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See Page 42.

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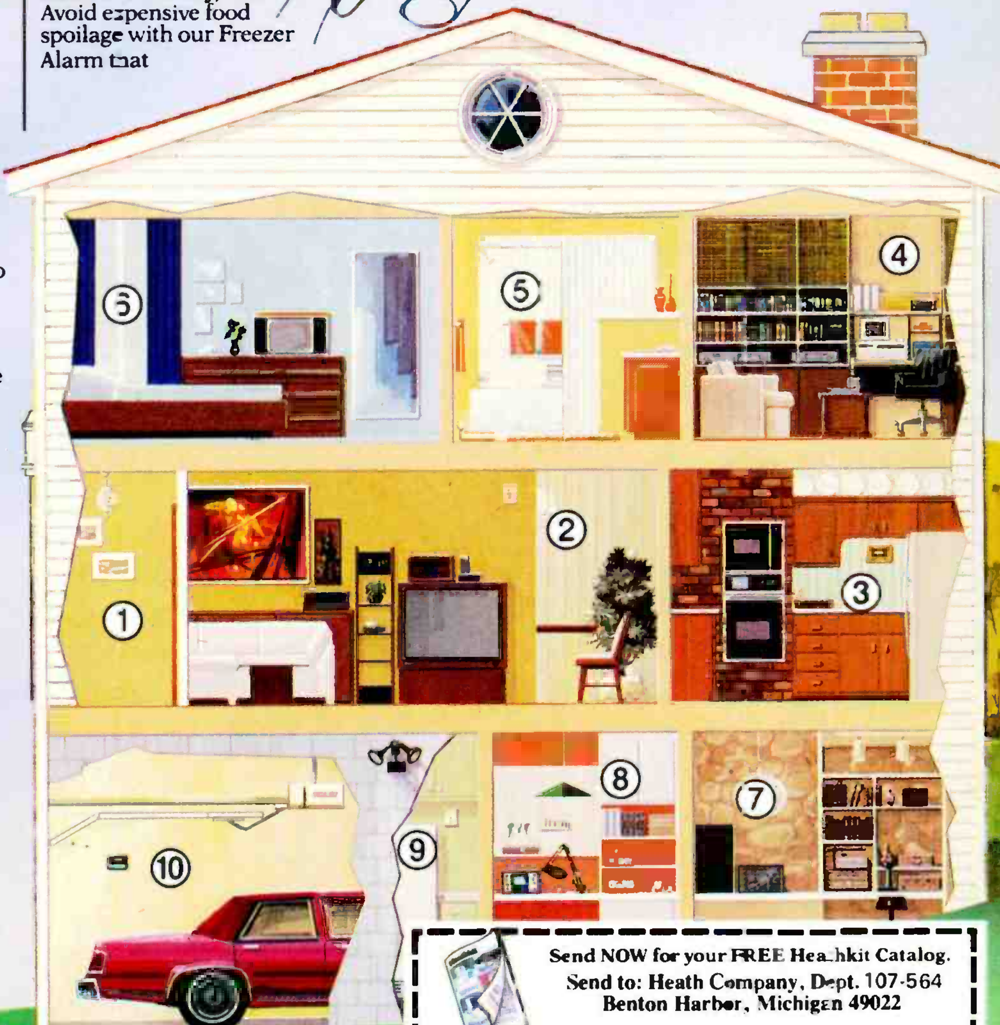

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Volume 4, No. 8

August 1987

CONSTRUCTION

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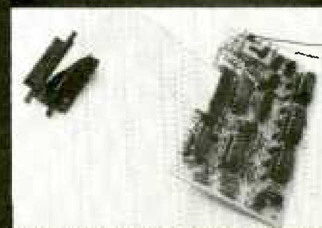
HANDS-ON REPORTS

SPECIAL COLUMNS

DEPARTMENTS



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Ellis On Antique Radio—page 88

Hands-on Electronics®

The Magazine for the Electronics Activist!

Blame it on the computer!

My $12.95 check bounced when my cash balance should have been $120. The cute thing at the bank said, "It's the computer's fault!"

My air filter was almost twice the size of the tin container on top of the carburetor. The pot-belled cashier at the auto supply store said, "It's the computer's fault!"

My wife placed a telephone order for one light-blue, king-size blanket she saw on sale in a newspaper advertisement. We received three plaid baby blankets. The screeching voice on the phone said, "It's the computer's fault!"

My bill at the checkout counter of the supermarket stated that I owed $265.75 for one quart of milk and two Twinkies. (Maybe that's why I'm over weight?) The lady at the register said, "It's the computer's fault!" Now, come on! She was using an ordinary cash register that she swore was a computer.

Some times I wonder whether or not the 8080 chips in some people's heads were dragged over a nylon carpet on a cold, crisp day.

The truth of the matter is that computers are taking the blame for their human counterparts. We can easily spot the shoddy work of a house painter, tailor, waiter, mechanic, and others whose arts and crafts are familiar to us. The computer is that mystical, magical, electronic device that cannot be blamed when it errs.

The truth is that computers do not err! The fault lies with those who input data. Do a sloppy job inputting at the keyboard and blame it on the computer. I guess many of us heard the expression, "Garbage in, garbage out." That is what I now announce to those who blame it on the computer.

There are very few professional people who are near perfect at the computer keyboard. One group is the editors of this magazine who seddum maek mescakes!

Julian Martin

Julian S. Martin, KA2GUN
Editor

STAFF

Volume 4, No. 8
August 1987

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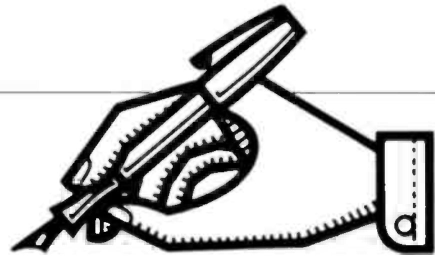


Pressure's On

I recently wrote an article for your magazine entitled *Build This Barometer*. Upon review, some miscalculations were found for the gain resistors on page 44, and in Table 1 on page 43. The seventh line on page 44 should read: "span is 166 mV (for our A/D converter input) and so the voltage gain needed is 4.43.

Now solving our gain equation for R_T we find that R_T equals 8242 ohms."

I hope that will not be a big deal, but I thought the mistakes should be passed along. Again I am sorry about the miscalculations.

—Scott Weatherwax

Unfortunately, that story got away from us before the corrections could be entered into the July issue. We present the table here for use by our readers who wish to build the project.

TABLE 1—CONVERSION RESISTOR VALUES

Unit	Required Gain v/v	Nominal Resistor (R_T in KΩ)	Actual Resistor Values Used R8 (in KΩ)	R10 (in KΩ)
PSI	4.43	8.82	7.32	2.
mbar	3.05	18.99	17.8	2.
cm H_2O	3.11	17.95	16.9	2.
in H_2O*	2.44	44.96	42.2	5.
mm Hg*	4.57	7.79	6.8	2.

*For these two types of units jumper J1 must be included in the Barometer design. In this design 2.5 V will be supplied to the sensor so its full scale output will be 18.8 mV.

Fleas for Sale

Would you please publish the following announcement in your letters column: The Philadelphia Area Computer Society is holding their fifth-annual Ham & Chip Flea Market, featuring great buys in computer software, ham radio, sound, and general electronic equipment; Saturday, August 15, 1987, 9:00 am to 1:00 pm, at the LaSalle University Parking Lot, 20th & Olney Avenue, Philadelphia, PA 19141. For further information Tel. 215/951-1255. The Philadelphia Area Computer Society meets on the third Saturday of each month at LaSalle University. User groups start as early as 9:00 am.

—S.L., Philadelphia, PA

We're always glad to inform our readers of large congregations of fellow hobbyists. In the field of electronics, the more the merrier. (You readers that attend should let us know how it turned out so we can determine whether to post the announcement next year.)

It Figures

I would like to comment on your splendid article *Electronic Fundamentals* in the March 1987 issue of **Hands-On Electronics**. I found your article very nicely done. The format was very straightforward, informative, and for the most part easy to read, but let me get to the point of why I am writing this letter to you. First off, look at the part about filters and start at question 32. You stated in that paragraph that if you looked at Fig. 12A that the output is taken from across the capacitor. How can the output be across the capacitor when it is more or less in series with the input and output signal? Isn't the output developed across the resistor?

Also your explanation concerning how frequency and X_c are inversely proportional in questions 33 and 38 is good, and I agree with it, but shouldn't your explanation in question 33 apply to Fig. 15, and vise versa concerning question 38 and Fig. 12? And in Fig. 14 you call the circuit a low-pass filter and in Fig. 15 a high-pass filter. I'm confused on this matter.

Please put something in your next issue to indicate if I am right or wrong. Again I would like to comment on an article well done. I am looking forward to reading more of your articles in the future.

—R.S.M., Governors Island, NY

Many thanks for your recent letter and the favorable comments about my article in the March, 1987 issue of **Hands-On Electronics** *magazine. I can certainly understand your confusion in frames 33 through 38. You are correct, Figs. 12 and 15 are indeed reversed. We sincerely apologize for the mix-up. I'm sure Hands-On will gladly put something in a forthcoming issue to note that problem. We appreciate your feedback, Mr. McHenry.*

—Louis E. Frenzel, Jr.

Color My World

I have been buying your magazine for quite awhile and enjoy it very much. I have built a number of projects from it. Also the information on the parts such as diodes, etc. Keep up the good work.

Which brings me to my question. I have acquired a lot of tantalum capacitors which are color coded only. I am trying to find somebody or someone who puts out a color chart to indentify the value of the capacitor. I have inquired at a great number places and nobody seems to know anything. Is there a way of checking the value without the use of the color code, or does the company that makes them keep the value a secret? Any help that you may give is appreciated.

—H.A.A., Parma, OH

Check the December 1987 issue of **Hands-on** *for Fact Card number 21. On it you'll find the color code schemes for various capacitor types, including tantalum. That should make it a rainbow day for you.*

No Magnetism

The device described by Lou Hinshaw in the article "Degauss Disks" (from the December 1986 issue) does not work. I wrote the author (care of editor) and included a self-addressed stamped envelope and never received a response—that was seven weeks ago. I would like to know if the problem with the device is mine or Mr. Hinshaw's.

—J.D.C., Aptos, CA

I always feel uneasy when a project as simple as a degausser fails to operate. It

means that I'll either have to expand the basic premises of physics to new heights, or check for the very obvious.

Pushing the first choice far out of my mind, I suspect the coil you're using must not be putting out a strong enough field. That may be due to shorted windings, or the fact that it may not have been designed to do so. Try a motor winding from something requiring more torque (and don't use a burnt-out winding.) That should help. Try testing the winding out with a compass before setting it up for use as a degausser.

Powerless

I have just completed the SCAN-MATE circuit from the September/October 1986 edition of your magazine. At first it didn't work, but when I reversed the battery connections it worked fine. In Fig. 1, it shows the + terminal of B1 to be connected to the source of Q2. If that is so, where did I go wrong?
—L.H., Panaca, NV

Switching the battery leads was the correct move. Figure 1 was wrong as can be seen from the photo on page 35 of that issue. You've got us top to bottom on that one!

A Helping Hand

Regarding your request for information on programming the SBE-12SM monitor scanner made by Linear Systems, if you haven't already received the information from anyone else, I can be of help to you. My neighbor has that model scanner including the instruction book.

The owners manual is 92 pages, making it impractical to make Xerox copies. My first suggestion would be to write to SBE Replacement Parts, 220 Airport Blvd., Watsonville, CA 95076, and ask them for the owners manual for the SBE-12SM scanner. Approximately the first 7-10 pages give instructions on scratching the little cards so that they would represent the desired frequency. Then the rest of the manual (some 80-85 pages) consists of a list of the various frequencies which the scanner may be programmed for.

An example will illustrate: If you would desire to program in 34,445 Megahertz, the manual would show 111100000001000, that would correspond to the spaces 1 through 15 on the little card, the ones would be peeled off, and the zeros would be left on. At first I thought it could be worked out mathematically by use of the conversion from binary to decimal numbers, but that didn't work out, as I believe some other factors are involved. Therefore it appears as though the manual will be necessary, but if you can't get one from the above address and you would give a list of some of the local frequencies that you are interested in, along with an SASE, I'd check them out for you. Good luck and 73.
—F.S., Hemet, CA

Thank you very much for your help. I'm sure Mr. Beaired will be pleased to receive the information.

It's readers like you, with the desire to really help someone, that make this an enjoyable column to work on. Further responses like yours will fill this column with a wealth of information for our audience. That is something all of us hobbyists would appreciate.

Questions, Questions

I'm writing this letter on three subjects. First, I built the ZX-81 printer interface for my TS1000 (from November 1986) and it works fine on the Tandy DMP105. I also read the article on adding NLQ to old printers (in April 1987). Is an adapter for NLQ on the DMP105 available or being designed?

Second, can anyone help me find a schematic for a Digital Sport Systems RF power amplifier model 500 SB? My direct request was returned and noted "Out of Business."

And last, why do reader service card requests take so long to arrive? One of my requests took at least 6 months to get from the card to my mail box, by which time I had lost interest in the product.
—E.O., Roosevelt, MN

Answering your first question first, we haven't heard anything on a kit for the 105, but don't give up hope. sending the company a request for such an upgrade will indicate a demand for the product. For every person that writes a letter, their are at least one hundred other people to lazy to write but with the same need.

Second, if any readers would like to help this gentleman please feel free to write in care of this column.

Third, reader service card requests are processed in very short order upon receipt. Next, the request for information is sent to the proper company. The ball is in their court at that point, and it is up to them to make as prompt a reply as they find possible.

Quizical Letter

I was reading the May issue of **Hands-on Electronics** and I would like to give some advice to the reader who was looking for an electronic quiz box. You recommended that he pick up a back issue of **Special Projects** that has plans for such a device lock out.

I was one of the readers who built the Lock Out, and although it works fine after it's finished, it took some time to get it finished and in working order. First of all, a few of the pin numbers are wrong which wasn't too hard to get around. The IC numbers on the schematic are not correct, (IC1, IC2, etc.)

Most important of all, the PC board diagram is way out of shape! After we pulled the finished board out of the etchant, we saw the trouble. Many of the traces were left out, pins left unconnected, and other pins shorted together. We used a photographic technique to reproduce the board so it looked just like what was printed in the magazine.
—K.V., Dubuque, IA

Thanks for the helpful hints. If any other readers have corrections they've made to our projects that help them to function correctly or more effectively, then by all means send them to us in care of this column. You never know how many people may need the information.

