, wide-open spaces in which to play.

A booklet included with the game kit says that the only limit to *Lazer Tag* is the "imagination" of the players. We may be lacking in just that quality—after an examination of the game, it seemed to us that another limitation is the potential player's battery budget. To get two *Starlytes* and *Starsensors*, along with a single *Starbase*, up and running cost a total of $22.75 in battery costs.

We wish that this were a product that especially fosters imagination; instead, it rather impressed us as much technological (and marketing) adieu about a fairly basic concept. The toys are handsomely designed, the use of infrared beams is at least clever, but it seems to us that *Lazer Tag* takes the long way around on a very short premise.—*G.A.*

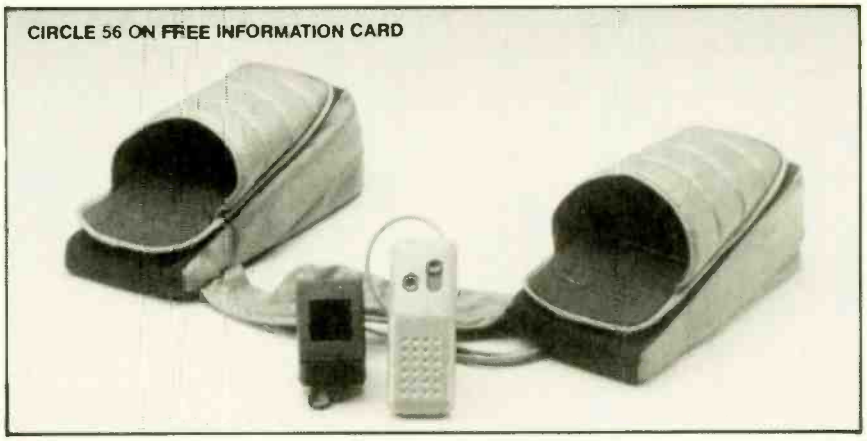
CIRCLE 55 DN FREE INFORMATION CARD

Happy Feat

FAMILY PRACTICE FOOT CHARGERS (FG-6). Manufactured by: Clairol, Inc., P.O. Box 10213 Stamford, CT 08902-0001. Price: $39.99.

Has a Nobel prize ever been awarded in podiatry? Of course not, which, given the importance of the task assigned to feet, indicates the ignoble regard in which they, and their comfort, are held. That feet are humble appendages is suggested by one of their nicknames, "dogs." Only the waggish Fats Waller ever penned a song devoted to the human foot, or "pedal extremities" as the tune, *Your Feets Too Big*, dubbed them.

Appliances devoted to foot care are no new development. Since the era of Edison, electricity has been applied to the problem of bringing relief to aching "dogs." What is new is a relatively low-priced product, *Family Practice Foot Chargers*, which seems to accomplish the same ends as some more elaborate devices for the care and comfort of feet.



CIRCLE 56 ON FREE INFORMATION CARD

The *Chargers* are two over-size slippers with Velcro bottoms resting atop connected, wedge-shaped, fabric-covered soft stands about 3½ inches tall at their highest point. A low-voltage transformer plugs into a wall outlet. A corded "remote control" features an on/off heat switch and a three-position vibration selector.

Clairol's information release for the product characterizes the *Foot Chargers'* action as a "massage," and quotes a podiatrist to the effect that the kneading action of a massage soothes sore muscles and ligaments, revs up circulation, and stimulates nerve endings. It also helps relieve fatigue and tension, while it pampers and rejuvenates overworked feet.

Those aren't claims which **GIZMO** can evaluate, but what we did find out is that everyone who put their feet in the

Chargers' slippers used similar adjectives to describe the experience—relaxing, rejuvenating, and so forth. Two aspects of the product which our tests discovered aren't outlined in the instructions.

Used without heat, the *Chargers*' vibratory action is more vigorous, particularly on the "high" setting. Also, users will want to select their wall outlets carefully. Plugged in to the wrong socket, the device interfered with television reception, causing lines to appear on the screen in synchronized response to the vibrating action of the *Chargers*.

For more direct massage delivered to the bottoms of the feet, this gadget can be used without the slippers. Although the supplied footwear will never win any fashion awards, they're thoughtfully designed. They fit feet up to the male size 13 and can also be adjusted to encase smaller feet more snugly. The slippers can be washed by hand.

Sold with a limited one-year warranty, *Foot Chargers* provide the same vibratory action as foot-care appliances costing significantly more. Over all, it also wins points for quiet and unobtrusive operation. Undoubtedly a popular gift item during the holidays; and if you want to pamper your own tired and/or aching feet, *Clairol's Foot Chargers* just might be a perfect fit.—*G.A.*

Private Lightning

EYE OF THE STORM. Manufactured by: Rabbit Systems, Inc., 233 Wilshire Blvd., Santa Monica, CA 90401. Price: $199.

It used to be that audiences were content to see special effects; nowadays, it seems, people want to live with them. Like spin-offs from the space program, consumer products abound, which come direct to the market from the big and small screens. It's impossible to imagine, for example, a product like *Eye of the Storm* from *Rabbit Systems*, Inc. without thinking of all the mad scientist laboratories of the silver-screen past.

For decades in the movies, no on-screen laboratory has been complete without the high-intensity crackle of electricity leaping and condensing under glass. For a little over a year, consumers have been offered the same effect for their home. *Eye of the Storm* is a mass-production version of "plasma spheres" which began appearing in limited editions a few years ago.

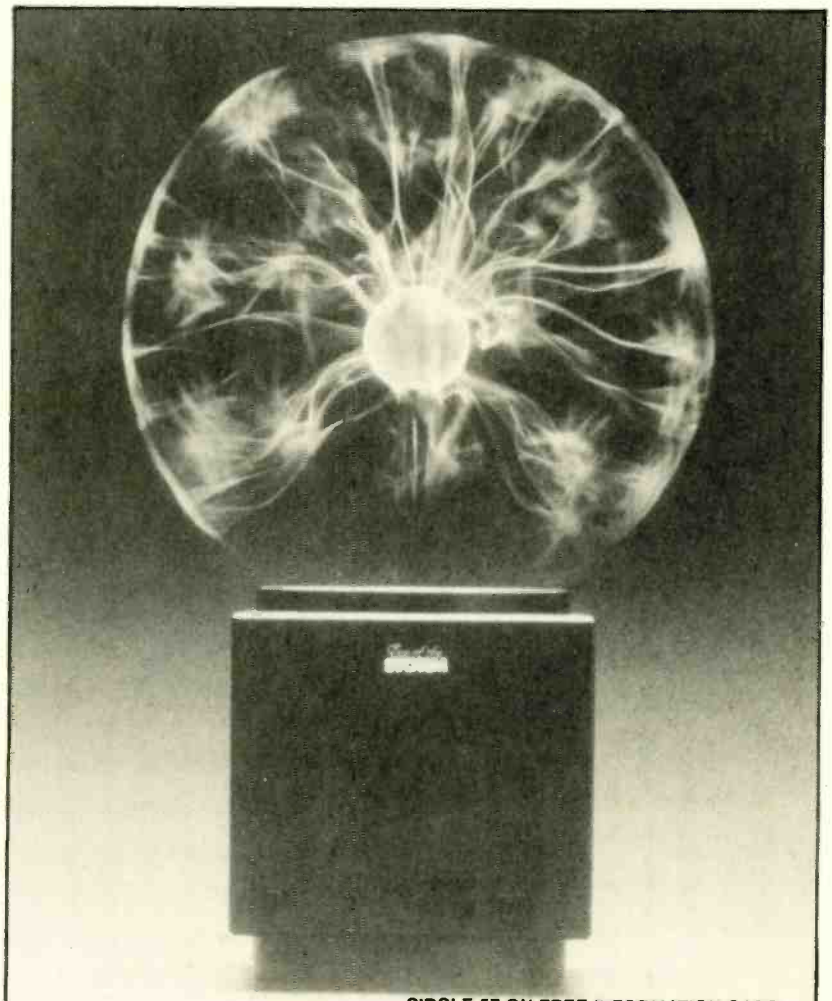
In this case, the sphere is 8 inches in diameter, filled with what *Rabbit* labels "a unique and secret formula of rare but harmless natural gases," mounted on a 6-inch tall black base. Within, a stream of "charged particles suddenly bursts forth into the atmosphere," producing "strands" and "wispy bolts" of magenta and blue. Touching the surface of the glass, gathers the "unchained lightning" creating what the company is pleased to describe as "beautiful swirling formations that follow your every move."

So what does the *Eye of the Storm* do for an encore? It adds sounds to the light show. Controls built into the unit's base vary power and frequency in the chamber. Other circuits allow response to sounds, including voices or music. Or in the more exalted language of the sales brochure, "the *Eye of the Storm* actually reacts to music with ever-changing rhythmical flashes of lightning. You can even talk to it and see the patterns of your voice reflected in its striking pulsations."

The brochure also gives the product a more dignified ancestry than the special-effects workshops of Hollywood, calling it a "Chamber of Living Lightning—originally developed by the 19th Century inventor Nicola Tesla." Plugged into a wall socket, we imagine that it is quite a draw on another of the master's celebrated inventions, alternating current.

We also wondered what kind of person could be imagined buying an *Eye of the Storm*? Electronics hobbyists would probably want to fabricate their own "chambers of living lightning," while non-enthusiasts might wonder about the efficacy of living with a ball of lightning in their living rooms. After all, the mere sight of the Eye Of The Storm can conjure up images of tiny lightning bolts roaming unobstructed through the house.

Just around the corner from the **GIZMO** office is a business—what used to be called a "mitt parlor"—that was just waiting for this product. The awning offers to "read the future," and a window display shows the tools of the trade; Tarot cards, a phrenology bust, and what's called a "crystal ball." Those items are spread around an *Eye of the Storm* casting its eerie spell over a fortune teller's consultation room.—*G.A.*



CIRCLE 57 ON FREE INFORMATION CARD

Sima Copykit video transfer device

Here's a consumer gizmo with a built-in short market life. A sign of the end of the home movie era it's called a *Copykit* and it allows camcorder owners to transfer and combine reels of 8-mm or 16-mm film onto videocassettes. Marketed by *Sima Products Corp.*, (4001 W. Devon Ave., Chicago, IL 60646), the *Copykit* consists of an optically flat mirror and an 8" by 10" rear projection screen. The device works by bouncing projected images off the mirror and onto the surface of the rear projection screen. No special lens attachments are needed, and the process also allows background music or narration to be added to the newly videotaped program. It will also work with slides. Of course in a few years time, when everyone's old home movies have been transferred or have disintegrated, consumer interest in *Copykit* will evaporate. Price: $39.95.

CIRCLE 58 ON FREE INFORMATION CARD

Sima Copykit

Nicola Tesla Book Company Catalog

Nicola Tesla remains an enigmatic figure in the history of technology: a brilliant theorist of electromagnetic phenomenon, bitter commercial and scientific rival of Edison, and an electrical genius who claimed visionary powers while suffering bizzare phobias. The Tesla Book Company (P.O. Box 1649, Greenville, TX 75401) specializes in material connected with this controversial scientific figure, ranging from no less than three biographies and a Yugoslavian-made biographical drama (with Orson Welles as the financier J.P. Morgan) on videocassette, through reprints of scientific articles published by Tesla during his life time, descriptions of his experiments and many patents, to books arguing that the Soviet Union is using Tesla's theories to construct "Scalar Electromagnetic Weapons." The firm offers a *Nicola Tesla Catalog* describing its merchandise. Price: $1.

CIRCLE 59 ON FREE INFORMATION CARD

Markline Motorized Spice Track

The automated kitchen has been fair game for comedy for decades, but the notion persists. For example Markline Co., Inc. (14 Jewel Dr., Wilmington, MA 01887) offers a *Motorized Spice Track*, which the company says "solves the problems of cluttered cupboards and hard-to-find spice bottles." Equipped with a dozen spice bottles, the Spice Track is battery powered and can be used with "most conventional store-bought spice containers." Easily cleaned, it's designed to be mounted under a kitchen cabinet or can be stored on a counter top. Price: $39.

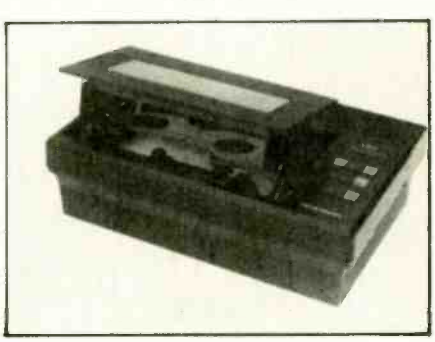
CIRCLE 60 ON FREE INFORMATION CARD

Motorized Spice Track

Shintom VHS Professional Cassette Rewinder

If a product were described as featuring "power-supply dual clutches, tension bands, and buffered brakes," in a blindfold test, you might guess that some kind of vehicle is being offered. In this case, however, it's a video accessory from Shintom West Corp.of America (20435 S. Western Ave., Torrance, CA 90501), the firm's *VHS Professional Cassette Rewinder* (VCW-210). In addition to the automotive-like characteristics listed above, the *Shintom VCW-210* features gear drive and the same "transport mechanism" used in actual VCRs. Constant torque ensures uniform tape tension and even tape alignment on the spool. Weighing in at 6.6 lbs., the *VCW-210* is aimed at the video trade. Shintom says that although it costs more than some rewinders, the unit "will stand the test of time." Price: $119.95.

CIRCLE 61 ON FREE INFORMATION CARD



VHS Cassette Rewinder

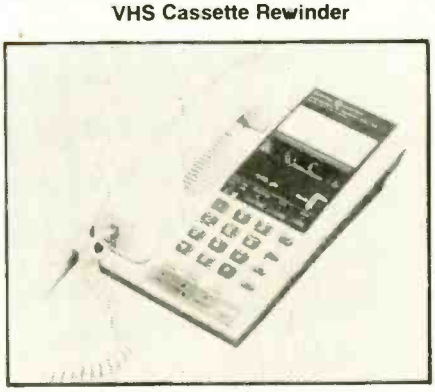
General Electric Wall-Mount Telephone/Answerer

The notion that telephone answering machines are somewhat exotic pieces of communication gear is long past. So much so that manufacturers scramble to come up with new variations on the answering-machine theme—like the *Wall-Mount Telephone/Answerer* (2-9890) from General Electric (Consumer Electronics, Electronic Park, Bldg. 5, Syracuse, NY 13221).

The "Answerer" half of the combo uses a single dual-track microcassette and features remote message retrieval, remote "on" function, a long-distance, charge-minimizing toll saver and a digital display that shows how many calls have been received. And a power-failure function ensures that the telephone will work even if power is lost.

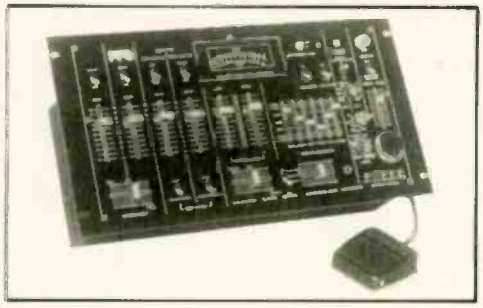
Its Telephone can be switched from tone to pulse operation, it has single-touch memory dialing for 3 emergency numbers, and can retain in memory 9 additional telephone numbers. The unit also features single-touch redial capability and a ringer volume control, which can shut off the bell completely. Price: $127.95

CIRCLE 62 ON FREE INFORMATION CARD



Wall-Mount Telephone/Answerer

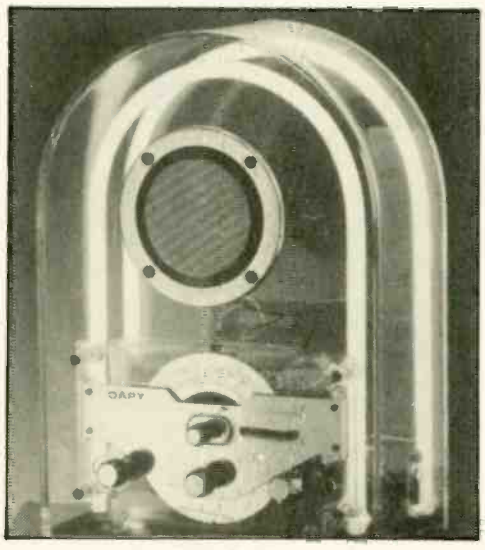
Gizmo/Bytes



Stereo Program Mixer

Phone-E

Shintom VCR



Neon Radio

Numark Stereo Program Mixer

It may be a small step for audio technology, but it's apparently an impressive leap in the world of live disc jockeying. We're referring to the new *Stereo Program Mixer* (DM1775) from the professional products division of Numark Electronics Corp. (503 Newfield Ave., Raritan Center, P.O. Box 493, Edison, NJ 08837).

The company hails it as "the world's first *Stereo Program Mixer* with built-in 4-second digital sampler." A "variable delay rate," makes it possible for DJ's to "create such popular effects as chorusing, flanging, phasing, hard slap and long echos." The unit even allows for "scratching and beat mixing" without a second copy of the record being scratched and beaten. The platter handler can privately preview sonic effects before unleashing them on the audience.

With a sampling circuit capable of storing 4 seconds of material, Numark points out, "broadcast DJ's can store station call letters and ID spots in memory." For the final touch of hands-free operation, the *DM1775* can be outfitted with Numark's *FS775 Foot Switch*. All this without the "need for additional playback equipment or multitrack dubbing." Price: $829.95.

CIRCLE 63 ON FREE INFORMATION CARD

National Communications' Phone-E

Cellular car phones aren't quite the novelty that they were a few years ago, but National Communications Groups, Inc. (P.O.Box 35610, Canton, OH 44720) still thinks they're worth a chuckle. The joke takes the form of the *Phone-E*, "an exact replica of a glass-mount cellular phone antenna." National Communications says its owners "enjoy the prestigious image of having a car phone without the annoyance and expense." The *Phone-E* is described as an all metal construction using the finest alloys, hard finish paint and the "same adhesive backing as a real cellular antenna." It comes gift-packaged complete with a 12-page owners manual. Price: $12.95

CIRCLE 64 ON FREE INFORMATION CARD

Shure Brothers ClearVoice Hands-Free Microphone

According to industry reports, there were some 651,000 cellular phones in use as last year began. A market of this size, and affluence, practically begs for accessories. Shure Brothers Inc. (222 Hartrey Ave., Evanston, IL 60202-3696), among the best known names in microphone technology has responded to the challenge with the *ClearVoice Hands-Free Microphone* (800HF) for use with cellular mobile telephones.

According to Shure, most cellular telephone owners "don't use their current hands-free' microphone because transmission is so poor." Besides representing an intolerable burden to the kinds of people who own cellular car phones, not using the hands-free mic can create traffic hazards for everybody.

The unit incorporates a cellular microphone and a dual low-noise, two-stage, amplifier system. The microphone, highly directional in its design, is claimed as 60 percent less-sensitive to the ambient noises surrounding transmitted conversation. Most cellular instruments, Shure says, can use the ClearVoice without modification. Price: $199.

CIRCLE 65 ON FREE INFORMATION CARD

Shintom Two-Head VCR

With the way that manufacturers group prices of competing systems, old-fashioned bargain merchandising sometimes seems a thing of the past in electronics. Not, however, if you're a comparative newcomer to the marketplace like Shintom West Corp. of America (20435 S. Western Ave., Torrance, CA 90501) which in January introduced a budget-priced, two-head *Video Cassette Recorder*, the *4530*. It's a few-frills, front-loading unit with frequency-synthesized tuning, HQ circuitry and a fourteen day/six event timer. Its twenty-eight-function remote is capable of memorizing sixteen pre-set positions. Along with this new VCR and others, Shintom unveiled its new corporate slogan, "The Fine Art of Technology." We certainly hope so. Price: $289.

CIRCLE 66 ON FREE INFORMATION CARD

Dapy Neon Radio

The French firm Dapy (431 W. Broadway, New York, NY 10012) has established itself in consumer electronics with unusual designs using neon tubing. Among the newer Dapy products is a *Neon Radio* inspired by the "cathedral-style" table radios of the 1930's.

This one features pink and blue neon bands, a clear plexiglass case and AM/FM reception via a single speaker. Separate power switches control the radio and the neon lighting. Price: $490.

CIRCLE 67 ON FREE INFORMATION CARD

Sony Portable CD Player

Portable CD players took off as a popular audio item as soon as they were introduced. Among the early players was *Sony Corp. of America* (*9 W. 57th St, New York, NY 10019*) and the firm's managed to stay abreast in this product field ever since. The newest model is the *D-160 Portable CD Player*, a compact unit Sony calls "an affordable CD player with all the trimmings." In a vehicle, the *D-160* operates via the cigarette lighter and includes a cassette adaptor (*CPA-1*) which can connect the player to a car stereo system. In contrast to some early modes, "it's designed to perform reliably and safely despite the shocks, shakes and other extremes of the car environment." As an at-home player, the *D-160* features a line out stereo mini jack and patch cords for connection to stereo systems and offers an optional wireless remote control with "play," "pause" and "stop." The unit can also be used with stereo headphones. Price: $249.95

CIRCLE 68 ON FREE INFORMATION CARD

Portable CD Player

Sharp Color LCD TV

Unveiled in prototype at last year's Summer Consumer Electronics Show, the miniature *Color LCD TV* (3ML100) from *Sharp Electronics Corp.* (*Sharp Plaza, Mahwah, NJ 07439*) only became available in January. Sharp promises much for this new product, including an end to "color bleeding, image flickering and poor contrast." The TV makes use of a "thin transistor active matrix system," which controls each of the unit's 92,106 pixels. The firm also says its "unique backlight system simulates natural sunlight, boosting picture clarity and brightness to unprecedented levels." The *3ML100* weighs under 11 oz. and can be powered by dry cell, car or rechargeable battery as well as via an ordinary household outlet with the supplied adaptor. Optional accessories include the touted backlight unit, rechargeable battery, car adaptor, A/V cable and "sunshade for outdoor viewing." If it's as good as Sharp says, the *3ML100* has a price to match its performance. Price: $599.95.

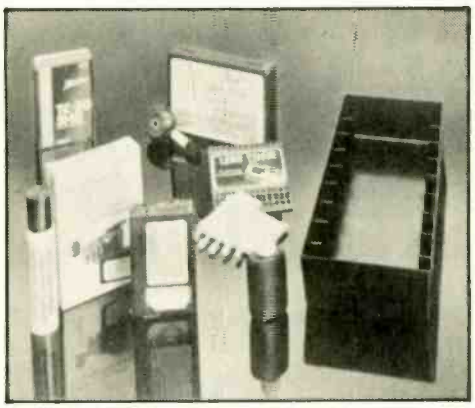
CIRCLE 69 ON FREE INFORMATION CARD

Color LCD TV

Zenith VHS-C Camcorder Care Kit

Selling the blades instead of the razor is a long-established angle in consumer marketing and while video may seem far removed from shaving, the same approach applies. Zenith Electronics Corp. (1000 Milwaukee Ave., Glenview, IL 60025), for example, is marketing a *VHS-C Camcorder Care Kit* for use with compact VHS equipment. The Kit includes a lens care and head cleaning systems. Lens tools include a dust brush, air atomizer, cleaning cloth, and a lens-cleaning solution. For head cleaning, there's a spray cleaner and a tape cartridge for application. Also included, a blank TC-20 SHG C-VHS video cassette. All of this comes packed in a reusable cassette case with 9 slots. Price: $39.95.

CIRCLE 70 ON FREE INFORMATION CARD



VHS-C Camcorder Kit

Jensen Mini Speakers

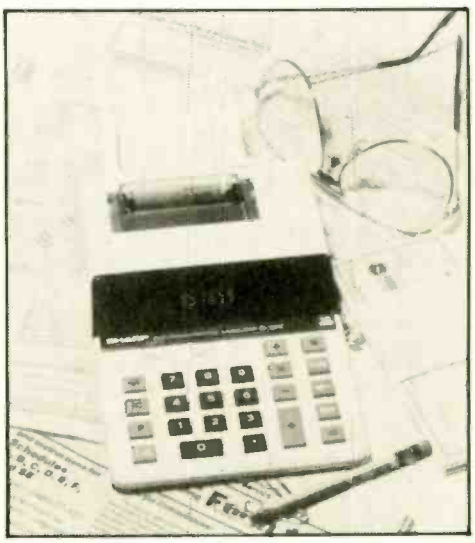
Big sound in small packages is the byword for mini-audio products, like the new *Mini Speaker* from the Advent Division of International Jensen (*4138 N. United Parkway, Schiller Park, IL 60176*). This mighty mite measures 11-in. tall, 6-1/2-in. wide and 5-1/8-in. deep, yet also can handle 40 watts continuous and 120 watts of peak power. The speaker uses a "tuned port enclosure" and its sensitivity (according to Advent) is rated at "88 dB at 1 watt/1 meter" with a harmonic distortion of less than 1.5 percent above 200 Hz at 1 watt." If the Mini Speaker sounds as impressive as its description it ought to win some awards. Price (per pair): $199.95.

CIRCLE 46 ON FREE INFORMATION CARD

Sharp Printing Calculator

Undoubtedly it's not their purpose to cause pain, but the folks at Sharp Electronics Corp. (*Sharp Plaza, Mahwah, NJ 07430*) want to remind everyone that it's possible to "meet the April tax deadline minus frustration." That can be done, they reason, by using a *Printing Calculator*, specifically the *EL-1601T*. It's a new mid-size model with arithmetic logic, in contrast to "adding-machine logic" found in many competing models. This unit features green fluorescent display, 3-position decimal select, and automatic sub-total along with 3-key memory, item count, and percent functions. The *EL-1601T* is sold with batteries and can also be operated with AC current. Price: $39.95.

CIRCLE 47 ON FREE INFORMATION CARD



Printing Calculator

Gizmo/Bytes

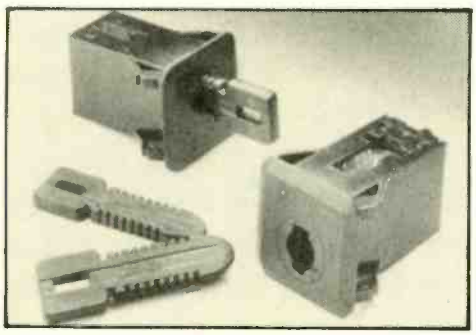
Quicksnap Camera

Fuji Quicksnap Camera

If they last long enough, some products manage to come full circle. The first cameras to achieve mass popularity were sealed units. Once exposures were made, camera and film were turned over to the manufacturer for developing. Fuji Photo Film U.S.A., Inc. (555 Taxter Road, Elmsford, NY 10523) has returned to that idea with its *Quicksnap Camera*. What makes this one different, besides its budget price, is that it's disposable. A roll of 24, 35mm color exposures with a cardboard camera built around it; once the pictures are taken, the entire *Quicksnap* package is turned over for developing.

Sold in a sealed foil container, the simple picture-taking device features a shutter speed of 1/100 second and a lens set at f/11. Meant for outdoor use, especially in situations in which camera owners might not want to use expensive equipment or for spur-of-the-moment picture taking, it might be dubbed a temporary camera. The whole package weighs 4 oz. and is easily pocket-size. Price: $9.95.

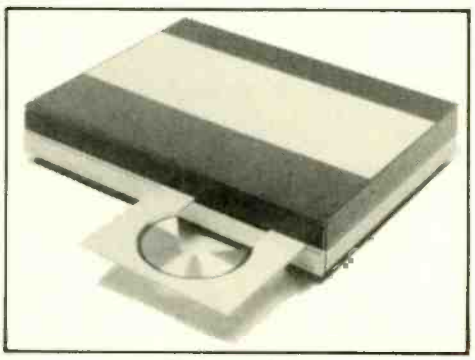
CIRCLE 48 ON FREE INFORMATION CARD


Data Key

DataKey's DataKey

The shape of computer technology is changing rapidly. One of the more interesting new "shapes" is in the form of a key. It's called *DataKey* (DK1000) and is described as a "rugged, portable memory device" by its manufacturer, *Datakey (407 W. Travelers Trail, Burnsville, MN 553337-9990)*. Designed to be carried in a pocket or even on a keychain, the small unit has a 1024-bit memory and retains data "even when exposed to dust, dirt, moisture or magnetic fields." The *Datakey* can be used to store, collect, back-up and transfer data, its most common application is in security. Besides the key, users must have an "access receptacle," either a $50 unit or in its stand-alone form (model RS232), $241. The *Datakey* itself is molded of "durable, static-resistant materials" and requires only 5 volts to operate. Price: $9.10.

CIRCLE 49 ON FREE INFORMATION CARD


Beogram CD

Bang & Olufsen Beogram CD

There's little doubt that compact discs have reshaped the world of recorded music. One company that has always kept up with changes in audio is the prestigious Bang & Olufsen of America, Inc. (1150 Feehanville Dr., Mount Prospect, Il 60056). Its latest entry into the upscale CD sweepstakes is the *Beogram CD* (5500), designed to integrate with the firm's *Beosystem 5500 Music System*.

The new player has sixteen-bit, four-times oversampling circuitry for each stereo channel. A "spacing" function facilitates recording onto tape. In terms of style, the *Beogram 5500 CD* is sleek, streamlined and very sophisticated. Price: $999.

CIRCLE 45 ON FREE INFORMATION CARD

Under Its Spell

(Continued from page 2)

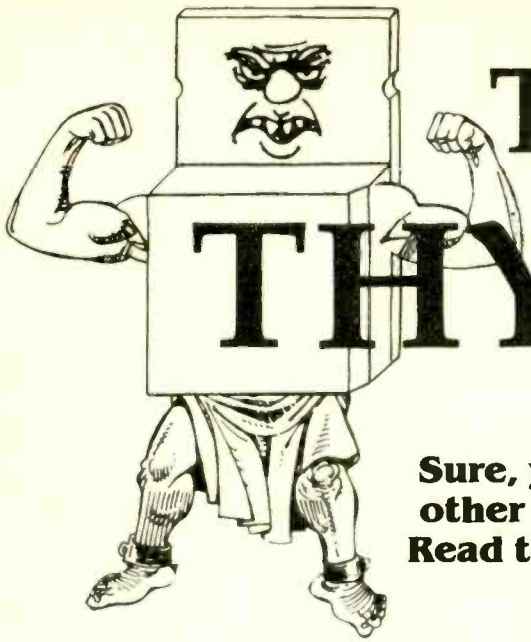
The example *Franklin* uses, the word "go," has some 25 senses of meaning listed through which the user downscrolls. Next to each sense listed a letter appears. Entering that letter from the keyboard brings up alternate words meaning the same. The user can return to each stage—from alternative word list to the original word's thesaurus entry to the definition to spelling correction—by punching the backstroke key.

This unit is so sophisticated that *Franklin* has included a "help directory," displayed by entering "—h," which provides brief explanations of each of the *Language Master*'s functions and capabilities. As an electronic spelling checker and dictionary/thesaurus, this product is probably the most practical unit currently available. Its limitations, for the most part, are the limits of any dictionary—electronic or otherwise.

Vocabularies are always finite. Entering "rock and roll" into the *LM* brought up the words "raconteur" and "reconquer" as the unit's guess as to what we were trying to spell. The *Spelling Ace* was completely stumped by the French term *"nom de plume,"* suggesting that we were trying to spell the word "mandibles." It should be noted that *Franklin* in its description of the Proximity/Merriam-Webster Concise Electronic Dictionary, which provides its spelling computers' database, says nothing about foreign words or phrases.

In using those language computers, we rather enjoyed the unexpected turns in the phonetic road to correct spelling. An incorrectly spelled "incendiary" entered into the *Language Master* brought up, in addition to the right spelling, "insinuator," "unsanitary" and "insinuated" as among the words the user was possibly trying to spell.

Market response to the *Franklin* quartet of spelling computers is such that the company put consumer advertising on hold for a while last winter. Advance word had it that further additions to the line would be announced at the winter Consumer Electronics Show. Even without assistance from *Word Whiz*, *Spelling Ace*, *Spellmaster* or the *Language Master*, it's clear that that spells "success" for those practical, fun word machines.—*G.A.*



The POWER of THYRISTORS

Sure, you know about SCR's, but what about the other members of the powerful thyristor family? Read this article and put oomph in your projects!

There's a lot of ground to cover in the immense field of semiconductor power control. Let's jump right into it starting with Triacs.

Triacs

The triac—originally designated bidirectional triode thyristor, and more commonly referred to as a triode AC semiconductor—is a three-terminal, NPNPN device used to control AC current in either direction. It can be triggered by positive or negative gate signals, which helps simplify circuit design. The basic construction of the triac is shown in Fig. 1A and its schematic symbols shown in Fig. 1B.

Figure 1C shows the N and P semiconductor sections between MT2 and MT1 (visualized as equivalent parallel NPNP and PNPN switches) with current flow defined in conventional terms. Since the triac is a bidirectional device, it has four separate switching modes (or in other words, operating quadrants).