Looking for a Stud

I always wanted to have my own stud-finder, but couldn't find a schematic for it. Can anyone at your magazine help me find a schematic for one?
—B.S., Chicago, IL

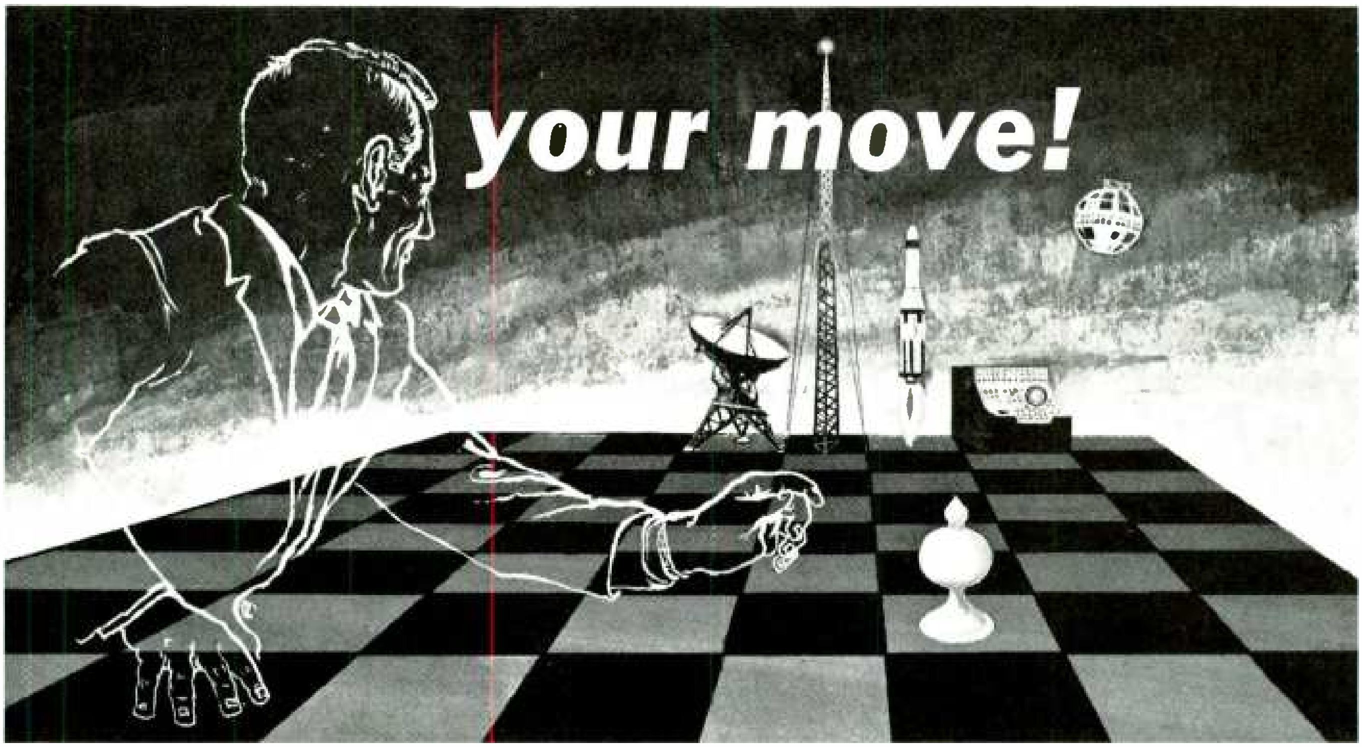
In the July/August 1986 issue we published an article on that very project. If you haven't got that issue, then check the back pages of this one for the reprint bookstore order form.

Switched Off

Someone should tell Herb Friedman that graphite pencils and electronic circuitry do not mix! I reiterate, never, ever use a graphite pencil to set dip switches, or to mark circuit boards and connectors. An inexperienced hobbyist could easily infer from the photographs accompanying the article Near Letter Quality from Old Printers that the pencil shown in nearly every photo is the proper tool for setting the dip switches. In fact, he states, "....using a pencil...mark the connector...." Why would one wish to place conductive material within the cabinet of any electronic equipment, and risk a future short-circuit? Incontrovertably, setting the switches with a pencil will allow loose carbon to enter the switch body, and conceivably short a set-open switch. Please, please print this letter before someone causes themselves a problem which will never be apparent to the eye. And tell Herb to get with the program!
—M.J.B., St. Croix, US Virgin Islands

We only presented the pencil as a pointer to certain components in the printer body, and didn't think anyone would use a pencil to set the switches. ■

Where's Your ELECTRONICS Career Headed?



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BOOKSHELF

Macro Programming for 1-2-3
By Daniel N. Shaffer

If you want to take your 1-2-3 worksheets a step further with new possibilities for power and control, then this book may interest you. It concentrates on the use of 1-2-3's keyboard macro facility in spreadsheet, graphics, and data-management functions. It also provides several tips

CIRCLE 53 ON FREE INFORMATION CARD

on how to make 1-2-3 spreadsheets faster, easier to use, and more powerful by taking advantage of the features of Ver. 2.0.

Through examples and exercises, the book gives step-by-step, hands-on experience needed to write macros with confidence.

Topics covered include: using range names; using the automatic typing features of 1-2-3; and using the programming features of 1-2-3.

Macro Programming for 1-2-3, No. 46573, is 304 pages and retails for $19.95. It's available through bookstores, electronics distributors, or if you prefer, direct from Howard W. Sams & Co. Inc., Dept. R40, 4300 W. 62nd St., Indianapolis, IN 46268; Tel. 800/428-SAMS.

Under the Apple
By Howard Bornstein

If you've got an Apple, how can you separate the software from the fertilizer? With a good book of course.

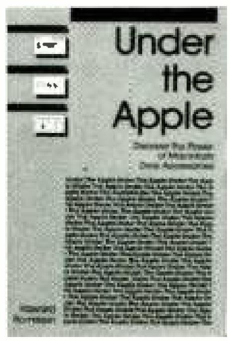
Under the Apple explains the concept of desk accessories and gives clear, informative instructions for evaluating, acquiring, installing, and using them.

The real power of the book is its evaluation of the desk accessories themselves. Over 100 programs are critically reviewed. The author personally tested all the programs and impartially presents their advantages and disadvantages. Illustrations abound. Actual screen dumps of programs running on the Macintosh show how each accessory works.

Under the Apple surveys commercial desk accessories, including a special chapter of desk-accessory sets, as well as shareware and freeware programs.

The programs are presented in ten categories: word processing; graphics; management; calculators; communications; general utilities; disk utilities; programmer's utilities; security; and games. Each accessory review includes discussions of: what it does; what you get; how it works; special features; limitations; and product and manufacturer information.

Under the Apple concludes with several useful Appendices that describe user groups and sources for shareware accessories. There are also



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three indexes listing programs by author, product type, and subject.

The book is 340 pages and priced at $15.95, from Info Books, PO Box 1018, Santa Monica, CA 90406; Tel. 213/470-6786.

Build a Better Music Synthesizer
By Thomas Henry

Looking for a music synthesizer that fills all your specialized needs, has features that spark your creativity, and seems to have been built with you in mind, all for a price you can afford? Now you can have it all. Using this

(Continued on page 12)

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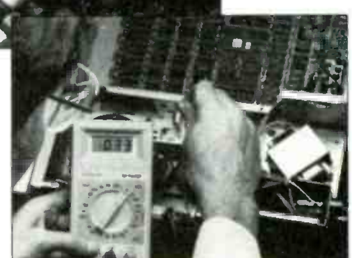

...then install the computer power supply, checking all the circuits and connections with NRI's Digital Multimeter. From there, you'll move on to install the disk drive and monitor.

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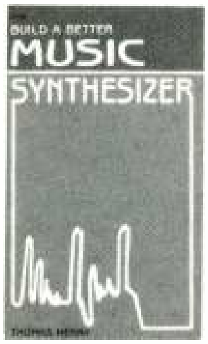
BOOKSHELF

(Continued from page 8)

easy-to-understand guide, any home experimenter, musician, or electronics hobbyist can build a music synthesizer that is better than some that are available ready-made, and for a fraction of the cost. You could be electronically creating music on your



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custom-tailored music synthesizer designed to produce exactly the types of sounds you want.

Starting with basic theory, the guide covers the components of sound, some typical synthesizer modules, control levels, impedance, power-supply requirements, and mechanical considerations. Based on his own experiences in building synthesizers, the author supplies "insider" tips, hints, and straightforward instruction with a minimum of heavy math and involved theory.

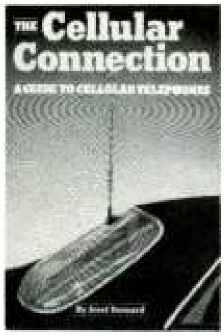
Ten complete construction projects are included which, when built, make up a complete studio-quality synthesizer that will measure up to, and even surpass, commercially-made units. And although a thorough treatment of circuit action is given for each of these projects, the emphasis is on how to actually build and use them. The projects include: deluxe VCO, four-pole lowpass VCF, a retriggerable ADSR, the super controller, a two-chip VCA, a complete digital keyboard, a quadrature function generator, a ring modulator, and the power supply.

Finally, you'll learn how to tie the whole system together into a usable instrument with instructions on wiring for low noise and power supply connections, ideas for microprocessor control, and even where to obtain parts. You'll also learn how to test and troubleshoot your synthesizer to ensure top performance. For $11.95, the 153 page book is available from Tab Books, Inc., Blue Ridge Summit, PA 17214; Tel. 717/794-2191.

The Celluar Connection
By Josef Bernard

If you're thinking about buying a mobile telephone, or if you already own one, *The Cellular Connection* is written for you.

The Cellular Connection is an up to date, fact filled, easy to read, soup-to-nuts guide to the booming world of cellular phones. Individual chapters cover: how the cellular system works; selecting a telephone and a telephone



CIRCLE 99 ON FREE INFORMATION CARD

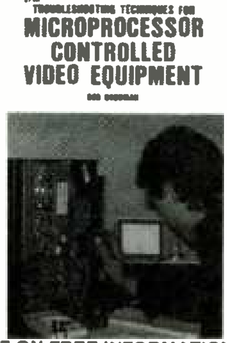
carrier; what features and services are available and how to get the best use from them; roaming (traveling) outside your home area; sending data via your phone's computer interface; dealing with operational difficulties; and safety and security.

Plus, more than 45 pages of informative illustrations and photographs, a handy list of roamer access numbers, a glossary of terms for easy reference, and a look at what's coming in the future.

With 148 pages, the book costs $9.95 plus $2 S&H, and is available from Quantum Publishing, Box 310, Mendecino, CA 95460.

Troubleshooting Techniques for Microprocessor-Controlled Video Equipment
By Bob Goodman

Microprocessors are being used in practically all of today's consumer-electronics devices. So great opportunities await the electronics



CIRCLE 77 ON FREE INFORMATION CARD

service technician who develops expertise in this area. This introduction to servicing "electronics brains" may be what you need to gain those skills. Electronics service technicians, engineers, computer service technicians, even advanced electronics hobbyists can learn how to get to the heart of most any problem and solve it skillfully and confidently.

The author breaks down the intricacies of microprocessors and digital electronics and demonstrates in easy-to-follow steps how to troubleshoot them when a problem occurs. You'll get a short course on digital electronics covering digital logic, logic gates, truth tables, and the functioning of microprocessors in general. Next you'll be introduced to troubleshooting techniques for logic circuits with information on the use of digital logic probes, logic monitors, and oscilloscopes. It even includes a complete chapter on the highly sophisticated troubleshooting method developed by Hewlett-Packard called signature analysis.

Handy hints and tips are also included in *Troubleshooting Techniques for Microprocessor-Controlled Video Equipment* that focus on the types of problems that most often occur in microprocessors and the easiest way to deal with them.

The 341 page book sells for $16.95 from Tab Books, Inc., Blue Ridge Summit, PA 17214; Tel. 717/794-2191.

VCR Troubleshooting & Repair Guide
By Robert C. Brenner and Gregory Capelo

Almost everyone is purchasing VCR's lately, including you hobbyists. So the demand for a technical text on VCR's has been answered with this

CIRCLE 53 ON FREE INFORMATION CARD

troubleshooting & repair guide.

This helpful troubleshooting guide is for the electronics hobbyist, layperson, or technician who needs a preventive maintenance and troubleshooting reference for VCRs. Limited electronics experience is required to use it, but more sophisticated service and repair functions are included for use by the service technician.

Topics covered include: introduction to VCR maintenance; basic troubleshooting; routine preventive maintenance; specific troubleshooting and repair; magnetic recording theory; VCR operating theory; and advanced troubleshooting as well.

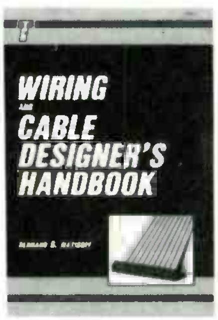
VCR Troubleshooting & Repair Guide, No. 22507, is 256 pages and retails for $19.95, and is available through bookstores, electronics distributors, or direct from Howard W. Sams & Co. Inc., Dept. R40, 4300 W. 62nd St., Indianapolis, IN 46268; Tel. 800/428-SAMS.

Wiring and Cable Designer's Handbook
By Bernard S. Matisoff

If state-of-the-art design techniques and manufacturing methods needed to produce reliable cable and wiring assemblies is your cup of tea, then drink this in.

Over recent years, conductor variations have become as complex as the components and systems they serve. So, if you want the wiring and cabling that you design and manufacture to stand up to today's complex electronics environment, you need a completely up-to-date coverage of the exacting requirements they must meet. And this is it!

Whether you are involved in the manufacture, use, or servicing of electronics supplies and equipment—computers, radio equipment, radar,



CIRCLE 77 ON FREE INFORMATION CARD

communications, avionics, automotive electronics—want to be sure the wiring and cabling involved is top of the line. This guide is a reference of physical characteristics, design techniques, manufacturing methods, and other data needed to produce highly-reliable cable and wiring assemblies. You'll learn all about various types of cables and wiring such as flat cables, flexible cables, coaxial cables, and shielded cables.

Although every electronics system or unit must be wired or cabled to

(Continued on page 16)

By Don Jensen

JENSEN ON DX'ING

There's plenty of scanner activity in the Caribbean

THE MOSQUITO COAST IS BUZZING these days. And Puerto Lempira, a down-at-the-heels port on the Caribbean coast of Honduras is the focal point for the action. *La Mosquitia*, as the area is known in Spanish, spills across national boundaries to include a good chunk of the Nicaraguan coastline—an area where a Contra organization, a Miskito Indian army (called KISAN) is up in arms against the Sandinista forces of the Managua government.

Puerto Lempira is the haven and staging area for Contra efforts. It isn't much of a town (really): unpaved streets, no running water for months, electricity that shuts down at 10 PM, a single hotel, and lots of bars.

But just across from the dirt runway that serves as Puerto Lempira's "international airport," is a house trailer—the only air-conditioned spot in that steamy town—which houses *SANI Radio*, the favorite station of the Miskito-speaking population of the area.

On the air since last August, that 10,000-watt shortwave outlet (broadcasting on 4,755 kHz) has become the rage of the Mosquito Coast with its program mix of country-western, reggae and tropical rhythms, plus news, health and nutrition tips, and Miskito folkloric stories.

The station, funded by the US Agency for International Development, broadcasts in Spanish as well as Miskito, plus some English and the lesser known Sumo Indian tongue.

Another shortwave voice in the area is HRXK, *La Voz de la Mosquitia*, 4,910 kHz, which operates from Campo Bautista, not far from Puerto Lempira.

Only a tenth as powerful as SANI Radio, HRXK is a struggling gospel broadcaster run by Baptist missionary, the Rev. Landon Wilkerson with help from a devoted group of supporters back home in Mississippi.

Technical problems have repeatedly knocked the station off the air, but each time it comes back, usually after a flying trip to Honduras by a faithful friend, a stateside radio engineer. Wilkerson vowed, early this year, to keep HRXK on the air despite the difficulties.

On the other side of the ideological-spectrum broadcasts is the domestic voice of the Managua government, *Radio Sandino*, which has daily programs in the Miskito language as well as in Spanish.

HRRI, SANI Radio can be easily heard most evenings in North America—in fact, it is said to be quite a favorite among Japanese shortwave listeners these days. HRXK, La Voz de La Mosquitia, which has no English programming by the way, can also be heard, though less well, by U.S. and Canadian shortwave listeners when the station is "up" and operating.

Station Profile

Radio Exterior de Espana is the overseas shortwave service of the Spanish government's public broadcasting network, *Radio Nacional de Espana*.

For 62 broadcasting hours daily, REE transmits to listeners overseas—both Spaniards abroad and a non-Spanish-speaking audience. Three-quarters of the station's programs are, not surprisingly, in Spanish. But there are six hours daily of English programming, plus shorter schedules in French, Arabic, and other languages of Spain—Basque, Galician and Catalonian.

REE has made a major commitment to international broadcasting. It operates five 100-kilowatt shortwave transmitters at Arganda del Rey, some 20 kilometers from Madrid; the newer and more powerful facility with a half dozen 350-kilowatt units at Noblejas, about an hour's drive from the capital, and a pair of 50 kilowatters at Tenerife in the Canary Islands, the service's relay station for programming to Venezuela and Central America.

Its offices, newsrooms, and studios are all to be found together at Casa de la Radio (Radio House), Prado del Rey on Madrid's outskirts.

Radio Exterior de Espana's aim with its international service, says the station, is to offer a realistic view of Spain to foreigners, focusing on its social and political institutions, as well as the Spanish culture and tourism.

Thirty broadcasters are involved in REE's foreign language programming.

The REE staff, in all, includes 100 journalists and broadcasters, with about 20 others involved in administrative work

One of the most active of a busy band of Florida shortwave DX enthusiasts is Steve Reinstein of Pembroke Lakes. Steve is co-editor of the well-respected shortwave newsletter, *DX South Florida*.

plus about 20 freelancers. Engineers, studio technicians, and other specialists who are drawn from the general Radio Nacional staff.

The Spanish language service seeks to reach Spanish emigrants in Europe, America, and Australia; fishermen and sailors, traveling businessmen and technicians, and others who speak the language—or who are learning it.

REE pays special attention to listeners who are studying the Spanish language, since the language, the service notes, is taught at more than 6000 colleges and universities around the world.

Shortwave listeners can look for Radio Exterior de Espana in English—identifying as the "Spanish Foreign Radio"—during the North American evening hours, form 0000 to 0200 UTC on 6,125 and 9,630 kHz, and from 0500 to 0600 UTC on 6,125 kHz.

Those seeking a QSL card in response to their reception report may obtain one by writing to: REE, Apartado !56-202, 28080 Madrid, Spain.

Book Look

New on the market is the *Shortwave Listening Handbook* (Prentice Hall Inc., Englewood Cliffs, NJ 07632) by Harry L. Helms. And it, indeed, lives up to its billing as "a comprehensive, one-stop introduction to shortwave radio," covering the how-to and technical aspects of the listening hobby.

Available in either paperback or hard cover, *Shortwave Listening Handbook* is a good basic guide to SWL'ing in all its intriguing aspects. If you've been listening to shortwave for some time, chances are that you've already stumbled across the mysterious "numbers" stations. Those presumed-to-be-espionage encrypted transmissions consist of groups of 4 or 5 numbers, in Spanish and other languages, which seem to drone endlessly on a variety of SW frequencies.

If you would like to know more about such operations, two books which may be of interest are *Uno, Dos, Cuatro* (Tiare Publications, PO Box 493, Lake Geneva, WI 53147) and *Guide to Embassy and Espionage Communications* (CRB Research, PO Box 56, Commack, NY 11725).

The former, written by an anonymous researcher who goes under the pseudonym, "Havana Moon," focuses specifically on the shortwave numbers stations, which have puzzled SWL's for a quarter of a century.

Author/editor Tom Kneitel is the author of the second book, which deals not only with the numbers transmissions but also the radio communications of the world's diplomatic corps. Tom has always found communications information and data that others gave up on!

Down the Dial

What are you hearing on SW? Drop a line to *Jensen On DX'ing*, **Hands-on Electronics**, 500-B Bi-County Blvd., Farmingdale, NY 11735, and let the rest of us know, via this column. Include your loggings, along with their frequencies and times.

Times are listed in Coordinated Universal Time (UTC); frequencies are given in kilohertz (kHz).

AUSTRALIA—6150, *ABC Melbourne*, broadcasts from transmitters at Lyndhurst. The programs, noted around 0830 hours, are intended for Aussie listeners in the inland "outback" and are separate and distinct from the overseas programming of *Radio Australia*.

BURMA—4,775, *Burma Broadcasting Service*, Rangoon, is not a commonly heard station, but it has been reported in the midwest with local vocals and news from 1225 hours.

ABBREVIATIONS

DX	long distance (over 1000 miles)
HRXK	La Voz de la Mosquitia
HRRI	SANI Radio
kHz	kiloHertz (1000 Hertz or cycles)
QSL	verification reply from broadcaster
REE	Radio Exterior de Espana
SW	shortwave
SWB'ers	shortwave broadcasters
SWL('s)	shortwave listener('s)
SWL'ing	shortwave listening
UTC/GMT	Universal Time Code/ Greenwich Mean Time
WMLK	the Assemblies of Yahweh

CHAD—5288, Moundou, a provincial city in this west African country has a domestic broadcaster that can be heard on this frequency at about 0500 hours, broadcasting mostly local African and French music.

CZECHOSLOVAKIA—21,505, *Radio Prague* can be heard at 1430 in English, with news following the horn interval signal and identification.

GALAPAGOS—4,810, *La Voz de Galapagos* is a fascinating DX catch on shortwave, broadcasting from the islands that Charles Darwin made famous in the 19th century. Actually the Galapagos is a little bit of Ecuador out in the Pacific. Programming is in Spanish, of course; look for this one during the evening hours, about 0130 to 0200.

CREDITS: Richard D'Anglelo, PA; Sheryl Paszkiewsicz, WI; David Swaringen, NC; Wilder Pickard II, IL; Kirk Allen, OK; Charles Weiss, OH; Ken Kashiwabara, CA; Rufus Jordan, PA; Brian Alexander, PA; John Prath, FL; North American SW Association, 45 Wildfower Road, Levittown, PA 19057)

HAITI—4930, 4VEH, Cap Haitien, another religious station, turns up here occasionally during the early mornings. You may hear French language news at 1100 hours.

NICARAGUA—6,162, *Radio Sandino*. Our lead item this month featured the stations broadcasting to the Miskito Indians of Nicaragua. This Managua-based shortwave voice is the other side of the ideological spectrum. Look for it at about 1000 hours.

NIGERIA—7,255, *Voice of Nigeria* is another African station with an unusual tuning signal, west African drums. This one can be heard at 0455 hours, just before the station's English transmission begins at 0500.

ROMANIA—15,250, *Radio Bucharest* operates simultaneously on 9,690 and 11,940, as well as this 25 meter band frequency. You can hear English news at 1300 hours.

SPAIN—6125, *Radio Espana Exterior* from Madrid is the foreign service of the Spanish national radio. Try tuning this one in at 0100 hours.

URUGUAY—9,595, *Radio Monte Carlo* provides all-Spanish programming from this shortwave outlet, which broadcasts from Montevideo during the evening hours.

USA—9,455, WMLK, this shortwave station is operated by a rather small religious sect know as the Assemblies of Yahweh. The enterprising organization got on the air by reworking a used medium transmitter and broadcasts from a converted gas station in Pennsylvania. Check this one out at about 0400 hours.

USSR—5,945, *Radio Tashkent*. This voice from Soviet Asia can be heard in English from 1200 to 1230 hours, with news, commentary and other kinds of programming.

VATICAN—6030, *Vatican Radio* follows up its French programming with a brief English program at 0050 hours, which was formerly heard on 6015. This one is easy to pull in.

VENEZUELA—11,852, *Radio Nacional* in Caracas, Venezuela, is another with all-Spanish programming, but is probably somewhat easier to hear. Try catching this one at about 0030 to 0100 hours; or else you might try its parallel frequency, 5,020 kHz.

YUGOSLAVIA—7,240, *Radio Yugoslavia*, Belgrade is an interesting eastern European shortwave catch. It broadcasts from 2215 hours in English, with news and "Tips for Tourists." It's a good catch.

ZAMBIA—4,910, *Zambia Broadcasting Service* from Lusaka in southern Africa begins its transmissions about 0340 hours with the haunting cry of the fish eagle. Programming begins just in advance of 0400 hours. ■

BOOKSHELF

(Continued from page 13)

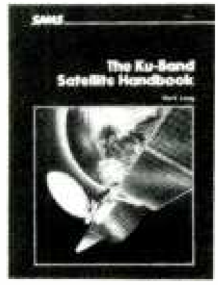
function in its intended use, very little information on their design and manufacture is currently available. The book will give you instant access to specific charts and tables of design and manufacturing parameters for specific conductor requirements. And because military equipment is subject to extremely severe conditions of usage, design, and workmanship standards, it will be these high standards that you will learn, to give your equipment the reputation of quality that is needed to stay competitive.

Containing 293 pages, the book retails for $41.50 from Tab Books, Inc., PO Box 40, Blue Ridge Summit, PA 17214; Tel. 717/794-2191.

The Ku-Band Satellite Handbook By Mark Long

If a good book on Satellite TV would put you in orbit, then Sams may have what you're looking for.

This book explores all of the various aspects of the transmission and reception of video, voice, and data signals by commercial communications satellites operating on frequencies within the 11-to-12 GHz range.



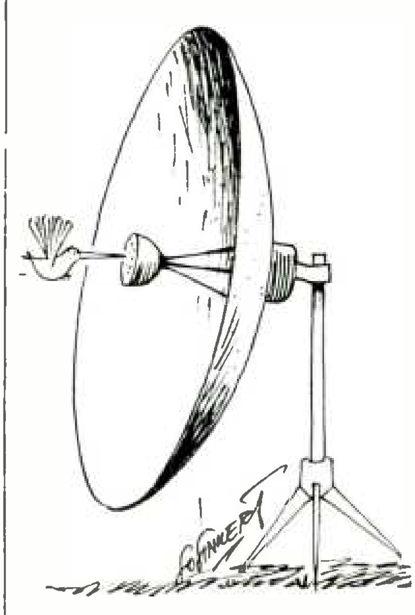
CIRCLE 53 ON FREE INFORMATION CARD

Topics covered include: from 4 to 12 GHz: the evolution of satellite technology; exploring the satellite system; the new frontier at 12 GHz; Ku-Band earth station antennas; Ku-Band LNB's, feedhorns, and polarizers; have dish, will travel; Ku-Band transportable uplinks; Ku-Band satellite scrambling systems; interactive satellite networks; and U.S. direct broadcast satellite (DBS) players as well as others.

The Ku-Band Satellite Handbook, No. 22522, is 320 pages and retails for $24.95. For your copy contact Howard W. Sams & Co. Inc., Dept. R40, 4300 W. 62nd St., Indianapolis, IN 46268; Tel. 800/428-SAMS.

A Correction

A mistake appeared in our report of the book John D. Lenk's Troubleshooting an Repair of Microprocessor Based Equipment in the March 1987 issue. The price quoted for the book was $12.95 instead of the true price of $21.95. We apologize to anyone experiencing trouble in ordering that book because of the error. ■



NEW PRODUCTS

Remote Control

CIRCLE 80

Is a "magic wand" that can control the television set, VCR, and cable box, all the stereo components in the house what you want? Well, Onkyo's Unifier, Model RC-AVI, is the industry's first audio/video universal programmable remote control. Today's modern audio/video systems typically incorporate three or more different remote controls. With the Unifier, all functions can be memorized by one handy master unit.

Any infrared remote control for any component from any manufacturer can be replaced by the Unifier: it is actually able to *learn* the control codes from other units. More than 100 different functions can be stored in the Unifier's memory.

The Unifier comes with control codes for Onkyo products already programmed in. Consumers can easily *teach* the unit how to control other components. For example, the user could simply hold, say, a video recorder's remote control head-to-head with the Unifier. For the control codes to be learned, he would press the VCR's remote control buttons and the matching Unifier buttons. The Unifier will signal when it has learned the new codes, and from then on it would be able to control the VCR.

The key to that versatility is an on-board, battery powered microprocessor that electronically transmits and stores the other remote's functions. The Unifier incorporates three main modes: Audio, Video, and Auxiliary. The audio mode allows remote control of an amp/tuner/receiver, cassette deck, CD player, and turntable.

The Unifier, Model RC-AVI, is packaged with two new Onkyo receiver models, the TX-82M and the TX-84M. It will also be available at a suggested retail price of $119.95.

For further information contact Onkyo Corp., 200 Williams Drive, Ramsey, NJ 07446.

Add Color to your Messages

If you like to get messages across in a big way, you may want to hang up the Gamma 305 electronic bill board. The model 305 offers three LED colors to choose from, red, green, and yellow, or all three combined. Contrasting background colors give the user 8 different color combinations. The Wireless remote-control

NEW PRODUCT SHOWCASE

keyboard enables programming from up to 30 feet, even through glass.

Some interesting features include: 2" characters, 8000 character memory with 90 day back-up, 22 display modes, upper and lower case letters, and pre-programmed animation.

CIRCLE 94 ON FREE INFORMATION CARD

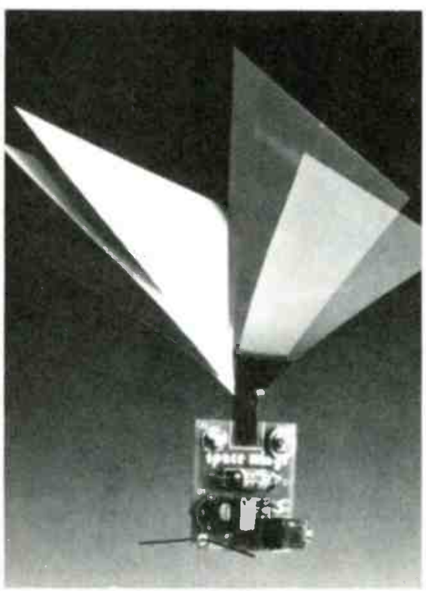
In addition to those standard features, it includes options such as attention getting customized logos or graphic creation. Memory cartridges for faster programming are also available.

The 305 retails for $599. For additional information in Florida Tel. 305/251-5775, for all else Tel. 800/522-SIGN, or write to: Gamma Technologies, Inc., 12161 SW 132nd Court, Miami, FL 33186.

Winged Robot

Yes, a robot with wings, but without motors! Space Wings resembles a large electronic butterfly. It's sleek silver wings move continuously using a nickel-titanium alloy wire called BioMetal. When electrically activated, the BioMetal wire contracts up by five percent of its length, pulling inward to close the wings. When unpowered, the wire relaxes and the wings reopen. In that way, Space Wings flaps six times per minute for tens of millions of cycles.

Space Wings gives hands-on experience with the new generation of shape-memory alloys. Space Wings is unique in that it moves entirely without the use of motors, solenoids, or magnets.



CIRCLE 74 ON FREE INFORMATION CARD

The Space Wings kit can be assembled in under an hour with little or no previous electronics experience. Each kit includes BioMetal wire, printed circuit board, electronic components, mylar wing material, and detailed instructions. A 3-Volt adapter powers the kit, and uses only 200 milliamps of current. When assembled, Space Wings stands just over six inches tall. The kit has a suggested retail price of $19.95, and is currently available from Mondo-tronics 20090 Rodrigues Ave. #1, Cupertino, CA 95014; Tel. 408/255-7055.

Personal Radio/Cassette Recorder

Ever hear a good tune on a portable radio and not be able to record it? Now there's a solution to that problem, the RX-SR25. For pleasure use, the user can listen to his favorite radio station or cassette tape through the included, lightweight stereo headphones. Selections from the radio can be recorded directly onto a cassette tape simply by making use of the one-touch recording feature.

CIRCLE 63 ON FREE INFORMATION CARD

The RX-SR25 also includes cue and review, the convenient feature that lets the user, while in the play mode, locate desired passages quickly and easily by pressing fast forward or rewind.

For business or school, the built-in condenser microphone allows the taping of important lectures or seminars.

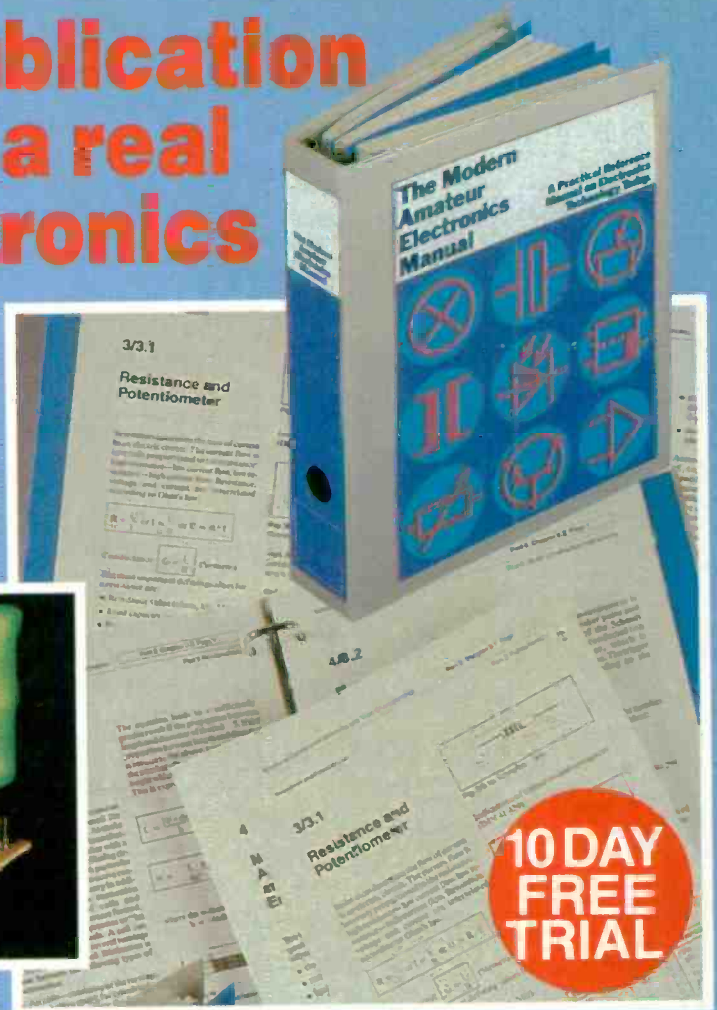
The RX-SR25 also has a metal/CrO_2 normal tape selector, offering metal tape compatibility in the playback mode. Other features include auto-stop, an LED FM stereo indicator, and a detachable belt clip. The unit operates on two AA batteries (not included). It is at the suggested retail price of $79.95.