Quadrants of Operation

Figure 2 gives typical four-quadrant characteristics. In quadrant I, triac operation is similar to that of the SCR, in that it is triggered into conduction by a positive gate signal during the positive half of the AC waveform, and MT2 is positive with respect to MT1. In second-quadrant conduction (MT2 positive), the triac is triggered into conduction by a negative gate signal. In third-quadrant operation, conduction—induced by a negative gate signal—is reversed (with MT1 now positive with respect to MT2). Fourth-quadrant conduction is similar to that of third-quadrant operation, in that MT2 is negative with respect to MT1. However, unlike third-quadrant conduction, the triac is turned on by a positive trigger.

Quadrants I, II, and III display the highest sensitivity. Quadrant IV has poor gate sensitivity (requiring up to five times the I_{GT} of quadrant I operation). Thus quadrant-IV triggering is seldom used in triac circuit design. Triac conduction in either quadrants I or III can be caused by excessive voltage across the main terminals. Therefore triac-control circuits are designed so that the minimum blocking voltage (V_{DRM}) is never exceeded.

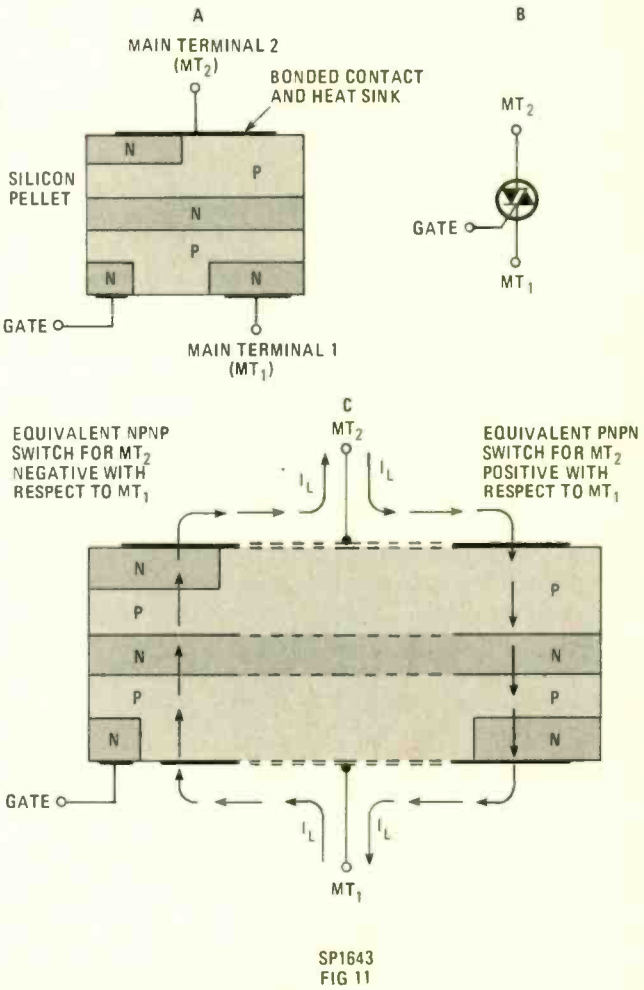


Fig. 1—The basic construction of the triac is shown in A; B shows its schematic symbol; and C shows the triac visualized as equivalent parallel NPNP and PNPN switches: current flow is shown in conventional terms.

Snubber Networks

Transients in the power line can cause off-state voltage to rapidly rise above breakover—at which time, leakage current through the device may induce avalanche-breakover, latching the triac into conduction. That rapid rise in voltage,

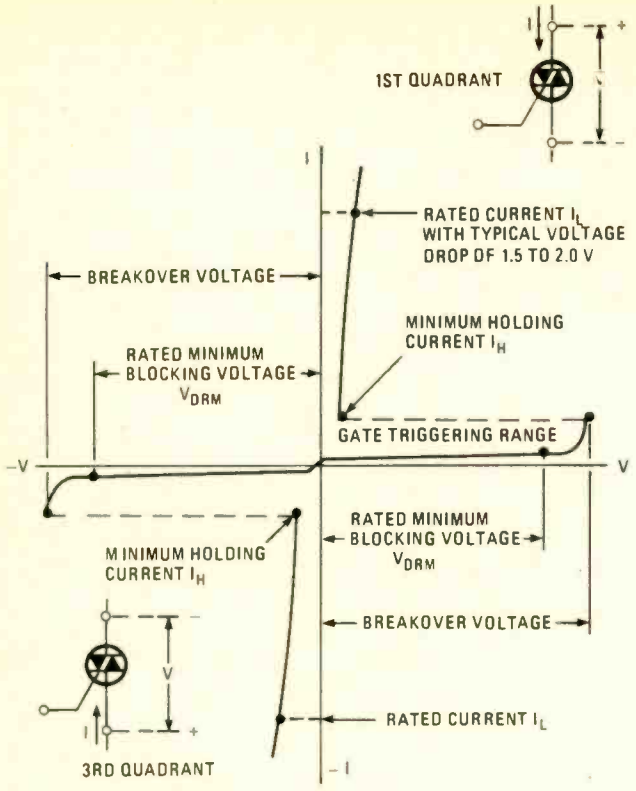


Fig. 2—This illustration gives typical triac four-quadrant characteristics. In the first quadrant, the triac is triggered by a positive gate signal; in second-quadrant conduction, the triac is triggered into conduction by a negative gate signal. In third-quadrant operation, conduction is induced by a negative gate signal; and in fourth-quadrant conduction, the triac is turned on by a positive trigger, making it a multifaceted device.

symbolized by *dv/dt*, is defined as the rate of voltage change with respect to time.

Off-state voltage need not exceed breakover for switching to occur. The rapid increase in voltage across the triac (referred to as critical or static *dv/dt*) results in a charging current through the internal capacitances of the device. When that charging current equals or exceeds the I_{GT}, the triac conducts. The charging current, a function of the capacitance and the rate of change of voltage across the capacitor (see Fig. 3A), is given by:

$$I = C(dv/dt)$$

where: I is charging current in amperes; C is capacitance in farads; *dv/dt* is the voltage change rate in volts per second.

Snubber networks—consisting of a series resistor and capacitor across the MT2 and MT1 terminals (as shown in Fig. 3B)—which similar to the arc-suppression networks sometimes used across relay contacts, can be used to prevent turn-on due to sharp increases in the off-state voltage and transient-induced breakover. When power is first applied, C_S acts as a direct short. By the end of one time constant (RC), V_C has risen to about 63% of the supply voltage, and after 5RC, V_C almost equals V_O. Across the triac the action is as shown in Fig. 3C.

Inductive-Load Implications

Unfortunately, most triac circuits are more complex to analyze. In inductive-load circuits, for example, current lags voltage. In addition, transient pulses riding on the waveform can result in much higher voltage-peaks across the TRIAC. Therefore, snubber-network designs must account for peak line voltages, load characteristics, and the device's static *dv/dt* rating. In general, the time constant of the RC-snubber network must be very small when compared to AC load conduction time.

Like the SCR, the triac should be triggered with a fast-rising waveform for reliable turn-on. However, care should be taken to avoid exceeding the gate power-dissipation limits of the unit. Unlike the SCR, the triac is usually turned on twice per AC cycle. It therefore, must turn-off promptly at the end of each half cycle so that it can be triggered in the opposite direction for the next half cycle (referred to as commutation).

A 60-Hz AC source may result in a commutation time of 1 mS or less, during which load current must drop below I_H to permit full turn-off. With resistive loads, successive turn-off/turn-on is easily accomplished, since voltage and current in a resistive AC circuit are in phase. Inductive loads, such

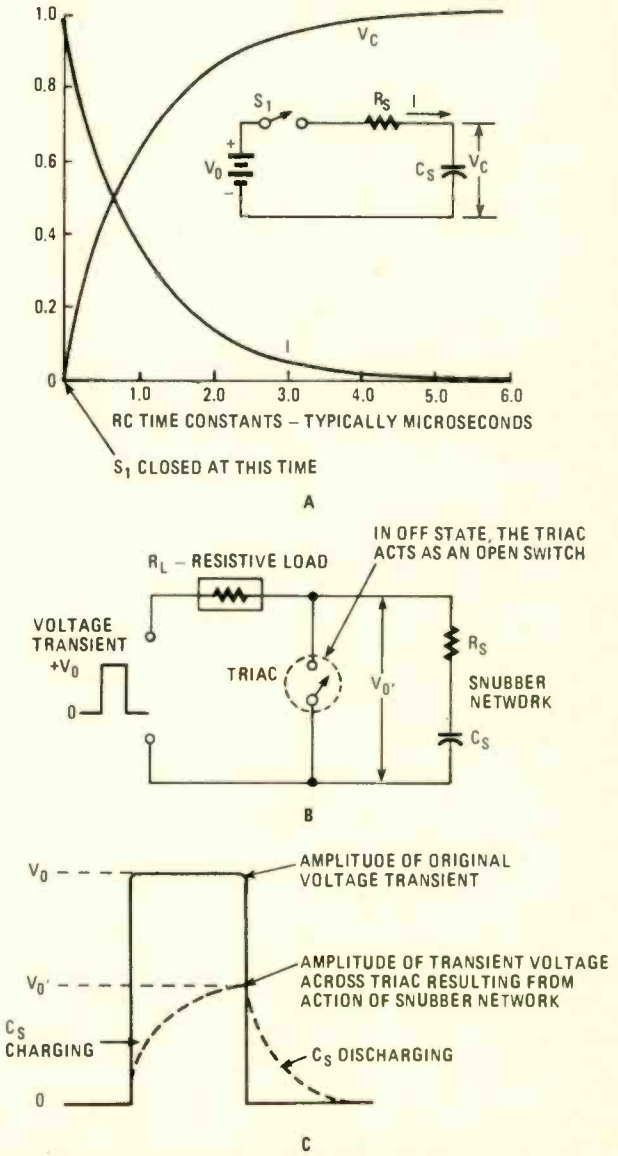
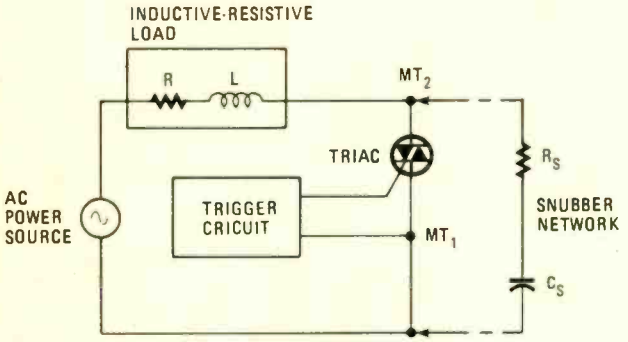
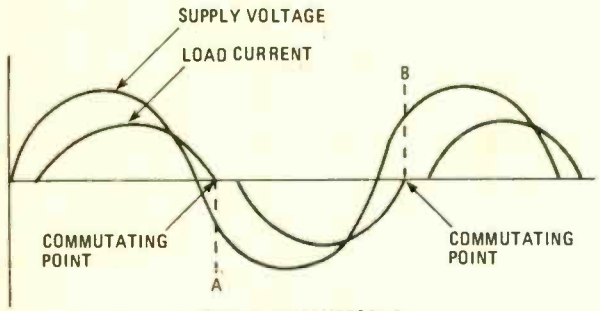


Fig. 3—Snubber networks—consisting of a series resistor and capacitor—which, similar to the arc-suppression networks sometimes used across relay contacts, can be used to prevent turn-on due to sharp increases in the off-state voltage and transient-induced breakover.

as motors and transformers, are a different story. As shown by the waveforms in Fig. 4, current in an inductive or inductive-resistive circuit lags the applied voltage. And that lagging current holds the triac in the on-state past the end of the half cycle.



(A) TRIAC INDUCTIVE-RESISTIVE LOAD CIRCUIT.



(B) CIRCUIT WAVEFORMS.

Fig. 4—A 60-Hz AC source may result in a commutation time of 1 mS or less, during which load current must drop below the holding current (I_H) for full turn-off. With resistive loads, turn-off/turn-on is easily accomplished, since voltage and current in a resistive AC circuit are in phase. Inductive loads, such as motors and transformers, are a different story. As shown by the waveforms, current in an inductive or inductive-resistive circuit lags the applied voltage. And that lagging current holds the triac in the on-state past the end of the halfcycle.

When load current finally drops below the holding level, the triac switches off. However, by that time, the next half cycle voltage has risen appreciably. That causes a sudden increase in voltage across the triac, which may induce premature triggering during the next half cycle. The maximum rate of rise in off-state voltage (known as the commutating *dv/dt*) that won't induce conduction is specified in terms of maximum rated on-state current, maximum-case temperature for the rated on-state current, and the maximum rated off-state voltage—all of which affect commutating *dv/dt* limitation.

Other Characteristics

The t_q for the triac is seldom specified as it is for the SCR, because the triac is normally expected to conduct during both halves of the AC signal. Generally speaking, triacs I_H and external circuit characteristics determine the point of turn-off.

As with other thyristors, triac operating characteristics may vary considerably with temperature changes. For example, gate trigger current (I_{GT}), gate trigger voltage (V_{GT}), and minimum DC I_H all vary inversely with temperature, as illustrated in Fig. 5. DC I_H is also related to voltage polarity across the main terminals, which for first-quadrant operation (MT2 positive) may exceed third-quadrant DC I_H by about 10 to 40 percent.

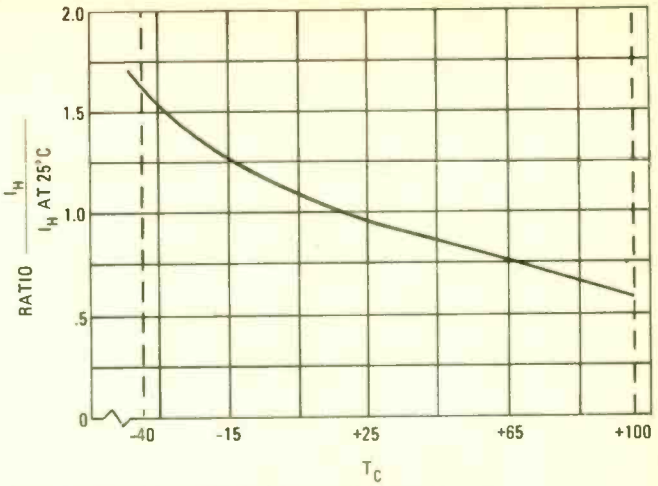


Fig. 5—As with other thyristors, triac operating characteristics may vary considerably with temperature changes. For example, gate trigger current (I_{GT}), gate trigger voltage (V_{GT}), and minimum DC holding current (I_H) all vary inversely with temperature, as illustrated. DC holding current is also related to voltage polarity across the main terminals, which for first-quadrant operation (MT_2 positive) may exceed third-quadrant DC holding current by about 10 to 40 percent.

Triac-control circuits require that careful design consideration be given to temperature characteristics concerning gate trigger, DC I_H, and *dv/dt* conditions. In particular, low-temperature operating environments require higher-amplitude trigger signals for reliable operation.

Switching Techniques

Triacs are available in a wide variety of current-handling capabilities and package types, and are triggered into conduction by a variety of methods—the application dictating the method. Triac-gate circuits can be designed for static, zero-voltage, or phase switching techniques—each providing specific advantages and limitations.

Static switching offers many advantages over mechanical switching, where relays or manually operated switches are used. With no moving parts, static switching eliminates arcing and contact bounce, resulting in more reliable operation and virtual elimination of radio-frequency interference (RFI). As with SCR's, triacs can be used in zero-voltage switching circuits to control the average power to the load (see the block diagram in Fig. 6A).

In zero-voltage switching, the triac conducts for virtually 360 degrees—triggered at about 0 and 180 degrees—of the cycle, with full power delivered to the load. The ratio of power-on/off intervals yields the average power applied to the load. For example, with a timebase of .5 second and the triac switched on for 15 full cycles, the average power applied to the load is half the full power. Like static switching, zero-crossing systems are virtually free of RFI problems.

Triac phase-controlled gate circuits allow conduction of load current during a specified portion of each half cycle, and allow the use of resistive gate-switching techniques to trigger the triac at angles up to 90 degrees. Resistance/capacitance phase-shifting networks may be used to delay firing up to nearly 180 degrees.

The performance of phase-controlled trigger circuits can be greatly improved by the use of trigger devices such as the diac. For low-voltage levels, the trigger device exhibits a

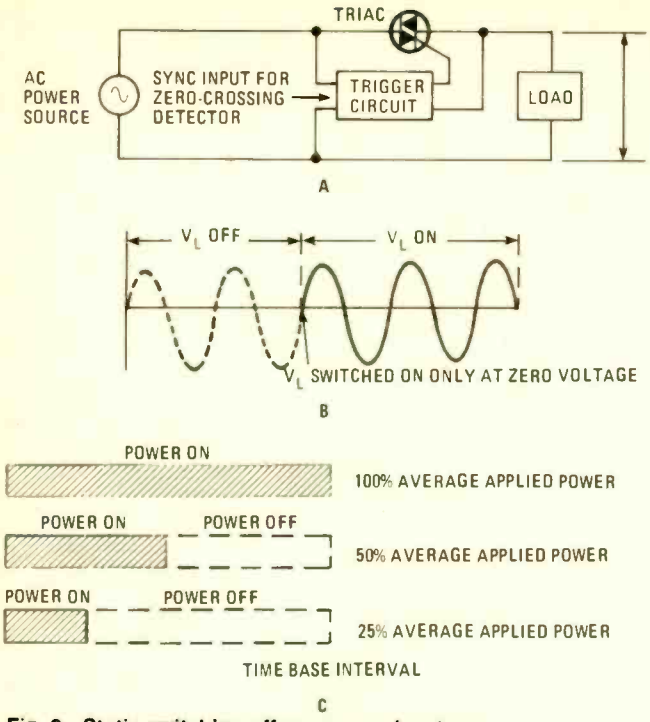


Fig. 6—Static switching offers many advantages over mechanical switching, where relays or manually operated switches are used. With no moving parts, static switching eliminates arcing and contact bounce, resulting in more reliable operation and virtual elimination of radio-frequency interference (RFI). Triacs, as with SCR's, can be used in zero-voltage switching circuits to control the average power to the load as in Fig. 6A.

high impedance, and except for a small leakage current, no gate signal is presented to the triac. When the applied voltage reaches the breakover level, the trigger device suddenly latches into conduction, applying a fast-rising trigger to the triac gate, and inducing turn-on of load current.

The diac is one of the more-common trigger devices in use today, although other devices, such unijunction transistors (UJT's) and special two-transistor switch configurations (fabricated as one integrated circuit) may be used.

Diacs

The diac—sometimes referred to as a bidirectional diode—is a three-layer symmetrical, two-terminal NPN semiconductor device (used extensively as a trigger device for the triac) capable of blocking or conducting current in either direction. It's similar in construction to an NPN bipolar transistor with no base connection. But unlike the bipolar transistor, the diac possesses uniform construction: The N- and P-type doping is essentially done in the same amounts at both junctions. And regardless of the polarity of voltage across its terminals, one junction will always be forward-biased and the other reverse-biased.

The operation of the diac is such that, prior to turn-on (as shown by the four-quadrant characteristic curve in Fig. 7), there is no current flow through the diac other than a small leakage current. But when the turn-on criteria is met, by increasing the applied voltage to the breakover-voltage level (V_{BO}), the reverse-biased junction goes into avalanche breakdown. That causes the device to exhibit negative resistance; resulting in increased current through the device as the voltage across it decreases.

Diacs are used extensively as triac-trigger devices in AC-

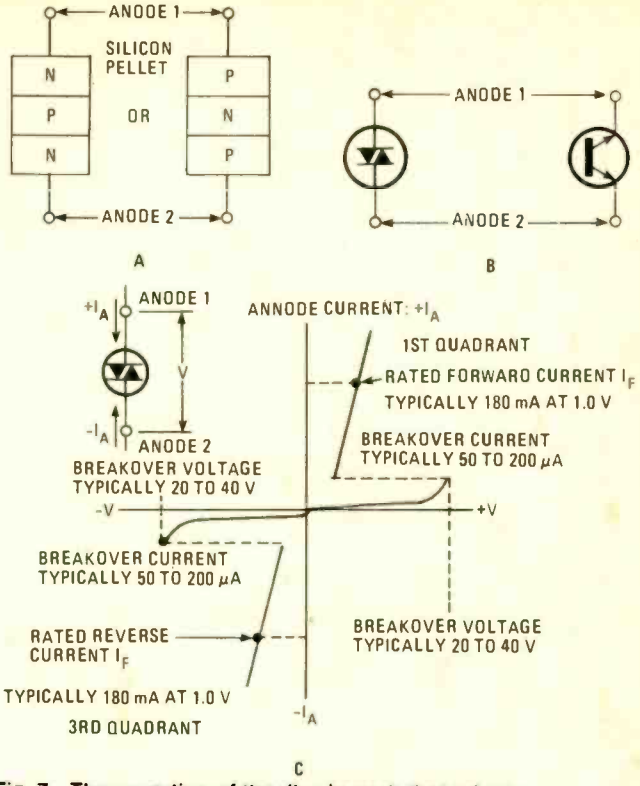


Fig. 7—The operation of the diac is such that prior to turn-on, as shown by the four-quadrant characteristic curve, there is no current flow through the diac other than a small leakage current. But when the turn-on criteria is met, by increasing the applied voltage to the breakover-voltage level (V_{BO}), the reverse-biased junction goes into avalanche breakdown. That causes the device to exhibit negative resistance; resulting in increased current through the device as the voltage across it decreases.

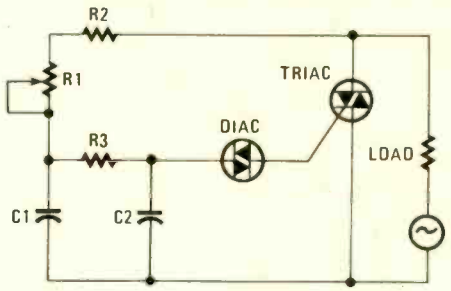


Fig. 8—Diacs are used extensively as triac-trigger devices in AC-control circuits such as lamp dimmers, heating controls, motor-speed controls, to name just a few. This is a typical triac phase-control circuit using a diac as a trigger diode for the triac gate.

control circuits such as lamp dimmers, heating controls, motor-speed controls, to name a few. Fig. 8 shows a typical triac phase-control circuit using a diac as a trigger diode for the triac.

SCS's

The silicon-controlled switch (SCS), which is similar in construction to the SCR, (see Fig. 9A) is a four-terminal/four-layer PNPN device (having two gate terminals), primarily used in low-power switching applications. Either gate can be used to turn on or turn off the main current through the device (Refer to Fig. 9B).

An equivalent two-transistor construction can again be used to describe the operation of the SCS (shown in Fig. 9C).

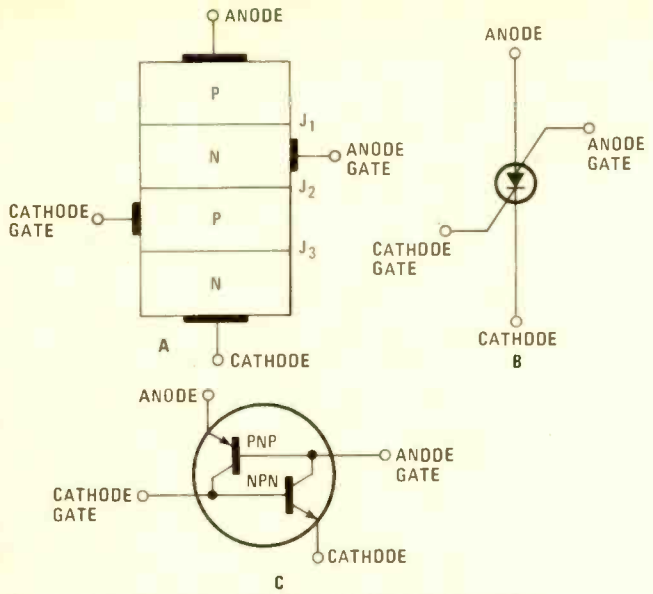


Fig. 9—The silicon-controlled switch (SCS), which is similar in construction to the SCR, is a four-terminal/four-layer PNPN device (having two gate terminals), primarily used in low-power switching applications. Either gate can be used to turn on or turn off the main current through the device.

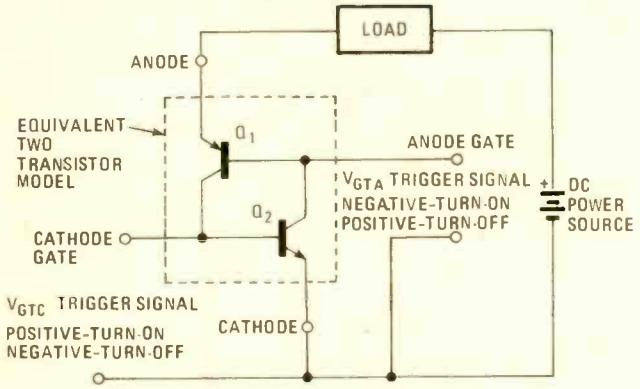


Fig. 10—A typical PUT relaxation-oscillator circuit. A voltage-divider network (consisting of R1 — R3) provides a fixed V_G. When anode voltage is lower than V_G (as shown in B), the PUT is off, and only negligible reverse-leakage current flows through the PUT, because the anode-gate PN junction is reverse biased.

The only difference between the SCS and SCR two-transistor construct is the second-gate terminal of the SCS. Fig. 10 shows the SCS two-transistor model connected to a load and a DC power supply.

Prior to the application of a trigger signal (to either gate terminal), the SCS is turned off. The collector-base junctions of both transistors are reverse-biased, preventing current flow. Note that a DC path from the anode-gate (gate nearest the anode in the 4-6B) to ground is not permissible, since such a path would allow load current to flow through the forward-biased emitter-base junction of Q1.

A positive cathode-gate trigger (V_{GTC}) or a negative anode-gate trigger signal (V_{GTA}) will turn on the SCS. Either gate signal results in base current in the respective transistor, thereby resulting in collector current. Since current flows through the base of the other transistor, the regenerative action immediately latches both transistors into saturation. Cathode-gate triggering is much more sensitive than anode-gate triggering. For example, specifications for a silicon-controlled switch might have a cathode-gate, trigger-current rating of 1 μA, while the anode-gate trigger current is on the order of 100 μA (with anode- and cathode-gate trigger voltages on the order of 0.8 V).

Turning Off an SCS

With the SCS conducting, how can it be turned off? There are three basic methods: a negative trigger signal to the cathode gate, a positive trigger signal to the anode gate, or momentarily shorting between both the anode and the cathode terminals.

A negative-trigger applied to the cathode-gate turns off Q2 (the NPN transistor), which, in turn, cuts off the base current to Q1, turning off its collector current. Similarly, a positive trigger signal applied to the anode-gate turns off the PNP transistor, interrupting the base current to Q2, turning it off. The operation of the SCS is virtually identical to the operation of the PNP-NPN transistor-latching configuration.

Like the SCR, the SCS can be turned off by reducing the anode-cathode current below the I_H level, which (as with other thyristors) can be accomplished by shorting the anode and cathode terminals with a mechanical or electronic switch. Figure 11 illustrates how a transistor switch can be used for that purpose. An alternate method for SCS turn-off is simply

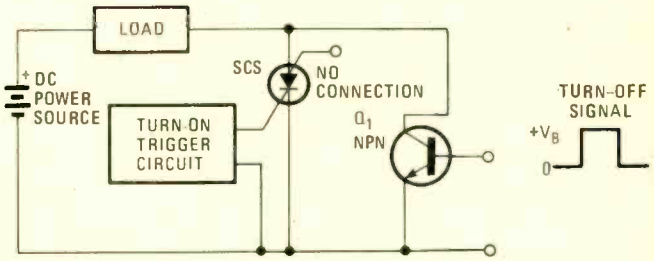


Fig. 11—Like the SCR, the SCS can be turned off by reducing the anode-cathode current below the I_H level, which (as with other thyristors) can be accomplished by shorting the anode and cathode terminals with a mechanical or electronic switch. This diagram illustrates how a transistor switch can be used for that purpose.

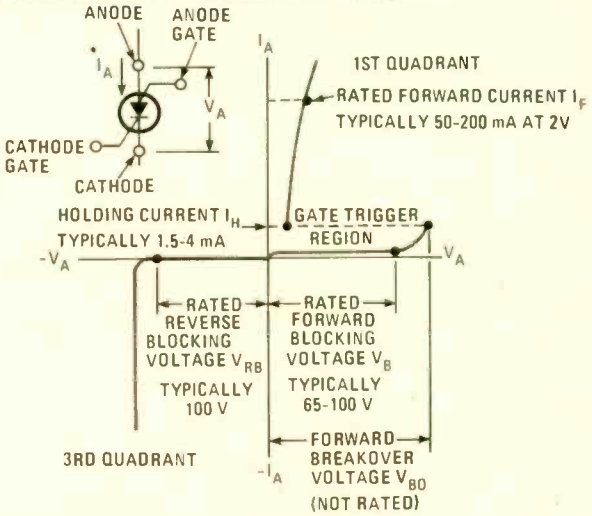


Fig. 12—Typical SUS four-quadrant characteristics are illustrated here. The SUS can be gated on when the applied forward voltage is below V_S. The gate can also be used in modifying SUS turn-on characteristics by acting as a trigger.

to open the anode circuit. Again, a transistor switch can be used. Typical four-quadrant characteristics for an SCS are given in Fig. 12.

The SCS may be used in many applications where a low-

level SCR with gate turn-on/turn-off capability is required. Lamp and relay drivers, digital counters, shift registers, voltage-level sensors, oscillators and pulse generators and driver circuits for neon display tubes are all areas where SCS's are used.

Gate Turn-Off Switch

The gate turn-off switch (GTO) is a three-terminal PNPN silicon device—used in automotive and other power-switching applications—whose construction and operation are similar to the SCR. But, unlike the SCR, the GTO can be turned off by a reverse gate current—a highly desirable characteristic in some power-switching applications. Figure 13 shows the basic construction (13A), schematic symbol (13B), and a two-transistor construction (13C) of the GTO. The two-transistor regenerative circuit analogy previously given for SCR operation is also applicable to the GTO.

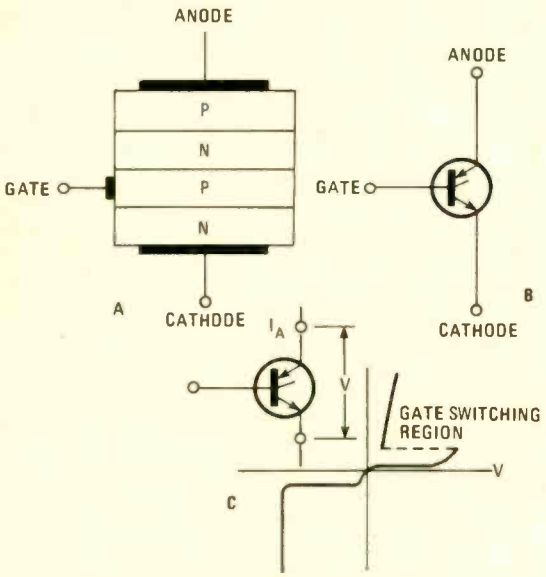


Fig. 13—Shown here is the basic construction, the schematic symbol, and a two-transistor construction of the GTO. The two-transistor regenerative circuit analogy for SCR operation is also applicable to the GTO.

The GTO features high-speed, gate turn-on/turn-off times, on the order of a few microseconds. Gate turn-off capability imposes two limitations compared with conventional SCR's; GTO's require more gate turn-on/turn-off current. The second limitation relates to maximum current and dissipation ratings. Because of the latter limitation, the high-voltage/high-gain silicon power transistor has become a serious competitor to the GTO.

Shockley Diode

The Shockley diode, a two-terminal semiconductor, is the most elementary of the PNPN structures. Designed for unilateral, or half-wave operation, it is usually produced as a low-current, low-voltage switching device, and is often used in SCR trigger circuits. Figure 14 gives basic details of the Shockley diode.

Like the SCR, the PNPN structure of the Shockley diode (Fig. 14A) may be analyzed in terms of a two-transistor construction (by grouping thus: $P_1N_1P_2$, $N_1P_2N_2$). But unlike the SCR, the Shockley diode does not have a gate connection and the N_1P_2 junction is reverse biased in conventional Shockley diode circuits.