For more information write to Panasonic Company, 1 Panasonic Way, Secaucus, NJ 07094.

(Continued on page 22)

A major NEW publication for anyone with a real interest in electronics

This brand new MODERN AMATEUR ELECTRONICS MANUAL provides you with a single comprehensive and practical reference work—to keep you completely up-to-date with all aspects of amateur electronics.



If you're excited about electronics...if you want to understand, assemble, repair, and have fun with electronics, you need...

THE MODERN AMATEUR ELECTRONICS MANUAL

...the major guide and reference volume in the electronics field.

No field is more fascinating than electronics. But no field changes more rapidly. Think of the advances in computer technology, audio and video equipment, short wave radio, to name just a few. To keep up-to-date you would probably have to read ten magazines.

Now with THE MODERN AMATEUR ELECTRONICS MANUAL, plus updates, you keep abreast of new developments, new equipment, new theories, new products.

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A world of fun for the electronics hobbyist.

THE BASICS. Learn about measurement instruments—neon bulb voltage indicators, VOMs, VTVMs. Build your own circuit boards. Check out the MANUAL's printed-on-film PCB layouts, ready to transfer to copper clad boards for immediate use.

EQUIPMENT. Latest information on stereo, VCR, compact disc, and other audio equipment is provided.

ASSEMBLY. Hobbyists interested in radios, synthesizers, computers, loud speakers and amplifiers can use the assembly instructions given for many kinds of electronic equipment.

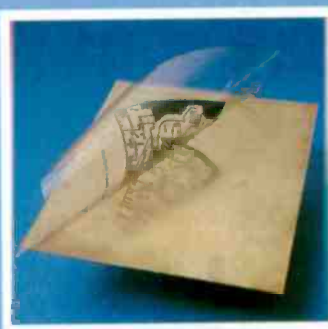
SHORT WAVE AND CITIZEN BAND RADIOS. The MANUAL gives you information on equipment and regulations. Learn what's legal before you go on the air.

COMPONENTS. Need capacitors, inductors, semi-conductors, switches, relays and many other kinds of electronic hardware? Check the MANUAL. You will find descriptions and sources and very often alternative possibilities.

COMPUTERS AND PERIPHERALS. Learn how to program your computer. Use BASIC or other languages; it's all in the MANUAL. Modems, bulletin boards, graphic cards, and much more are all explained.

SUPPLY SOURCES. Every hobbyist is constantly on the prowl for parts. The MANUAL's reference sheets save you time. They tell you where you can obtain hundreds of components. Updating sheets assure that your volume is always current.

ALWAYS UP-TO-DATE. WEKA Publishing, one of the largest technical publishers in the world, sends you supplements several times a year. You put these in the appropriate sections of the book—a sturdy, well-built looseleaf binder.



Assemble your own CIRCUIT BOARDS—we give you ready-to-use PCB layouts on film—a very popular feature.

IMPORTANT: WEKA Publishing is independent of any electronic manufacturer. We provide fair and unbiased information on equipment, as well as on sources of parts and service.

THE MODERN AMATEUR ELECTRONICS MANUAL

Editors: Gunter Haarman, Roger Dorey, John Weddebaum. Basic Edition: 400 Pages, 8" × 12". Price: $49.95. Supplements: Sent to all subscribers several times a year at a cost of 25¢ per page. Supplements can be discontinued at any time.

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NEW PRODUCT SHOWCASE

(Continued from page 18)

TNC Tuning Indicator

Are you a user of TAPR TNC-1-s, TNC-2-s or a clone such as the MFJ-1270? If so, a new tuning indicator has hit the streets that you may want to tune into.

The MFJ-1273, $49.95, lets you tune in HF, OSCAR and other non-FM packet stations fast, because it shows you which direction to tune your radio. All you have to do is center a single LED and you're precisely tuned in to within 10Hz.

CIRCLE 97 ON FREE INFORMATION CARD

Twenty LED's give high resolution and wide frequency coverage to make tuning very easy.

The MFJ-1273 tuning indicator plugs into the MFJ-1270 and all TNC-1's, TNC-2's, and clones that have the TAPR tuning indicator connection.

It comes with a double guarantee. If ordered directly from MFJ, it may be returned within 30 days for a prompt refund, less shipping. It is also covered by MFJ's One Year Unconditional Guarantee.

To order, or for more information, contact MFJ enterprises, Inc., PO Box 494, Mississippi State, MS 39762; Tel. 800/647-1800, or 601/323-5869.

Supertwist LCD Terminal

If you're looking for a portable with a twist, then laptop one of these.

The enhanced T1100 Plus battery-powered PC is identical to its predecessor except for the new higher-contrast LCD.

Supertwist technology allows more light to pass through and bounce back, creating darker characters and improved screen contrast.

CIRCLE 96 ON FREE INFORMATION CARD

The supertwist screen is standard on all new units and can be added to existing models through an upgrade program. (Pricing and availability of the upgrades is unknown right now.)

The computer, powered by an 80C86 microprocessor running at 4.77 or 7.16 megahertz clock speed, features two 3.5 inch 720KB diskette drives and standard interfaces for an RGB color monitor, monochrome composite monitor, parallel printer, RS-232C serial communication device, expansion chassis or external 5.25-inch diskette drive.

They are priced at $1999 for 256 kilobytes of random access memory and $2399 for 640KB RAM.

For more information contact Toshiba America Inc., Information Systems Division, 9740 Irvine Blvd., Irvine, CA 92718; Tel. 800/457-7777.

Remote-Control Booster

If you've got a big room, a wireless optical-power booster for electronic remote control devices may be what you need. With Zapit attached to the front of the controller, the obstacles of low performance and limited range are eliminated, making remote operation of home electronics more convenient.

CIRCLE 59 ON FREE INFORMATION CARD

Zapit, a battery-operated device, receives infrared light from a remote control through a special lens system which amplifies and re-transmits the infrared signal. That power boost allows the beam to bounce off walls and ceilings for ultra-fast activation of components (television, VCR, stereo). There is no need to point the remote control in order to command the equipment, and Zapit's increased power allows users to move far out of the normal remote control range—over 100 feet.

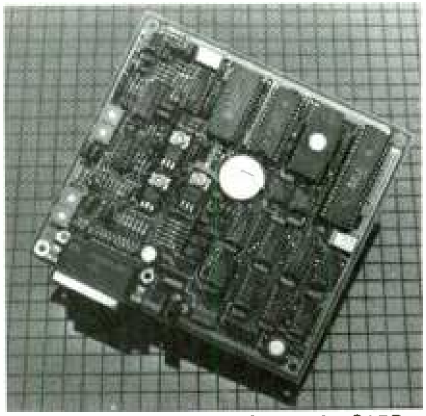
Designed for ultimate convenience, Zapit also serves as a handy base for the remote control unit, holding it at an angle for easy accessibility.

Zapit is priced at $24.95 suggested retail. For more information contact Monster Cable, 101 Townsend Street, San Francisco, CA 94107; Tel. 415/777-1355.

Repeater Controller

The new S-COM 5K is a low-cost, compact repeater controller just right for you hobbyists. The state-if-the-art CMOS microprocessor design supports both a repeater and a control receiver, and requires only 60 mA at 12 VDC.

Applications include control of main site repeaters, remote receiver links, por-



CIRCLE 70 ON FREE INFORMATION CARD

table repeaters, and emergency repeaters.

Operating parameters, such as ID callsigns, courtesy message, timeout timer, pre- and post-timeout messages, CW pitch, and CW speed, are remotely programmable via DTFM commands, eliminating trips to the repeater site to make programming changes. Data is retained in nonvolatile memory. Three logic inputs and three logic outputs are provided for site control and monitoring purposes.

Among the many other features included are CW shaping, a watchdog monitor, flexible repeater interfacing, a CW clock and calendar, DTFM muting, security passwords . a *polite* identifier, transient protection, power MOSFET outputs, and high-quality, G10FR glass-epoxy PC board.

The board measures 5.5 by 6 inches, with the tallest component only 0.5 inches above the board.

Options include full IC socketing, 1.75 by 19-inch rackmount cabinet, wall-mount power supply, and Audio delay Module.

The S-COM 5K comes with a 1-year warranty. The assembled and tested board, with all connectors and manual, is priced at $179.

For information, contact S-COM Industries, PO Box 8921, Fort Collins, CO 80525. For orders Tel. 800/621-8387, ext. 244. For technical information Tel. 303/493-8316.

Cellular Antenna

If a highly refined, second-generation, cellular mobile-phone antenna, is what you need, read on. The Model APD852.3, employs a unique, patented A/S mounting technology that couples the antenna to the coaxial cable through window glass, providing a secure, fast, no-holes installation. The company estimates that over 70% of all cellular mobile installations employ On-Glass antennas.

On-Glass II features a coupler design, just ⅝-in. high, that minimizes visual impact, fits between defroster grid wires, and virtually eliminates any potential defroster interference.

Also new is a quick-removal whip connection with the male stud on the swivel, preventing any accumulation of water. The whip can be adjusted through 90° to its vertical position and locked by means of a single set screw. For smoother cable installations, On-Glass II provides a mini-

CIRCLE 69 ON FREE INFORMATION CARD

connector at the coupler. An advanced adhesive system holds the antenna securely yet allows for subsequent removal.

No field tuning is needed; each On-Glass II is factory tuned and inspected. Finally, the antenna is protected by a highly resilient, black, DURA-COAT finish that resists abrasion, and offers a high-tech, contemporary appearance.

For further information about the On-Glass II cellular mobile antenna, contact The Antenna Specialists Co., 30500 Bruce Industrial Parkway, Cleveland, OH 44139-3996.

CD Saver

There's good news and bad news for those who use CD's like frisbees. Compact Discs, although durable, are far from immune to damage. Frequently used CD's often develop light scuffs and cobweb scratches that can cause audible problems—ticks, pops, dropouts, and sputtering—which can severely diminish your enjoyment of the music.

Even when fine scratches do not cause

(Continued on page 107)

By Herb Friedman

FRIEDMAN ON COMPUTERS

Sometimes you have big trouble if you don't get the whole *enchilada*

THERE IS NO DOUBT THAT WE ARE rapidly approaching the time when every home and office will be equipped with a personal computer—most likely, it will be an IBM-clone. Not necessarily IBM-compatible, because that implies that the computer might use different hardware but the same software. I mean an honest-to goodness-clone: one that takes IBM-type plug-in adapters.

I'm certain that many of you are now in high dudgeon, ready to take pen in hand and lecture me on the virtues of your Apple, Commodore, or Atari computer. And still others are certain to write and prove with *undisputable facts* that their old CP/M computers—be they Kaypro, Osborne, SWTP, or only Heaven knows what else—is superior to an IBM PC. But I'm not talking about superiority. I'm talking about what will be, and what "will be" is fast becoming an IBM-clone world.

Fortunately, those persons new to personal computing usually have no trouble getting a couple of cartons of hardware up-and-running because they usually buy the whole *enchilada*: every piece of hardware and the matching cables.

When there are problems in getting an IBM-clone up-and-running, it usually turns out that the user is an "old hand" at computing, and has tried to save a few dollars by using the cables, interconnects, and sometimes the hardware, from the old computer system. In particular, the most difficult problems to resolve usually develop when someone tries to drive an old serial printer, or an inexpensive modem, from the clone's serial port.

That can lead to the brain-numbing frustration of *Catch-22*, because when you can't get the serial hardware running, you must then face an arrogant dealer who smiles and tells you that they don't support anything except what they sell. In other words, they won't test your new computer—which is working fine by itself—with your old printer or modem. Well, I'm going to help you wipe the arrogant smile off the salesman's face.

A Helping Hand

The problem that many of you face when interfacing IBM-clones with serial peripherals is that the IBM-type serial adapter—which IBM calls an *Asynchronous Communications Adapter*—requires that each and every handshake connection be accounted for, or else it won't work.

Let's look at what that accountability means. Assume that you have an older serial printer: a model that's still being sold for "pocket change" in the mail-order marketplace. Most likely, regardless what other connections it might have, it will work using only the connections shown in Fig. 1: a TX (signal in) on pin 3, a chassis ground on pin 1, a signal ground on pin 7, and a *busy* (*Data Terminal Ready*) on pin 20.

We will assume that you know enough to connect the chassis (frame) ground, or the printer might combine the chassis and

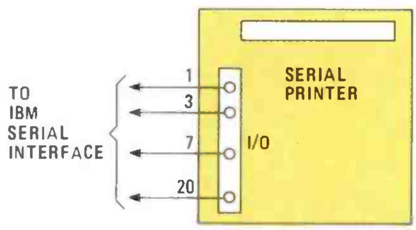


Fig. 1—Only three wire connections are usually required for the average serial printer: pin 3 (signal), 7 (signal ground), and 20 (the *busy* handshake). Pin 1, which is the chassis ground, is often connected within the printer to pin 7.

signal grounds on pin 7. So we're talking about three connections: Pins, 3, 7 and 20 (in Fig. 1). Quite possibly, you also have an acoustic or non-hayes-compatible modem, so it uses pin 1, pins 2 and 3 for input and output signals, and the signal ground on pin 7.

Because you took the time to read the manual that came with your computer, you know that the IBM-serial adapter is meant to drive a modem (not a printer) straight-across: meaning pin 2 to pin 2, pin 3 to pin 3, pin 20 to pin 20, etc. So you know that to drive a printer, you must reverse the wiring to signal-pins 2 and 3 just as you did with your old computer. In fact, you can even use the same cables because the connectors match. Those of you who have not read your manuals, have fortunately redeemed yourselves by reading this column, escaping the fate of the heathen.

Here Comes Trouble

Whoops! Something's gone wrong. The printer doesn't work. So you try the modem. That doesn't work, either. Obviously, you deduce, the computer is defective: so you pay a hefty shipping charge to ship it back to the dealer for repairs. Then the equipment comes back with a note to the effect that everything is A-OK. But your serial peripherals still won't work. *Wha' Hoppen*?

What happened is that, unlike the serial I/O's on many other computers (which work fine if you use only the signal connections you really need), the IBM-type serial I/O requires that every handshake connection be connected to something—or the interface won't work.

To explain: The serial interface uses pins 4, 5, 6, 8, and 20 as handshakes. The signals on those pins either tell the peripheral that the computer is ready for use, or they tell the computer that the the peripheral is ready. For example, pin 5 is the *Clear To Send* (CTS), a signal originating at the printer or modem. Many early computers simply ignored the CTS. If you told the computer to output to a modem or printer, it went ahead and output. Alas, that's not so with the IBM-clones. They do nothing unless they receive a CTS signal from the peripheral.

It's the same thing with pin 8, the *Received Signal Detector* (RSD) that originates at the modem. If the IBM-clone doesn't receive the RSD it's not going to do a thing. Then there's the pin 6 handshake, the *Data Set Ready* (DSR) line. It originates at the modem or the printer and tells the computer that the peripheral is ready for use. An IBM-clone will do nothing without that handshake.

Of course, there are handshakes that originate at the computer: pin 20 is the *Data Terminal Ready* (DTR), while pin 4 is *Request To Send* (RTS). Both tell the peripheral that the computer is ready.

Now as we said, most early equipment ignored most or all of those handshake lines, but not the IBM-clone (figure that). So if you use one of your early printer or modem cables that do not account for all the handshakes, your IBM-clone's serial I/O will either not work, or the computer

FRIEDMAN ON COMPUTERS

will lock up—depending on the particular circumstances and equipment.

The Remedy

What should you do? Simply use all the handshakes. Figure 2 shows how that can be accomplished to drive a low-cost draft printer that normally uses only the pin 3, 7, and 20 connections. Note from Fig. 2 that at the IBM end of the cable pin 4 is shorted to pin 8, and pin 6 is shorted to pin 20. That all there is to it.

You don't understand what's happening? OK, we'll take a closer look. The computer itself makes pins 4 (RTS) and 20 (DTR) high to show that it is ready. The jumper from pin 4 to pin 8 puts the pin 4 high on pin 8, so the computer thinks it's getting an RSD signal from the peripheral. Similarly, the computer's high on pin 20 (DTR) is jumpered to pin 6, so that the computer thinks it's getting a DSR from the peripheral. All handshakes are now accounted for; therefore, the computer will output to the printer. The printer's *busy*, which is connected to pin 5 (DSR) at the computer, is really the only handshake that is working, and it controls the output from the computer. The computer stops sending when pin 5 gets a *busy* signal from the printer, which indicates that the printer isn't yet ready to accept additional data.

For those of you with similar problems when using a modem, again make certain that all handshakes are accounted for. If necessary, use the computer's pin 4 to force any unused handshake line high, the same as we did for the printer connection.

Our final tip this month is for those of you who are using parallel printers and get only partial printing of a screen dump (using the *PRINT SCREEN*) command. Your problem isn't the connections, but something called "timing out." Many early printers, particularly daisy-wheel models, have a small buffer of several hundred bytes. When you enter a *PRINT SCREEN* command, the printer starts, the screen cursor drops several lines down, you get a few lines of clean hardcopy (print out), but suddenly the printer stops. It does the same thing every time you try, never printing beyond the same character.

What's happening is that the printer is relatively slow after its buffer fills. The computer fills the buffer almost instantly, and the printer starts printing, ever so slowly. The buffer doesn't attempt to refill until its almost empty, so many seconds—perhaps a minute—goes by before the buffer signals the computer to output data. Meanwhile, the computer is doing nothing, so it assumes it is finished printing or that the printer has been turned off; and so it "times out," returning the computer to the non-printing mode. All that gets printed is the data that first filled the

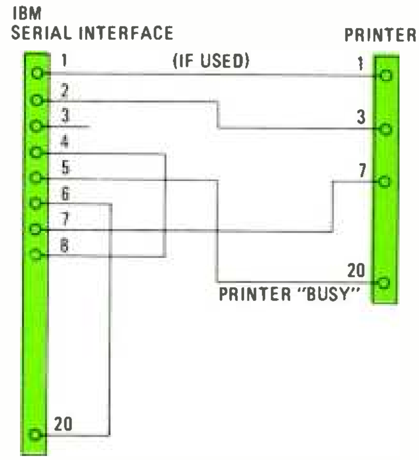
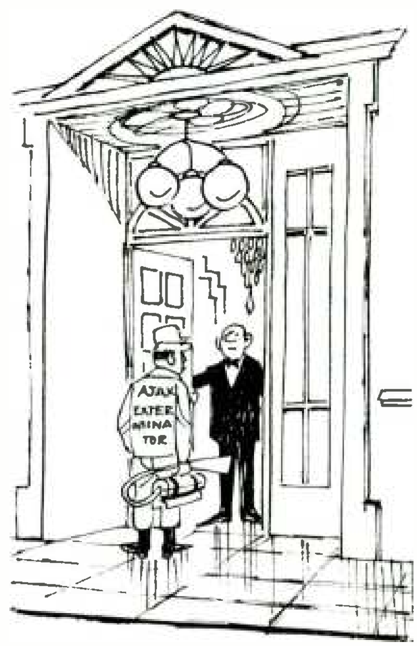


Fig. 2—The IBM-type serial adapter will not work unless all the handshake connections are accounted for. Shown here is a wiring arrangement that will work with most inexpensive serial printers. Take note that it's possible that your printer might not use pin 20 for the busy line. If that is the case, simply connect it to the appropriate printer pin.

printer's internal buffer.

The "time out" was deliberately built into PC/MS-DOS to prevent the computer from locking up if the printer isn't connected or turned on. Lock-up was a common problem with earlier computers.

The way around the timeout/slow-printer problem is to use "spooler" software (it usually works), or better still, a complete printer buffer between the computer and the printer. In that way, the computer fills the complete buffer and is ready for immediate use while the printer takes its own sweet time to do the printing. ■



"You the embassy that's bugged?"

By Marc Saxon

SAXON ON SCANNERS

If you're shopping for a scanner, this one's worth a look

☐ADMITTEDLY, IT'S HARD TO THINK OF A piece of electronics gear as being controversial, but Radio Shack's Realistic PRO-2004 scanner has earned that label for itself. This is a keyboard-programmable 300-channel scanner base station that was originally announced to cover from 25 to 520 MHz and from 760 to 1300 MHz. In other words, it could tune all two-way communications frequencies between 25 and 1300 MHz, except the 520 to 760 MHz band, which is used only for TV broadcasting.

That enormous frequency range was virtually unknown in a scanner intended to sell in the moderate $400 price range; so scanner owners were anxiously awaiting its arrival. However, in advance of the set's appearance, Radio Shack announced that the specifications of the PRO-2004 had been changed and that the scanner would not cover two small frequency subbands in the 800 MHz range that were allocated for use by cellular mobile telephones (CMT's). Many scanner enthusiasts yelled "foul," and from that day on the PRO-2004 has been the center of an ongoing controversy.

But as fate would have it, when the PRO-2004 finally arrived in Radio Shack stores across North America, it turned out to be a rather fantastic piece of equipment with many exciting features combined with splendid performance. Some found that the PRO-2004 could be modified internally to receive the two CMT frequency bands, thus restoring it to its originally-announced specifications!

In addition to its copious 300-channel coverage and big frequency range, the set offers 10 different search ranges, a direct search function that lets you start a search (up/down) from any frequency shown on the LCD display, ten scan banks, selectable mode (AM/NFM/WFM) for each channel; selectable 5/12.5/50 kHz search steps, memory backup, bright/dim panel lights, plus a feature that prevents the unit from stopping on a frequency without any sound. Those "bells and whistles," plus standard scanner features (delay, lockouts, slow/fast scan rates, etc.) make the PRO-2004 an extremely attractive and versatile unit.

The ability to receive the exotic UHF military aeronautical band (225 to 400 MHz) is a wonderful feature, which we liked a lot. In use, the Realistic PRO-2004 seemed remarkably free of "birdies" and the intermod problems that often show up in programmable scanners.

The PRO-2004 is a truly excellent scanner, what might be conservatively described as "state-of-the-art." We were very impressed with this unit and we think you will be, too. Trot over to your nearest Radio Shack store and ask them to show you one in action. One of the things to look for is that, despite its sophistication, it's relatively simple to program and operate. A status line on the LCD display keeps you well informed as to what's going on at all times.

Lights, Camera, Action!

One of our readers, Rusty Knowles, of Illinois, passes along the news that when the new film *Vice-Versa* was being filmed in his home town, just outside of Chicago, IL, there was plenty of two-way usage by the film crews. The star of the film is Judge Rhinehold, who frequently used the Motorola HT-440 handhelds to communicate with the Assistant Director and other members of the film crew.

Rusty said that he located the frequency on his scanner and it turned out to be 173.225 MHz. One of the crew members said that Columbia Pictures had rented all of the two-way equipment. Our advice is for readers to check out this frequency any time they see a motion picture or TV production crew in their area. Other frequencies also normally used by these crews include: 152.87, 152.90, 152.93, 152.96, 152.99, 153.02, 173.275, 173.325, and 173.375 MHz.

An anonymous reader in Texas writes to ask about so-called "800 MHz trunked" communications systems. He says that stations licensed for such systems have numerous channel assignments and he wonders how you are supposed to know which one(s) to monitor.

Those communications systems use all of the available frequencies, and individual transmissions within an exchange of communications will pop up on different channels from within those authorized to the licensee. That makes monitoring trunked systems a bit difficult for those not having the sophisticated computer-controlled equipment designed for such

The Realistic PRO-2004 scanner features 300-channel coverage, 10 different search ranges, direct search (up/down) from any frequency shown on the LCD display, 10 scan banks, selectable mode (AM/NFM/WFM) for each channel; 5/12.5/50 kHz search steps, memory backup, bright/dim panel lights, and a feature that keeps the unit from stopping on inactive frequencies.

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SAXON ON SCANNERS

systems. Computerized equipment permits the receivers and transmitters to synchronize operations with one another through the constantly-changing frequencies used.

A number of police departments are presently using such 800 MHz systems, as they are also using CMT's for supplementing their other existing communications facilities. CMT's, in particular, have proven very useful for surveillance and other specific types of confidential investigatory work.

Airport Communiques

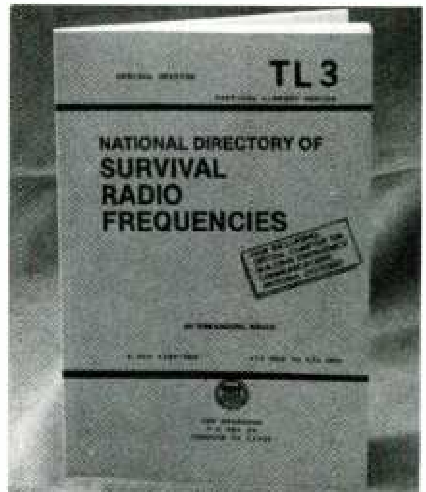
Bob Mirto of Pasadena, CA asks where to tune on his scanner to hear the private air/ground "company" frequencies used by airlines.

Those frequencies mostly lie within the range of 128.825 and 132.0 MHz, and also include commuter lines operating on 122.825 and 122.875 MHz. Airline ground services on-site at major airports can be found on the following frequencies: 406.65, 460.675, 460.70, 460.725, 460.75, 460.775, 460.80, 460.825, 460.85, and 460.875 MHz.

At larger airports, virtually all of those 460 MHz channels will be found to be active with baggage handling, maintenance, ticketing, passenger service, and administrative personnel. Makes for good listening, but low-powered units make it hard to hear on a scanner more than a mile or two from the airport.

Special Edition

The new "Special Edition" of the *National Directory of Survival Radio Frequencies* has just come out. The listings section shows, on a state-by-state basis, the 5,000 frequencies most often used by state PD's, CD, forest-fire towers, fish/game wardens, search/rescue teams, turnpike/parkway authorities, parks/harbors/bridges, disaster, military, National Guard, prisons, alchololic-beverage control, weather, etc.



The new special edition of the *National Directory of Survival Radio Frequencies* lists, on a state-by-state basis, the 5000 frequencies most often used by local and federal authorities, and has been expanded to include complete construction details of many antennas, to cover 1600 kHz to VHF.

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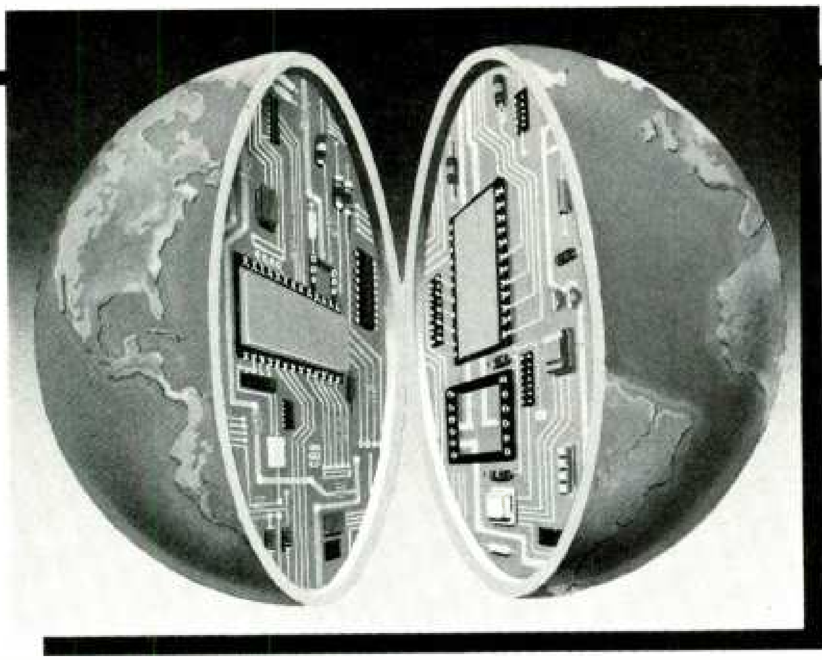
The new edition has been expanded to include complete construction details of many antennas (1600 kHz to VHF) that may be quickly and easily fabricated from on-hand materials during any sort of an emergency. The improvised antennas are all worth knowing about in the event of the loss of your communications antennas due to storms or other unexpected events.

The Special Edition of the National Directory of Survival Radio Frequencies available at $8.95, plus $1 shipping/handling in the USA/Canada (Canadians please send a Postal Money Order made out in US funds). Order it directly from CRB Research, PO Box 56-GP, Commack, NY 11725.

Let's hear from our readers! Send your questions, photos, suggestions, etc. to: *Saxon on Scanners*, **Hands-on Electronics**, 500-B Bi-County Blvd., Farmingdale, NY 11735. ■



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HIDE-A-WAY STEALTH

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AUGUST 1987

Avoid being harassed for having a police radar

By J. L. Pearson

NO ONE THAT VENTURES OUT ON OUR INTERSTATE HIGHWAY system would say that the 55 mph speed limit is being observed. Anyone that does observe it soon creates a moving roadblock and would find it safer to drive with the flow of traffic. The result is a gold mine for state and local municipalities that choose to use radar speed traps as a revenue source. In addition, it has been demonstrated in a Florida court that erroneous readings were easy to produce. Erroneous radar speeding summonses have been estimated to be as high as 30%. The driver-defensive response has created a huge market for radar detectors. That, in turn, has made the devices a target of theft. In addition, a detector clearly visible on the dash out on the open road can result in harassment. In some areas, although contrary to the Communications Act of 1934, ordinances against detection devices are in effect. All those factors combine to make a remote or hidden detector a highly desirable item.

Remote detectors usually have the antenna and RF electronics in a black box mounted behind the grill, under the front bumper, or even disguised as an add-on road light. A small control box and remote alarm may then be hidden under or in the dash-board. Those work, but the low placement of the antenna may result in blockage of the incoming radar beam by intervening vehicles. The cost is usually high, and the units may not be easily switched from car to car.

We will describe a simple, inexpensive way to allow any good superhet radar detector to be mounted remotely. No changes are made to the detector unit. It may be easily switched from car to car and can be mounted in any of a variety of unusual locations.

Reveiw of Radar

Before we describe our circuit and system in detail, let's take a quick look at some microwave and radar basics, and why radar detectors are effective. We apologize beforehand to the professional microwave engineers among our readers for the lack of complex formulae in the explanation that will be presented. We are going to take a simple, practical, hands-on approach.

In all systems, active radars transmit a signal and then listen for a returning echo from a "target." A good analogy would be a person at night standing on the shore of a lake shining a flashlight (transmitter) out over the water looking for someone in a boat. Although the person in the boat might spot the flashlight being directed toward him from miles away, the person on shore could only spot the boat when it was near enough to reflect sufficient light back to the searcher's eyes (receiver). That distance would depend on many variables, one of which is just how reflective the target boat actually was.

RADAR DETECTOR SYSTEM

detector with this super trooper snooper

In a similar manner, the speed radars in use today direct an unmodulated beam at the moving target. The returning echo is shifted in frequency by an amount that is related to the speed of the target (doppler shift). It is then compared to the transmitted frequency by a heterodyne process within the receiver portion of the speed radar. The resulting beat is within the audio range. That is processed by additional circuitry and read out in miles per hour.

How reflective a target is affects the radar detection range. It is entirely possible for a large, relatively distant, flat-surfaced, semi-trailer rig to return a stronger echo than a much closer Fiberglas sports car when both are in the beam simultaneously.

The actual RF frequency used depends on the type of radar response desired. It varies from less than 10 MHz for modern computer-controlled, "over the horizon" radars to the millimeter-wave range of 30 to 300 gigahertz (1 GHz — 1000 MHz) for airborne and precision radars. At the microwave frequencies used by speed radars (10.525 GHz & 24.150 GHz), the analogy to light is valid. Just as the flashlight, the radar emits a beam.