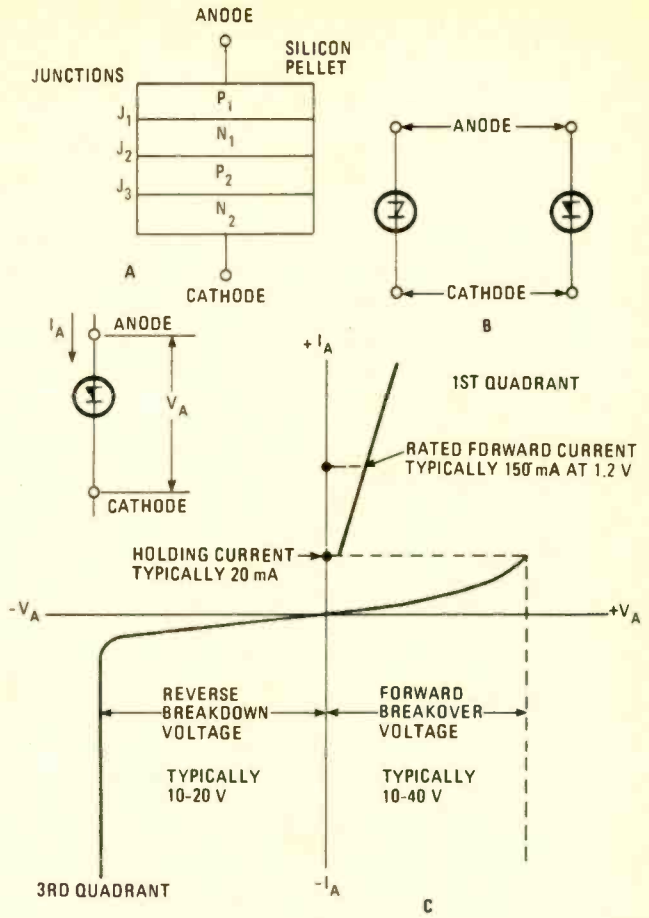


Fig. 14—Shown in A is the basic construction of the Shockley diode; its schematic representation is shown in B; and C is the four-quadrant operation of the Shockley diode.

Refer to Fig. 14C. When forward voltage is increased to the breakdown level, an avalanche current flows across the N_1P_2 junction, causing both equivalent transistors to snap (latch) into full conduction. A typical SCR trigger circuit using a Shockley diode is shown in Fig. 15. Note that V_{GEN} (the trigger-circuit source voltage) must be in phase with the AC power source. When V_{GEN} reaches D2's V_{BO}, it snaps into conduction and fires the SCR, and the resulting low impedance presented by D2, R2, and the SCR gate circuit, discharges the capacitor for the next positive halfcycle. The firing angle of the SCR can be adjusted by varying the resistance of R1.

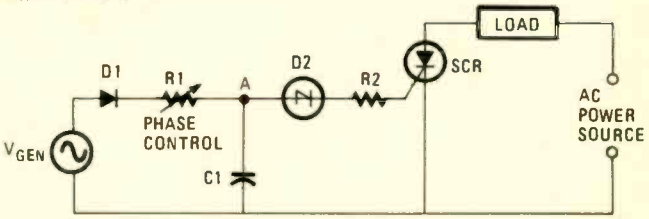


Fig. 15—A typical SCR trigger circuit using a Shockley diode. Note that V_{GEN} (the trigger-circuit source voltage) must be in phase with the AC power source. When V_{GEN} reaches V_{BO}, D2 conducts, firing the SCR.

The UJT

The unijunction transistor (UJT), a unique member of the thyristor family, is a two-layer, three-terminal PN device fabricated on an N-type silicon bar with ohmic contacts for

the two base terminals. The emitter section, a P-type material, is deposited between the base 1 and base 2 regions. Fig. 16 shows details of basic construction of the device, an equivalent electrical circuit, and the most-commonly used symbol.

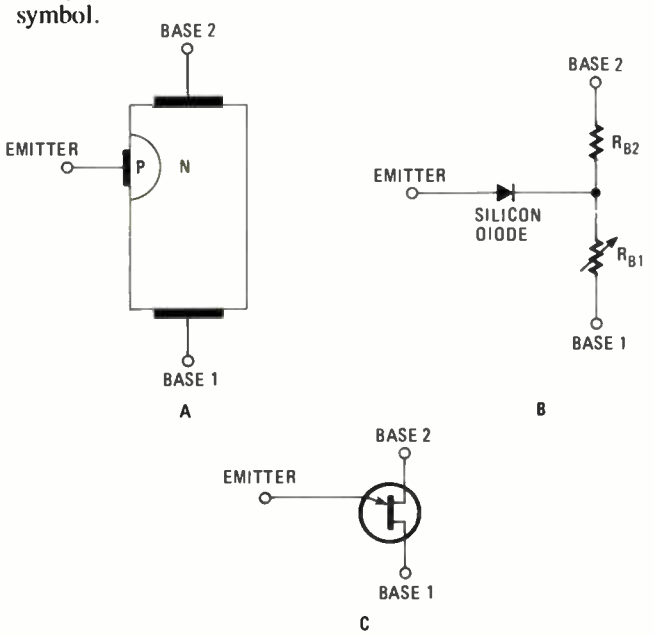


Fig. 16—The unijunction transistor (UJT), a unique member of the thyristor family, is a two-layer, three-terminal PN device fabricated on an N-type silicon bar with ohmic contacts for the two base terminals (see Fig. 14). The emitter section, a P-type material, is deposited between the base 1 and base 2 regions. Shown here are details of basic construction of the device (A), an equivalent electrical circuit (B), and the commonly used symbol (C).

Possessing only one PN junction, the UJT exhibits negative resistance characteristics (e.g., an increasing emitter current results in a decreasing voltage between the emitter and B1) which is useful in generating gate-trigger signals for higher-power thyristors. UJT operation can best be explained through the electrically-equivalent construction—which is connected in a test circuit with a variable DC, emitter-biasing supply and a fixed DC power supply for the base terminals—shown in Fig. 17A. Resistors R1 and R2 are simply current-limiting resistors for the circuit.

The N-type silicon semiconductor region comprising the base material, is lightly doped, having a small number of free electrons, which will support only a small current between the two base terminals. With no emitter current, the DC resistance across that N-type material from B1 to B2 is on the order of 4700 to 9000 ohms. As shown in the equivalent circuit, the PN junction acts as a silicon diode connected to the two base regions. Note that the relative values of R_{B1} and R_{B2} depend on where the P-type emitter material is located along the N-type bar.

The Stand-Off Ratio

An important UJT operating parameter is its intrinsic standoff ratio, symbolized by the Greek letter eta (η), and defined as the ratio of R_{B1} to the total base resistance when the emitter current is equal to zero. That relationship is expressed as:

$$\eta = R_{B1}/R_{B1} + R_{B2},$$

where, η is a ratio, and R_{B1} and R_{B2} are the equivalent base

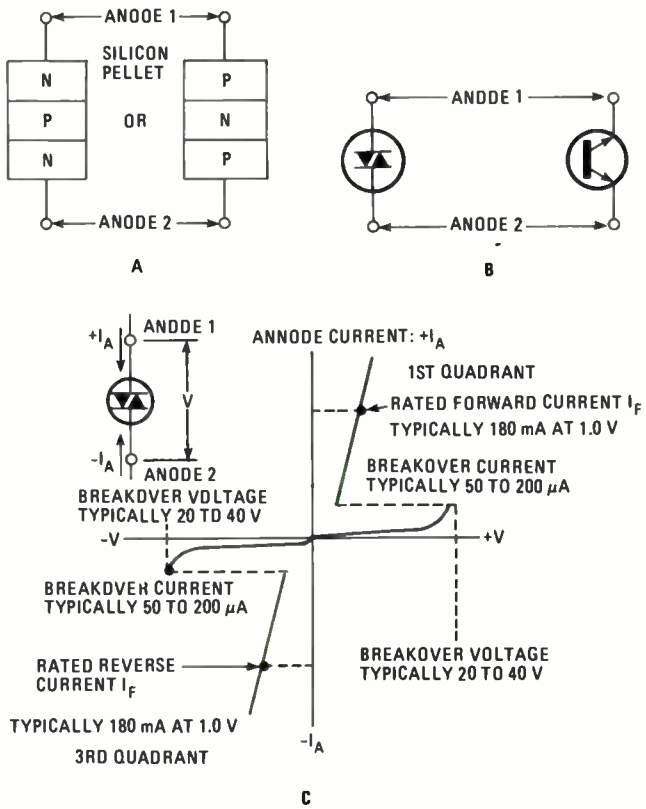


Fig. 17—When emitter voltage rises above V_P, V_{RB1} might be expected to increase accordingly. With individual components (a silicon diode and two resistors, as shown in A) that's exactly what would happen. However, gate-voltage decreases in a UJT as emitter current increases. B shows a typical UJT emitter current-voltage curve for V_{BB} adjusted to 10 Volts.

resistances in ohms (see Fig. 17A). Typical values of η vary from about 0.5 to 0.8 for most UJTs. Knowing the intrinsic standoff ratio is important, because using η and the applied voltage across the base terminals (V_{BB}), we can calculate the internal voltage across R_{B1}, which is given by:

$$V_{RB1} = V_{BB} \times R_{B1}/(R_{B1} + R_{B2}),$$

or

$$V_{RB1} = \eta V_{BB}.$$

For example, if η is 0.65 and V_{BB} is 10 Volts, then;

$$V_{RB1} = 0.65 \times 10 = 6.5 \text{ Volts}$$

Voltage V_{BB1} represents a reverse-bias voltage on diode D1. In order for an emitter current (I_E) to flow, the emitter voltage (V_E) must rise above V_{RB1} by about 0.7 Volts—the internal barrier potential for a silicon diode. The emitter voltage that will cause the diode to be forward biased and conduct an emitter current is usually designated V_P, which is given by:

$$V_P = \eta V_{BB} + V_D,$$

or

$$V_P = \eta V_{BB} + 0.7 = 7.2 \text{ Volts}$$

When emitter voltage rises above V_P, V_{RB1} might be expected to increase accordingly. With individual components

(a silicon diode and two resistors, as shown in Fig. 17A) that's exactly what would happen. However, gate-voltage decreases in a UJT as emitter current increases. Figure 17B shows a typical UJT emitter current-voltage curve for V_{BB} adjusted to 10 Volts. Reducing V_{BB} results in corresponding lower values of V_P, V_E, V_V, and I_V.

That's because the forward-biased PN junction injects a flood of positive charge carriers (holes) into the lightly doped N-type base region. Being positively charged, they're swept toward the negative potential at B_1, reducing the effective resistance of R_{B1} to as low as about 50 ohms—which produces a small voltage drop. Accordingly, V_E will drop to a value of less than 1 Volt in most circuits. The UJT, now conducting maximum current through the base regions, is said to be in the on-state condition.

The B_2 region is virtually unaffected by emitter current, and R_{B2} remains about the same (the primary action of the unijunction transistor takes place in the emitter and R_{B1} portions of the device).

Typical UJTs

UJT's are available with power ratings up to about 450 mW; typical interbase and emitter V_R ratings from about 30 to 60 Volts; maximum RMS and peak emitter current levels on the order of 50 mA and 2 A, respectively, and emitter-triggering current (I_G) ranges from about 0.4 μA to 12 μA.

Triggering or turn-on time of UJT's is seldom specified. But the UJT is useful in oscillator and timing circuits for frequencies ranging from 1 Hz to 1 MHz. Emitter-voltage fall time is sometimes specified for relaxation-oscillator circuits as a function of capacitance, and usually range from a few microseconds to about 100 μS.

The Complementary UJT

What is a Complementary Unijunction Transistor (CUJT)? The Complementary Unijunction Transistor is a silicon planar, monolithic device having unijunction characteristics: but with superior stability, a much tighter intrinsic-standoff ratio and lower saturation voltage, low leakage current, the ability to temperature compensate and calibrate at room temperature, and up to 100 kHz operating frequency.

Its characteristics are like those of a standard unijunction transistor, except that the currents and voltages applied to it are of opposite polarity, while providing superior stability and better uniformity than previously available in UJT's. The much tighter spread of intrinsic standoff ratio is a significant advantage. (For most applications, polarity is not important.)

The CUJT can be used in most applications now using standard UJT's. Its unusual stability and uniform properties make it ideal for stable oscillators, timers, and frequency dividers. Its key advantage over conventional UJT's is its predictability over the specified temperature range, allowing engineers to use design curves to select the correct compensating resistor (R_{B2}), instead of performing expensive temperature testing on individual devices. Another advantage is the low B_1-to-emitter voltage drop at high-current levels, allowing generation of high output pulses with low base-to-base voltages.

PUT

The programmable unijunction transistor (PUT), having three terminals designated as anode, gate, and cathode, looks

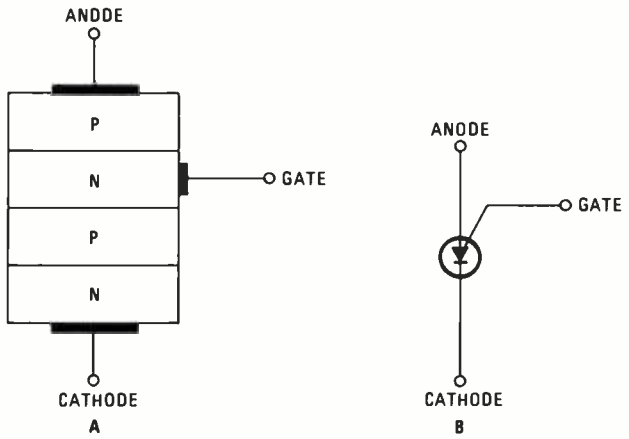


Fig. 18—The PNPN structure of the PUT is shown in A; while the schematic symbol for the PUT is shown in B.

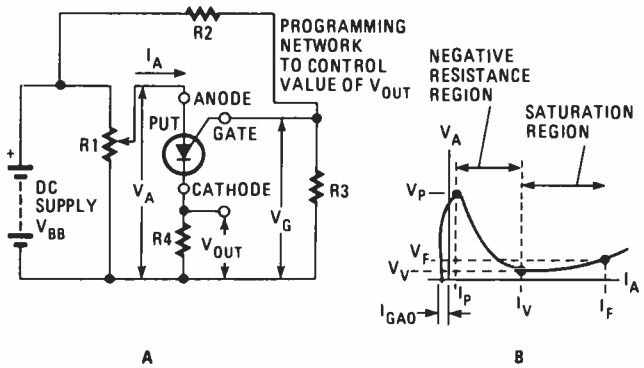


Fig. 19—The programmable unijunction transistor (PUT) is a four-layer PNPN device. Its major advantage over the UJT is the programmability of its operating parameters.

and acts like an improved UJT. However, examination of the internal structure of the PUT reveals it to be another four-layer PNPN device (as shown in Fig. 18). The major advantage of the PUT over the UJT is the programmability—via external resistors—of its operating parameters.

A voltage-divider network connected to the gate provides control of the peak voltage (V_P) of the output signal. Figure 19A shows a PUT in a test circuit, in which a voltage-divider network (R2–R3) provides a fixed V_G. Potentiometer R1 is connected as a variable voltage divider to control the anode voltage.

When anode voltage is lower than V_G, the PUT is off, and only negligible reverse-leakage current flows through the PUT. That's because the anode-gate PN junction is reverse biased. That leakage current is indicated in the characteristic curve in Fig. 19B as I_{GAO}.

When anode voltage—called the peak voltage, and identified as V_P on the curve—rises above gate voltage by about 0.7 Volts, the anode-gate junction is forward biased, allowing turn-on. At that point, the PUT latches into full conduction and exhibits negative-resistance over a portion of the curve. By adjusting the ratio of the gate voltage-divider network, we can program the device for different values of V_P, while allowing us to control the I_P value.

The output of a PUT is normally taken at the cathode, and when off, V_{out} is nearly zero. When the PUT is triggered into conduction, V_{out} suddenly rises to a positive value, which is controlled by the design of the circuit. When used as a thyristor trigger, V_{out} is adjusted to around 2 to 6 Volts. The turn-on time is extremely fast; it can be as low as 80 nS.

Advantages

Unlike the UJT, the PUT is used in applications where a high-speed, low-power electronic switch is required; for instance; relaxation oscillators, timers, and phase-control circuits. The relaxation oscillator is useful in triggering high-power SCR's, since it is capable of producing pulsed, high-current trigger signals. Figure 20 shows a typical PUT relaxation-oscillator circuit and the pulsed output waveform at V_{out}. Note that a conventional UJT could be substituted in the circuit, resulting in similar performance.

Thyristor Switches

The silicon unilateral switch (SUS) and silicon bilateral switch (SBS)—also three-terminal devices—are among the newest and most advanced members of the thyristor family. They are actually small integrated circuits containing transistors, Zener diodes, and resistors, whose construction provide improved performance and reduces cost. The SUS and SBS possess negative-resistance switching characteristics similar to those of three-and four-layer diodes and UJT's. They are capable of producing fast-rising, high-current trigger signals for power thyristors such as SCR's and triacs.

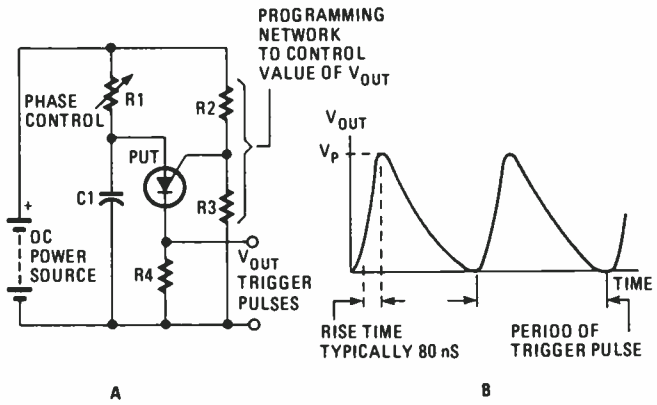


Fig. 20—A typical PUT relaxation-oscillator circuit. A voltage-divider network (consisting of R1 — R3) provides a fixed V_G. When anode voltage is lower than V_G (as shown in B), the PUT is off, and only negligible reverse-leakage current flows through the PUT, because the anode-gate PN junction is reverse biased.

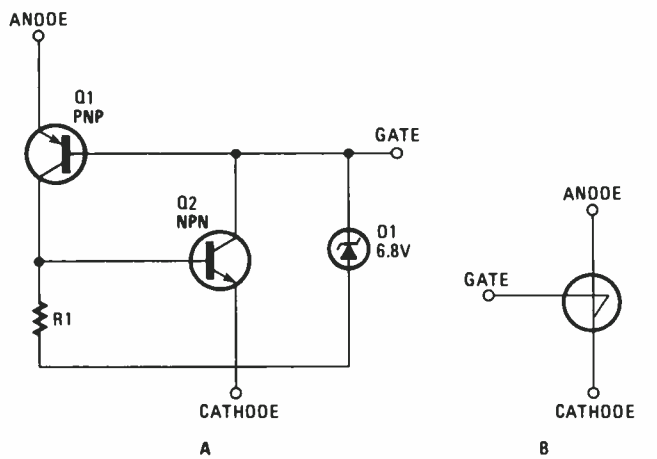


Fig. 21—The equivalent electrical circuit for the SUS is shown in A: and its schematic symbol is shown in B. Designed as a unilateral switching device, the SUS is similar in performance to a low-power SCR, except that an anode gate is used instead of the usual cathode gate.

Let us examine the theory behind the SUS first. The equivalent electrical circuit and symbol for the SUS are shown in Fig. 21, which is similar in performance to a low-power SCR, except that an anode gate is used instead of the usual cathode gate. The SUS is designed as a unilateral switching device; only current from anode to cathode should be allowed. Reverse current, if permitted, can result in damage to the SUS.

An NPN and a PNP transistor are connected in a regenerative latch configuration. A Zener diode (D1) is connected in parallel with the gate and cathode terminals. Current through the device is essentially zero as long as the voltage the anode to cathode is held to a value less than the rated switching voltage (V_S).

When the applied voltage is increased to the V_S level, the SUS switches on when: the value of V_S is equal to the emitter-base forward-bias voltage of Q1 plus the breakdown voltage of D1 (or roughly 0.7 + 6.8 Volts for the circuit in Fig. 21); current from the base of Q1 turns on the PNP transistor; collector current from Q1 flows into the base terminal of Q2 and collector resistor R1. the collector current of each transistor provides base current for the other transistor, and this regenerative action quickly drives both transistors into saturation. A typical SUS four-quadrant characteristic is illustrated in Fig. 22.

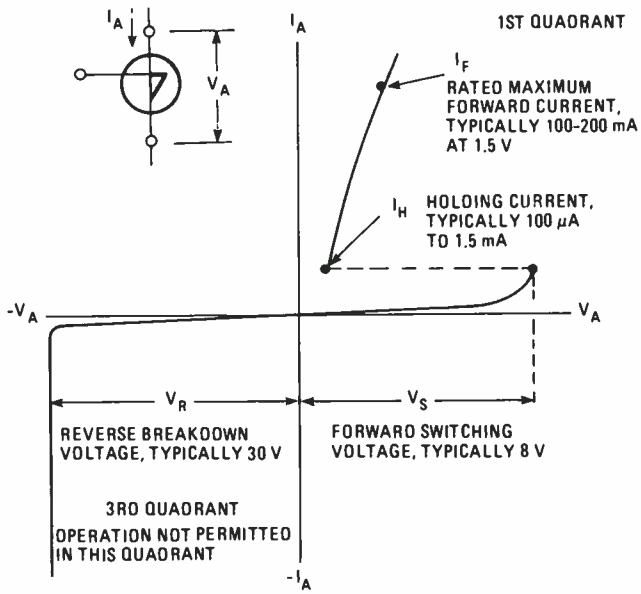


Fig. 22—Typical SUS four-quadrant characteristics are illustrated here. The SUS can be gated on when the applied forward voltage is below V_S. The gate can also be used in modifying SUS turn-on characteristics by acting as a trigger.

Turning Off a SUS

Once turned on, the SUS remains on until anode current drops below I_H. Turn-off methods used in SCR circuits are also used for the SUS. As with the SCR, the SUS t_q is longer than turn-on time. Depending on external circuit characteristics, SUS t_q time may range up to about 25 μS.

The gate may be used to turn on the SUS when the applied forward voltage is below V_S. That is accomplished by switching a DC path between the gate and cathode. The gate can also be used in modifying SUS turn-on characteristics. For example, an external Zener diode with a lower breakdown voltage can be connected across the gate and cathode; thereby decreasing the value of V_S required to turn on the device.

Now that we have covered the theory for the SUS, the operation of the silicon bilateral switch (SBS) is easy to understand.

SBS

The SBS is simply two SUS's in a single package connected for bilateral current operation. Figure 23 gives the circuit configuration and the commonly used symbol. Transistors Q1 and Q2 are connected as one of the two transistor-latching circuits on the chip. With anode 1 positive, D1 is forward biased and acts as a conventional rectifier.

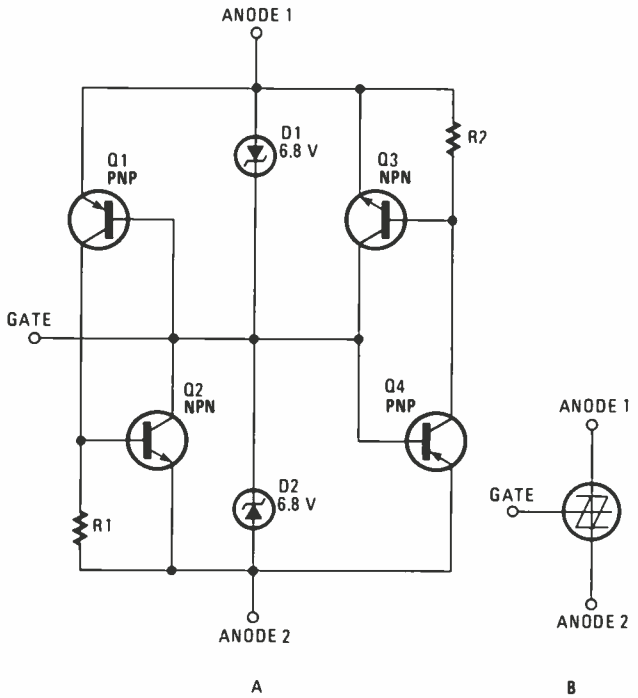


Fig. 23—The SBS is simply two SUS's in a singled package connected for bilateral current operation. Fig. 23A shows an SBS equivalent circuit and B shows its schematic symbol.

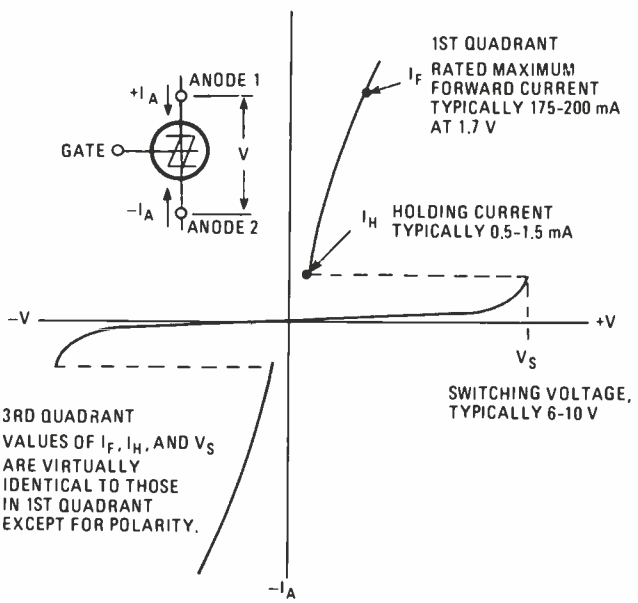


Fig. 24—The typical SBS characteristics are shown here. For most SBS's, V_S ranges from about 6 to 10 Volts. Due to the uniform construction, the SBS exhibits excellent symmetrical operational characteristics. Like the SUS, the SBS can be controlled via the gate terminal.

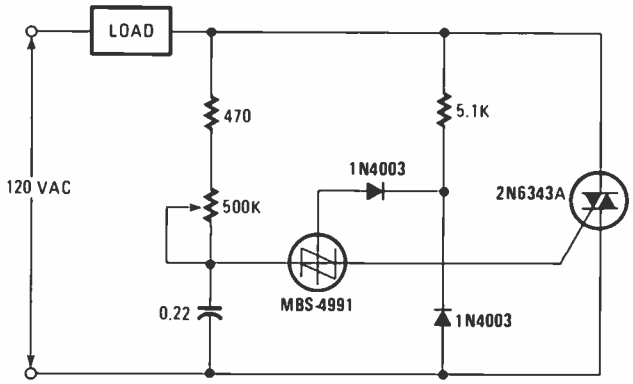


Fig. 25—An SBS full-range lamp dimmer—referred to as a hysteresis-free power controller is shown here. The gate is used to eliminate "flash-on" of the lamp when the phase control is adjusted for no power to the load.

As the applied voltage across the anode-1/anode-2 terminals is increased to V_S, D2 undergoes Zener breakdown and turns on Q1. That action causes Q2 to conduct, and both transistors are quickly switched into saturation. The primary conduction path for a positive voltage on anode 1 is through Q1 and Q2. Transistors Q3 and Q4 remain off during that interval.

For I_R operation, the SBS mirrors forward-current operation. When the voltage applied to anode 2 is positive Q4 and Q3 form the primary conduction path. During that halfcycle, D2 acts as a forward-biased diode, and D1 undergoes Zener breakdown when the applied voltage equals V_S.

Figure 24 shows typical SBS characteristics. V_S ranges from about 6 to 10 Volts. The SBS exhibits excellent symmetrical characteristics. For example, variations in switching voltages for forward and reverse current are held to about 0.2 to 0.5 Volts. That characteristic is referred to as the absolute switching voltage difference in SBS specifications. Like the SUS, the SBS can be controlled via the gate terminal. The maximum off-state I_G is about 5mA, while maximum on-state I_G is limited only by the power-dissipation rating.

Applications as Switches

The SUS and SBS are designed for high-speed signal switching applications where V_S stability and low cost are required. In addition to serving as triggers for power thyristors, SUS's and SBS's are used in digital circuits involving frequency dividers, ring counters, bistable memory circuits, and pulse generators; voltage sensing in electronic crowbars, or overvoltage protection for DC power-supplies circuit.

One interesting application of the SBS trigger is the full-range lamp dimmer—referred to as a hysteresis-free power controller—shown in Fig. 25. There the gate is used to eliminate "flash-on" of the lamp when the phase control is adjusted for no power to the load. Without the gate connection, the timing capacitor cannot discharge through the SBS during each AC cycle. Therefore, the voltage across the capacitor can build up and eventually trigger the SBS; resulting in triac turn-on and a momentary flash of the lamp.

The 1N4003 rectifiers permit flow of gate current at the end of each AC positive halfcycle, turning on the SBS. The triac is triggered and the timing capacitor discharges to near zero volts.

Believe it or not, the components presented here are really not all of the Thyristor types available. They are, however, the most frequently used and those you will find most useful in hobbyist applications. ■

TAME THE DOS TIGER

Knowing what DOS can do is sure to make your computing a bit easier.

By Jeff Holtzman

AFTER MUCH DELIBERATION, YOU'VE FINALLY TAKEN the plunge and bought a brand new PC compatible from the Chop Stix Computer Company. After setting up the hardware, you followed the instructions in the DOS manual, created a "bootable" system disk, and started learning. So you know the basics of using MD, CD, RD, COPY, DIR, etc.

But what next? How can you use DOS commands and programs to increase your computing efficiency? What kinds of programs—both free (public domain) and commercial—can aid the process? What about DOS? How does it work internally?

In this article, we'll provide an overview of the internal workings of DOS, how to use DOS and other programs to organize your hard disk, and then go on to show you how to boot your system in the proper configuration for your hardware and software.

What is DOS?

DOS is an acronym for *D*isk *O*perating *S*ystem. So, as you might expect, one of DOS's primary tasks is to manage the disks—hard and floppy—connected to your PC. In addition, DOS also manages your keyboard, your video screen, your serial and parallel ports—in fact, just about all the hardware connected to your PC.

DOS is composed of several separate files, all of which must be present on the disk that you boot from. You've undoubtedly seen a file called COMMAND.COM on your boot disks; COMMAND.COM is what accepts keyboard commands from you, executes internal commands (like DIR), external programs, and batch files, etc.

It relies on two files that you probably haven't seen, because they are "hidden" on your disks. Later in this article we'll show how they're hidden; and still later, we will show how to view them and how to modify their status. But for now you only need know that they exist.

The BIOS, which, actually, is not part of DOS, is contained in an EPROM (or a ROM) on your PC's CPU board. That EPROM contains the lowest-level software routines (those that directly control the hardware) that DOS uses to accomplish its chores. Figure 1 illustrates the relationship between the various files discussed thus far.

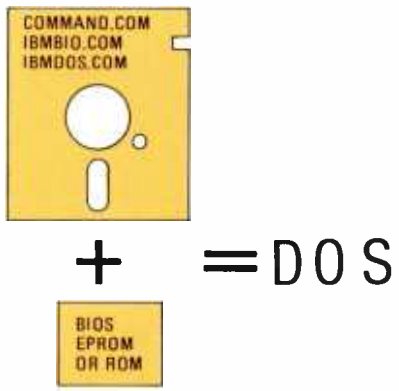


Fig. 1—DOS is composed of three disk files: IBMBIO.COM, IBMDOS.COM, and COMMAND.COM, that together with the BIOS EPROM (or ROM) control your PC.

Disk Organization

DOS is a file manager—but what does that mean? A standard MS-DOS floppy disk holds 360K of information. Both sides are used, and each side is divided into 40 tracks (concentric circles) and 9 sectors (segments). See Fig. 2.

Other floppy-disk formats exist, including the 1.2-megabyte AT format, the 720K 3.5-inch format used by most portables, and the 1.44-megabyte 3.5-inch format used by IBM's new PS/2 machines. Hard disks in general have many more tracks and sectors than floppy disks, but all disks share the same basic structure; only the numbers change.

When you copy a file from one disk to another, what really happens is that information from specific tracks and sectors on one disk is copied to specific tracks and sectors on the other disk. In general, information will not be copied to the exact location on the second disk as where it could be found on the first.

However, the Diskcopy program included with DOS does do a track-by-track, sector-by-sector copy, as do some pro-

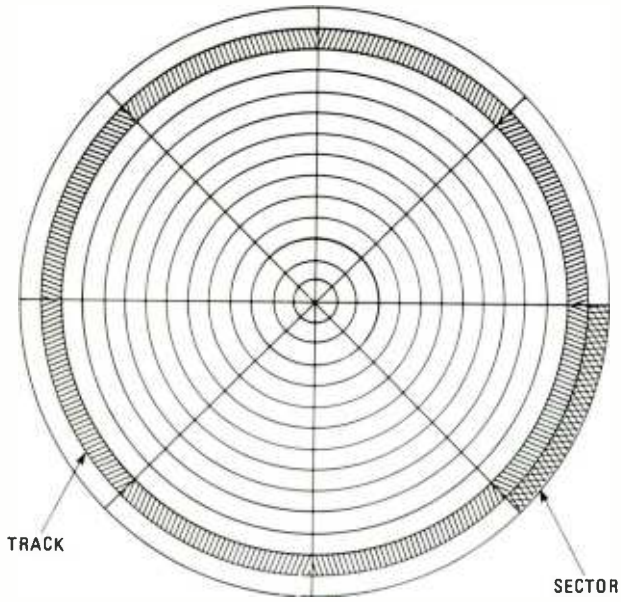


Fig. 2—Forty tracks at nine sectors per track yield a total of 360 sectors per side, or 720 sectors for both sides. Each sector contains 512 bytes, for a total of 368,640 bytes.

grams that copy so-called copy-protected disks. At the user level, you do not need to know anything about tracks and sectors; DOS does all the housekeeping, and makes sure, when you type CCOPY A:FILE1 B:FILE2 that there is enough space on drive B: for FILE2, and places the file on that disk in whatever space is available. How does it know how much space is available? Via the directory and the FAT (*F*ile *A*llocation *T*able).