Carrying the analogy one step farther, visualize the lights of an oncoming car at night. You can see the scattered and reflected light from the car around a bend or over a hill. In the same manner, because of reflections from other cars, buildings, trees, etc., a detector in the target can "see" an oncoming radar beam around corners and over hills. The target can see the transmitter before the radar has a clear shot at the target.

A beam of light may pass through substances transparent to it, or be blocked, absorbed, or reflected by substances opaque to it. The same principle applies to a microwave beam. The trick is to know what materials are microwave transparent or opaque. Most plastics, epoxies, dry wood, and plastic foams are transparent to microwaves. Fiberglass, being epoxy plus glass strands, is used for covering many radar-antenna openings. Non-metallic paints usually have little effect also. Rubber sheeting or any compound containing carbon or metal particles act to absorb or block the energy.

Any metal surface will act as a reflector. Wire mesh from window screen or a chain-link fence usually will reflect, but the size of the mesh openings is a factor here. Metal films on plastic may be made thin enough to see through but can act as reflectors for microwave energy.

A good, practical example of the reflection of microwaves can be seen by taking a look at some microwave relay towers (see Fig. 1). The reflective coating on an ordinary, flat-glass mirror is an excellent reflector of microwaves just as it is of visible light. It consists of a thin film, usually aluminum, that has been deposited on one side of the glass.

Likewise, the thin, semi-transparent, metalized, reflective plastic window insulating material available at building supply and auto specialty stores is also a good radar reflector and is ideal for our project. We have used it in a number of installations over the last eight years. The use of substances transparent to microwaves may be noted by observing the big golf ball like radomes used to enclose the rotating antenna of some airport radars.

Remote Indicators

In our application we can use the reflective property of metalized film to reflect radar signals toward the detector

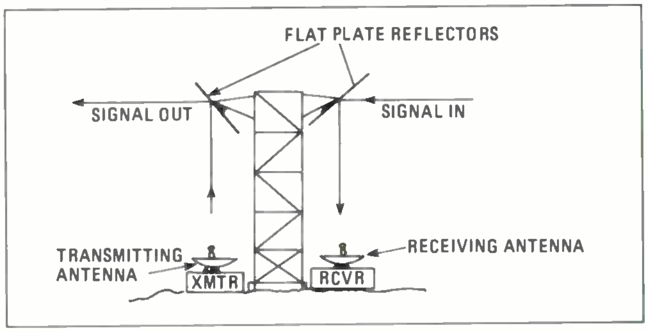


Fig. 1—To boost a microwave signal, a microwave mirror is used to reflect the signal into a receiver that feeds it into a transmitter whose signal is bounced off another mirror. Phone companies do that often for long distances.

even if it is hidden in the trunk. If no suitable spot can be found for trunk mounting, the suggestions for non-reflective mounts in Fig. 2 may be useful.

The detector unit we have used in all of our installations is Cincinnati Microwaves' *Escort*. It signals the driver with light and audio. A field-strength meter is provided on the detector, but the audio serves the same purpose by varying from a slow beep to a steady tone as the signal strength increases (distance closes). The tone has a different pitch for X-band and K-band radar, thus enabling one to determine just what kind of radar it is.

A working hidden detector, no matter where you place it, is useless unless we can tell when it detects something, so remote indicators are needed. We chose to use a microphone and amplifier at the hidden detector and a speaker under the dashboard to transmit the sound and alert the driver. A photocell monitors the detector signal light and lights a pilot lamp in the dash-mounted on/off switch. A volume control is provided on the circuit board for initial setup and could be located on the dash if desired. Experience has proven that the fewer adjustments available in a multi-user car, the better. Who wants a dash wired for hyper-drive anyway?

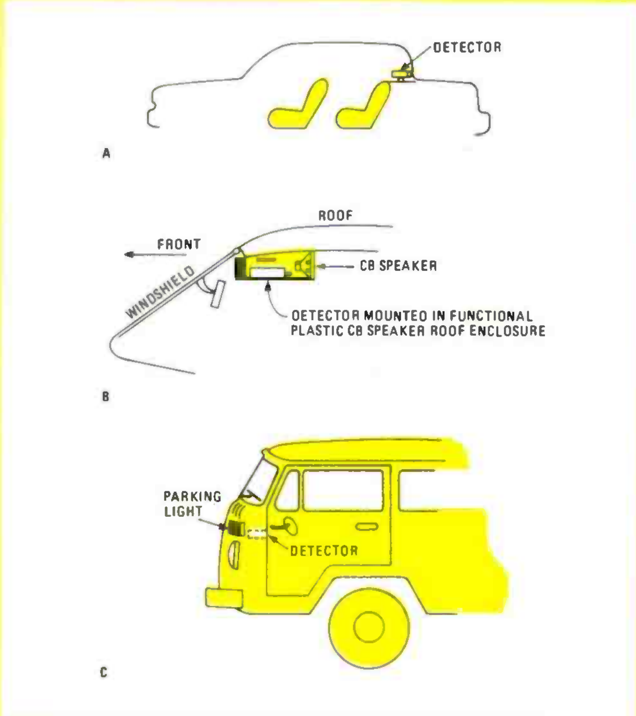


Fig. 2—If trunk mounting is not a possibility for your vehicle, the remote detector can be placed inside an add-on brake light (A), a fake roof-mounted CB enclosure (B), or even behind a forward-facing parking light (C).

Suprise! Behind this CB/dash instrument enclosure is a cleverly concealed radar detector. The CB is functional, but the enclosure affords enough room for the detector.

Where to Mount It

Determining a good mounting spot in your vehicle is relatively easy. The slope of the rear window in most autos is just about right to reflect the signal down into the trunk through existing large holes in the horizontal, metal shelf behind the rear seat. The cloth-covered cardboard or plastic trim panel is usually considered to be transparent to radar and need not be cut.

The following night-time procedure will enable you to verify the proper locations for the detector and the metal film. Choose a dark spot and set up a flashlight about 20-ft. in front of the car (see Fig. 3), at the height of the center of the windshield. The beam should be level with the ground and shine through the windshield and rear window. Use a small, flat mirror placed against the inside of the rear glass to reflect the light beam down to the rear shelf. Mark the spot on the under side of the rear shelf where the reflected light falls with a spot of tape. If the spot will not allow for the mounting of the radar detector and remote circuitry move the mirror to another location and try again. By trial and error, it's usually possible to locate an opening in the metal (if any) under the shelf and a mirror placement that will be satisfactory. The radar will be reflected in the same manner. Mark the location on the glass with a grease pencil for later installation of the reflective plastic material.

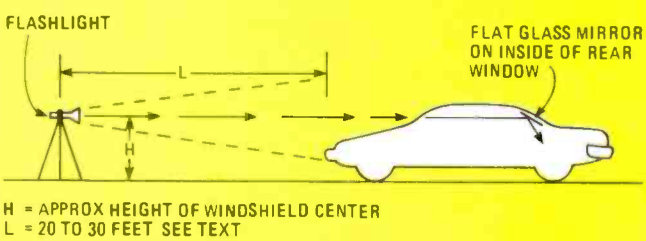


Fig. 3—Using a camera tripod (or a friend with patience) is essential for determining the proper placement of the mirror and mounting bracket. Use a little tape to hold the mirror in place while marking the rear under shelf.

The specified reflective plastic sheet should be cut to shape and installed on the rear window according to the manufacturer's instructions. Keep it as small as possible and esthetically pleasing to avoid any conflict with vehicle regulations or your spouse. Although you can see through it, it has the additional benefit of decreasing the glare of following headlights at night time.

Remote Circuit Audio

The audio pickup and amplifier consists of MIKE1, U1, U2, and their associated components (see Fig.4). MIKE1 is an electret condenser microphone. The unit specified comes with all coax and leads already attached. It requires a well-filtered DC voltage of a nominal 4.5 volts. That is provided by R1, R2, C1, and C2. The audio output of the mike element is coupled to U1 via C3. U1 is a variable attenuator that is controlled by a DC voltage applied to pin 2. As constructed, that control voltage is taken from a board-mounted, trimmer potentiometer (R3), which is set at installation time.

If a remote volume control is desired, R3 could be replaced by a dash-mounted potentiometer. The required leads would then be taken from the existing R3 board attachment points. Zip cord is ideal for that application because the potentiometer needs only two leads and a ground.

The output of U1 at pin 7 is input to the amplifier driver stage (U2, pin 6). Capacitor C6 is the interstage coupling capacitor. The remote-mounted speaker is directly driven by U2 via C9.

Light Sensor

The signal-alert light on the radar detector is monitored by the photo-resistive cell, SR1. The cell has a high dark resistance that falls to a few thousand ohms when illuminated. Trimmer potentiometer R9 and SR1 in series form a voltage divider. When the current through that series pair increases,

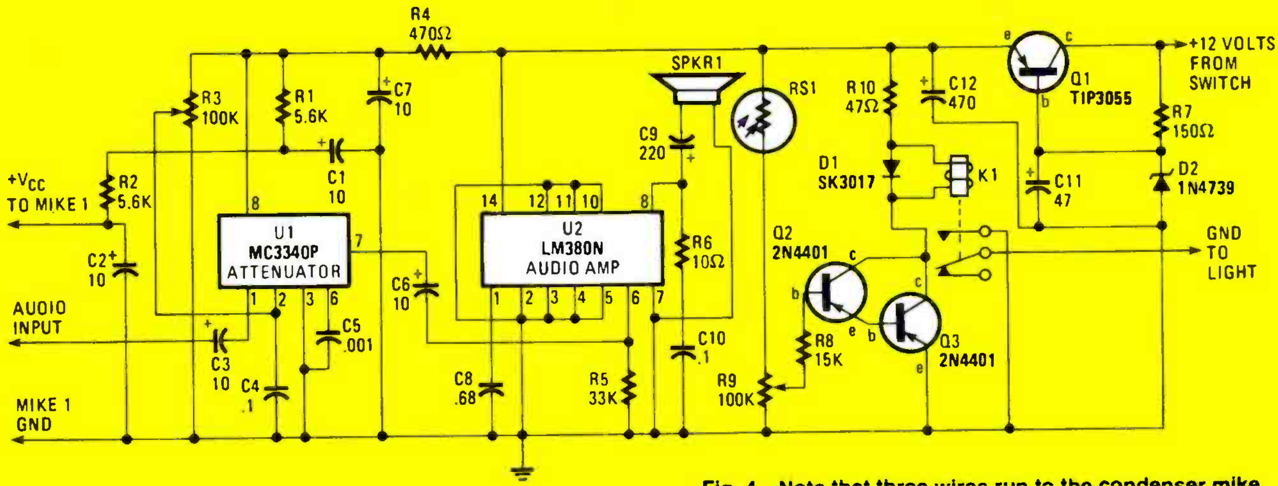


Fig. 4—Note that three wires run to the condenser mike in the remote circuit. That is because the mike requires external power to function properly.

a voltage is developed across R9. That causes the Darlington pair (Q2 and Q3) to conduct, actuating K1. As wired, the normally-open contact provides a ground to actuate the remote pilot light. Resistor R10 limits the current through the relay coil to the required value. D1 suppresses any spikes generated by K1.

Power Supply

The electrical system in the average auto provides an extremely dirty source of power. It may vary from about 10 to 15 volts, and all manner of nasty noise spikes abound. The regulator circuit shown has proven adequate to the task of taming that jungle. Resistor R7, capacitor C11, and Zener diode D2 provide a stable voltage to the base of the pass transistor Q1. The nominal 8.5 volts available at the emitter of Q1 is further filtered by C12. R4 and C7 decouple the stages for stable operation at all gain settings of R3. The nominal 4.5 volt mike element voltage and additional filtering are provided by R1, R2, C1, and C2.

Circuit Construction

The circuit may be built on the standard proto board specified (see Fig. 5). A drilled, etched, marked board and detailed manual are available for easier construction (see Parts List). The component leads will form the circuit runs in most cases. Where short jumpers are needed, #22, solid, bare hookup wire or the equivalent is used. The #22, stranded insulated wire is used for the remote leads and photocell connections. The shielded coax needed for the audio input is part of the mike element.

Note that C5 and a jumper between pins 3 and 12 of U2 are installed under the board. Note also that the Vcc bus foil is cut at column 12 so that the decoupling resistor, R4, may be installed as shown.

Mounting Bracket

Because of the wide variety of radar detectors and mount-

PARTS LIST FOR THE STEALTH RADAR DETECTOR

SEMICONDUCTORS

D1—SK3017 silicon diode, 600-volt, 1-A, or equivalent
D2—1N4739, 9-volt, 1-watt, Zener diode (Radio Shack 276-562 or equivalent)
Q1—TIP3055, NPN silicon power transistor, V_{ce}=70 volts, I_c=15-A (Radio Shack 276-2020 or equivalent)
Q2, Q3—2N4401, NPN, silicon transistor (Radio Shack 276-2058 or equivalent)
U1—SK3891, variable electronic attenuator, integrated circuit (Motorola MC3340P, or equivalent)
U2—LM380N, audio-amplifier integrated circuit

CAPACITORS

C1–C3, C6, C7—10-µF, 16-WVDC, axial electrolytic
C4,C10—.1-µF, 50-WVDC ceramic disc
C5—.001-µF, 50-WVDC ceramic disc
C8—.68-µF, 15-WVDC, radial-lead, Tantalum
C9—220-µF, 35-WVDC axial-lead, electrolytic
C11—47-µF, 16-WVDC radial-lead, electrolytic
C12—470-µF, 35-WVDC axial-lead, electrolytic

RESISTORS

(All are 1/4-watt, 5% units unless otherwise specified).
R1, R2—5600-ohm
R3, R9—100,000-ohm, PC-mount trimmer potentiometer (such as Radio Shack 271-338)
R4—470-ohm
R5—33000-ohm
R6—10-ohm
R7—150-ohm, 1/2-watt
R8—15000-ohm
R10—47-ohm, 1/2-watt

ADDITIONAL PARTS AND MATERIALS

K1—5-volt, 75-mA, SPDT miniature relay (Radio Shack 275-246 or equivalent)
MIKE1—Electret condenser mike element
SR1—Cadmium sulfide photo resistor
S1—SPST, illuminated rocker switch
SPKR1—4- to 6-ohm speaker
PC board (Dirijo PCRD-1 or proto board), 4 PC-board mount standoffs, # 24-gauge sheetmetal bracket (as required), sheetmetal screws, cable clamps, paint, epoxy, # 22 bare solid and insulated stranded wire, 4-conductor # 22 stranded wire, aluminized mylar sheet reflector as required (see text).

A drilled, etched, part-marked, PC board is available for $4.95 (plus $2 for shipping and handling) from Dirijo Corp., PO Box 212, Lowell, NC 28098. They also produce "The Radar Evader Manual" which deals with other radar evasion techniques and costs $12.95 (plus $2 for shipping and handling) if purchased separately, or you can pay $15.95 (plus $2 for S&H) to order them both.