Basically, the FAT is a listing of all clusters (collections of several sectors) on the disk; each entry in the list indicates whether a cluster is used, unused, or bad. When you format a disk, bad clusters are so marked in the FAT by the format program. A 360K diskette has 512 bytes-per-sector, and 708 sectors (512 bytes/sector, 708 sectors = 362,496 bytes). Each cluster is composed of two sectors, so there are 354 (708/2) clusters.

You may have noted a discrepancy in the numbers listed above. Earlier we stated that there are 40 tracks and nine sectors per track; that gives a total of 720 sectors (40 tracks, 9 sectors/track * 2 sides). But just now we said that there are 708 sectors. So what happened to the remaining 12 sectors, or 6144 bytes?

The directory occupies seven sectors (112 entries, 32 bytes/entry), and the FAT occupies four sectors. The remaining sector is the first sector on the disk; it's called the Boot Sector. The Boot Sector contains a table of information about the disk's format (bytes-per-sector, sectors-per-cluster, sectors-per-track, number of sides, etc.). It also contains a short program that begins the boot process, i.e., it loads the hidden files mentioned above, and allows them to take control of the machine. The remaining 708 sectors comprise the data area.

Directory Organization

The directory contains the list of files on a disk. Each directory entry consists of 32 bytes; a 360K diskette can have a maximum of 112 (root) directory entries. However, a 360K diskette may have many more files than that, because subdirectories can have an essentially unlimited number of files.

As shown in Table 1, each 32-bit directory entry is composed of eight fields. Fields 1 and 2 consist of the eight-byte file name and the three-byte extension, respectively. We usually separate the name and the extension with a period (AUTOEXEC.BAT); the period is not stored in the directory.

TABLE 1—DIRECTORY STRUCTURE

Field	Length (Bytes)	Description
1	8	File name
2	3	File Type
3	1	Attribute
4	10	Reserved
5	2	Time
6	2	Date
7	2	Starting FAT entry
8	4	File size

Field three is a single byte; each bit of that byte is a flag that is treated separately. The meaning of each flag is shown in Table 2. For example, depending on the setting of the first flag, a file can be marked as *read-only*, meaning that it can't be erased or changed. A file can also be marked as *hidden*, which means it won't show up in directory listings.

Further, it can be marked as a *system file*, which is a file that is used only by DOS when booting. There are two such files; in an IBM version of DOS, they're called IBMBIO.COM and IBMDOS.COM. (In MS-DOS systems, those files go by other names.) Usually, all three flags of both files are set; i.e., the files are set to read-only, hidden, and system status.

TABLE 2—ATTRIBUTE BITS

Bit	Value	Meaning
0	1	Read-only
1	2	Hidden
2	4	System
3	8	Volume Label
4	16	Subdirectory
5	32	Archive
6	64	Unused
7	128	Unused

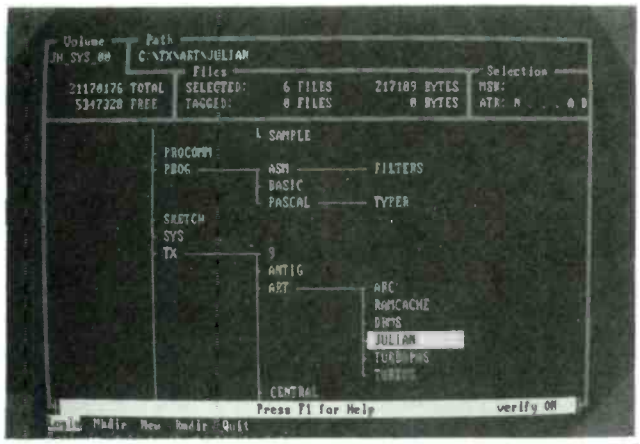
The next flag indicates that the current directory entry is a volume label. When you format a disk with the /V parameter (e.g., FORMAT A: /V), you can give it a name (e.g., JOE-DISK-1). That name is stored in the directory as if it were the name of a file. However, the volume label flag is also set, so DOS knows that that entry does not correspond to a file, but actually represents the name given to that disk.

In a similar manner, the next flag indicates that the current directory entry does not represent a regular disk file, but instead is a subdirectory. Actually, a subdirectory is a standard disk file whose internal structure is identical to the standard directory structure, with one important difference: a subdirectory's size is limited only by available disk space. Otherwise, it consists of 32-byte entries in the format being discussed.

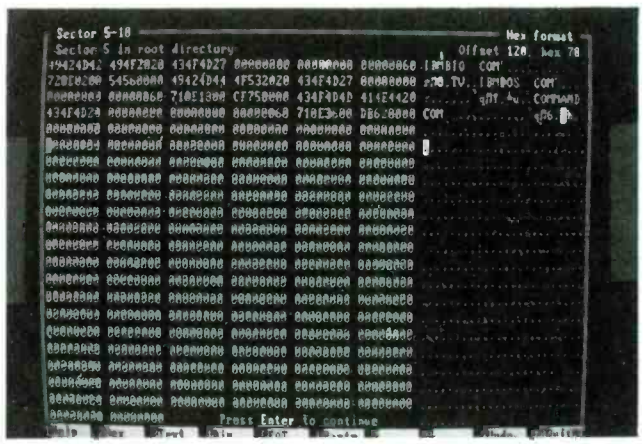
The last flag is called the *archive bit*; DOS sets that flag every time a file is changed in any way. The archive bit is not set when a file is copied, only when it is changed. The archive bit allows backup software to determine which files need to be backed up. It is normally cleared by backup software only after the file has been backed up successfully.

The last two bits of the file-attribute byte have not been used by any version of DOS to date.

Referring back to Table 1, the remaining fields of each



OverView is a shareware program that accomplishes much of what commercial disk- and file-management utilities can do.



The Norton Utilities chief claim to fame is the ability to "unerase" (or recover) files, but they are also useful for byte-level disk editing, and many other things as well.

directory entry are used as follows. Field 4 contains 10 bytes that are reserved for future use; fields 5 and 6 contain the time and date, respectively, each in two encoded bytes. Field 7 contains the starting cluster number (in two bytes), and field 8 contains the file size (in four bytes).

Modifying Directory Entries

You can view and change the status of the read-only, hidden, system, and archive flags of the files in a subdirectory with ATTR.COM (included on the DOS Tool Kit disk). Use of that program is discussed in an accompanying article.

You can also use *Overview*, a shareware disk and file manager (also on the Tool Kit disk) to change file attributes, move, copy, and delete files by group, etc. Overview's main screen is shown in the photos.

Last, the Norton Utilities (available commercially) provide similar capabilites, and come with a number of highly useful utility programs, including a byte-level disk editor that allows you to change any byte on a disk, including directory entries, as shown in the photos.

Software Sources

PC Tools, Central Point Software, Inc., 9700 S.W. Capitol H'way., Portland, OR 97219, 503/244-5728.
The Norton Utilities (Advanced Edition), Peter Norton Computing, 2210 Wilshire Blvd., No. 186, Santa Monica, CA 90403; 213/453-2361.
KeepTrack Plus, The Finot Group, 2390 El Camino Real, Suite 3, Palo Alto, CA 94306, 800/628-2828 ext. 700, or 415/322-6161.
XTree, Executive Systems, Inc., 15300 Ventura Blvd., Suite 305, Sherman Oaks, CA 91403, 800/634-5545, or in CA 800/551-5353.
PCED, The Cove Software Group, PO Box 1072, Columbia, MD 21044.

DOS Tool Kit

Note: The author has assembled a DOS Tool Kit, which consists of a number of public-domain programs that are indispensable for disk and file maintenance, file browsing, etc. All programs discussed in the accompanying articles, along with several others, and documentation, are included. Send $5 with a formatted DSDD diskette and mailer, or $10 without disk and mailer, to: HOE-DISK-1, PO Box 3564, Ann Arbor, MI 48106. Please allow 6 to 8 weeks for delivery.

To learn how to use the Norton disk editor, experiment on a scratch diskette—and never experiment on your hard disk! One misplaced byte, and your whole disk—floppy or hard—could be rendered useless!

The Tree: Root and Branches

You can think of the directory structure as an inverted tree, with the "root" at the top and "branches" growing downward. The upper-most directory is called the *root directory*; directories at lower levels are called *subdirectories*. The root directory in any given disk format can contain only so many entries—112 for a standard 360K floppy disk. Each entry may be a file, a subdirectory, or the disk's volume label (which is specified when the disk is formatted).

Each subdirectory may contain an essentially unlimited number of entries (files and further subdirectories); the only limit is available disk space. It's important to note that a subdirectory may contain subdirectories of its own, and that those subdirectories may in turn contain their own subdirectories, and so on.

At any given level, a subdirectory and all associated sub-subdirectories (and sub-sub-subdirectories, etc., ad infinitum) is known as a branch. The directory immediately above a given directory is called the "parent" of that directory.

For example, the tree shown in Fig. 3 contains a root directory and two subdirectories. The subdirectories themselves have subdirectories, and the FINANCE sub-subdirectory even has subdirectories of its own. Note that there are two sub-subdirectories labeled LETTERS: One is in the WORK branch of the tree, and the other is in the PERSONAL branch. The two LETTERS directories are completely independent; and barring some sort of catastrophe, DOS will always keep files placed in one totally separate from files placed in the other.

Directory and File Specifications

How do you tell DOS which LETTERS directory you'd like to use? Via a path specification. Don't confuse that with DOS's PATH command, which allows you to specify a list of directories where your program files are stored.

Assume that you have a word processor called *Edit* that allows you to specify the file (including a complete path specification) that you want to edit on the command line. To edit a file called HOE-HOE.HOE in your personal-letters

directory, you might invoke EDIT like this (assuming that you're working from hard-disk drive C):

C>EDIT \PERSONAL\LETTERS\HOE-HOE.HOE

To edit the file in your work letters subdirectory, you might invoke your editor like this:

C>EDIT \WORK\LETTERS\HOE-HOE.HOE

In both cases, no matter which directory you're in when you start the editor, the file will be placed in the precise directory you want. Also notice that in both cases, the path specification begins with a backslash, that each directory's name is separated from the next by another backslash, and that the path specification ends with the name of the file that you want to edit.

In a complete path specification like those shown above, the beginning backslash refers to the root directory; the others are simply place-holders that separate one name from the next. It might have been better had Microsoft used different symbols to refer to the root directory and to the separators; but the company didn't, so we just have to live with it.

When wouldn't a path specification begin with a backslash? When an incomplete path spec was given. There are a number of occasions when that might happen. For example, if you were in your personal-letters directory and you wanted to edit the file there, you'd just type:

C>EDIT HOE-HOE.HOE

But suppose you were in the FINANCE subdirectory and wanted to edit a letter in the work letters directory—would you have to type out the full path spec in that case? No. DOS provides a shortcut so you could do it like this:

C>EDIT ..\LETTERS\HOE-HOE.HOE

The double-dot (..) is a shorthand notation that refers to the parent directory of the current directory. In this case, it means \WORK, so that if you substitute \WORK for .. you get the entire path specification: \WORK\LETTERS\HOE-HOE.HOE.

The double-dot shortcut is very useful when you want to move up a level. Typing:

C>CD ..

while in the \WORK\FINANCE\JAN subdirectory will move you to \WORK\FINANCE. Also, whenever you want to move down a level, just type the name of the subdirectory you want to go to. If you're in the root and want to go to the PERSONAL subdirectory, just type:

C>CD PERSONAL

And from any subdirectory, just type

C>CD \

to get back to the root directory.

You may have noticed that whenever you issue a DIR command while in a subdirectory, the directory listing begins with two entries, a single dot (.), and a double dot. We know that the double dot refers to the parent of the current directory—but what about the single dot? It refers to the current directory itself. You can use it as shorthand when you want to refer to all files in the current directory. For example, to copy all files in the current directory to drive B:, you'd type:

C>COPY . B:

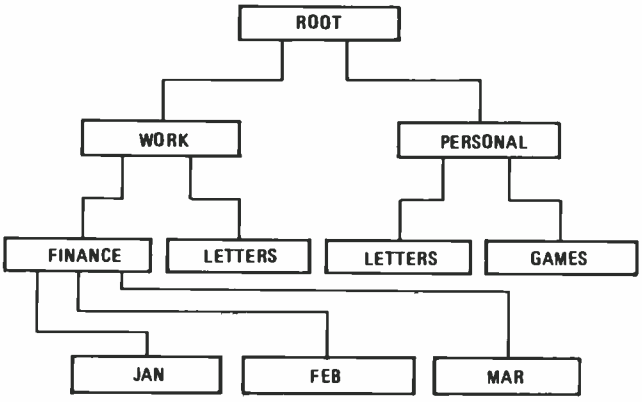


Fig. 3—A disk (hard or floppy) may have many subdirectories organized in a "tree" structure. Subdirectories with identical names (for example, LETTERS) may reside in different branches.

You can also delete all files with a similar syntax:

C>DEL.

Just be careful not to delete files you didn't mean to delete! Not all versions of DOS accept the single-dot syntax, but all (above and including 2.0) accept the double-dot syntax.

Practical Hints

Understanding how to specify paths correctly and how to use the shortcut characters can save you a great deal of time. For example, if I had a dollar for every time an instance like the following occurred, I'd be writing this from the Riviera. Most people, when asked to list the contents of a directory they're not currently in, will first change to that directory, list it, and then change back to where they came from, occasionally with an intermediate step, such as changing to the root directory.

That's a waste of time. If you're in the \WORK\FINANCE\JAN subdirectory, and your boss asks you what's in \WORK\FINANCE\FEB, all you have to do is issue this command:

C>DIR \WORK\FINANCE\FEB

If he then asks for a copy of FUBAR.COM in your \PERSONAL\GAMES directory, all you have to do is copy it to the floppy in drive A:

C>COPY \PERSONAL\GAMES\FUBAR.COM A:

Wildcards work too. Suppose you're playing FUBAR and your boss comes up with an urgent request (i.e., an order) for a copy of all financial data from March. Just exit FUBAR and type:

C>COPY \WORK\FINANCE\MAR*.* A:

On March 31 you're in the \WORK\FINANCE\MAR subdirectory, and want to prepare for tomorrow, April 1, by creating a new APR subdirectory on the same level. Are you going to type in the entire path specification? I hope not! This is much easier:

C>MD ..\APR

Organizing Your Subdirectories

In general, you want to keep as few files as possible in your root directory. On your boot disk (floppy or hard) you'll need

five files: COMMAND.COM, CONFIG.SYS, AUTOEXEC.BAT, and two hidden files that DOS placed there for you when you formatted the disk. Only the three named files will show up in directory listings. Actually, although most people do have them, CONFIG.SYS and AUTOEXEC.BAT are not strictly necessary, so COMMAND.COM may be the only visible file in your root directory. In addition, there are some programs that place their configuration files in the root directory automatically.

You'll want four subdirectories to hold your basic system files:

1. \DOS : to contain all your DOS files (FORMAT, DISKCOPY, etc.).

2. \SYS : to hold any device drivers (a RAM disk, for example, or a mouse driver) loaded via CONFIG.SYS. An accompanying article explains the use of CONFIG.SYS in detail.

3. \BAT : to hold any batch files (other than AUTOEXEC.BAT, which must reside in the root).

4. \PRO : to hold the miscellaneous collection of utility programs and small applications programs that we all end up with.

In addition, you'll probably want a separate subdirectory for the program files of each major application program that you use. And you'll probably also want separate directories for the data files created by each.

For the sake of discussion, let's say that you use WordStar, dBASE III Plus, and Lotus 1-2-3. You use WordStar to write letters, school papers, and your secret project, The Great American Novel. You'll want sub-subdirectories for each. You use dBASE to maintain a list of your collection of rare jazz recordings, and the inventory for your father's hardware store. That's two sub-subs here. Last, you use 1-2-3 to analyze business trends at the hardware store, and to maintain your grandmother's stock portfolio. Two more. The entire tree appears as shown in Fig. 4.

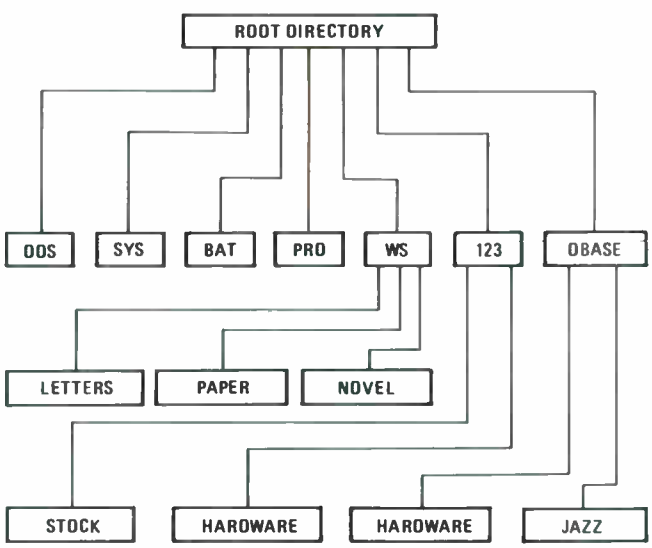
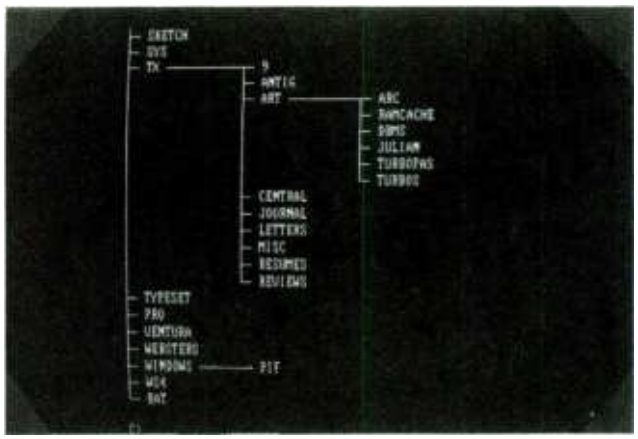


Fig. 4—A well-organized hard disk has four subdirectories (DOS, SYS, BAT, and PRO) for DOS and often-used programs, separate subdirectories for each major application, plus separate sub-subdirectories for the data generated.



The public-domain program VTREE provides a graphic representation of your hard disk's directory structure.

Subdirectory Structure

Of course, you may want to create more directories for other applications programs and their data files. Soon you have so many subdirectories that you have trouble remembering their names and relationships. To help alleviate the problem, DOS comes with a program called TREE, which displays a textual listing of all subdirectories. A much better display is provided by VTREE (Visual Tree), which is included on the DOS Tool Kit disk.

A program in Norton Utilities takes the visual approach a step further. Like VTREE, NCD (Norton Change Directory) provides a visual representation of your disk's tree structure. In addition, however, the program also lets you navigate your disk via the cursor keys. A sample NCD screen display containing a fairly complex directory structure is shown in the photos.

```
CD:
DARC A LET87A C:*.LET
DCOPY LET87A.ARC C:
DC:
C
```

Fig. 5—Create a letters archive as shown here.

The shareware program OverView (included on the Tool Kit disk) also provides a visual tree representation, and it contains many useful file-manipulation commands. You can copy, rename, and delete files and subdirectories, and you can move files, individually and by group—and there are several ways of specifying groups.

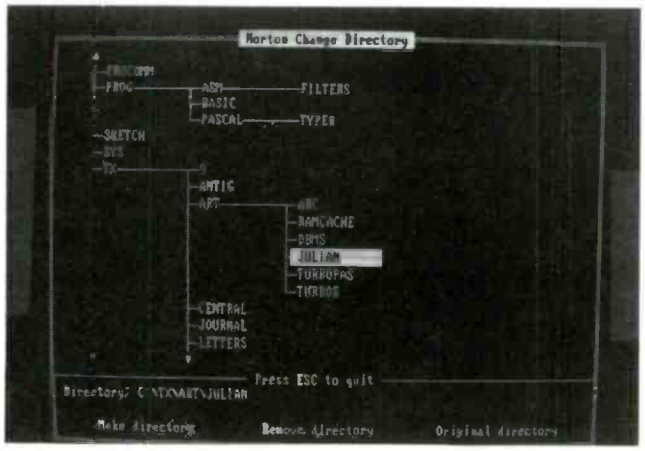
Getting to and from various subdirectories can involve a great deal of typing, especially if you have several levels of subdirectories. Sometimes the double-dot can help, but often it can't. PUSH and POP (on the Tool Kit disk) can, though.

Suppose you're in \WORK\FINANCE\JAN and want to go to \PERSONAL\LETTERS, do some work, and then return. You could type a CD (with the complete path spec), do your work, and then type another CD (again with the complete path spec). Or you could type the following:

```
C>PUSH
C>CD \PERSONAL\LETTERS
```

Then do your work, and when through type:

```
C>POP
```



Norton Utilities' NCD program provides a graphic representation of your hard disk's directory structure and allows you to traverse it using the cursor keys.

KeepTrack also provides a graphic tree, and is very convenient for backing up your hard disk to floppy disks. The program will even estimate the number of floppies necessary to back up all files since the last backup!

and you'll be back where you started. PUSH and POP can maintain as many as eight levels of subdirectories.

You say all that organization is nice, but you've got a disorganized mess that would be impossible to clean up—not true! Using DOS alone, you can move files by COPYing them and then DELeting them from their original locations. A program called MOVE (also on the Took Kit disk) can move a file or files more efficiently than the DOS-only method, because with MOVE, data is not copied (which can take a long time for large files), only the directory entry is moved.

MOVE accepts normal DOS file and path name conventions, so, for example, to move a file called MUSIC.MAN up a level, you would type:

C>MOVE MUSIC.MAN ..

Or to move all files from \WORK\LETTERS to \PERSONAL\LETTERS you would type:

C>MOVE \WORK\LETTERS*.* \PERSONAL\LETTERS

Unfortunately, MOVE cannot move an entire branch; however, several commercial utility programs (including KeepTrak, Xtree, and PC Tools, shown in the photos will allow you to "cut and prune" entire branches.

Another impediment to hard-disk organization is DOS's inability to rename directories. RENDIR (on the Tool Kit disk) can! To use the program, you must be in a directory above one that you want to rename. For example, to rename \POE to \HOE, you must be in the root directory.

With MOVE, RENDIR, and possibly one of the commercial programs, you should be able to re-organize your hard disk in no time at all!

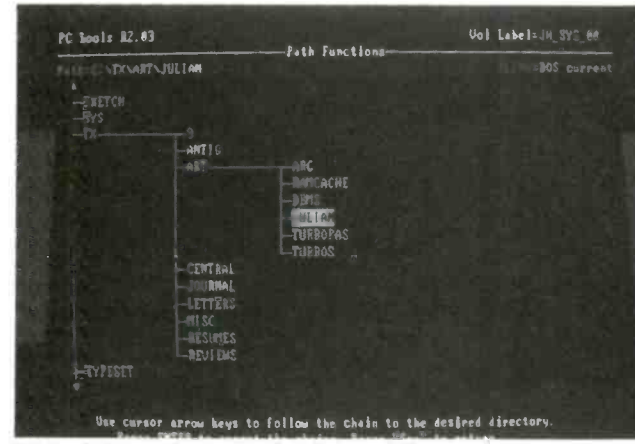
Miscellaneous File-Manipulation Utilities

Whatever state your subdirectory structure is in, occasionally you'll find it hard to locate a file. It's WHERE to the rescue! Just give it the name of the file (or files, using wildcards) you're after, and in a few seconds you'll find out where it exists, if it does. If you're not sure how you spelled the name, type in the first few letters followed by wild cards. For example:

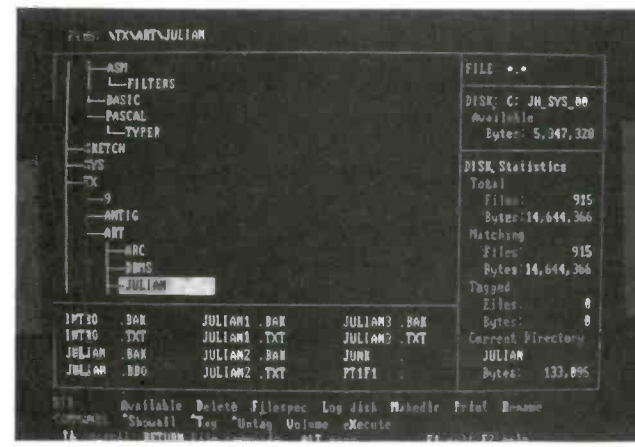
C>WHERE FU*.*

Every file has four attributes (which are stored in the file's directory entry): archive, system, hidden, and read-only. The archive attribute is normally on, and is only turned off when a file has been archived (backed up). Two DOS boot files (IBMBIO.COM and IBMDOS.COM, which go by other

(Continued on page 100)



PC Tools is another powerful disk and file manager; you can load it in RAM permanently and call it up from within any program. For example, if you run out of space in your word processor, you can call up PC Tools, format a new disk, and save your document.



XTree combines the disk- and file-management tools of KeepTrack with low-level disk-editing functions.

E-Z MATH

TRIG MADE SIMPLE

By Louis E. Frenzel

If you found trig tough or impossible in school this is the article for you. Here Frenzel gives it to you short and sweet.

WAIT! JUST BECAUSE THE TITLE SPEAKS OF "TRIGonometry" is no reason for you to avoid this article. Believe me, trig is not all that difficult. Maybe you didn't learn it in school. Or maybe you had difficulty with it. So what? This article will take care of that. We're going to introduce you to basic trig, but better still, we're going to show you how to use it to solve some common electronics problems.

Remember last month we showed you how right triangles could be used in solving problems with LCR circuits? Well, we will take this triangle analysis one step further. With the use of trig, you'll be able to compute phase angles as well as voltages, currents, and impedances. All you need to get started is paper, pencil, and your scientific calculator with trig functions.

Introduction to Trig

Trigonometry is simply the mathematics of triangles. It covers a lot of territory, but basically it is based on the mathematical relationships that exist between the lengths of the sides of a triangle and the sizes of the angles. By letting the sides and angles represent electronic or other quantities, all kinds of useful problems can be solved as you will soon see.

We are going to restrict our discussion to right triangles here, as those are the ones useful in electronics. Figure 1 shows a right triangle. One angle (C), of course, is the right angle of 90°. The sum of the angles in any triangle is 180°. In Fig. 1, A, B and C are the angles, so

$$A + B + C = 180^\circ$$

If C is a right angle, then

$$A + B + 90 = 180^\circ$$

or the sum of A and B is

$$A + B = 90^\circ$$

Playing with a Triangle

Now look at the right triangle in Fig. 2. After a little study,

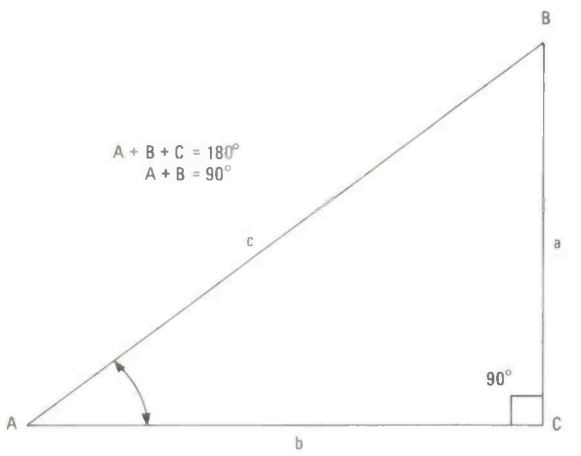


Fig. 1—In a triangle the sum of all the angles equals 180°. In a right triangle things are simplified because one of the angles is 90° so the remaining angles must add to 90°.

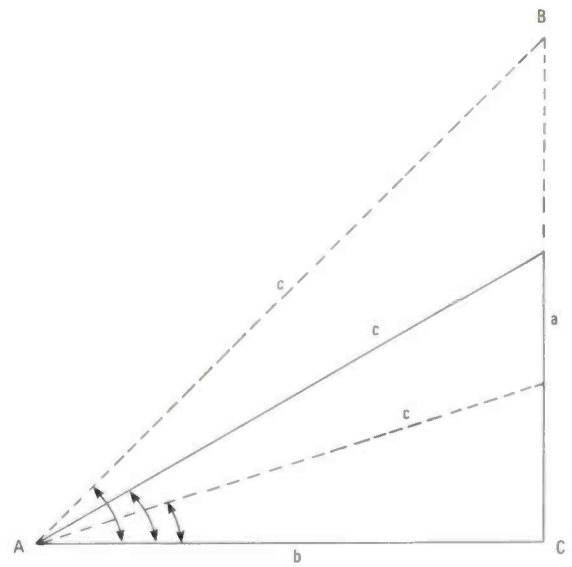


Fig. 2—Varying one of the sides of a triangle varies the angle opposite it. It also varies the hypotenuse.

it will suddenly dawn on you that there are real, logical relationships between the sizes of the sides and the angles. For example, what if we were to lengthen side a? Naturally, angle A would get bigger. Angle B would get smaller. Side c would also get a little bit longer. Shortening side a would make angle A smaller and B bigger. And side c would be shorter.

Now, assume angle B is increased. You got it, side b would get longer. Reduce angle B and side b gets shorter.

As it turns out, those relationships in right triangles are very precise and we can compute them. The relationships are expressed as ratios of side lengths. These ratios are known as trigonometric functions. The basic ones are called sine, cosine, and tangent.

The Sine Function

Take a look at the right triangle in Fig. 3. Note that we have labelled the sides and angles as before. And let's assume we want the trig functions for angle A. Side a is referred to as the "opposite" side because it is directly opposite the angle of interest, in this case A. Side b is labelled the "adjacent" side because it is adjacent or next to angle A. The other side (c) is called the hypotenuse because it is opposite the right angle C.

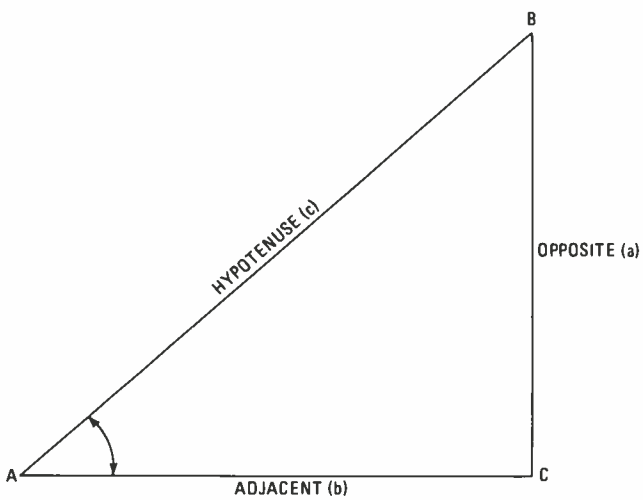


Fig. 3—The side closest to the angle (A) you're considering is the adjacent side (b). The other side (a) is of course called the opposite side and the side opposite the 90° angle (c) is the hypotenuse (it's the longest side).

Now we can define the trig functions.

sine of angle A = opposite/hypotenuse

We abbreviate this as

$$\sin A = a/c$$

Here's an example. If side a = 10 and side c = 20, then

$$\sin A = 10/20 = .5$$

When the ratio is .5, then angle A will be 30°. That is always true in a right triangle. We express this as

$$\sin 30° = .5$$

It doesn't really matter what the actual lengths of sides a and c are, as long as their ratio is .5, angle A is 30°.

Someone has gone to all the trouble of determining the ratio of a to c for all angles between 0 and 90 degrees. The extremes are obvious. When side a is zero, then surely angle A is 0°. Looking at Fig. 2, you can see that A gets smaller and smaller as a is decreased. A = 0 when a = 0.

Now if you make a larger and larger while b gets smaller, angle A increases. That means that angle A gets larger up until the point where side a and c merge or become the same. Their ratio is 1. At that time, A is 90°. Angles between 0 and 90 degrees give ratios or sine values between 0 and 1.

Tabulations that show the ratio for each angle are known as trig tables. You can buy a book of trig tables to use in solving triangle problems. But, the easiest way to get these numbers is to use your scientific calculator. Just punch in the angle number, then hit the sine SIN key to get the ratio. Piece of cake.

The Cosine Function

Another useful trig function is cosine. Refer back to Fig. 3. It is the ratio of the adjacent side to the hypotenuse.

cosine of angle A = adjacent/hypotenuse

$$\cos A = b/c$$

Again there are cosine tables to tell you what ratio corresponds to which angle and vice versa. Like the sine, the cosine will be some value between 0 and 1 with angles between 0 and 90 degrees.

A Tan Without Sun

The third trig function we will consider is tangent, the ratio of the opposite to the adjacent sides or

tangent of angle A = opposite/adjacent

$$\tan A = b/a$$

Most trig tables also have listings of tangent values. Tangent values for angles between 0 and 90 degrees run from zero to infinity.

Exercising Some Keys

Get out your scientific calculator and turn it on. Press the CLEAR key to erase any previous operation. Now, key in 30°, then press the sine (SIN) key. The display should read .5 as you saw earlier. Now try some other angles between 0 and 90 degrees. The larger the angle, the larger the sine value. If A gets bigger, side a gets bigger so the ratio value increases. Smaller angles give lower sine values because as the opposite side gets smaller, the ratio decreases. Use your calculator to fill in the sine (sin) column in Fig. 4.

Now do the same for cosine and tangent. Punch in the angles and record the corresponding ratio values and record them in Fig. 4.

Working Backwards

The way you have used your calculator is to find the numerical ratio that corresponds to the angle whose value you

ANGLE	SIN	COS	TAN
0°			
15°			
30°			
45°			
60°			
75°			
90°			

Fig. 4—Fill in the values of the functions for these angles.

know. There is also a way to find the angle that corresponds to a known ratio. In other words, you know the ratio but want to find out what angle corresponds to it. These are called reverse trigonometric functions. We just rearrange the simple formulas given earlier. We also give the reverse trig functions different names. The reverse sine is called arcsin and we write it thus:

$$A = \arcsin(a/c)$$

Sometimes it is written like this:

$$A = \sin^{-1}(a/c)$$

In fact, this is probably how it is expressed on your calculator. Usually, one button is used to compute both sine and arcsin. To get the arcsin value, you press an inverse (INV) key first, then press SIN.

The reverse cosine and tangent functions are

$$A = \arccos(b/c)$$
$$A = \arctan(a/b)$$

or:

$$A = \cos^{-1}(b/c)$$
$$A = \tan^{-1}(a/b)$$

To complete the reverse functions, you follow these steps.

1. The lengths of the sides are known. 2. You compute their ratio by dividing one by the other. 3. You press the INV key. 4. You press the desired function key SIN, COS, or TAN). For example, keying in .5 and pressing INV and SIN will give you 30° on the display.

To check this, go back to the simple trig tables you generated earlier. Key in the ratio values and verify that you get the related angle using the procedure above.

Practical Problems

With the basics out of the way, we can move on to some actual uses.

Assume that you are dealing with the triangle in Fig. 5. You know the length of side a is 40 feet and that angle A is 30°. With just this information, you can compute all of the

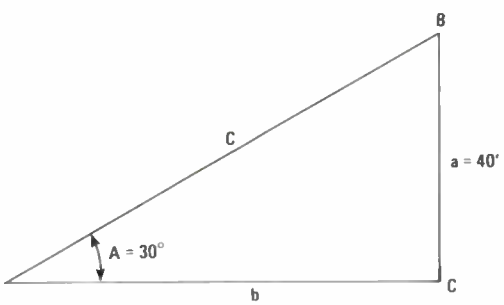


Fig. 5—IF you know an angle and a side of a right triangle you can easily determine the value of the unknown side.

other sides and angles. Angle B is easy to determine because

$$A + B = 90°$$

Therefore, to get B we subtract A from 90

$$B = 90° - A$$
$$B = 90° - 30° = 60°$$

Now let's compute the length of the hypotenuse (side c). Since we know the length of the opposite side a and angle A, we use the sine.

$$\sin 30° = a/c$$

We use algebra to rearrange this expression to solve for c. If we multiply both sides by c and divide both sides by sin 30, we get

$$c = a/\sin 30°$$

Plug in the values given earlier.

$$c = 40/\sin 30°$$

The sine of 30°, as your calculator will tell you, is .5. So

$$c = 40/.5$$
$$c = 80 \text{ feet}$$

Easy, huh? Were you really expecting this to be that hard?

Hypotenuse Hunting

You could also use the cosine to compute the hypotenuse because its ratio contains c.

$$\text{cosine } A = b/c$$

Ooops! We don't the know the length of the adjacent side b. Or do we? If we switch over and use angle B instead of angle A, then side a is the adjacent side. We computed angle B earlier as 60°. Therefore

$$\cos B = a/c$$
$$\cos 60° = 40/c$$

Rearranging to solve for c, we get

$$c = 40/\cos 60°$$

Your calculator will tell you that cos 60° = .5. So our calculation is the same.

$$c = 40/.5 = 80 \text{ feet}$$

Everything checks out.

Using the Tangent

To get the length of side b, you could use the tangent.

$$\tan A = a/b$$
$$\tan 30° = 40/b$$

We multiply both sides of the equation by b and divide by tan 30° to solve for b.

$$b = 40/\tan 30°$$
$$b = 40/(.5773)$$
$$b = 69.3 \text{ feet}$$

Back to Pythagoras

Another way to get the length of side b is to use the Pythagorean theorem that you learned last month.

$$c = \sqrt{a^2 + b^2}$$

or since you know sides a and c

$$b = \sqrt{c^2 - a^2}$$
$$b = \sqrt{80^2 - 40^2}$$
$$b = \sqrt{6400 - 1600}$$
$$b = \sqrt{4800}$$
$$b = 69.3 \text{ feet}$$

That's what you got before, so it checks out.

You could have used sine to find the length of b also. Just use angle B.

$$\sin B = b/c$$

You know B is 60° and c is 80 feet. Rearranging to solve for b

$$b = c \sin B$$
$$b = 80(\sin 60°)$$
$$b = 80(.866) = 69.3 \text{ feet}$$

By now, you are probably realizing how all these things are tied together. Using the trig functions and Pythagorean theorem, you can compute any side or angle. All you have to know is just two pieces of information about the triangle, an angle and a side or two sides, and you can figure all the rest. Is that great, or what?

One More Time

Now here's another example. The problem is to find the height of a tall antenna tower without climbing it for a measurement. One way to do this is to wait for a sunny day and measure the length of the tower's shadow. But to do this, you need to know the angle of Sun with respect to Earth. Refer to Fig. 6.

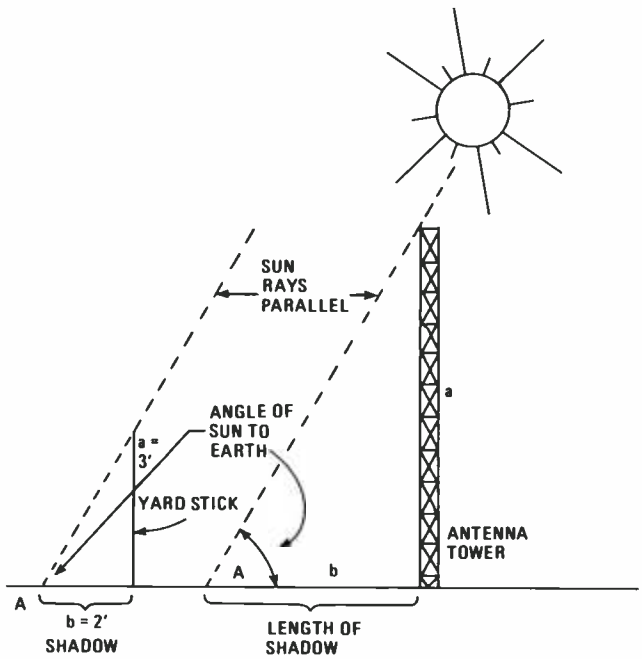


Fig. 6—Since the value of the trigonometric functions of an angle do not vary with the size of the triangle, you can use a little triangle to help solve problems with big ones.

To find that angle, you can determine it on a smaller scale with a smaller shadow. Take a yard stick and hold it vertical to the Earth in the sun. Now measure the shadow. Assume it is 2 feet. You now know the opposite and adjacent sides of a small right triangle as Fig. 7 shows. So you can find the Sun angle using arctangent.

$$A = \tan^{-1}(a/b)$$
$$A = \tan^{-1}(3/2)$$
$$A = \tan^{-1}(1.5)$$
$$A = 56.31°$$

This is the same angle that the Sun's rays make with the Earth at the tower. The reason for this is that because the Earth is so far away from the earth (93,000,000+ miles), all rays are assumed to be parallel.

Next we go measure the tower shadow. Suppose it is 36 feet. Using that length and the angle, you can compute the tower height using the tangent.

$$\tan A = a/b$$
$$a = b \tan a$$
$$a = 36\tan 56.31°$$
$$a = 36(1.5)$$
$$a = 54 \text{ feet}$$

Practice Problem

It's time for you to try your hand at this. 1. Refer to Fig. 7. Side C = 100 feet and angle B = 40°. Solve for all other sides and angles. Use the Pythagorean theorem to check your results. 2. It has been determined that the angle of the guy wire that gives the best support on an antenna tower is 45°. The tower is 70 feet high. The guy wires will be connected to the top of the tower and on the ground. How long must each guy wire be? How far away from the tower base will the guy wire be anchored in the Earth? Draw a picture of the problem first, label everything given, then compute the answers.

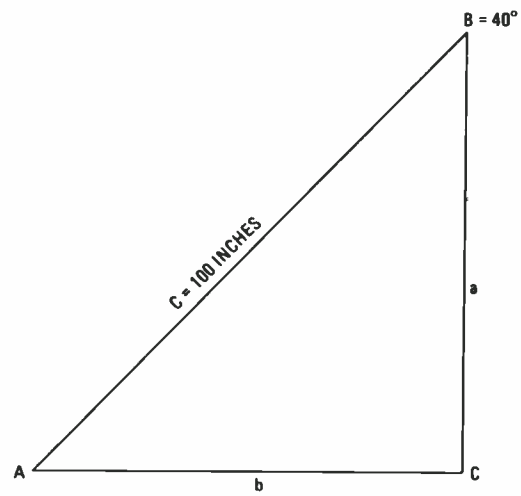


Fig. 7—If you know an angle and the hypotenuse, it's not tough to find out the values of the shorter sides.

Electronics Examples

And now for the good part. Let's use trig to solve some real electronic problems. Take a look at Fig. 8. It shows a simple RC network. We know the values of R and C and the value and frequency of the applied voltage. We know that in a capacitive circuit that the current leads the applied voltage. The current flows in R so the output voltage (V_O) across the resistor leads the applied voltage (V_S) also. But by what phase angle?

First, we compute the capacitive reactance:

$$X_C = 1/6.28fC$$
$$X_C = 1/6.28(2 \times 10^6)(100 \times 10^{-12})$$
$$X_C = 796 \text{ ohms}$$

We can now calculate the total circuit impedance using the resistance and reactance values with the familiar formula

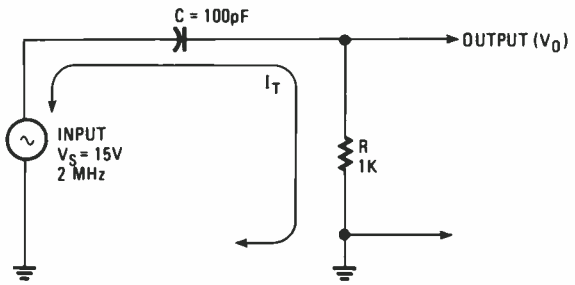


Fig. 8—Trig comes in handy when you try to figure out the phase shift in a circuit. Capacitors shift the phase by 90°, but this circuit contains a resistor which changes the shift.

based on Pythagorean theorem of right triangles

$$Z = \sqrt{R^2 + X_C^2}$$
$$Z = \sqrt{1000^2 + 796^2}$$
$$Z = \sqrt{1{,}000{,}000 + 633{,}616}$$
$$Z = \sqrt{1{,}633{,}616} = 1278 \text{ ohms}$$

The total circuit impedance, of course, sets the current. We can find it using Ohm's law.

$$I_T = V_S/Z$$
$$I_T = 15/1278 = .0117\text{A or } 11.7 \text{ mA}$$

Now we can compute the voltage drops across each component with Ohm's law.

$$V_R = I_R = .0117(1000) = 11.7 \text{ Volts}$$
$$V_C = IX_C = .0117(796) = 9.3 \text{ Volts}$$

Turning to Vectors

With this information, we can now construct a vector diagram. Refer to Fig. 9. In a series circuit, the current is common to all components so it becomes the reference vector I. The voltage across the resistor is in phase with the current so we draw a vector for V_R coinciding with I.

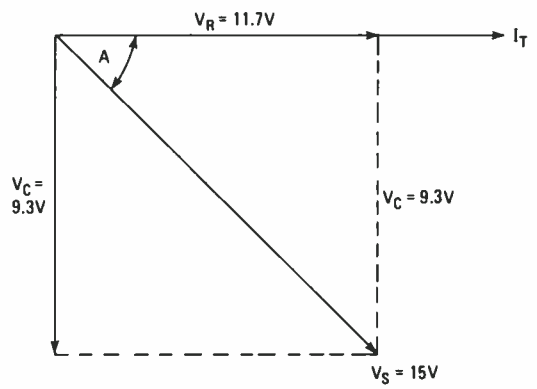


Fig. 9—If you know the values of the voltage drops across components in a circuit, you can find the drop across the source using the Pythagorean theorem or trig functions.

The current I_T in a capacitive circuit leads the applied voltage. Another way to say this is that the voltage across the capacitor lags the current. Normally, a lagging vector is drawn in a clockwise direction from the reference vector. The capacitor voltage V_C lags the current by 90°.

According to Kirchhoff's current law, the sum of the voltage drops in a series circuit equals the applied voltage. If we add up the V_R and V_C we computed earlier, we get

$$V_R + V_C = 11.7 + 9.3 = 22 \text{ Volts}$$

That's not right because V_S is 15 volts as indicated in Fig. 8. Since the two voltages are 90° out of phase, we can't add them directly. It has to be a vector sum.

The vector sum can be found graphically by extending the V_R and V_C vectors in Fig. 9 to form a rectangle, then drawing in the diagonal which represents the vector sum, in this case, the applied voltage V_S.

What we did in drawing the rectangle and the diagonal is to form a right triangle. The sides are resistor and capacitor voltages. We can use Pythagorean theorem to compute the length of the hypotenuse whose length is the applied voltage

$$V_S = \sqrt{V_R^2 + V_C^2}$$
$$V_S = \sqrt{11.7^2 + 9.3^2}$$
$$V_S = \sqrt{136.89 + 86.49}$$
$$V_S = \sqrt{223.38} = 14.95 \text{ volts}$$

This is approximately the supply voltage of 15 volts.

We could also have used trig to find the supply voltage (hypotenuse). We know the lengths of the opposite (V_C) and the adjacent (V_R) sides. Their ratio is the tangent of angle A. So we use arctan to find angle A.

$$A = \tan^{-1}(V_C/V_R)$$
$$A = \tan^{-1}(9.3/11.7)$$
$$A = \tan^{-1}(.795)$$
$$A = 38.5°$$

Diagramatically

Referring to Fig. 9, you can see that A is the angle between the current I and applied voltage V_S. Therefore, you can see that the current and the output voltage V_R leads the applied voltage by 38.5°. If we draw the sine waves representing these voltages, they would look like Fig. 10.

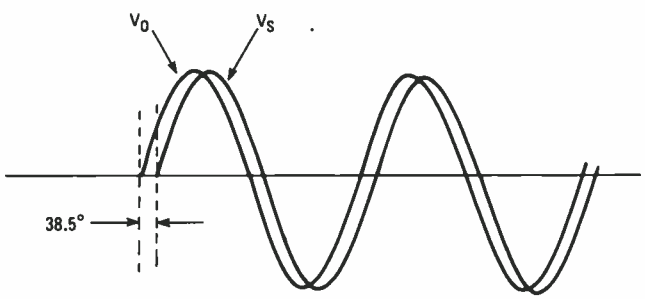


Fig. 10—On an oscilloscope the phase difference between the source and output voltages is very noticeable, but unless you can perform X *vs.* Y measurements you can't read it.

Another way to find the applied voltage is to use either sine or cosine. You know the angle and both the opposite and adjacent sides. The hypotenuse is computed by rearranging the sine or cosine expressions

$$\sin A = V_C/V_S$$
$$V_S = V_C/\sin A$$

or

$$\cos A = V_R/V_S$$
$$V_S = V_R/\cos A$$
$$V_S = 9.3/\sin A = 9.3/.62 = 15$$
$$V_S = 11.7/\cos a = 11.7/.78 = 15$$

Check the calculations yourself just to be sure you understand.

Another Example

Let's take an example of a parallel LCR circuit as shown in Fig. 11. Our main interest here is to find the phase shift between the total circuit current I_T and the applied or source voltage V_S. All of the resistance and reactance values are given. Since the source voltage is common to all components, we can compute the current through each with Ohm's law.

$$I_R = V_S/R = 12/50 = .24 \text{ A}$$
$$I_C = V_S/X_C = 12/40 = .3 \text{ A}$$
$$I_L = V_S/X_L = 12/30 = .4 \text{ A}$$

Kirchhoff's current law says that the sum of the branch currents in a parallel circuit equals the total line current drawn from the AC source. But, of course, we know we can't add these currents directly because they are all out of phase with one another. We have to use a vector sum. So let's first draw a vector diagram. See Fig. 12.

The applied voltage V_S is common to all components so we use it as our reference. The resistor current is in phase with this voltage so we draw the I_R vector on top of V_S.

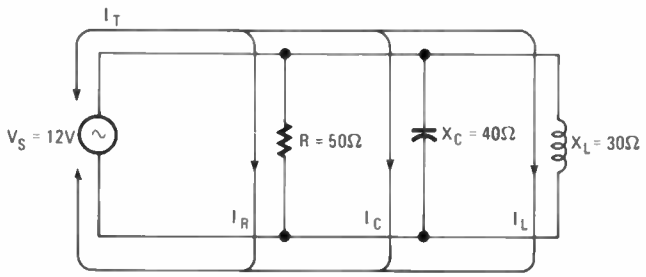


Fig. 11—Trying to determine the current following through the components in this tank circuit would be futile.

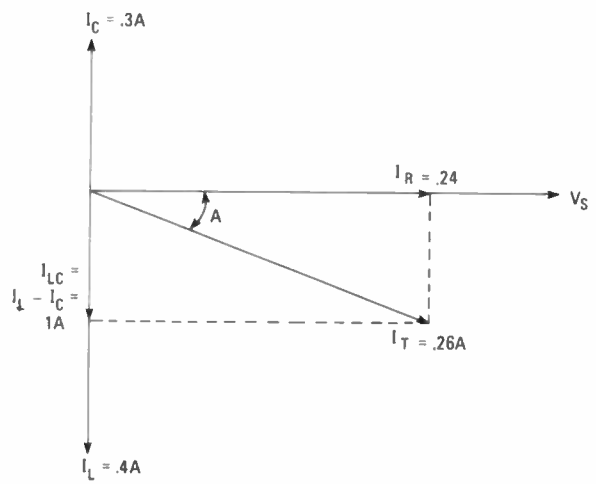


Fig. 12—The vector diagram of the tank circuit clears up any confusion about what is going on in the circuit.

The current in the capacitor leads the applied voltage by 90°. Leading vectors are drawn counter-clockwise from the reference. So I_C points straight up. The current in the inductor lags the voltage by 90°. It is drawn clockwise from the reference voltage or straight down. The key thing to note here is that I_C and I_L are 180° out of phase with one another. They are completely opposite. When I_C is peak positive, I_L is peak negative and vice versa. Because they are in opposition, they will cancel one another. Since I_L is greater, it will cancel I_C leaving the difference between the two or

$$I_{LC} = I_L - I_C = .4 - .3 = .1 \text{ A}$$

Since I_L is larger, the difference current I_{LC} lags the applied voltage by 90°. We draw this on top of the I_L vector in Fig. 12. The circuit is acting as if it only contains an inductor that draws .1 A. At 12 volts, this equivalent inductor has a reactance of

$$X_L = V_S/I_{LC} = 12/.1 = 120 \text{ ohms}$$

To the AC generator, the circuit looks like a 120 ohm inductor in parallel with the 50 ohm resistor. The capcitor is effectively not there.

Vector Summing

Okay, we can now do our vector sum. All we do is add I_{LC} to I_R. To do this, we extend I_R and I_{LC} to form a rectangle as shown in Fig. 12. Then we draw the diagonal which is the vector sum of the equivalent coil and resistor currents. This is the total circuit current I_T. As before, we created a right triangle.

We can use Pythagorean theorem to find I_T

$$I_T = \sqrt{I_R^2 + (I_L - I_C)^2}$$
$$I_T = \sqrt{.24^2 + .1^2}$$
$$I_T = \sqrt{.0576 + .01}$$
$$I_T = \sqrt{.0676} = .26 \text{ A}$$

At last we can find the phase angle. It is angle A in Fig. 12. Since all of the sides of the triangle are known, you can use sine, cosine or tangent. Just to review, we will use them all.

$$A = \sin^{-1}(I_{LC}/I_T)$$
$$A = \sin^{-1}(.1/.26)$$
$$A = \sin^{-1}(.3846)$$
$$A = 22.62°$$

$$A = \cos^{-1}(I_R/I_T)$$
$$A = \cos^{-1}(.24/.26)$$
$$A = \cos^{-1}(.923)$$
$$A = 22.62°$$

$$A = \tan^{-1}(I_{LC}/I_R$$
$$A = \tan^{-1}(.1/.24)$$
$$A = \tan^{-1}(.4167)$$
$$A = 22.62°$$

The total current lags the applied voltage by 22.62°.

Practice Problem

Now, take a few minutes to practice what you learned. Try out your new-found knowledge on this problem. 3. In the circuit of Fig. 13, a coil is used in place of the capacitor in the

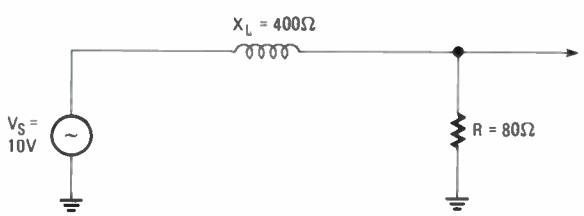


Fig. 13—Remember when solving practice problem 3 that you can use either the Pythagorean theorem or trig.

(Continued on page 100)

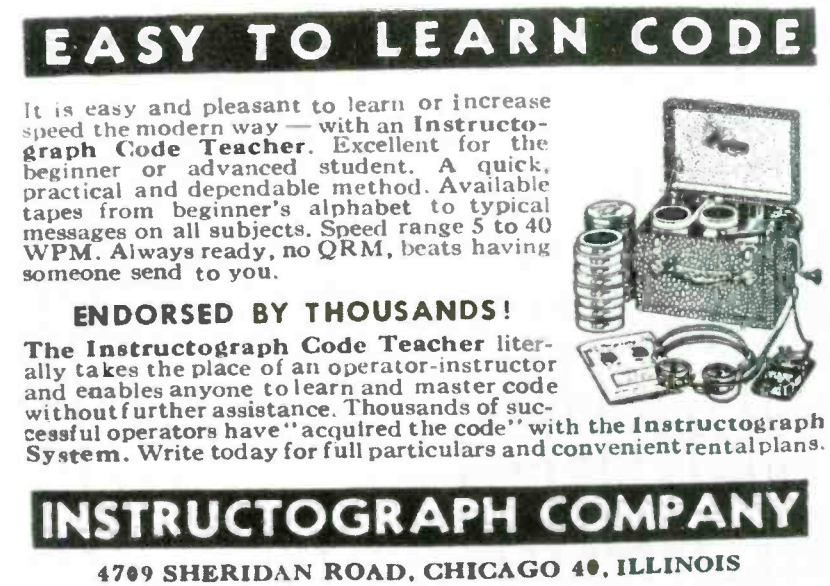
By Marc Ellis

ELLIS ON ANTIQUE RADIO

A collectible from the serious side of radio.

LOOK OVER THE "INDEX OF ADVERTISERS" for any major radio-oriented, hobby magazine from the 1930's, '40's, '50's or '60's, and the chances are good that you'll see an entry for the Instructograph Co. Turn to the indicated page number, and you'll find a modest fractional-page ad like the one pictured in the photos. Changing rarely in content or appearance, this little announcement certainly must qualify as one of the longest-running advertisements for a particular piece of electronics gear.

Of course the reason the advertisement didn't have to change was that the equipment being sold remained unaltered. The company had only one basic product to sell; it was sturdy and well-made; it filled a useful niche; and the manufacturer saw no reason to modify its design from the original 1930's concept. Produced with only minor variations for decades, archaic looking even while it was being sold, the Instructograph code practice machine is now considered a classic in any antique-radio collection.



Modest ads like this one sold Instructograph equipment in major radio-oriented hobby magazines of the 1930's, '40's, '50's and '60's.

Introducing the Instructograph

The Instructograph machine produces Morse code characters from rolls of pre-punched paper tape. Operating somewhat like a reel-to-reel tape recorder, but with a set of contact points in place of the playback/record head, the tape is wound from a supply spool to a take-up spool by means of a motor drive. The points are opened and closed by the tape perforations as they move by, keying the code-reproducing oscillator device.

Continuing the analogy with reel-to-reel magnetic recording, the messages are organized on the Instructograph's paper tape in much the same manner as they would be on a half-track monophonic, audio tape. As the tape moves in one direction, the contact points respond to the code groups perforated along the tape's top edge. After the tape runs out, the supply and take-up reels are switched, turning the tape upside down. What had been the bottom edge now becomes the top, and the contact points respond to another set of code groups perforated along that edge.

Over the years, the Instructograph was offered in a small variety of different configurations. It was available with a 110-volt electric motor or with a crank-wound, phonograph-type, spring motor (both were variable speed). And it could be supplied with or without a built-in code oscillator. The oscillator could be a 110-volt model, to go with the electric-motor machine, or a battery-operated model for use in the spring-motor machine.

This is a complete Instructograph outfit, which dates from about 1965, but has 1930's appearance. The machine was produced for decades with little change.

Machines without the built-in oscillator keyed an external reproducing device—either an oscillator for Continental (radio-type) Morse or a telegraph sounder for American (railroad-type) Morse. Regardless of how it was configured, the Instructograph always came with a library of ten double-sided, code-practice tapes (recorded in the purchaser's choice of either Continental or American Morse).

An order blank that was packed with my 1965-vintage machine pegs the price of an electric model with built-in oscillator at $53.00 (minus headset and key). At a time when a good set of code-practice records sold for right around $10.00, that represented quite an investment. (Perhaps the comparison isn't quite fair, since the Instructograph's speed control provided a lot of flexibility that's not offered by records. And the built-in oscillator made it possible to send code as well as receive it).

In any case, unless you had money to burn, you didn't buy an Instructograph out of a casual interest in Morse code. It was a piece of apparatus that appealed to career professionals (press and railroad telegraphers, ship's radio operators, and the like) as well as serious "hams." It could be used to prepare for government licensing exams, and to sharpen and improve your skills after the license was obtained. The Instructograph was a machine that meant business and looked it.

Anatomy Of A Classic Machine

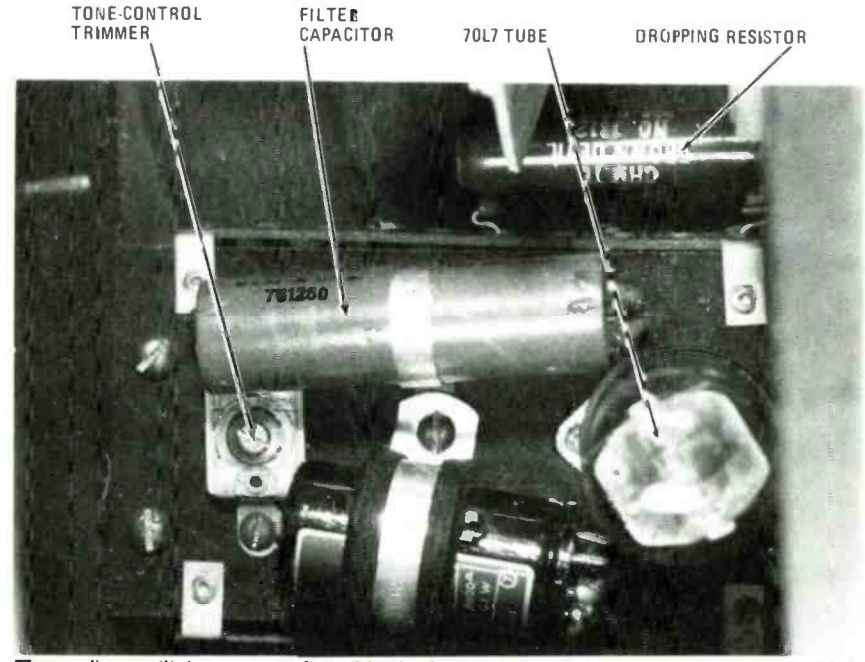
The Instructograph in my possession is an AC-operated model with built-in oscillator. Judging from a handwritten date found on the accompanying literature, it was manufactured in the mid-1960's. If so, that would make it a very-late model. After about 1969, ads for the machine were no longer seen in the radio press.

This close-up of the top panel shows the transport system for perforated tape.

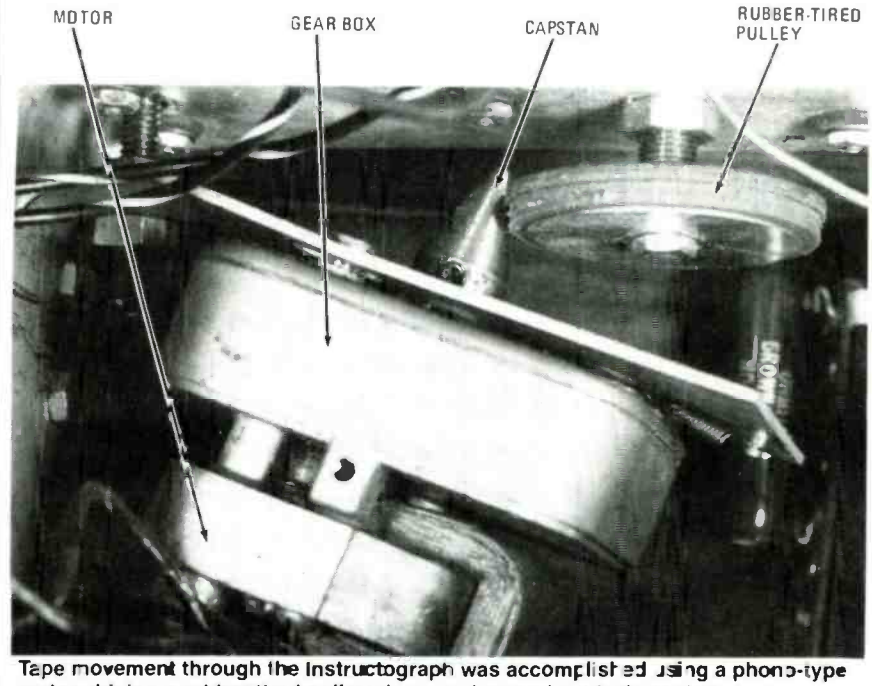
The set is housed in a sturdy, imitation-leather-covered, wood case of the type popularly used for test gear of the 1920's, '30's, and early '40's. Opening the cover exposes the tape-drive mechanism, contact points, operating controls, and binding posts for phones and key—all mounted on a polished Bakelite top panel.

The controls include a master POWER switch, VOLUME control, and TAPE-SPEED ADJUST. The POWER switch is a 3-way type with *off, oscillator only*, and *oscillator* and *motor* positions. Oscillator and motor was used for receiving from a tape; oscillator only, for practicing sending.

For a machine that's otherwise so well-planned and well-built, the panel labeling is a little on the inadequate side. Stick-on labels identify the three positions of the POWER switch and warn against handling the binding posts with the power on, but that's about it. The first-time user has to check the instruction manual to identify the other controls and the functions of the binding posts.



The audio-oscillator module found in the Instructograph featured a 70L7 tube, which is a combination of amplifier and half-wave rectifier in a single envelope.



Tape movement through the Instructograph was accomplished using a phono-type motor, driving a rubber-tired pulley via a gearbox and conical capstan.

I checked some of the illustrations in the manual (which—judging by the knob design—show an older version of the Instructograph) to see if a label or two had perhaps fallen off my machine. But the machine illustrated had none at all! Apparently even the few labels I did have had been put on the later models as an afterthought.

Like everything else about the Instructograph, the tape-drive system is sturdy, simple, and interesting. A hefty, phonograph-style, synchronous motor turns a cone-shaped capstan through a gearbox. The capstan is in contact with a rubber-tired drive pulley, which rotates the take-up reel. The turning take-up reel pulls the tape through the contact-point assembly, and that's all there is to transporting the tape!

The speed-control knob moves the motor-and-capstan assembly (which is mounted on a hinged housing) in rela-

(Continued on page 105)

By Herb Friedman

FRIEDMAN ON COMPUTERS

Use your computer to search through thousands of solid-state devices to find the exact part you need.

AS BOTH FAITHFUL AND INFREQUENT readers of this column are aware, I have little enthusiasm for schemes that attempt to replace the printed page with a computer file. Unfortunately, among the latest attempts are the floppy-disk substitutes for a solid-state reference handbook.

The way that latest scourge works, you are supposed to keyboard the needed specifications for a solid-state device, and quicker than you can "flick a flea," the computer is supposed to spit out everything you need to know. Well, until Motorola came out with their *SPECS IN SECS* disk, all the floppy-disk device-data schemes that I'd tried were abject failures.

More often than not, it took longer to learn the system and use the disk than it did to thumb through a reference guide. In fact, except for the Motorola disk, none had the data needed by experimenters. Some had such esoteric data specs that I had to go to the printed reference guide anyway, so I could have saved a lot of time—and confusion—if I had simply started out with the printed literature.