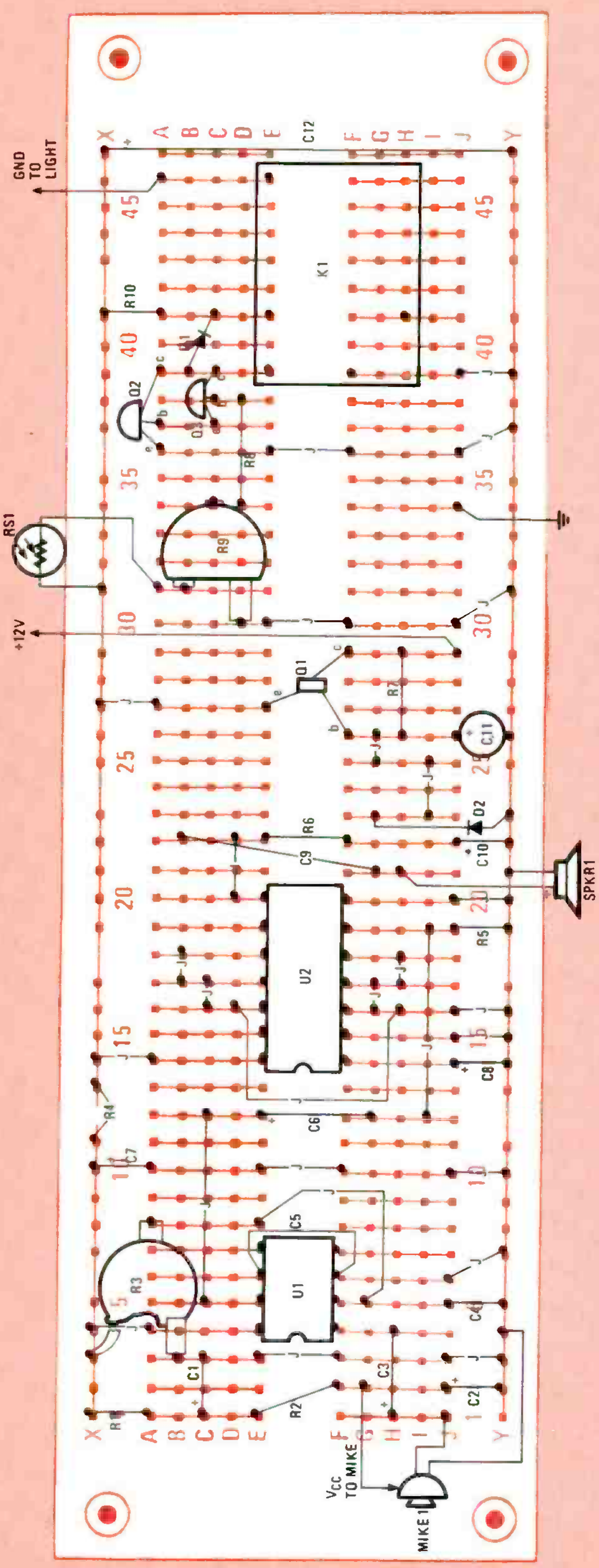


Fig. 5—Be sure to place the jumpers on the circuit board before placing the components on, as some of them can be run under components. An example of that is the one beneath R3. You may wish to run some components, like capacitor C5, under the board, but be sure C5 is connected as close to the pins of V1 as possible. Electrical noise in a car can creep into your circuit, so C5's placement is important.

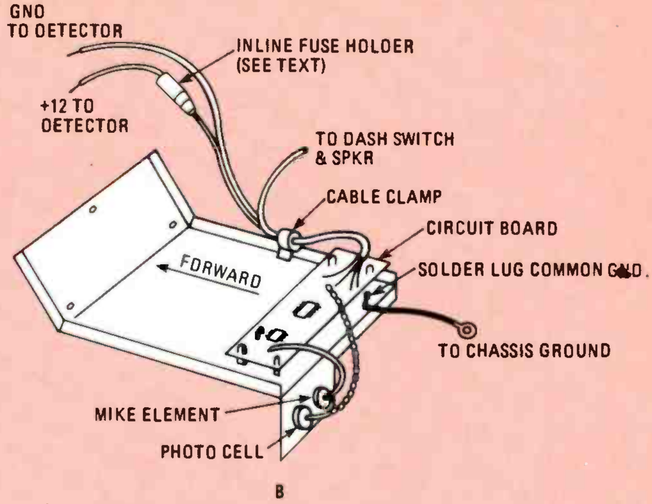


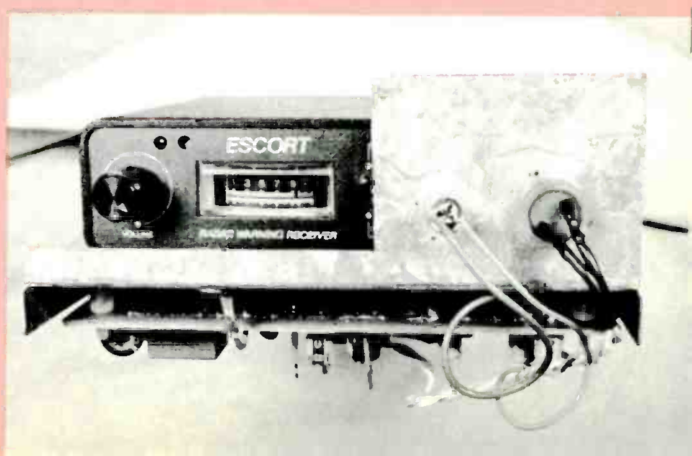
Fig. 6—If you don't have any sheet-metal working tools, you can place the sheet in a vice, cushioning it between two boards lined up at a bend line, and bend it by hand. If you wish you can hinge two pieces of wood to make a sheet-metal brake that will provide leverage.

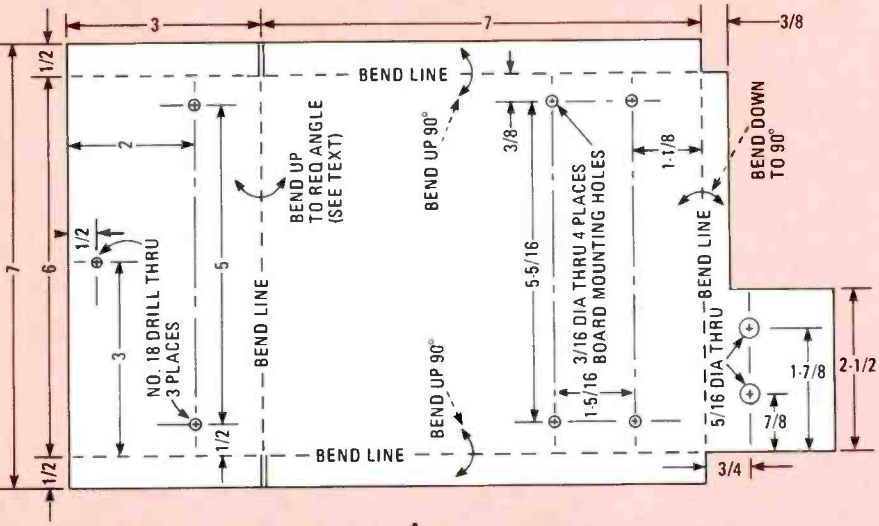
ing positions available, a *fits all* mounting-bracket design has not been provided. We will, however, give some guidelines and a detailed drawing of a bracket similar to that shown in our trunk-mounted installation (see photo).

Some general attributes should be included in the design of your bracket:

- Provision must be made to support the photocell and the pickup mike element adjacent to the detector's warning light and speaker openings.
- Velcro attachment of the radar detector to the bracket is recommended if the detector is to be transferred to any other vehicles.
- A mounting for the circuit board is required.
- Some provision to vary the inclination of the mounting bracket is needed to allow "peaking" of the signal as mentioned in the installation section.
- The material used should be sturdy enough and secured to the auto structure to withstand the normal vibrations experienced in an automobile.
- Do not create a safety hazard by allowing sharp corners, edges, or other hazardous parts to be placed anywhere in the passenger compartment.
- Provide proper fuse protection for the detector and all other circuitry.

You should design your bracket so that the sensors are in front of their corresponding components on the detector. They can be held in place with epoxy.





A

Fig. 7—The holes for sensor placement are, of course, dependant on your radar detector, and are shown here only as an example. When gluing the audio and photosensitive sensors in place be sure not to cover the sensors with epoxy.

The mounting bracket will vary with the make of the vehicle and the desired mounting location. Fabricate your bracket following the general outline shown in Fig. 6.

Installation and Testing

The installation procedure will vary with the make and model of your vehicle. In general, where any wires must pass through metal, they should be protected by rubber grommets. Run the needed wires through available wiring raceways when possible.

Be sure to provide a proper fuse at the +12-volt source so that the entire circuit is protected. The remote control panel and speaker placement are also vehicle dependent. Any 4-16-ohm small diameter speaker will do. The speaker can usually be glued to the under-dash structure using a silicone adhesive.

Add-on panels containing various switch and pilot light combinations are available at auto accessory or electric hobbyist stores. When possible, we have used the illuminated rocker switch specified in the Parts List and mounted it directly in the dashboard.

Since most speed cops are not very cooperative in providing test signals, and most hobbyists do not have microwave sources available, a good setup and test range can be provided by the microwave door openers in shopping centers and such. Their signal is identical to the X-band radar signal. They may be easily located by the false alarms they produce in your detector. Intrusion detectors installed in many banks will also work, but the employees tend to panic at suspicious autos in their parking lots.

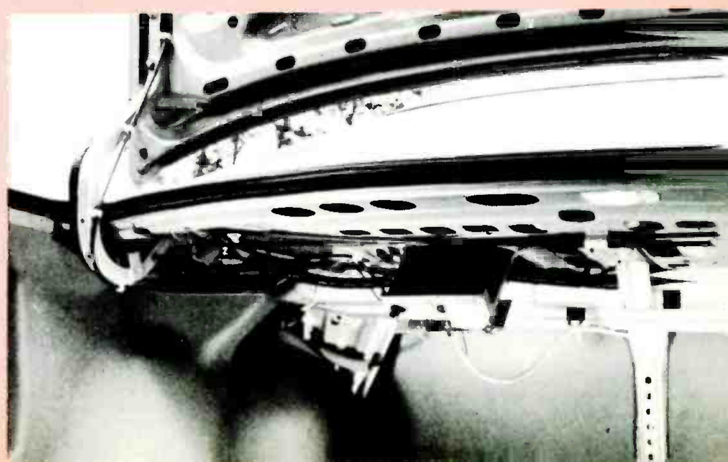
If you are not sure just how transparent or opaque to microwaves a substance may be, use the following procedure. Aim your detector toward the chosen signal source. Place the material in question over the antenna (usually the front) of the detector and note the effect on signal strength. Most plastics, sytrofoam, thin dry wood, cloth, etc., will have no noticeable effect. You may see some variations caused by reflections and standing waves that will exist in most practical environments. Please note that substances transparent to the X-band are usually OK at the higher K-band frequencies. Thoe only real test of the K-band characteristics, however, is a working K-band radar or signal source.

After installation, the following setup procedure should be used. Aim your vehicle at the source. Get far enough away so that you have a weak signal indication. Adjust the angle of the mounting bracket for maximum signal strength. Set the detector volume control to maximum and adjust the level potentiometer (R3) on the circuit board for the desired volume inside the vehicle. The photocell sensitivity adjustment (R9) should also be set to allow the remote light to follow the action of the detector-alert light.

One potential problem could exist with the trunk mount, and that is blockage by rear-seat passengers. Our experience has been one of no degradation in apparent sensitivity. Perhaps all of our friends are airheads. A more likely explanation is that multiple reflections are present in the passenger compartment, and the microwaves have numerous paths to reach the rear reflector. The detector should now function with the same apparent efficiency as it did mounted on the dash or your sun visor. It will also be less of a temptation to a thief or provocation to law enforcement personnel. ■

The reflective film not only functions well for our application, but looks good also. When placed at the right height, it will help cut down the glare from headlights behind you.

Notice that no metal interferes with the radar detectors "view" of the reflective film. That allows it to receive the maximum signal from the metalized-film coating.



HANDS-ON REPORT

HEATHKIT BAUD RATE ANALYZER

Finally, an easy way to know if the baud rate is really what it's supposed to be.

□SOMETHING AS SIMPLE AS MATCHING the baud rate between *serial-computer devices* has probably caused more grief and hair-pulling frustration than anything else having to do with personal computing. If just one switch of many is set incorrectly—on either the sending or receiving end of a circuit—serial peripherals simply won't talk to each other in a common language.

Printers will print garbage, teletypewriters will lock up, light pens won't write, and modems won't communicate. Unfortunately, other than having the devices work properly when the baud rate was correct, there was no convenient way to determine if the signals were, in fact, actually set to the required baud rate.

But now there's a way you can quickly—actually within seconds—check the baud rate of any serial-communications circuit. Simply plug Heathkit's *Baud Rate Analyzer* into the circuit, press an odd (1, 3, 5...A, C, E) keyboard key, and a row of LED's indicate the serial circuit's baud rate. If the analyzer is connected into a "live" circuit, you don't even have to touch the keyboard; the characters on the signal wires will light the LED's to indicate the baud rate.

Baud Rate

For those of you unfamiliar with the term *baud rate*, we'll take time out for a quick-and-dirty explanation. For all practical purposes, the term *baud rate* means the same thing as *bits per second*. In conventional serial-computer circuits, every character, graphic symbol, and control code is represented by a "character group;" 10 or 11 bits that contain the conventional 8-bit ASCII character code we all know!.

The very first bit is a *start bit*, which tells the receiving equipment to "start counting now." Following the start bit are the eight bits that represent an ASCII number from zero to 255. After the eight ASCII bits is a *stop* bit that tells the receiving equipment that the complete ASCII code has been sent; to "stop counting bits and get ready to receive another character group representing another character." (Some early, very-slow serial computer equipment used two stop bits to stop the ASCII count.)

By convention, the bits can be sent at the rate of 300, 600, 1200, 2400, 4800, 9600, 19.2K, or 38.4K bits per second. In technical jargon, bits-per-second, or *bps*, is called *baud rate*. Although nit-pickers can prove mathematically that bits-per-second is not truly baud rate, the difference exists only in their minds and in their equations; in the communications circuits, it's the same thing.

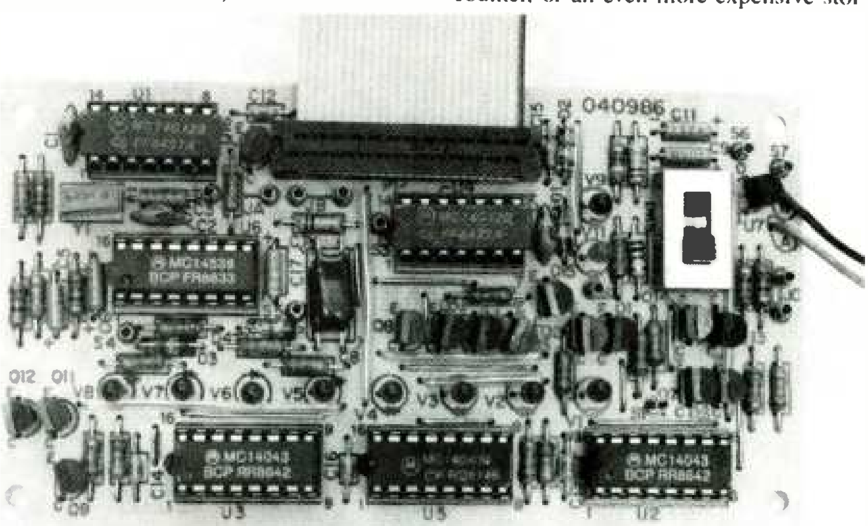
The maximum number of American/English words-per-minute, or wpm, is equal to the baud rate. For example, 300 baud is 300 wpm, 1200 baud is 1200 wpm, etc. But keep in mind that if the characters aren't sent at the maximum rate, if there is any time at all allowed between the groups of 10 bits that make up a character, the wpm rate will be less than the baud rate. (We'll leave the subject of converting baud rate to wpm for another article at another time.)

Although all 10 bits have the same pulse width, it logically follows from what we know that the faster the baud rate the narrower the pulse width—because we must squeeze more bits into each unit of time. That's generally a valueless bit of information (pun intended), but as we'll show, it's the principle by which the Heathkit Baud Rate Analyzer works.

What's What?

As you may well understand by now, the timing of the bits is extremely important. In particular, the receiving device must know the precise timing of the signal bits. If the signal is say, 1200 baud, and the receiver is set for something else (perhaps 300 or 2400 baud), all the user will get is garbage, both on the video display and from the printer. Looking at it from the other way around, the sending equipment must transmit at the baud rate expected by the receiving device, or the user again gets trash.

Normally, determining a signal's baud rate involves a rather-expensive frequency counter, or an even more expensive stor-



The Heathkit Baud Rate Analyzer is assembled on a printed-circuit board. The black strip across the top-center is a 25-pin header that is supplied as part of a factory- assembled D-connector harness. For more information on this Heathkit circle no. 88 on the Free Information post card.