But like everything else, once someone shows how to do something right, everyone smiles, claims that it "could be done by anyone," and we can expect to soon be drowned in a sea of Motorola-like clones. But until someone actually does it, all we have is Motorola's *SPECS IN SECS*, so let's see how it can be used by the average experimenter.

Motorola's *SPECS IN SECS* is contained on a single floppy disk. Sorry, the assortment of transistors isn't included.

Thousands of Specs

As shown in the photos, *SPECS IN SECS* (without the assortment of transistors) comes on a 5¼-inch unprotected floppy for IBM-compatible computers having at least 384K RAM. (The truth of the matter is that Motorola wants you to hand out copies to your friends and co-workers.) The disk is nothing more than a database for more than 1600 bipolar power transistors and TMOS Power MOSFETs, plus more than 3500 cross references.

The only instructions needed to run the disk are printed on the sleeve (following *Friedman's Rule*, which states that "the thinner the manual the better the program.") After starting the program, all you have to do is enter the characteristics that *you* require in a power device. Within seconds, the program locates and displays every Motorola device that's likely to work. Of course, the more specs you enter the more specific the display will be.

For bipolar transistors, you can specify the characteristics for breakdown voltage, collector current, power dissipation, polarity, package style, price, and 10 other important parameters. For TMOS Power MOSFETs, the data disk displays breakdown voltage, drain current, $r_{DS(on)}$, power dissipation, price, and seven other parameters.

Or you can work the other way 'round. If you have an assortment of parts in the proverbial junkbox, you can enter each number and the program will display the specs.

Starting Out

The program comes up with the main menu screen shown in the photos—allowing you to select operation in five languages: German, English, Spanish, French, or Italian. You can select Bipolar or TMOS products. And you can select the screen color: Blue, Green, Monochrome, Red, or Yellow. As shown, the *default* functions are highlighted.

As shown in the photos, the screen display for part number MJE6040. Notice that the screen display contains what most consider to be *the* most im-

portant data, as well as the price in quantities of 100+. If the data is what you want, pressing F2 will produce a screen-print snapshot on your printer.

The next photo is interesting. It is the display for the MJE6040 when German was selected as the language. Notice that everything, including the prompts are in German.

And what if you're not interested in the specs on a particular part number? What if you want the program to tell you what part to use? Simple! You shift to the *parametric* mode, which is technese for *just enter the characteristics needed*, and you'll get the screen display shown in the photos. You can enter data for any of the 12 items, and then call for a search. As shown in the Photo, in response to the specific data entered, the computer will list all those devices that fit your specs.

Finding the Part

Okay, so you have used the program to locate the part that will do the job; but where do you buy it? Again there's no hassle. The program supports a database of Sales Offices in the U.S. and several countries. Simply pressing the keys corresponding to a state or international area will bring up a listing of local Sales Offices. For example, if the keys NY are pressed, the program will produce a list of New York Sales Offices.

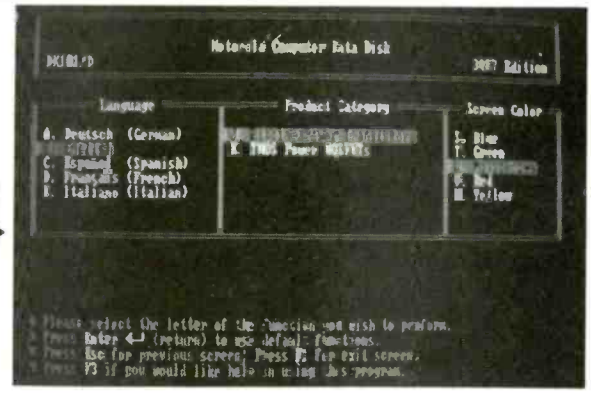
Notice that once again you are given the option of making a screen print. The computer will even print a request for information that you can mail off to the local Sales Office.

If you can't wait to get your hands on a copy of *SPECS IN SECS*, send $2 with a request for DK101/D to: Motorola Semiconductor Products, Literature Distribution Center, P.O. Box 20924, Phoenix, AZ 85063. (Pricing in U.S. dollars for U.S. delivery only.)

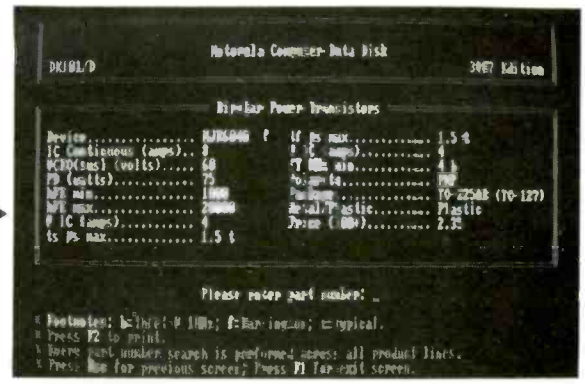
The Non-compatible Compatible

Unfortunately, Motorola's *SPECS IN SECS* disk falls victim to a problem we planned to cover in response to much reader mail. It appears that a popular "IBM PC/XT compatible" turbo-motherboard isn't all that compatible. (The company must go nameless be-

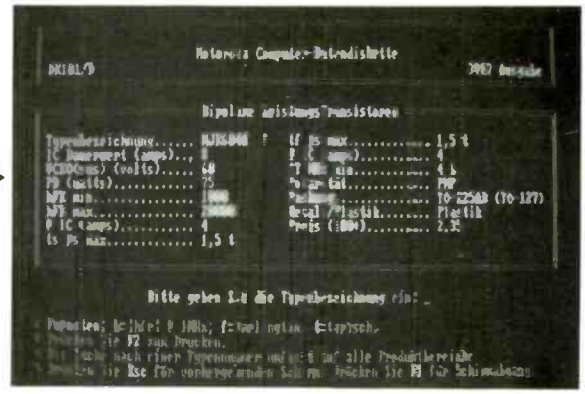
(Continued on page 98)



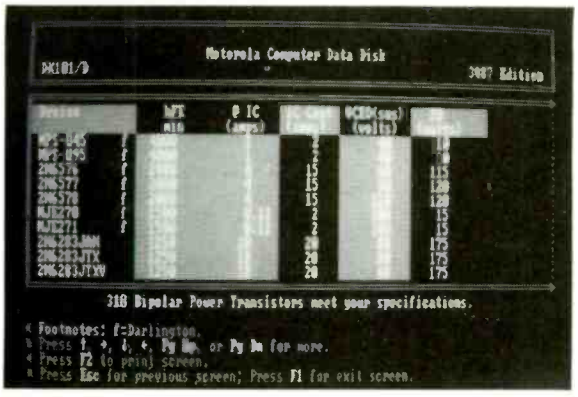
The main menu selects the language, device type, and screen color.



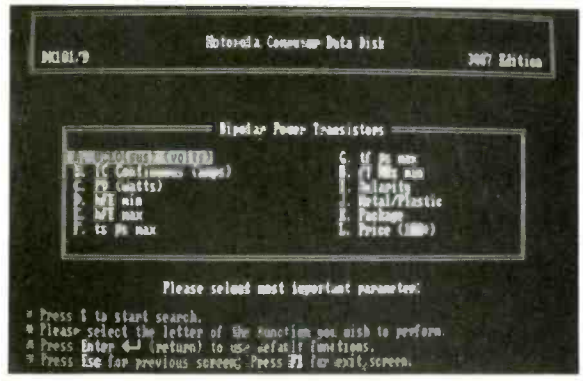
This is how the screen appears when you have requested the data for a specific device; in this case, the MJE6040.



This is how the screen display for an MJE6040 appears when you have selected German as the language. Notice that everything, including footnotes are in German.



If you know the characteristics of the part needed, you enter them from the parametric search screen.



The parametric search produces a listing of all devices meeting the list of specified criteria.

By Joseph J. Carr, K4IPV

CARR ON HAM RADIO

Two-meter FM operation

OLDER HAMS, UNDOUBTEDLY, remember when operating on VHF meant using both grossly overpriced and extremely temperamental equipment that produced only enough power to get around the corner...or so it seemed. I can still recall (with a certain degree of nostalgia) using a crystal-controlled *Gonset Communicator III* on Field Day, into a rotatable five-element vertical Yagi antenna.

Although the rig output only a few watts, and was one of the few 2-meter rigs that worked consistently well, the general perception was that 2-meters was a *cross-town* band only. But from a 3600-foot mountain in Virginia's Blue Ridge range, we easily worked down into North Carolina, over into West Virginia, and even up to Pennsylvania and Delaware. Twenty-five years ago that was a thrill on "two."

Several factors combined to make 2-meters a very-popular band. No longer the haunt of VHF DX'ers with massive antenna arrays (and a wild gleam in their eyes), or the lonely tinkerer experimenting with VHF circuits and communications, 2-meters is now one of the standard bands in the line-up of most ham equipment.

One of the factors in 2-meter's surge in popularity was the introduction of repeaters on 2-meters, while the other was the design of low-cost, solid-state equipment.

According to popular legend, the repeater craze started in California with former TAB Books editor Ken Sessions, K6MVH. Figure 1 illustrates how a repeater works. A site is selected for the repeater that offers a commanding *view* of the entire region. Popular as repeater sites, are tall office and/or apartment buildings, tall radio broadcast-station towers (on which two-way antenna space is rented), and mountains. The general rule—access permitting, the higher the better.

The repeater consists of a receiver and a transmitter connected such that the detected output of the receiver is used to modulate the transmitter. Two different frequencies are used, F1 and F2 (as illustrated in Fig. 1). At the repeater site, the transmitter frequency (outgoing) is F1, while the receiver frequency (incoming) is F2. User stations, whether base types, handhelds, or mobile units transmit and receive on the opposite configuration of frequencies; in effect, transmitting on F2 and receiving on F1. Thus, the repeater receives the signals from the user stations and retransmits them on some other frequency...to which the user receivers are tuned.

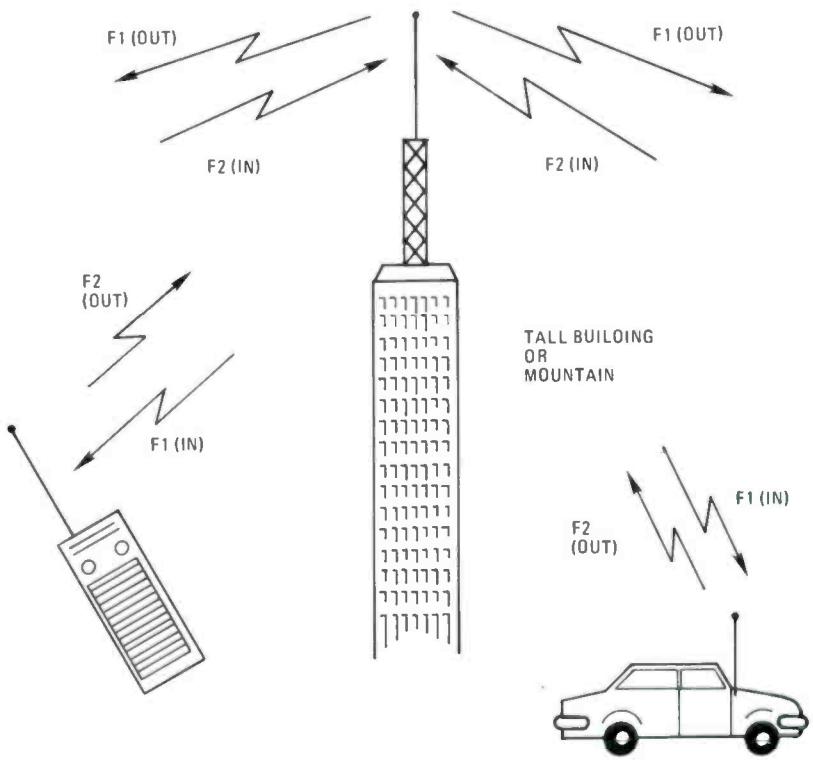


Fig. 1—A repeater consists of a receiver and a transmitter connected such that the detected output of the receiver is used to modulate the transmitter. The repeater (as illustrated here) transmits on one frequency (F1) while the receiver captures the incoming frequency, F2. User station—base types, handhelds, or mobile units—transmits on F2 and receives on F1.

Because of the repeater, low-powered communications are no longer limited to a short radius. A person with only a few watts of RF output power can now communicate over a very-wide range covered by the repeater. Thus, two low-powered mobile units many miles apart, can now communicate as if they were right next door (well...almost). Distances of 100-miles are possible, although that would be an exception.

Because repeaters are found all over the country, and so many repeater "channels" are available (600+ is usually quoted in ads for rigs), it is possible to cross the country and never be out of range of at least one repeater. In densely populated regions of the country—the east coast, and W6-land, for example—it is more common than not to be able to call up a dozen or more repeaters from any single location.

Some repeaters are equipped with *autopatch* capability, which means that the repeater is connected to the telephone lines. Authorized users are allowed to make telephone calls of a strictly personal and non-business nature over the autopatch. In most cases, members of the repeater are issued a code number that permits access to the autopatch. Non-members can use the repeater, but are not allowed to use the autopatch feature—it costs money and only supporting users are permitted access to the equipment.

Types of Rigs

The buyer today literally has an embarrassment of riches to select from when shopping for a 2-meter rig. Figures 2 through 5 show several of the models that are available. The rig shown in Fig. 2 is a base station intended for home use. That set, an Icom Model IC-727A, is typical of all-mode units, in which the user can select either

Fig. 2—The rig shown here is an Icom Model IC-727A base station intended for home use, and is typical of all-mode rigs, which allow the user to select either CW, AM, SSB or FM modes. Like most modern ham rigs, it offers memory as well as VFO tuning.

CW, AM, SSB or FM modes. Like most modern ham rigs, that one offers memory as well as variable-frequency oscillator (VFO) tuning.

Figure 3 shows a typical mobile system—the Icom IC-27A. Note the size relative to the hand-held microphone. The microphone not only serves the microphone function, but also contains

Fig. 3—Shown here is a typical mobile rig—the Icom IC-27A. Note the size relative to the hand-held microphone. The microphone not only serves the microphone function, but also contains the Touchtone pad needed to use the autopatch, and up/down switches to change the set's operating frequency.

the Touchtone pad needed to use the autopatch, and up/down switches needed to change the operating frequency of the rig without bending down (while driving!) to touch the front panel. Systems of that size tend to have an RF output in the 10- to 25-watt range, with amplifiers available to boost the power output to as high as 150-watts.

Figure 4 shows a typical handheld rig, the Icom Model IC-02A. Self-contained with receiver, transmitter, and autopatch Touchtone pad, the set offers several watts of RF output power. The flexible antenna used in that rig (and most handheld 2-meter sets) is called a *Rubber Ducky*.

Figure 5 shows two popular accessories for the 2-meter handheld transceiver. Once you start to use a handheld, you will find that the convenient carry method is in a holster hanging from your belt...which is exactly the wrong location for monitoring and using the radio. If you are called, or want to make a call, then you have to unbutton the strap, lift the set to mouth level and talk...and by that time your caller has given up and gone to 40-meters to compete with *Radio Moscow*.

The accessory shown in Fig. 5 is an MFJ speaker microphone. It contains both microphone and loudspeaker functions in the same case, and can be mounted from a clip on your shoulder.

Fig. 4—Typical of handheld rigs, the Icom Model IC-02A is self-contained with receiver, transmitter, and autopatch Touchtone pad; and offers several watts of RF output power.

When positioned on the shoulder under the ear, it makes it easy to monitor traffic on the radio; and then to talk, you just reach up and press the mike button ...or take the microphone off and respond.

The accessory shown in Fig. 5B is the MFJ charger stand. Handheld radios are battery operated, and most use rechargeable NiCd batteries. The charger serves not only as a stand to store the rig, but also as a battery charger.

Perhaps the best thing about modern 2-meter systems is that commercially-available transceivers are top performers and are relatively low in cost. The first rigs we used were converted Motorola and GE commercial land-

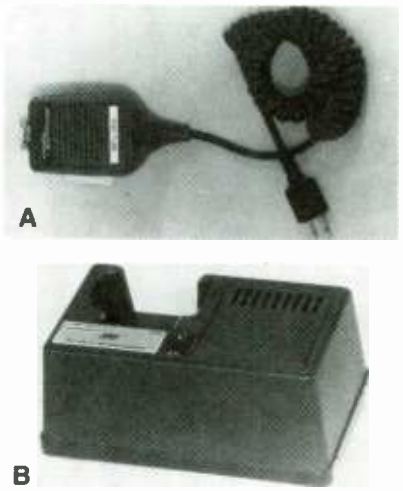


Fig. 5—Shown here are two popular accessories for the 2-meter handheld transceiver. The accessory shown in "A" is an MFJ speaker microphone, which incorporates both microphone and loudspeaker functions in the same case. The accessory shown in "B" is the MFJ charger stand.

mobile rigs, which typically operated on a single channel. Later those rigs were expanded to six to twelve channel solid-state units and cost a small fortune. I once paid $300 for a six channel Heathkit that output only 10-watts. But today, $200 buys a synthesized 600-channel system, and for $300 one can buy the rigs with tremendous capability.

Here we are, once again at the end of the space allotted to us for the month. But we'll be back again in about 30 days (give or take a few) with more hobby communications stuff. And in the mean time let us hear from you. We welcome your tips, comments, and questions. Send all correspondence to Joe Carr, K4IPV, at PO Box 1099, Falls Church, VA 22041. ■

CIRCUIT CIRCUS

By Charles D. Rakes

Some of the most useful ICs can be found among the most overlooked.

IN THE REALM OF HOBBY ELECTRONICS many an integrated circuit has been overlooked by the average enthusiast—whether for the lack of understandable supporting literature, or for the inability of the hobbyist to envision a useful application for a specific component. One such underutilized component is the Sprague type UGN-3013T Hall-effect, solid-state switch, which has purposely been designed to be extremely stable in operation.

What's Inside

From the outside this low-cost, Hall-effect digital switch appears much the same as any simple three-terminal device. But as they say, "looks can be deceiving," as revealed by the functional block diagram shown in Fig. 1. The chip contains an internal voltage regulator, solid-state, Hall-effect generator, an amplifier, a Schmitt-trigger, and an open collector output transistor. All of those electronic goodies are integrated on a single monolithic silicon chip.

Any DC source of 4.5 to 16-volts will operate the internal voltage regulator and power switch. The magnetic field is detected by the Hall-effect generator, and the small output signal voltage is increased to a useful level by the internal amplifier. The amplified signal is then fed to the Schmitt-trigger circuit, which adds the hysteresis necessary to provide a non-oscillating switching output. The output of the Schmitt trigger is tied to the base of an open-collector transistor, which is capable of sinking up to 25 mA in the "on" state.

Getting Acquainted

In the applications department, the 3013T can be put into operation as the nucleus of a very sensitive magnetic-detector circuit. Figure 2 illustrates the Hall effect switch in its simplest form. The LED always turns on when a permanent magnet is positioned, as shown, very close to the face side of the 3013T package.

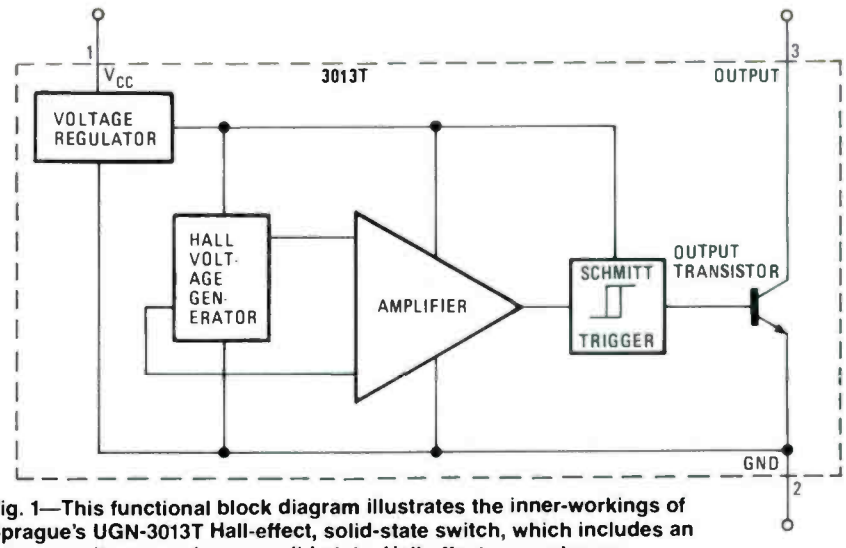


Fig. 1—This functional block diagram illustrates the inner-workings of Sprague's UGN-3013T Hall-effect, solid-state switch, which includes an internal voltage regulator, a solid-state, Hall-effect generator, an amplifier, a Schmitt-trigger (providing hysteresis), and an open collector output transistor (which can sink up to 25 mA in the "on" state.

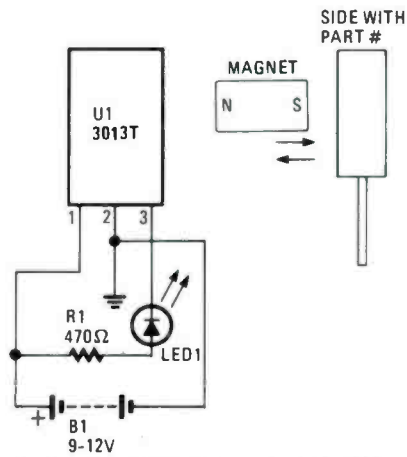


Fig. 2—This circuit illustrates the Hall effect switch in its simplest form. The LED turns on when a permanent magnet is positioned in close proximity to the face side of the package. The typical magnetic flux density of 300 Gauss—or roughly the equal of todays small permanent magnets—is necessary to activate the switch.

The typical magnetic flux density necessary to activate the switch is 300 Gauss. If your Gauss meter happens to be on the blink, that's roughly equal to the strength of todays small permanent magnets positioned within an eighth of an inch of the surface of the 3013T package. Once activated, due to the built-in hysteresis, the magnet must be moved away from the switch by about a sixteenth of an inch to cause the switch to open.

That operating feature makes the 3013T switch a good choice in such applications as security systems, ignition systems, keyboard key switches, and many other instances where the operating magnet is close to the Hall switch.

Boosting Sensitivity

The sensitivity of the switch can be increased 100-fold by adding the components shown in Fig. 3. If you can relate back to the early days of radio, when regeneration was introduced and how it literally turned out to be the elixir that made DX reception a reality, then the gain of our magnetic detector should be no surprise.

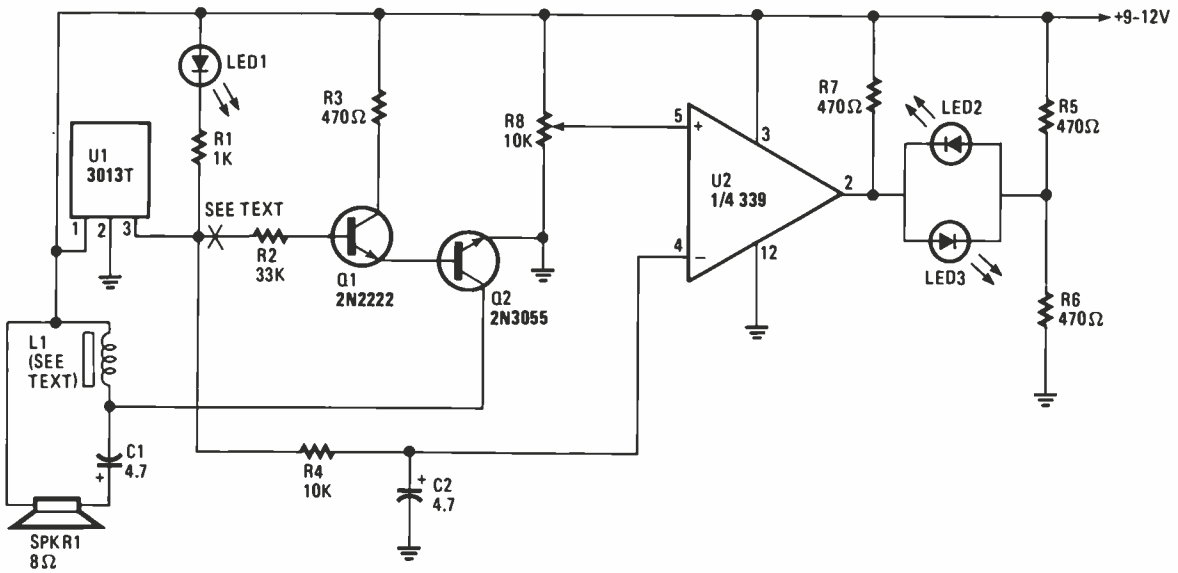


Fig. 3—The sensitivity of the switch can be increased 100-fold by reconfiguring the circuit, as shown here. The output of the 3013T is connected to a two-transistor, direct-coupled amplifier, which operates Q2 via Q1. Transistor Q1, in turn, drives a small electromagnetic coil that is positioned next to the Hall switch.

The output of the 3013T is connected to a two-transistor, direct-coupled amplifier with the output of Q2, a power transistor, driving a small electromagnetic coil that is positioned next to the Hall switch. Bias current for Q1 is supplied through LED1, R1, and R2, and operates like an ON switch when no magnetic field is present near the 3013T switch. Q1's current flows into the base-emitter junction of Q2 turning it on and switching the full supply voltage across the magnetic coil, L1.

If the coil is positioned near the back side of the 3013T and in the proper direction LED1 should light. As the electro-magnetic field is detected by the 3013T, it switches on—removing the bias from Q1 and Q2, turning both off and momentarily turning off the coil current. When the coil current is turned off, the magnetic field ceases and the 3013T switches off, and the coil is re-activated and the cycles continue with an on/off rate of about 1kHz.

This regenerative amplification circuit turns the docile 3013T switch into a super sensitive magnetic detector that can sniff out a strong permanent magnet at a distance of a foot or more.

Here's how the circuit detects a magnetic field. As the circuit oscillates on and off the pulsed output of the 3013T is fed through a smoothing circuit, R4 and C2, and to one input of the comparator. The comparator's other input is connected to a pot for setting the switching point of the two output LED indicators. With the circuit operating and R8 set so the two output LEDs are blinking on and off, the circuit is functioning in its most sensitive mode. When a magnet is moved within the detection range of the circuit the output pulses vary in width and the average output voltage changes and is detected by the comparator, causing one of the LEDs to light and the other to go dark.

You can make L1 by winding about 500 feet of No. 30 copper wire on a soft iron core, or if that seems like too much work, do as I did and scrounge a 50 to 100-ohm coil from an old relay or buzzer. The circuit can be built on a section of perfboard with the 3013T device located in an area clear of magnetic materials and placed such that the coil can be located near the face or back of the device. Actually, other than the position of the coil to the 3013T, there's nothing critical about the circuit or its construction scheme.

Experimenting with the circuit. A speaker can be added if an audible output is desired, or for a more accurate indication a voltmeter can be connected across the output LEDs. In any case, the sensitivity of the circuit hinges on the location of L1 in relation to the face or back of the 3013T switch. If placing the coil to the face of the device won't cause LED1 to light then try moving the same end of the coil around to the back side of the switch and the circuit should take off. It doesn't matter which side of the 3013T is used for placing the coil next to, but all external magnets should be detected from the opposite side of the 3013T. L1 should be positioned only as close to the 3013T as is necessary to cause LED1 to light. If the coil is too close to the switch, the circuit's sensitivity will be reduced.

PARTS LIST FOR THE MAGNETIC DETECTOR

C1, C2—4.7-μF, 25-WVDC electrolytic capacitor
C3—0.27-μF, 100-WVDC Mylar capacitor
L1—50-to-100-ohm coil (see text)
LED1–LED3—Jumbo LED (any color)
Q1—2N2222 (or similar) general-purpose NPN silicon transistor
Q2—2N3055 NPN power transistor
R1—1000-ohm
R2—33,000-ohm
R8—10,000-ohm potentiometer
R9—4700-ohm
R10—25,000-ohm potentiometer
SPKR1—Small 8-ohm speaker
U1—3013T Hall switch, integrated circuit
U2—LM339 quad comparator, integrated circuit
U3—555 oscillator/timer, integrated circuit

ADDITIONAL PARTS AND MATERIALS

Perfboard, IC sockets, various magnets, potentiometer knobs, power source, wire, solder, etc.

Getting Tricky

An independent AC magnetic bias can be used with the detector circuit, which can add to the stability in experimenting with weak magnetic fields and in using the circuit for an electronic

(Continued on page 99)

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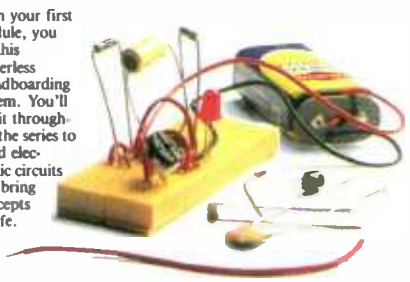

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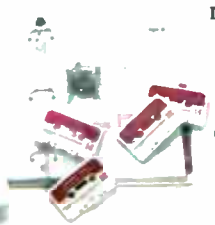

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By Don Jensen

JENSEN ON DX'ING

Shortwave Olympics

☐THE 25TH OLYMPIAD—THE QUADrennial sports spectacular—is scheduled for Seoul, Korea in September. The Olympics is a prestigious event for the host nation, the first to be held in the Far East since the 1964 Tokyo games. Naturally, the Koreans want to make sure that everything goes smoothly.

To that end, *Radio Korea*, the overseas service of the Korean Broadcasting System, is updating its technical facilities for the event, and SWL's can look forward to extensive shortwave coverage both before and during the Olympics.

Just before they begin, though, Radio Korea will mark a significant milestone, the 35th anniversary of the beginnings of its English language radio service.

It was in the summer of 1953 that the Korean War ended with the signing of a cease-fire agreement at Panmunjom, on the famed "38th parallel," the dividing line between North and South Korea. And less than a month later, Seoul's reborn shortwave station, then called the *Voice of Free Korea*, began broadcasting 15 minutes of English daily.

That was expanded some years later, to 45 minutes, and eventually, to an hour-long English program each day, beamed to various parts of the world at different hours. In 1973, the Voice of Free Korea was given its present name, Radio Korea.

Other foreign languages were added to Radio Korea's daily schedule, including Japanese, Russian, Chinese, and seven others, plus, of course, Korean. The latest language to be added by the station was Italian, with programming starting in 1985.

Radio Korea uses some 20 different frequencies on shortwave for its various one-hour program blocks, for a total of 126 hours of programming each day. The programs include listener-response shows, "From Us to You" and "Shortwave Feedback," which seek letters from the Radio Korea worldwide audience.

The Korean shortwave broadcaster puts a good signal into the United States and Canada, particularly during those transmissions beamed directly to North America. Those one-hour programs are scheduled for 0100 UTC on 15,575 kHz; 0500 UTC on 6,060 kHz; 1300 UTC on 9,750 and 15,575 kHz; and 2300 UTC on 15,575 kHz.

Additionally, Radio Korea puts out eight more hours of English programming during the day to other parts of the world, which sometimes can be received with decent signals in North America. Some of the frequencies to try include 6,480, 7,275, 7,550, 9,570, 9,870 and 13,670 kHz. So, if you manage to tune in on one of their SW broadcasts, why not drop them a line.

Getting comfortable—probably listening to hard-to-hear domestic Latin American stations, his specialty—is Russell L. Scotka of Margate, FL

Fooling Around

It's an old, old, old tradition...*April Fool's Day*. And on April 1, one or another of the major international broadcasters usually concocts some sort of program hoax, just for fun and to amuse its listeners.

Sometimes the "fooler" is a phony news story planted in the station's regular broadcast. I recall one such April 1 tale aired by a certain station, a straight-faced account, a supposedly first hand report of the spaghetti harvest in Italy.

The biggest hoax to hit the SWL hobby, though, was staged by a listener, not a station, 30-years ago this year. It had such an impact (at the time) that it is still spoken of in shortwave-listening circles, even by those who weren't even born at the time, but only have heard the tale passed on by their DX'ing elders.

The hoax was the brainchild of a teenage Californian, who, in 1958, claimed to have heard a new station called Radio Nibi Nibi. Nibi Nibi! Imagine a tiny coral isle in the blue Pacific, ringed with white sandy beaches. From that tropic paradise, supposedly came the shortwave signals...a 20-minute program at 0900 UTC, in the

Credits:
James Davicson, Ont; Charles Weiss, OH; David Clark, Ont; John Herkimer, NY; Art Harris, NY; Al Gastle, Ont; Ontario DX Association, PO Box 161, Station A, Willodale, Ont M2N 5S8; North American SW Association, 45 Wildflower Rd., Levittown, PA 19057.

island's native tongue, Aku-Aku; lush music, throbbing drums, coming from an island said to be "12,650 miles southwest of Sheboygan, Wisconsin." And, it was alleged, radio Nibi Nibi's unique tuning signal was the "sound of falling coconuts."

Hey, wait a minute! Phony as a three-dollar-bill, right? Just check out your Rand-McNally and in less than a minute you'd discover there just isn't such a place. The whole report was a hoax, and that should have been obvious from the very start.

Trouble was that too many people took it seriously, including at least one radio DX editor, who got *burned* when he "spread the news." Embarrassed he vowed to track down the culprit who sent in the info on that phony-baloney SW station.

Eventually, it all came out and the young fellow, who already had a reputation in several radio clubs for "imaginative" shortwave loggings, was found out. What had probably begun merely as a joke—and a rather obvious one at that—backfired.

The fellow was tossed out of several hobby clubs and the name of his fictitious shortwave "catch," Radio Nibi Nibi has gone down in radio lore as the epitome of the shortwave hoax!

Sychronous Detection

I bought a Sony ICF-2010 portable receiver, writes Michael A. Covington of Athens, GA, and wondered how long it would be before I heard a station that required the use of its synchronous detector. I didn't have to wait long.

I came across a *Voice of America* "feeder" transmission to one of its overseas relay transmitters on 7,768.5 kHz. There were different programs on the two sidebands of the same carrier—English on the lower and Portuguese on the upper sideband.

The synchronous detector picked them apart with only a small amount of crosstalk. None of the other detection methods—conventional AM of the SSB product detector—could make of it anything but gibberish.

My conclusion, he says, is that synchronous detection is here to stay. Why not do shortwave stereo that way?

Well-known receiver analyst and publisher of the new *Passport to World Band Radio*, Larry Magne more than agrees with you. He says the '2010 is "a generation ahead of the pack" because of synchronous detection.

ABBREVIATIONS

AM	amplitude modulation (modulated)
DX	long distance (over 1000 miles)
DX'er	listener to shortwave broadcasts
DX'ing	listening to shortwave broadcasts
FM	frequency modulation (modulated)
HCJB	Voice of the Andes
kHz	kiloHertz (1000 Hertzs or cycles)
kw	kilowatt (1000 watts)
MW	Medium wave
PST	UTC +8 hours
QSL	verification reply from broadcaster
QSL'ing	sending of reception report to station
RAI	Radio Austria International
RCI	Radio Canada International
RDI	Radio Database International
RN	Radio Nederland
SW	shortwave
SWB'ers	shortwave broadcasters
SWL('s)	shortwave listener('s)
UTC/GMT	Universal Time Code/

An AM shortwave signal has three parts, a *carrier*, plus two *sidebands*. Think of the carrier as a sheet of paper, Magne says, with the sidebands being the *ink*—the printed information upon the carrier.

Usually, the two sidebands, upper and lower, are identical, but reversed images of each other. You only need one of the sidebands for an intelligible signal. When there is spillover from an adjacent unwanted station, it is possible, therefore, to select the favored sideband and reject the one that is suffering most from the interference.

With synchronous detection, says Magne, you can listen to just one sideband by itself without adding distortion. In reader Covington's case, the station had separate programming on each sideband, because it was a point-to-point feeder service, not intended for direct reception by the typical listener. But it makes a dramatic case for synchronous detection.

Sony 2010 owners may find their owner's manual does not explain synchronous detection as well as it might. A better explanation, I think, is found in the *Radio Database International "White Paper"* evaluation of the 2010 receiver, written by Magne. It is available for $4 postpaid from RDI Publication Information, Box 300, Penn's Park, PA 18943.

And by the way, stereo shortwave likely will be in our future, though I'd hesitate to say just how soon it will arrive.

Down the Dial

What are you hearing? Why not let other SWL's know? Send your reception data, including frequencies and times, to *Jensen On DX'ing*, **Hands-on Electronics**, 500-B Bi-County Blvd., Farmingdale, NY 11735. As always your questions and tips are appreciated.

Here are some of the shortwave loggings recently reported by other listeners. As usual, all times are given in *Coordinated Universal Time* (abbreviated as UTC), and equivalent to EST + 5 hours, CST + 6 hours, MST + 7 hours or PST + 8 hours.

5,025 kHz—Most SWL's have, at one time or another, heard *Radio Havana Cuba*'s English programs. But Cuba also has a shortwave station—*Radio Rebelde* which can be heard during the evenings, and also around 1000 UTC—that relays domestic Spanish-language programs, often with some terrific Cuban music.

6,014 kHz—A nice bit of exotica is *Radio Tanzania Zanzibar*, which has been heard on this frequency in Ontario with news in Swahili at 0330 UTC.

7,240 kHz—From Belgrade comes *Radio Yugoslavia*'s English programming with news at 2100 UTC.

9,640 kHz—*Radio Kiev*'s English programs actually are transmitted by a number of stations throughout the Soviet Union, not just those located in the Ukraine. Listen for this one at 2330 UTC.

12,015 kHz—Also broadcasting in English at 1200 UTC, that's early morning in North America, is *Radio Ulan Bator* in Mongolia. Interference has been reported from two stations, one in the Soviet Union, the other a Chinese outlet.

15,165 kHz—*Radio Denmark*, for many years, has had no English programs, choosing to broadcast instead in Danish to Danes abroad. Still, you can hear an English identification announcement from the station, following its interval signal at 1630 UTC.

15,474 kHz—*Radio Nacional Arcangel San Gabriel* is a really exciting catch for the lucky DX fan. The station, operated by the Argentine Military, broadcasts from Antarctica. Programming is in Spanish, and it has been reported "peaking" in strength—though not a very good signal at best—at around 2300 UTC. ■

By Marc Saxon

SAXON ON SCANNERS

Awake to your favorite FM broadcast station or, if you prefer, you can wake to the intrigue of the scanner world

THE IDEA THAT THE WORLD SHOULD wake up to the many jobs of scanning has taken upon itself a whole new meaning, thanks to the design engineers of Regency Electronics, Inc. That's because Regency's recently released Z-60 scanner has a fancy, built-in alarm clock. Now, you can not only wake up to the world of scanning, but you can also do it to your favorite FM broadcast station if you prefer having a more-sedate way of facing the morning rush hour.

The Regency Z-60 has it all—the alarm clock, the 88 to 108 MHz FM broadcast band, and no less than fifty channels of scanner communications covering just about everything you'd ever want to monitor. That includes the VHF-Low Band (30 to 50 MHz), VHF Aero (118 to 136 MHz), 2-meter ham (144 to 148 MHz), VHF-High (148 to 174 MHz), UHF-ham (440 to 450 MHz), UHF (450 to 470 MHz), and UHF-T (470 to 512 MHz). Yes you get all of that, plus ten channels that are reserved for the FM broadcast band.

No crystals are required, everything is programmed with the front-panel keypad. When the unit leaves the factory, it is pre-programmed with sixty popular frequencies, which can quickly be changed to any others by punching up a few buttons on the front panel. You can also search band-segments to locate new frequencies when it's in its search/scan mode.

Its other features include a vacuum-fluorescent digital display, advanced no-batteries permanent memory system, a priority channel, optional two-second delay, plus channel lockouts. The display panel is set up to flash all sorts of programming messages.

The scanner is supplied with a telescoping antenna, plus provision has been made for the use of an external antenna. It's got a sedate and attractive woodgrain case, and the whole *shebang* is capable of both AC power mains or a 12-volt vehicle battery operation.

All-in-all, quite a nifty package. This user-friendly scanner carries a $379.95 suggested retail price tag, although we've seen it being advertised around for much less than that.

Regency's Z-60 scanner has a built-in alarm clock, allowing you to wake to the world of scanning, or your favorite FM broadcast station. In addition, it boasts no less than 50-channels of scanner communications covering just about everything you'd ever want to monitor—including VHF-Low, VHF Aero, 2-meter ham, UHF-High, UHF-ham, UHF, and UHF-T.

More details on the Z-60 can be obtained from Regency Electronics, 7707 Records Street, Indianapolis, IN 46226. Or, you can get more information from Regency by circling No. 51 on the Free Information Card.

The Sky's the Limit

Aeronautical communications have always been a source of enjoyment and excitement. Mail received here from readers confirms that, but also reveals that most *monitors* miss out on much of what there is to hear because they insist upon clinging to only their local control tower and other air-traffic control frequencies. Loosen up, and see what else is out there!

For instance, try 126.2, 130.65, and 134.1 MHz. Those are frequencies popular with military aviation. Or, there are a whole bank of frequencies set aside for the exclusive use of aircraft manufacturers testing their wares. You never know what to expect to pick up on these channels, which include: 123.125, 123.15, 123.175, 123.2, 123.225, 123.25, 123.275, 123.325, 123.35, 123.375, 123.4, 123.425, 123.45, 123.475, 123.525, 123.55, and 123.575 MHz. Some aircraft manufacturers have also been noted on 36.90 MHz.

Many airliners and corporate aircraft have telephones that enable air-to-ground calls to be placed in a manner similar to car telephones and ship-to-shore phones. Ground stations are located in many American cities. Most of these stations operate on a single channel, although a few have two and even three operating frequencies. It's a duplex (that is, tow-frequency) system with the ground stations operating on twelve available frequencies lying between 454.70 and 454.95 MHz (25 kHz spacing).

The aircraft operate between 459.70 and 459.95 MHz. Even if you aren't within range of any of the 79 ground stations, you should be able to copy the aircraft stations in the 459 MHz band. By the way, frequency 454.675 MHz is used by all of the ground stations for (non-voice) signalling purposes when ground-to-air calls are being placed.

Another little-known frequency we especially like is 122.775 MHz. It isn't active at all airports, but at many medium- and larger-sized fields, it's used for communications aircraft operating on ramps to talk with utility vehicles—such as fuel trucks, repair and other vehicles operating on the field.

Realistically Restored

A large number of readers have written to ask if we can tell them how to restore the "missing" 800 MHz cellular bands in their Realistic PRO-2004 scanners. The first step is to unplug the power cord.

Next, remove the four screws on the rear of the unit, and slide it out of the case from the front. Turn the unit upside down and note that there's a shielded, metal box. Pry the lid off the box and you'll see it's most prominent contents, the CPU chip (IC-503) complete with its 64 pins. About in the middle of the unit, adjacent to the CPU chip, but on the opposite side of the board, will be a row of diodes. Look for the one marked "D-513," which may or may not be there.

If it's there, it will be right next to or very close to D-512, which *is* present. If you can see D-513, then clip one lead and push it aside. That restores both cellular bands! If no D-513 is visible from the

(Continued on page 98)

HANDS-ON REPORT

ELITE SOFTWARE BLACKJACK MASTER

Home computer program plays BlackJack at the rate of 24,000 hands/hour, tabulates performance of all possible hands, and provides hours of educational play!

MANY OF US HAVE ENVISIONED THIS scene in which we participate: We stroll casually with measured steps as we approach a crowded gaming table. The players are hushed by our presence. A few players shift positions opening a slot for us to play. After a few deals and carefully measured bets, the pit boss approaches and says respectfully, "Surely, Monsieur, you do not wish to continue. Ze bank will be broken!" Dream? Yes, it is. Reality, it could be to a lesser degree if you prepare for the BlackJack table with *BlackJack Master*!

Elite Incorporated has a new personal-computer program, which will open new entertainment-horizons for card games on home computers. The program is called BlackJack Master, and it provides the ability to *play*, *practice*, and *simulate*.

In the *play* mode, the user can play BlackJack using all popular casino rules. Users can play with friends or computer-players. In the *practice* mode, the user can select and practice player situations like ace-hands, or pairs, with the program providing coaching and special displays to improve playing skills.

The main attraction of BlackJack Master is the program's ability to *simulate* playing strategies at 24,000 hands per hour. At that speed it is possible for the user to see the long-term results of 10 hours of simulated casino play in only 3 minutes. The program will let the users test their playing strategies and compare those of the experts, without risking a cent. Later on you will discover that this information is printed out in tabular form for you to inspect and evaluate.

If you are a beginner like the reviewer of this program, BlackJack Master starts you off in the *practice* mode to develop skills, then you can try them out in the *play* mode.

If you are a casual player, the program in the *practice* mode allows you quickly to review and sharpen your skills. You practice here to acquire casino-type playing experience. A peek into the simulation mode will expand your concepts on overall play.

Serious players become thoroughly familiar with the operation of the *simulation* mode in which the player rapidly learns to evaluate his present playing strategy and compare it with that of others. Return to the *practice* and *play* modes to try what you have learned in the *simulation* mode.

Fig. 1—The main menu gets to the point quickly by offering the options available in the BlackJack Master software, and gets you involved with the game immediately.

Fig. 2—Practice makes perfect, and this menu offers several ways to learn the correct play. Hands are not played out—only the first play (hit, double, split, or stand) is considered.

What if you are a rank beginner to the game of BlackJack? The manual supplied with he software introduces you to the game and explains the rules.

Hardware and Software

Your computer system must be an IBM PC/XT/AT, PC Jr. of true compatible type. (This reviewer used an IBM XT and a Taiwan clone without experiencing any problems.) In addition, the

computer will require at least 128K bytes of RAM, one 5¼-in. floppy-disk drive, and PC-DOS or MS-DOS 2.0 or higher. A graphics board is *not* required. A color monitor is not required but it is supported by the software.

BlackJack Master can be run from a floppy-disk drive or it can be run from a hard-disk drive where it resides in a subdirectory entitled BJM. While in the subdirectory, type A:INSHARD. That action will automatically transfer all the BJM files to the hard disk. Now, BlackJack Master can be run from the hard disk by typing BJM at the DOS prompt.

Be careful. The floppy disk is not write-protected. Changing the rules of play and strategy tables will write to the diskette. When using the hard disk, the original diskette is used as a key to start the program. Once up and running, you may remove the diskette for storage.

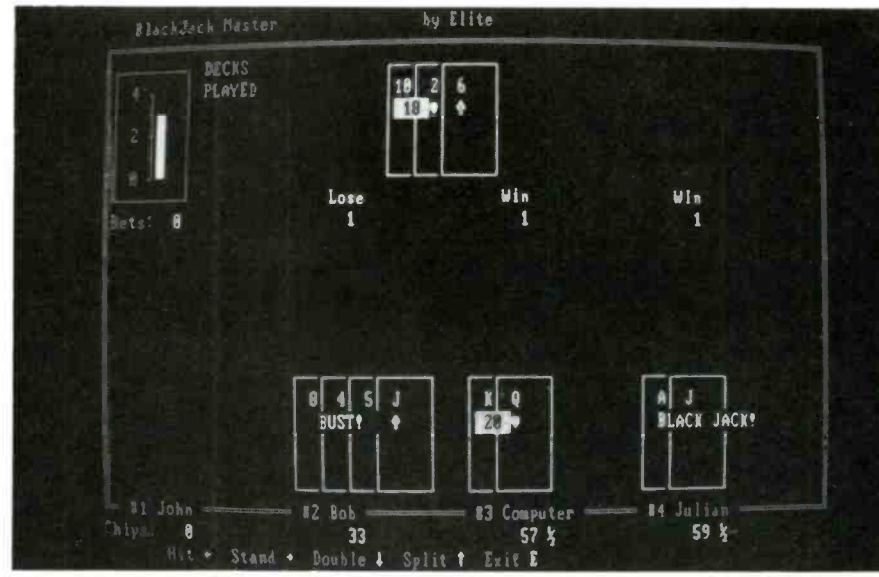


Fig. 3—The game is in progress. Four players (John, Bob, Computer, and Julian) are playing against the house. Four decks are used and three decks have been dealt. John has no hand to play, because he lost all of his 50 chips. The reversed number block in Bob's and dealer's hands indicates hand total during play.

Practice Mode

Once you know the basic rules for playing BlackJack, you enter the *practice* mode as instructed by the main menu (see Fig. 1)—select item B. Item A is used to change the rules, but we will forego that for now.

The *practice* mode menu (see Fig. 2) will ask you to select a specific practice situation. Select item B—*Practice all hands*! BlackJack Master will respond by dealing cards related to the situation you requested, and it will respond to the four basic game instructions; hit, stand, double, and split.

Now the practice truly begins. If you have not made the best choice, you will receive a coach phrase which hints at a better action to take. The program will stay at the preset display until you make the *right* choice. When you make the proper play, BlackJack Master presents another situation for your action. The practice hand is *never* played out. The *practice* mode is for sharpening your decision-making ability to specific situations. What happens thereafter in the deal is in the "laps of the gods."

Play Mode

Follow the instruction in the Main Menu and you'll enter the *play* mode. At the beginning, play only one hand until you grasp the play requirements and can think reasonably fast. In the *play* mode you can play up to four hands by yourself, or have a total of four persons playing; or, if you wish, the computer can play alongside you. (See Fig. 3.) Since that player has a solid silicon memory, it recalls all the rules and makes the correct plays. It is a good idea to watch its play.

Each player is assigned 50 chips by default or whatever number selected. Players can bet any amount at each hand; however, BlackJack Master only waits a few seconds at the *place-you-bet* prompt. At the beginning of play, should a response not be given, BlackJack Master will enter one chip as the initial bet. Once play has begun, players need not continue to place bets BlackJack Master will place the same player bet for the next hand provided that it receives no further instruction(s).

A *help* screen (see Fig. 4) is available and it pops up when F1 is keyed. That screen is helpful in assisting you to speed up or slow down play, toggle sound on and off, toggle Coach help on and off, toggle clock display on and off, and perform other functions that will become important as you get into the game.

Simulate Mode

The BlackJack Master will automatically play, to any strategy you select, at the rate of 2400 hands an hour in the *simulate* mode. (See Fig. 5.) You can select up to 1-million plays which will take 416 hours to complete—that's too much! 10,000 plays will yield excellent statistics and 1000 plays will reveal definite trends. The *simulation* mode can be

(Continued on page 99)

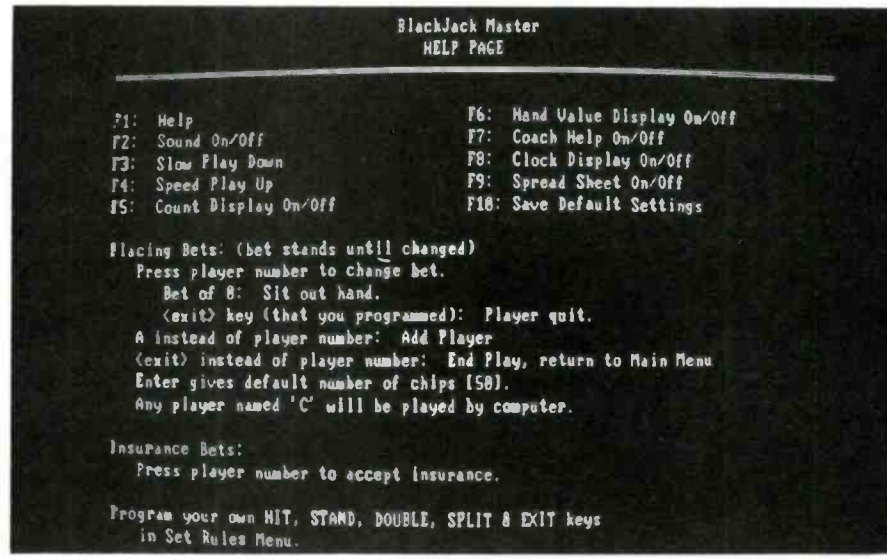


Fig. 4—The *Help Page* pops up when you press the F1 key. It is self explanatory and makes the beginner feel comfortable using the program.

BIGGER THAN A GALAXY

(Continued from page 16)

Tully became aware that the structure was much larger than previously thought, and that it extended beyond the range of current catalogs of individual galaxies.

Tully began looking at so-called "rich" clusters farther out in space, hundreds of millions of light-years distant from the Milky Way. Each rich cluster comprises thousands of densely packed galaxies, with each galaxy containing roughly 100-billion stars.

Tully analyzed a large body of data on the position of rich clusters within a spherical volume of space with a radius one-tenth that of the observable universe, centered on planet Earth. He then used a Cray supercomputer to graphically construct maps of the distribution of those galaxies as they would appear to an observer at various points in outer space.

As a result of that analysis, Tully concluded that about 60 of those rich clusters are concentrated in a single immense Supercluster Complex, with the *Local Supercluster* and its one rich cluster, Virgo, only a part of the larger entity.

The coincidence of the two planes of structure that form that larger entity on such radically different and immense scales suggests that there is a physical connection. Tully has named the structure the *Pisces-Cetus Supercluster Complex* after the constellations in which it is found.

It takes one-billion light-years—about 10 percent of the age of the universe—for light to cross the length of the complex, suggesting that its pattern must have been laid down shortly after the birth of the universe.

Tully's Views

The observation of such immense, flattened structures poses a couple of major challenges to conventional theories of galaxy formation. One relates to the apparently contradictory observation that microwave background radiation, a relic of the Big Bang, is dispersed uniformly across the sky. The conventional picture would have the large-scale structure arising from gravitational collapse of a primordial concentration of mass. However, if concentrations of the required size existed at that time, they should have given rise to irregularities in the relic background radiation.

Also, it is surprising that the Pisces-Cetus Supercluster Complex has not accelerated galaxies to much higher velocities than are observed.

Though those problems may yet be resolved in the context of conventional theories, alternatively the speculative theory of cosmic strings might provide an explanation.

In addition to the discovery of the Pisces Cetus Supercluster Complex, Tully has obtained preliminary evidence for additional massive structures.

"There are four other apparent Supercluster Complexes involving similar numbers of rich clusters and comparable dimensions," he said. "The complexes overflow the volume of space that has been surveyed, and there are no good observational limits on how large they might be.

Dr. Tully's investigations suggest that matter distributed in space is not smooth and homogeneous. Indeed, his findings show that this is not the case, our universe is *lumpy*. ■

SAXON ON SCANNERS

(Continued from page 94)

component side of that circuit board, then remove the eight screws that hold that subassembly down to the chassis.

Remove the two obvious cable plugs that are in the way and turn the subassembly upside-down to expose the solder-side of the board. There will be a single unmarked diode in about the same location as if it were on the top of the unit near D-512. Clip one lead of that diode, and you've got 800-MHz coverage.

After you reassemble everything, including placing the scanner securely back inside of its case, there's one more thing to deal with. When searching the 870 to 890 MHz bands, the channel spacing is 30 kHz. The PRO-2004 doesn't normally search in 30 kHz steps, although it can be forced to do so in the cellular band. To do that, program the set to search from 870 to 890 MHz, then press the STEP key, followed by pressing the front-panel RESET key (don't confuse that key with the rear-panel button marked RESTART).

Let's hear from you with your comments, questions, photos, tips, and whatever. Write to: Marc Saxon, *Saxon On Scanners*, **Hands-On Electronics**, 500-B Bi-County Blvd., Farmingdale, NY 11735. ■

FRIEDMAN ON COMPUTERS

(Continued from page 84)

cause they might correct the problem before you read this column.)

What it comes down to is that the speaker has unusually low volume, and some IBM-type programs simply won't run. Well, first off, as to the speaker problem, if you have a compatible turbo-motherboard having low speaker volume, double-check the speaker connections on the board. IBM used pins 1 and 4—the two outside pins—of a 4-terminal connector for the speaker.

For whatever reason, the folks who designed the compatible motherboard made pins 1 and 2 the speaker output; pins 3 and 4 are a voltage source for an LED indicator. If you connect an IBM-type speaker assembly to the compatible motherboard, you will barely hear any sound from the speaker. Simply move the pin-4 wire in the speaker's connector to pin 2.

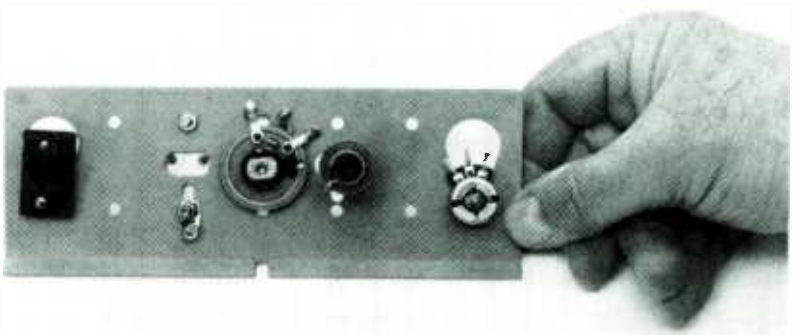
As to program non-compatibility: you're just stuck. I have tried a Hercules monitor adapter, all IBM adapters, even an IBM BIOS ROM, and the so-called compatible simply won't run some of the lesser-known programs such as IDIR and *SPECS IN SECS*. Lotus, dBase, and all the other biggies run just fine. It's simply the old story: "Only an IBM computer is truly 100% IBM compatible."

If you plan to use any kind of special or unusual software that is intended for an IBM computer, make absolutely certain it will run on the clone or compatible you're planning to buy. See it run. Do not accept verbal guarantees. ■

SOLDERLESS BREADBOARDS

(Continued from page 46)

lated color-coded 5-way binding posts that you connect in any way that you want. For example, you can use two posts as central tie points for power-supply connections that branch out to individual rows or strips of terminals, while the other posts are used for input and output connections...or for any other purpose. As you can see from the photographs, the terminal posts are prelabeled GND, V_a, V_b, and V_c, which sort of simplifies remembering which terminal represents what.



This is how the five components look from the back of the panel. Imagine trying to keep them separated if they were simply floating around on your workbench.

The edge panel simply slips into a slot on the rear of the breadboard's base. No hardware of any kind is needed to keep it in position. Notice the small keyway (center of the bottom edge) that keeps the panel from sliding to the side.

The breadboard shown, called the *Student*, model *NB-112P* ($16.95), is the smallest of the four in the line. Its distribution strip has 200 tie points, its terminal strip has 610 tie points. The overall size of the breadboard is 2.2 × 6.5 inches.

The next larger model is the *Hobbyist*, model *NB-124P* ($34.95), whose 4.4 × 6.5-inch breadboard has a distribution strip with 400 tie points and a terminal strip with 1220 tie points.

The third model in the line is the *Professional*, model *NB-134P* ($49.95), whose 5.8 × 6.5-inch breadboard has a distribution strip with 400 tie points and a terminal strip with 1830 tie points.

Finally, there's the jumbo *Elite*, model *NB-145P* ($59.95), with a 7.7 ×

(Continued on page 100)

BLACKJACK MASTER

(Continued from page 96)

used to confirm the playing strategy should you not want to use that suggested by BlackJack Master.

Rules Menu

Casinos play BlackJack by different rules. In New Jersey, the state Gaming Commission establishes overall rules of play, but the number of decks in a given game will vary. Because of that and other subtle differences, odds between casino and player shift. The great advantage of BlackJack Master is its ability to customize play to casino rules. The *rules* menu allows the player to set the exact rules by which practice, play, and simulations will be done. See the example in Fig. 6.)

The values the brackets show in the *rules* menu are the default settings. They indicate which factors are used and you may change them to rules of the

Fig. 5—Let the computer do the playing at 2400 hands per hour. You select the situation and evaluate your strategy against the computer's strategy. Who knows, you may be smarter!

casino that you will be visiting. If you are a serious player, check the casino rules thoroughly.

The keyboard actions and display colors (the J and K items in Fig. 6) do not apply to the BlackJack game. You may select any keys to represent the actions of *hit*, *stand*, *double down*, *split*, *surrender*, and *exit*. This reviewer found that the selection supplied with the software was totally satisfactory and sensible.

If you can enable a color monitor with your computer, then you can select which colors will be used for background. Green is preferred for background to match the felt playing surface found in casinos. All other selections are for your pleasure. The reviewer admits that he much prefers a monocolor presentation.

It's a Hit

This review of BlackJack Master does not detail the *simulate* mode and the statistical tables that can be developed by the player. Those software attributes are reserved for the serious player who wants to confirm every possible play and game variation, that he will experience in casinos. Those tables can be printed and examined when away from the computer. Nevertheless, no matter what your level of play may be, from amateur to professional, BlackJack Master offers multiple functions and modes to shape and sharpen the player's skill. BlackJack Master has the power and ability to provide serious fun for the BlackJack player.

BlackJack is still a game of chance. Regardless of the strategy used, you can still sit down and lose ten or more hands. That's a fact! It happened to the reviewer in the first play session—eleven straight loses. Strategies are made for long-term playing, and even then,

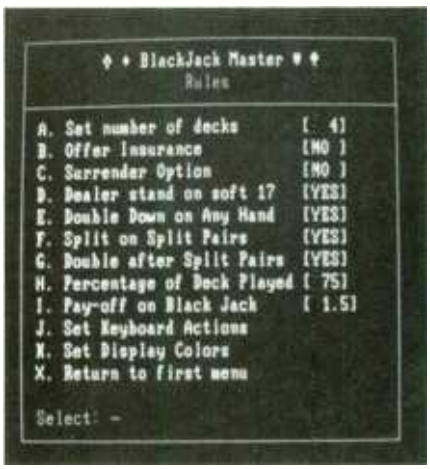


Fig. 6—The rules menu allows the player to play BlackJack under any casino's regulations. Here, the house uses four decks and shuffles the deck after 75 percent of the cards have been dealt. The insurance offer is a fool's wager and has been eliminated—see above.

you can be a loser. There is no guarantee. You can run out of chips before the breaks go your way. The law of many states and countries permit you to gamble in casinos. If you must wager money, be sure that the rent or mortgage is paid, all your charge accounts are up-to-date, and the money you wager is that part of your income that would normally be used for movies, entertainment, fancy dinners, and the like. There is no strategy that is foolproof!

BlackJack Master lets you test your playing strategies and compare them to those of experts without risking a cent. The software and manual are priced at $49.95. The diskette is available for the IBM PC and all true compatibles. For more information, contact Elite, Incorporated, 201 Penn Center Boulevard, Suite 301, Pittsburgh, PA 15235, or telephone 412/829-7770. For more information circle No. 30 on the Free Information Card found in this issue. ■

CIRCUIT CIRCUS

(Continued from page 88)

compass. The 555 oscillator in Fig. 4 makes a good bias generator and connects to the detector circuit in Fig. 3 to drive the two-transistor amplifier and bias coil L1. Remove R2, in Fig. 3, from pin 3 of the 3013T and connect it to pin 3 of the 555 in Fig. 4.

The oscillator's frequency can be varied from 100Hz to over 500Hz with R10, and the frequency range can be lowered by increasing the value of C3.

The detector circuit using the independent oscillator works best at frequencies below 500Hz.

If you have been looking for a project that's well suited for unlimited experimenting then grab a 3013T switch and start out with our magnetic receiver and go from there.

One source for the 3013T is DC Electronics, P.O. Box 3203, Scottsdale, AZ 85257, priced at $.98 plus $2.00 ship/handling/insurance charges. ■

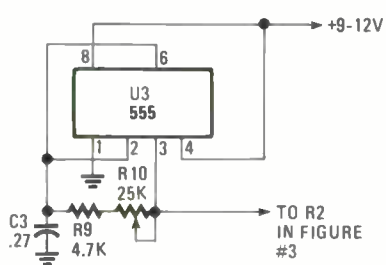


Fig. 4—The 555 oscillator makes a good bias generator to drive the two-transistor amplifier and bias coil L1. To connect it to the circuit in Fig. 3, disconnect R2 from pin 3 of the 3013T and tie pin 3 of the 555 to the free end of the resistor.

6.5-inch breadboard, having a distribution strip with 500 tie points and a terminal strip having 2440 tie points.

It didn't take much experimenting to determine that a simple thing like a panel that supports larger components puts the X-tra Edge Solderless Breadboard head and shoulders above other breadboards. There is no way to describe, or even appreciate, what it means to have some way to support larger components when breadboarding a circuit.

X-tra Edge Solderless Breadboards can be ordered for the prices shown direct from the distributor, Chenesko Products Inc., 21 Maple St., Centereach, NY 11720. Add $3 postage and handling for each breadboard kit. NY State residents must add the appropriate sales tax. ■

TRIG MADE SIMPLE

(Continued from page 80)

example. The procedure is the same except you will use inductive reactance (X_L) in place of X_C. Also draw the vector diagram remembering that the current will lag the applied voltage. Find the phase angle between the input (V_S) and output voltages (V_O). ■

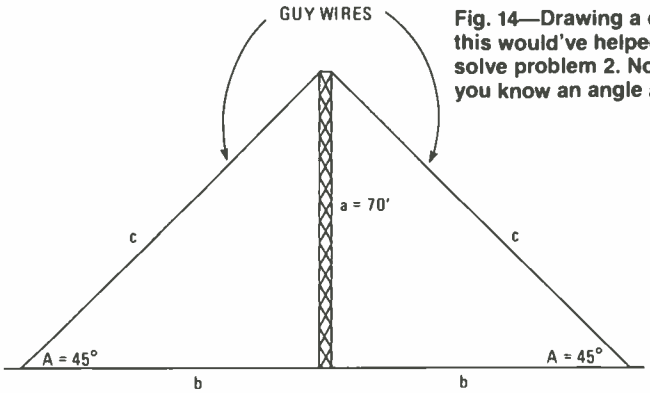


Fig. 14—Drawing a diagram like this would've helped you solve problem 2. Notice that you know an angle and a side.

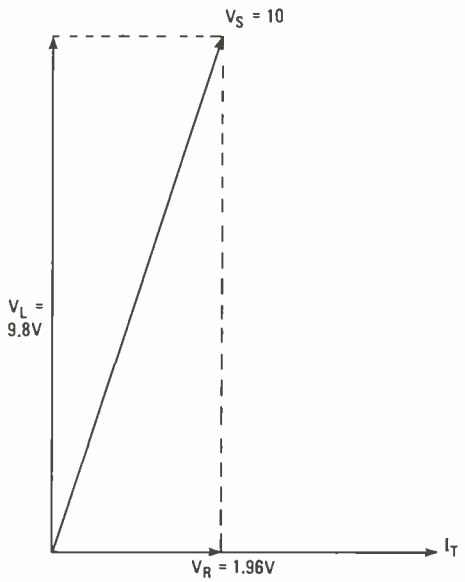


Fig. 15—If the vector diagram you drew to help you solve problem 3 looks like this chances are you got it right.

Answers to Practice Problems

1. B = 40°, c = 100
A = 90–B
A = 90°–40 = 50°
cos A = b/c = b/100
b = 100 cos 50
b = 100(.643) = 64.3 inches
sin A = a/c
sin 50° = a/100
a = 100sin50
a = 100(.766) = 76.6 inches
$c = \sqrt{a^2 + b^2}$
$c = \sqrt{76.7^2 + 64.3^2}$
$c = \sqrt{5867.56 + 413449}$
$c = \sqrt{10002.05} = 100.01025$ or round off to 100

2. (Refer to Fig. 14.)
sin A = a/c
c = a/sin A
c = 70/sin 45°
c = 70/(.7071)
c = 99 feet
Each guy wire is 99 feet long. Add a foot on each end for leeway in attachment. The distance from the tower base is:
tan A = a/b
b = a/tan A
b = 70/tan 45°
b = 70/1 = 70 feet

3. (See Fig. 15) $Z = \sqrt{R^2 + X_L^2}$
$Z = \sqrt{80^2 + 400^2}$
$Z = \sqrt{6400 + 160000}$
$Z = \sqrt{166400} = 408$ ohms
$I_T = V_S/Z = 10/408 = .0245$ A
$V_R = IR = .0245(80) = 1.96$ Volts
$V_L = IX_L = .0245(400) = 9.8$ Volts
$A = \tan^{-1}(V_L/V_R)$
$A = \tan^{-1}(9.8/1.96)$
$A = \tan^{-1}(5)$
A = 78.7°

TAME THE DOS TIGER

(Continued from page 74)

names in systems running MS-DOS, not PC-DOS) always have the system and hidden attributes set. A hidden file does not show up in normal directory listings; the system attribute is really a carryover from CP/M, and doesn't do anything in the DOS world. Last, a file with the read-only attribute bit set cannot be changed or erased.

The problem is that DOS itself provides little or no control over the file attributes. However another Tool Kit program can: ATTR.COM. You can turn any attribute (or combination thereof) on or off, on any single file or wildcard-selected group of files. For example, to hide and set to read-only status all files in the current directory, you'd type:

C>ATTR +H +R *.*

To view the status of all files in the current directory, type:

C>ATTR *.*

For a message listing ATTR's syntax, type:

CATTR

(with no parameters).

Archives

Unrelated to the archive-file attribute is the archive file, which has the extension .ARC. Originally developed for use with computerized bulletin-board systems (BBS's), an .ARC file contains a group of related files, each of which is compressed in one of several ways, according to its contents. .ARC files provide a simple way of keeping a group of related files together, and file compression allows for shorter transfer times (i.e., lower long-distance bills).

There are other uses for .ARC files, however. For example, if you write many letters, you soon find your letters directory

(Continued on page 102)

LETTER BOX

(Continued from page 4)

exausted from trying to squeeze all the units feature into a small space he lost it by the time he got to the end.

Filling a Vacuum

This letter regards a letter on page 6 of the February 1988 issue of **Hands-on Electronics** written by G.Y. He needed a 6H6 tube to restore a VTVM. I Just checked my stock of parts, and found I have four of them. I would send him one if you could give me his address.
—O.R.B., Appleton, WI

I'm sure G.Y. will be glad to recieve your letter. We forwarded it immediately, so look for his reply in your mail box. Thanks for helping a fellow hobbyist out.

Two Little

I found one small "typo" in my article "How Many Microfarads" in the January 1988 issue. On page 61, the first equation should read as follows:

$$C1 = 1.44T/(R1+2R2)$$

The first "2" was ommitted.
—J. Axelson

Thank you for another project our readers found useful and enjoyable. We all look forward to the next one. Sorry about the error.

A Higher Level

I really appreciated the logic-level detection circuit on page 73 of the December 1987 **Hands-On Electronics**. But the Mickey Mouse pulse detector circuit incensed me to lash together the enclosed circuit. It pulses the yellow LED triggered on rising and falling edges. Only one IC is used to execute all functions.

I've been enjoying your mag for about a year. Thanks for doing a good job.
—B.M., Seattle, WA

Thanks for the neat circuit. It is presented here as Fig. 1 for the enjoyment of our readers. ■

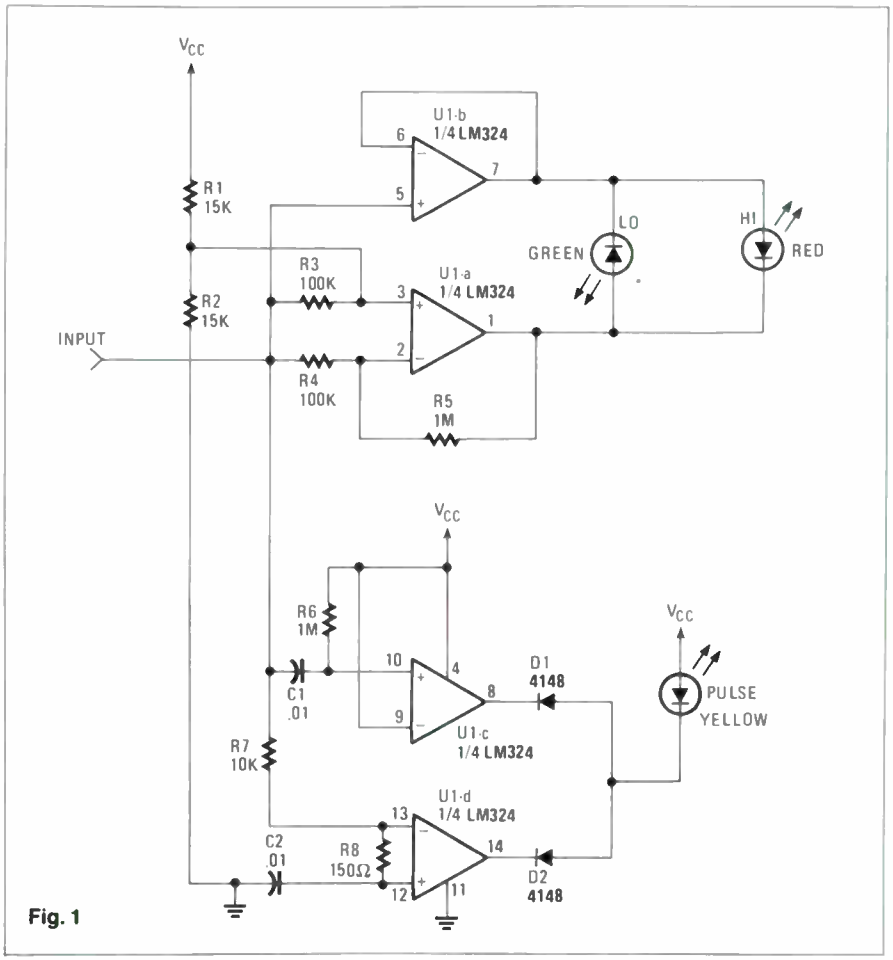


Fig. 1

TAME THE DOS TIGER

(Continued from page 100)

cluttered with outdated letters that you hardly ever look at. One way of dealing with them is to create an .ARC file every few months, store all currently un-ARC-ed files there, and then delete them from the letters directory.

Let's take an example. You want to create an archive file called LET87A.ARC that contains all currently un-ARC-ed letters (all of which you wisely named with a .LET extension). Type:

C>ARC A LET87A *.LET

and ARC will do the job. To obtain a list of ARC commands, invoke ARC from the command line with no parameters:

C>ARC

Those parameters are shown in Table 3.

ARC works much, much faster on a RAM disk. If you have one set up as drive D, just log on D, create the ARC file there, and then remember to copy the ARC file back to your hard disk. The procedure is outlined in the photos. The ARC utility (with complete documentation) is included on the Tool Kit disk, as is a RAM disk program. Information on setting up the RAM disk is contained in an accompanying article.

If you do use ARC files, you may find yourself wondering where a file is. WHERE (discussed above) helps you find un-ARC-ed files; SFIND (on the Tool Kit disk) does what WHERE does and will also (optionally) search all ARC files on your disk.

By dividing your hard disk into logically organized subdirectories, you make it easier to store and locate your files.

TABLE 1—ARC COMMANDS

```
Jsage: ARC (amufdxerplvtc)
            [bswno]
              [g<password>]
                <archive>
                  [<filename>...]

Where:    a   =  add files to archive
          m   =  move files to archive
          u   =  update files in archive
          f   =  freshen files in archive
          d   =  delete files from archive
          x,e =  extract files from archive
          r   =  run files from archive
          p   =  copy files from archive to standard output
          l   =  list files in archive
          v   =  verbose listing of files in archive
          t   =  test archive integrity
          c   =  convert entry to new packing method
          b   =  retain backup copy of archive
          s   =  suppress compression (store only)
          w   =  suppress warning messages
          n   =  suppress notes and comments
          o   =  overwrite existing files when extracting
          g   =  Encrypt/decrypt archive entry
```

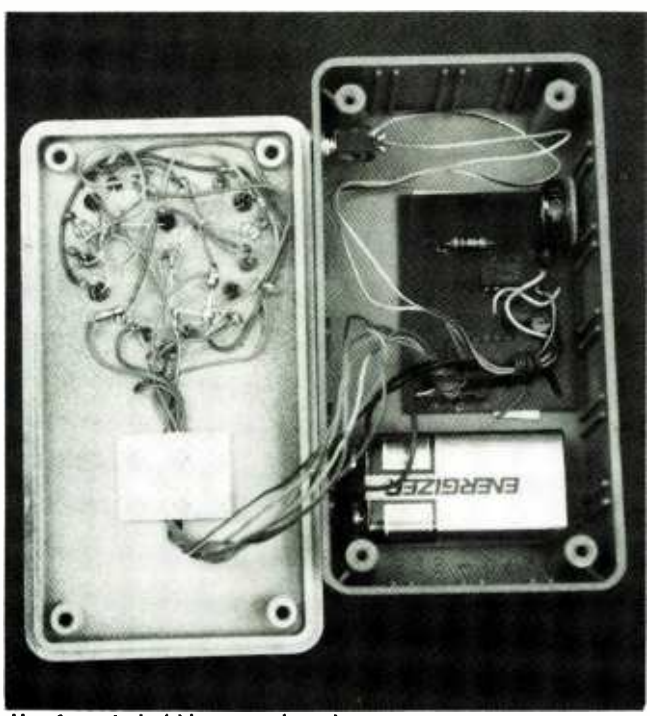
Note: All options are specified on a single line. E.G.:
C>ARC A LETTERS*.LET
C>ARC x LETTERS *.LET

The price is longer path specifications, but programs like PUSH, POP, and NCD can eliminate much typing. Then use MOVE, RENDIR, and ARC to organize your files, ATTR to protect and hide them, and WHERE and SFIND to locate them. ■

THE ELECTRONIC GIFT

(Continued from page 34)

of the cathode (common) leads of the LEDs on the outer perimeter of the heart design (or other chosen design), and have all of the anode leads facing toward the center of the design. By mounting the LEDs in that manner you will be able to identify the anode and cathode leads even after the leads have been trimmed during wiring.



Use foam to hold jumper wires down.

A small piece of double-sided foam tape is used to secure both the battery and the PC board to the bottom of the project box assembly by attaching the cover. You should now have a working project once you flip the switch to its "on" position. If the LEDs fail to light, go back and recheck your connections on the PC board and also on the LEDs. Any LEDs that are wired backwards with respect to their anode and cathode connections will not light. By simply switching the wires on one of the LEDs, you can determine whether or not that is the problem if the LED lights correctly after you have reversed the original connection that you made during hook-up. You should now be pleased to be able to give a unique gift (and one that you made yourself) to your "special someone"!

Happy building and happy giving! ■

PARTS LIST
FOR THE ELECTRONIC GIFT

SEMICONDUCTORS

LED1–LED18—Any size, shape, or color light-emitting diode
U1—MM74C925N 4-digit counter integrated circuit
U2—LM555 timer integrated circuit
Q1—MPS3704 NPN transistor (or equivalent)

ADDITIONAL PARTS AND MATERIALS

B1—9-volt alkaline battery
C1—1-μF Tantalum capacitor
R1—100,000-ohm ¼-watt resistor
R2—1-Megohm potentiometer
S1—SPST miniature toggle switch

ZETA NOISE BLOCKER

(Continued from page 40)

Improved Comprehension

The effort involved in distinguishing speech from background noise is tiring and stressful to hearing-aid wearers. Because the Zeta can effectively reduce noise, it enables the user to wear hearing aids for longer periods of time and in more situations. With greater usage of the instrument, the hearing impaired person is better able to function in the normal-hearing world with less fatigue and stress.

Testing Zeta's Abilities

The most recent tests of the device were performed by Cindy Ellison, M.A., of Comprehensive Audiologic Services in Grand Rapids, MI, who examined the performance of the Zeta in four common noise environments with hearing-impaired subjects. Results show that the ability of subjects to understand speech in the presence of background noise can be nearly doubled by the device.

In her evaluation of the Zeta, Ellison tested each subject (wearing a Zeta-equipped hearing aid) in several different situations: with the hearing aid in a quiet environment, with the Zeta bypassed in four commonly-encountered noisy environments, and with the Zeta enabled in the same four noisy environments. The primary-speech signal was presented at 68 to 72 decibels (SPL), which approximates the level of average conversational speech. The noises included low-frequency sounds, high-frequency sounds, cafeteria noise, and cocktail party babble. For each noise situation, subjects were asked to repeat words from single syllable word lists read to them with a competing noise in the background.

A "test score" represented the percentage of words they repeated correctly. The results summarized in Table I show that the Zeta provides meaningful increases in intelligibility, especially when considering that a 10-point improvement in single-syllable word recognition can translate into a 20–25 point improvement in sentence comprehension.

Years in Development

The Zeta's effectiveness has been confirmed by independent clinical studies, conducted at Michael Reese Hospital and John F. Kennedy Medical Center in Chicago, which concluded that speech comprehension in noisy situations can be nearly doubled by using the Zeta.

During its 12-year development, the Zeta Noise Blocker progressed through basic research and theoretical development, prototype design, one-year algorithm (software) adjustment at Michael Reese Hospital in Chicago, clinical testing and three years of chip design prior to its initial introduction to the public.

Just how good is a Zeta-based hearing aid? My Dad mailed his old hearing aids to me and suggested that I wear them in a noisy environment at home or in the office. This I tried several times at different sites. The noises from an electric fan on my desk, boiling water on a stove, wind-blown leaves in the yard, and the impact printer coupled to my IBM PC computer all prevented me from understanding the spoken words of my wife and friends.

Already, thousands of hearing-impaired individuals wear Zeta-equipped aids made available to them by hearing-aid manufacturers. In time, through the efforts of many hearing professionals and electronics scientists, hearing devices with the Zeta Noise Blocker and other yet undreamed of innovations will restore to those with impaired hearing the sounds of life and communication we all take for granted. ■

HANDS-ON MARKETPLACE

FOR SALE

VACUUM tubes + parts for antique radios to color TVs. **M. OHMANN,** Box 314, Albany, MN 56307.

TELEPHONE TAP monitor room and telephone conversations. Range unlimited. **LISTEN,** 603 Elgin, Muskogee, OK 74401. (918) 683-9589.

CLASSIFIED AD ORDER FORM

To run your own classified ad, put one word on each of the lines below and send this form along with your check to:

Hands-on-Electronics Classified Ads, 500-B Bi-County Boulevard, Farmingdale, N.Y. 11735

PLEASE INDICATE in which category of classified advertising you wish your ad to appear. For special headings, there is a surcharge of **$10.00.**

( ) Plans/Kits ( ) Business Opportunities ( ) For Sale
( ) Education/Instruction ( ) Wanted ( ) Satellite Television
( ) _____

Special Category: $10.00

PLEASE PRINT EACH WORD SEPARATELY, IN BLOCK LETTERS.
(No refunds or credits for typesetting errors can be made unless you clearly print or type your copy.) Rates indicated are for standard style classified ads only. See below for additional charges for special ads. **Minimum: 15 words.**

1	2	3	4	5
6	7	8	9	10
11	12	13	14	15 ($21.00)
16 ($22.40)	17 ($23.80)	18 ($25.20)	19 ($26.60)	20 ($28.00)
21 ($29.40)	22 ($20.80)	23 ($32.20)	24 ($33.60)	25 ($35.00)
26 ($36.40)	27 ($37.80)	28 ($39.20)	29 ($40.60)	30 ($42.00)
31 ($43.40)	32 ($44.80)	33 ($46.20)	34 ($47.60)	35 ($49.00)

We accept MasterCard and Visa for payment of orders. If you wish to use your credit card to pay for your ad fill in the following additional information (Sorry, no telephone orders can be accepted.):

Card Number _____ Expiration Date _____

PRINT NAME _____ / SIGNATURE _____

IF YOU USE A BOX NUMBER YOU MUST INCLUDE YOUR PERMANENT ADDRESS AND PHONE NUMBER FOR OUR FILES. ADS SUBMITTED WITHOUT THIS INFORMATION WILL NOT BE ACCEPTED.

CLASSIFIED COMMERCIAL RATE: (for firms or individuals offering commercial products or services) $1.40 per word prepaid (no charge for ZIP code)...**MINIMUM 15 WORDS.** 5% discount for same ad in 6 issues within one year; 10% discount for 12 issues within one year if prepaid. **NON-COMMERCIAL RATE:** (for individuals who want to buy or sell a personal item) $1.15 per word, prepaid....no minimum. **ONLY FIRST WORD AND NAME** set in bold caps at no extra charge. Additional bold face (not available as all caps) **25¢ per word additional.** Entire ad in boldface, $1.70 per word. **TINT SCREEN BEHIND ENTIRE AD:** $1.75 per word. **TINT SCREEN BEHIND ENTIRE AD PLUS ALL BOLD FACE AD:** $2.05 per word. **EXPANDED TYPE AD: $1.85 per word prepaid.** Entire ad in boldface, $2.20 per word. **TINT SCREEN BEHIND ENTIRE EXPANDED TYPE AD:** $2.30 per word. **TINT SCREEN BEHIND ENTIRE EXPANDED TYPE AD PLUS ALL BOLD FACE AD:** $2.70 per word. **DISPLAY ADS:** 1" × 2¼"—$160.00; 2" × 2¼—$320.00; 3" × 2¼"—$480.00. **General Information:** Frequency rates and prepayment discounts are available. **ALL COPY SUBJECT TO PUBLISHERS APPROVAL. ADVERTISEMENTS USING P.O. BOX ADDRESS WILL NOT BE ACCEPTED UNTIL ADVERTISER SUPPLIES PUBLISHER WITH PERMANENT ADDRESS AND PHONE NUMBER. Copy to be in our hands on the 18th of the third month preceding the date of issue (i.e.; Aug. issue copy must be received by May 18th). When normal closing date falls on Saturday, Sunday or Holiday, issue closes on preceding work day. Send for the classified brochure. Circle Number 49 on the Free Information Card.**

COPYGUARD corrector restores rental movies. Connects between VCRs. Satisfaction guaranteed. $59.95 plus $4 handling. **1-(800) 338-8751.**

INTRODUCTORY offer: Standard resin core solder 1 pound roll $4.99. Product and price listing sheet free with order or by request. **NUTTER RIDGE PURVEYORS,** Star Route Province Road, Strafford, NH 03884.

CABLE TV converters. Scientific Atlanta, Jerrold, Oak, Zenith, Hamlin. Many others. "New" **Video Hopper** "The Copy Killer." Visa, M/C & Amex **1-(800) 826-7623. B&B INC.,** 10517 Upton Circle, Bloomington, MN 55431.

PLANS/KITS

BUILD this five-digit panel meter and square wave generator including an ohms, capacitance and frequency meter. Detailed instructions $2.50. **BAGNALL ELECTRONICS,** 179 May, Fairfield, CT 06430.

PROJECTION-TV...Convert your TV to project 7 foot picture...Results comparable to $2,500.00 projectors...Total cost less than $30.00...Plans and 8" lens $21.95...Illustrated information **free, MACROCOMA-HH,** Washington Crossing, PA 18977. Creditcard orders 24 Hours. (215) 736-3979.

CRYSTAL radio sets, plans, parts, kits. Catalog $1.00. **MIDCO,** 660 North Dixie Highway, Hollywood, FL 33020.

DJ beatmeter you can build. Organize your L.P.s by beats per minute like the pros do to make "mixing" faster and easier. Plans and instructions $2.00. **LERCOM,** P.O. Box 2274, Sta.1, Kingsville, TX 78363.

VOICE disguisers! FM bugs! Telephone transmitters! Phone snoops! More! Catalog $1.00 (refundable): **XANDI ELECTRONICS,** Box 25647, 32L, Tempe, AZ 85282.

ELECTRONIC Dowser—Book of theory and complete plans for sensitive Cryptesthesic/Galvanic instrument, $10. **NOVA SYSTEMS,** 11208-C Iron Oak Trail, Austin, TX 78750.

TUBES - 2000 TYPES
DISCOUNT PRICES!
Early, hard-to-find, and modern tubes. Also transformers, capacitors and parts for tube equipment. *Send $2.00 for 20 page wholesale catalog.*
ANTIQUE ELECTRONIC SUPPLY
688 W. First St.•Tempe, AZ 85281•602/894-9503

DIGITAL oscilloscope. A unique project. Plans $5.00. **MIKE McGLINCHY,** 214 Verano Dr., Los Altos, CA 94022.

DETECTIVES, experimenters. Exciting new plans. Hard to find micro and restricted devices. Large catalog $5.00 refundable on 1st order. **WILSON,** P.O. Box 5264, Augusta, GA 30906.

2716/58/32/32A EPROM burner plans with two extra projects plus hardware bonus $2.50 plus $1.00 S/H. **GALLIUM JUNCTION,** 540-C N.E. Northgate Way, Ste 542, Seattle, WA 98125.

SURVEILLANCE electronics, debugging, kits latest high-tech. Catalog $2.00. **TECHNOLOGY SERVICES,** 829 Ginette Street, Gretna, LA 70056.

DAZER electronic protection. Complete kit with PCB $45.00. Catalog free! **QUANTUM RESEARCH,** 17919-77 Ave, Edmonton, Alberta T5T 2S1.

GIANT displays (8" x 4") 7-segment red L.E.D. kit—$25.00 plus $3.00 S/H. Partials available! House numbers, clocks, readouts. Data $2.00 refundable. Visa, M/C, Amex. **ELVIS,** Box 208, Parry Sound, P2A 2X3 Canada.

ADVERTISING INDEX

HANDS-ON ELECTRONICS magazine does not assume any responsibility for errors that may appear in the index below.

ANTIQUE RADIO

(Continued from page 82)

tion to the drive pulley. Turning the knob causes the pulley to ride at different levels on the conical (having the shape of a cone) capstan, driving the pulley at different speeds. The system works very well, giving a wide, smoothly-controlled range of tape speeds.

The little, one-tube, tone-oscillator module is also worthy of comment. All of the components are firmly mounted on a tough-looking piece of Bakelite or other composition material about an eighth of an inch thick. Visible parts include the tube, dropping resistor for line operation of the tube filament, filter capacitor, and a little mica trimmer for controlling oscillator tone.

The tube turned out to be a 70L7, which is a type I'd had no previous experience with. The RCA tube-manual showed it to be a combination half-wave rectifier and beam-power amplifier. I never knew such an "animal" existed! It was obviously designed to be used in place of separate rectifier (such as the 3475) and output amplifier (such as the 50L6) in economy radio receivers.

A Short Code Practice Session

To get a feeling for what it was like to use the Instructograph, I threaded up one of the intermediate tapes, and started to copy it. I don't know exactly what speed it was because the system is not calibrated in any way. The later tapes in the series have the characters closer together than the earlier ones and, of course, the transport speed of any tape can be varied. The manual recommends that you estimate speed by counting the number of five-letter character groups heard per minute.

All-in-all, I'd recommend the Instructograph as a fine addition to any radio collection. It looks archaic enough to have come right out of Sam Morse's lab and, properly cleaned and polished, will be quite an eye-catcher. If you'd like to practice taking code, though, I'd suggest a good cassette-tape or computer course!

See you next month, when I hope to pick up the saga of the development of the vacuum tube where I left off last year. And remember, your comments are always welcome. Write to Marc Ellis, C/O **Hands-on Electronics,** 500-B Bi-County Blvd., Farmingdale, NY 11735. ■

SUNRAYCER

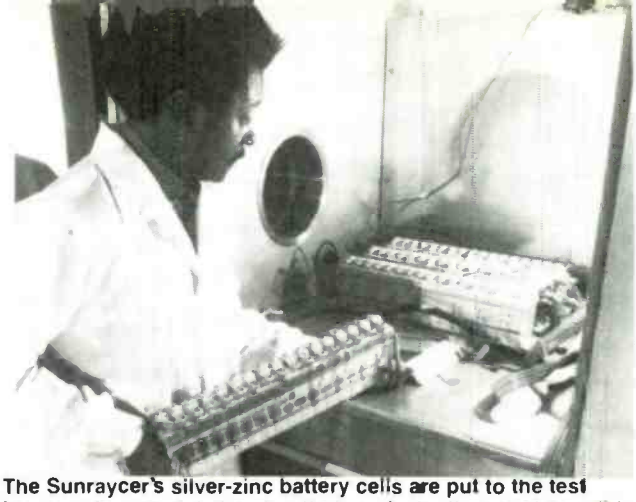
(Continued from page 31)

The chassis and suspension were products of teamwork among GM's engineering staffs. Low-speed aerodynamics and lightweight structures for the vehicle were perfected by GM's Design Staff. Holden's Motor Company, GM's subsidiary in Australia, provided expert race coordination.

Sunraycer's future is limited. Once you take the big one, what's there to conquer? Another race, another site, another cup—they're unimportant compared to the contribution to progress. No, your family car won't be powered by the sun in the next decade, or maybe decades to come. But there will be substantial contributions to transportation from the design elements on Sunraycer.

The Magnequench motor will find its way into aircraft and space applications. Its extreme light weight coupled with its ability to out-perform other electric motors will find acceptance in commercial and military aircraft. By creating a market for solar-power golf carts, the cost of manufacturing solar cells may drop the price considerably, making applications in other areas more feasible.

Solar cells will heat the hot-water tank, operate well pumps in areas where power lines do not reach, and will someday be used in other applications, uses that we have yet to consider. Even the total concept of Sunraycer may affect design changes in the future as fuel oils become scarce and prices soar.



The Sunraycer's silver-zinc battery cells are put to the test in an environmental chamber that produces the worst-possible conditions a vehicle could possibly experience in Australia.

Sunraycer is more than a racing toy to a few gifted engineers, it's the beginning of new conceptual ideas to conserving energy that we use today to tan our skins. Sunraycer won a race so that we may win the future. ■

TWO-WHEELER COMMUNICATOR

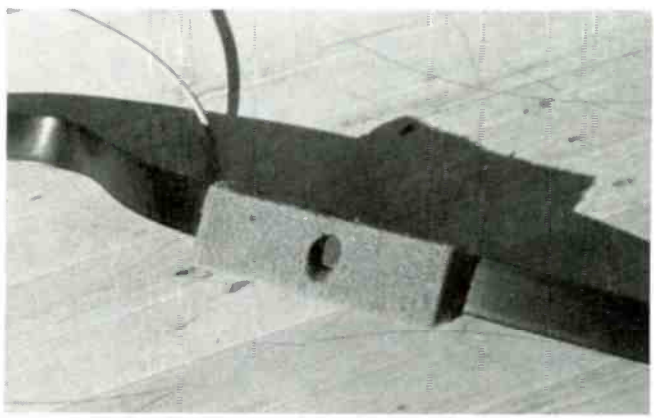
(Continued from page 45)

hole in the center to fit snugly over the mike element. Use contact cement and glue in place. Take the other foam rubber piece and glue it on the back side of the belt to match up with the other foam piece.

Take two strips of Velcro material and attach one to each end of the belt material with one on the front and one on the back side. Connect a mini plug on the opposite end of the shielded cable and your mike is ready to use. Better build two while you are at it.

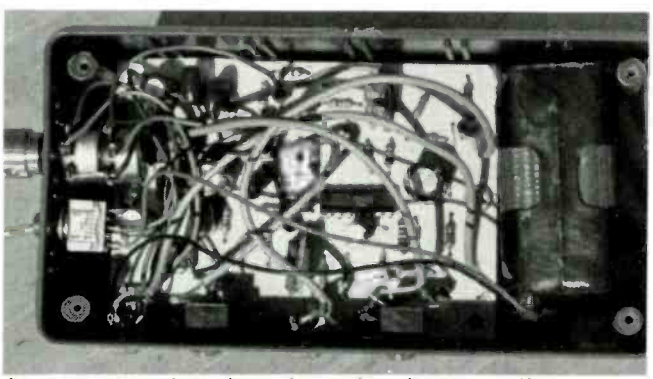
Checking Out the Communicator

Set R23, R24, R25, and R26 to mid position. Plug in both mikes and earphones, and connect B1. Turn S1 on and place M1 and the headphones from J1 on. Without an input to the mike the phones should be silent, count, starting with a whisper, from 1 up increasing in volume until the amplifier is switched on. Check the other amplifier channel in the same way. The exact setting of the threshold pots, R23 and R24, will depend on the amount of outside noise, but the mid position is a good place to start.

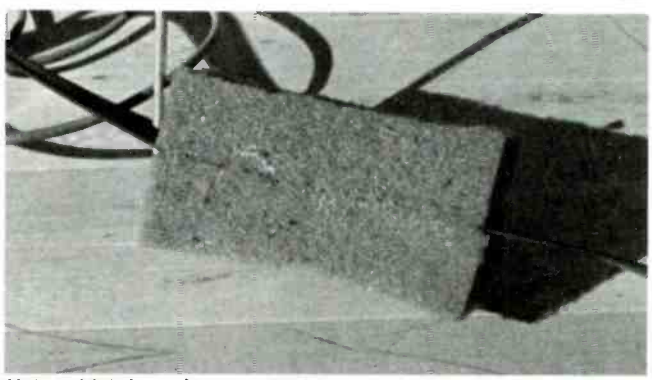


The mikes should be well embeded in their foam to prevent irritation. You may wish to place a thin sheet of foam in the hole to prevent the transmission of breathing noises.

Just remember the mike that's plugged into J3 must be paired with the headphone connected to J2 or you will be talking to yourself, and the same holds true for J1 and J4. If everything checks out A-OK, then you are ready to locate a brave buddy to hit the road and complete the dynamic testing of the communicator. ■



As you can see the unit can be made quit compact if you use the printed-circuit board. The use of shielded cable is recommended because of the noise the bike can produce.



Using thick foam is essential to ensure proper windscreening and comfort for the wearer. Seal the two pieces of foam thoroughly together and to the strap.

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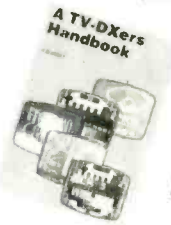

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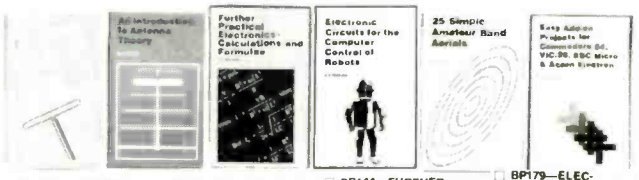

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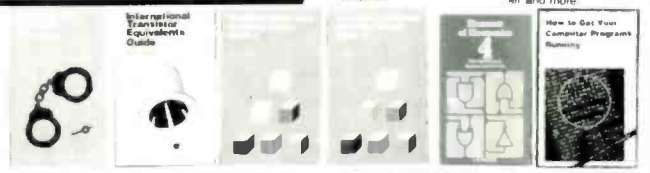

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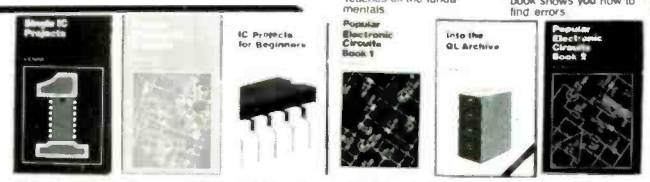

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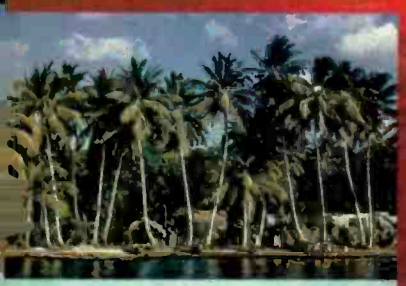

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