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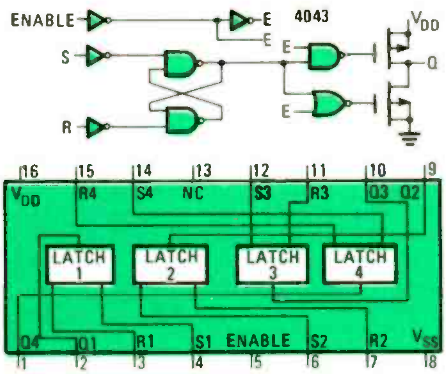
Hands-on Electronics

43 Hands-on Electronics FactCard — 4043: Quad Tri-State NOR R/S Latch



Features

- Wide supply voltage range — 3V to 15V
- Low power — 100nW (typ.)
- High noise Immunity — 0.45 V_{DD} (typ.)
- Separate SET and RESET inputs for each latch
- NOR and NAND configuration
- TRI-STATE output with common output enable

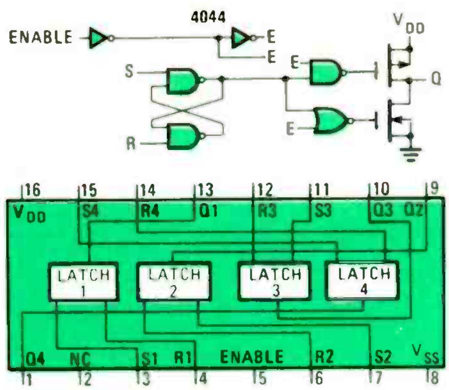
Absolute Maximum Ratings

V_{DD} Supply Voltage	−0.5 to +18V
V_{IN} Input Voltage	−0.5 to V_{DD} +0.5V
T_S Storage Temperature Range	−65°C to +150°C
P_D Package Dissipation	500 mW
T_L Lead Temperature (Soldering, 10 seconds)	260°C

Recommended Operating Conditions

V_{DD} Supply Voltage	3 to 15V
V_{IN} Input Voltage	0 to V_{DD} V
T_A Operating Temperature Range	−55°C to +125°C
	−40°C to +85°C

44 Hands-on Electronics FactCard — 4044: Quad Tri-State NAND R/S Latch



Features

- Wide supply voltage range — 3V to 15V
- Low power — 100nW (typ.)
- High noise immunity — 0.45 V_{DD} (typ.)
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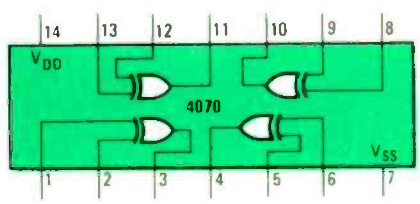
V_{IN} Input Voltage	−0.5 to V_{DD} +0.5V
T_S Storage Temperature Range	−65°C to +150°C
P_D Package Dissipation	500 mW
T_L Lead Temperature (Soldering, 10 seconds)	260°C

Recommended Operating Conditions

V_{DD} Supply Voltage	3 to 15V
V_{IN} Input Voltage	0 to V_{DD} V
T_A Operating Temperature Range	−55°C to +125°C
	−40°C to +85°C

45 Hands-on Electronics FactCard — 4070: Quad 2-Input Exclusive-OR Gate



Truth Table

INPUTS		OUTPUTS
A	B	Y
Low	Low	Low
Low	High	High
High	Low	High
High	High	Low

Features

- Wide supply voltage range — 3.0V to 15V
- High noise immunity — 0.45V_{DD} typ.
- Low power TTL compatibility — fan out of 2 driving 74L or 1 driving 74LS
- Pin compatible to CD4030A
- Equivalent to MM54C86/MM74C86 and MC14507B

Absolute Maximum Ratings

V_{DD} Supply Voltage	−0.5 to +18V
V_{IN} Input Voltage	−0.5 to V_{DD} +0.5V
T_S Storage Temperature Range	−65°C to +150°C
P_D Package Dissipation	500 mW
T_L Lead Temperature (Soldering, 10 seconds)	260°C

Recommended Operating Conditions

V_{DD} Supply Voltage	3 to 15V
V_{IN} Input Voltage	0 to V_{DD} V
T_A Operating Temperature Range	−55°C to +125°C
	−40°C to +85°C

43 Hands-on Electronics FactCard — 4043: Quad Tri-State NOR R/S Latch

STATIC ELECTRICAL CHARACTERISTICS

CHARACTERISTIC	CONDITIONS V_O (V)	V_{IN} (V)	V_{DD} (V)	LIMIT at 25°C (TYP)	UNITS
Quiescent Device	—	0,5	5	0.02	
Current,	—	0,10	10	0.02	µA
I_{DD} Max	—	0,15	15	0.02	
Output Low	0.4	0,5	5	1	
(Sink) Current	0.5	0,10	10	2.6	
I_{OL} Min.	1.5	0,15	15	6.8	
Output High	4.6	0,5	5	−1	mA
(Source)	2.5	0,5	5	−3.2	
Current	9.5	0,10	10	−2.6	
I_{OH} Min.	13.5	0,15	15	−6.8	
Input Current I_{IN} Max.	—	0,18	18	$\pm 10^{-5}$	µA
3-State Output Leakage Current I_{OUT} Max.	0,18	0,18	18	$\pm 10^{-4}$	µA

CHARACTERISTIC	CONDITIONS V_O (V)	V_{IN} (V)	V_{DD} (V)	LIMIT at 25°C (TYP)	UNITS
Output Voltage	—	0,5	5	0	
Low-Level	—	0,10	10	0	
V_{OL} Max.	—	0,15	15	0	V
Output Voltage	—	0,5	5	5	
High-Level,	—	0,10	10	10	
V_{OH} Min.	—	0,15	15	15	
Input Low	0.5,4.5	—	5	—	
Voltage,	1,9	—	10	—	
V_{IL} Max.	1.5,13.5	—	15	—	V
Input High	0.5,4.5	—	5	—	
Voltage	1,9	—	10	—	
V_{IH} Min.	1.5,13.5	—	15	—	

44 Hands-on Electronics FactCard — 4044: Quad Tri-State NAND R/S Latch

STATIC ELECTRICAL CHARACTERISTICS

CHARACTERISTIC	CONDITIONS V_O (V)	V_{IN} (V)	V_{DD} (V)	LIMIT at 25°C (TYP)	UNITS
Output Voltage	—	0,5	5	0	
Low-Level	—	0,10	10	0	
V_{OL} Max.	—	0,15	15	0	V
Output Voltage	—	0,5	5	5	
High-Level,	—	0,10	10	10	
V_{OH} Min.	—	0,15	15	15	
Input Low	0.5,4.5	—	5	—	
Voltage,	1,9	—	10	—	
V_{IL} Max.	1.5,13.5	—	15	—	V
Input High	0.5,4.5	—	5	—	
Voltage	1,9	—	10	—	
V_{IH} Min.	1.5,13.5	—	15	—	
Input Current I_{IN} Max.	—	0,18	18	$\pm 10^{-5}$	µA

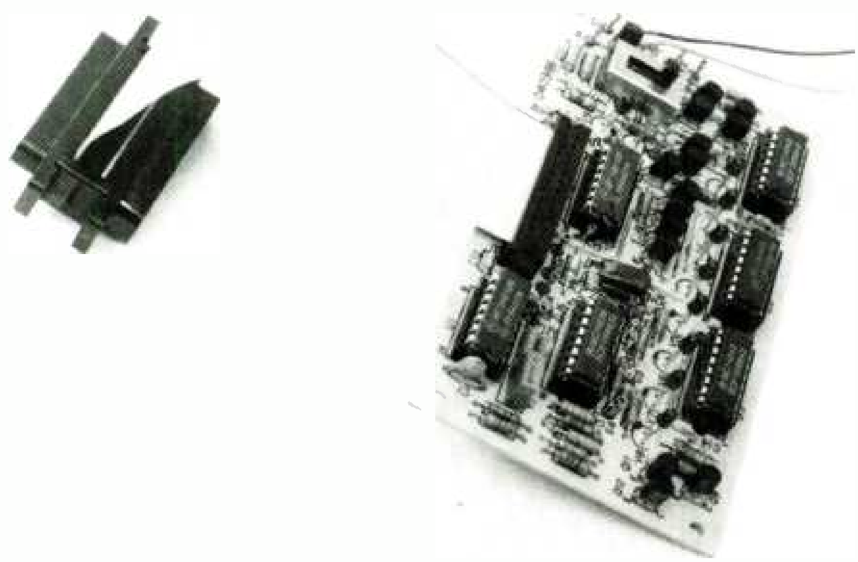
CHARACTERISTIC	CONDITIONS V_O (V)	V_{IN} (V)	V_{DD} (V)	LIMIT at 25°C (TYP)	UNITS
Quiescent Device	—	0,5	5	0.02	
Current,	—	0,10	10	0.02	µA
I_{DD} Max	—	0,15	15	0.02	
Output Low	0.4	0,5	5	1	
(Sink) Current	0.5	0,10	10	2.6	
I_{OL} Min.	1.5	0,15	15	6.8	
Output High	4.6	0,5	5	−1	mA
(Source)	2.5	0,5	5	−3.2	
Current	9.5	0,10	10	−2.6	
I_{OH} Min.	13.5	0,15	15	−6.8	
3-State Output Leakage Current I_{OUT} Max.	0,18	0,18	18	$\pm 10^{-4}$	µA

45 Hands-on Electronics FactCard — 4070: Quad 2-Input Exclusive-OR Gate

STATIC ELECTRICAL CHARACTERISTICS

CHARACTERISTIC	CONDITIONS V_O (V)	V_{IN} (V)	V_{DD} (V)	LIMIT at 25°C (TYP)	UNITS
Quiescent Device	—	0,5	5	0.02	
Current,	—	0,10	10	0.02	µA
I_{DD} Max	—	0,15	15	0.02	
Output Low	0.4	0,5	5	1	
(Sink) Current	0.5	0,10	10	2.6	
I_{OL} Min.	1.5	0,15	15	6.8	
Output High	4.6	0,5	5	−1	mA
(Source)	2.5	0,5	5	−3.2	
Current	9.5	0,10	10	−2.6	
I_{OH} Min.	13.5	0,15	15	−6.8	
Input Current I_{IN} Max.	—	0,18	18	$\pm 10^{-5}$	µA

CHARACTERISTIC	CONDITIONS V_O (V)	V_{IN} (V)	V_{DD} (V)	LIMIT at 25°C (TYP)	UNITS
Output Voltage	—	0,5	5	0	
Low-Level	—	0,10	10	0	
V_{OL} Max.	—	0,15	15	0	V
Output Voltage	—	0,5	5	5	
High-Level,	—	0,10	10	10	
V_{OH} Min.	—	0,15	15	15	
Input Low	0.5,4.5	—	5	—	
Voltage,	1,9	—	10	—	
V_{IL} Max.	1.5,13.5	—	15	—	V
Input High	0.5,4.5	—	5	—	
Voltage	1,9	—	10	—	
V_{IH} Min.	1.5,13.5	—	15	—	



This is the completed project ready for installation in its cabinet. Notice there are two back-to-back connectors on the test-wire harness; one is a D-socket, the other a D-plug, so you can match any "standard" D-connector.

age oscilloscope, and a lot of time and effort; all of which isn't needed if when you use the Heathkit Baud Rate Analyzer. Simply connect Heathkit's analyzer into the circuit through either its attached male or female D-connector, and almost instantly read out the baud rate. It's just that simple.

How it Works

The Heathkit analyzer, which is available only in kit form, is powered by a 9-volt transistor radio battery. A single slide switch on the front panel serves as both the power switch and the pin 2 and pin 3 data connections.

In serial communications, the data can be either on pin 2 or 3. You simply move the slide switch to the position that causes a red LED DATA indicator to flicker. Moving the switch also turns on the power, which lights a green POWER LED. The baud rate is indicated by a string of red LED's. For example, if the baud rate is 1200, a "bar" of light will be created by the LED's representing 300, 600, and 1200 baud. Baud rates of 300 and under—such as the 110 baud rate of early teletypewriters—will illuminate only the 300-baud LED, which actually represents a baud rate equal to, or less than 300.

This is the "business end" of the analyzer. A string of LED's turn on when testing a circuit. The baud rate is equal to the highest value illuminated LED. The "data" LED blinks when a serial circuit is active. It is used to determine the proper setting for the adjacent slide switch.

The analyzer determines the baud rate by measuring the width of each character's start pulse, which is why the analyzer responds only to ASCII characters having odd decimal values.

Remember we said earlier that each character group actually contained 10 bits, of which the start bit was the first bit. The first ASCII code bit is actually the second bit in the sequence, and it is always off for odd codes, and on for even codes. If, for example, you press the keyboard's number 1 key, the ASCII code is 47, an odd value, so the first code bit—the one after the start bit—is off. The analyzer senses the leading edge of the start bit and starts timing. When the analyzer senses the trailing edge of the start bit it stops timing and interpolates the pulse-width time into baud rate, and causes the appropriate LED's to light. The analyzer then counts the timing for nine additional pulses and resets itself, waiting for the next start bit.

At this point you should be saying to yourself: "Aha! I know why it won't read ASCII codes that are even." You're right!—if you think the even codes turn on the second bit, which ties itself to the first bit. The analyzer "sees" the start and the first code bit as a single start bit and assumes the start bit is twice as long as it really is, causing the analyzer to indicate a baud rate exactly one-half the real baud rate. Yup! That's just what happens. But if you follow instructions, the device reads correctly.

On the other hand, if you're testing an *active* communications circuit and the LED's flicker between two values the true value is always the higher one. (Because an active circuit has both even and odd ASCII codes.)

One Evening

The kit assembly takes one very-long, or two moderately-long evenings. As shown in the photographs, the analyzer is assembled on a single printed-circuit board. A complete testing procedure that uses the analyzer's own LED's as test indicators is built into the device. Even the tiny plug-in connections for the test wires are part of the printed-circuit board. As usual, the Heathkit assembly manuals are, of course, excellent.

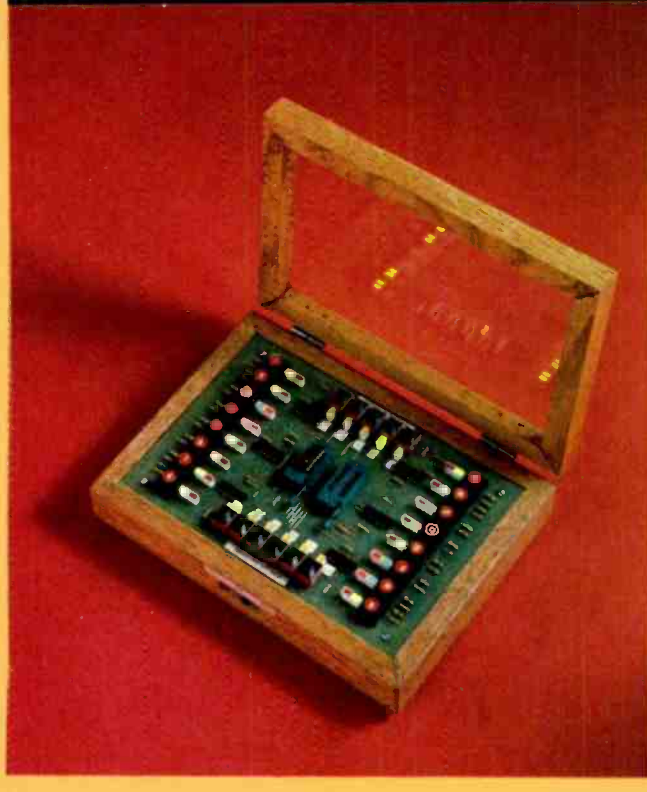
All in all, the Heathkit Baud Rate Analyzer is the least expensive, and certainly the most convenient way to check out the baud rate of serial circuits. For more information write directly to the Heath Company, Benton Harbor, MI 49022. Or circle number 88 on the Free Information post card found in this issue. ■

Build the...

DIGI-LYZER IC TESTER

By W. Schopp

Now you can quickly check questionable IC's to determine whether they are worth keeping or not



YOU'VE STRUGGLED FOR DAYS GETTING YOUR CIRCUIT to operate just the way that you want it to. And now it's time to clean up. You put away your tools and meter, fold up your schematics and notes, sweep off your workbench. Suddenly, there they are—those questionable chips. You vaguely remember switching those *chunks of silicon* for new ones when some part of the circuit failed to perform as intended.

But then, suddenly, your memory takes a complete leave of absence; and you can't recall whether changing the chip made any difference. And so the problem becomes painfully clear: You hate to put those chips back into your inventory with the good ones only to give you possible problems at some future date.

You also don't want to throw them away because they not only cost good money (and the cost of survival being what it is these days), but they also might save you a trip to town if you happen to need that particular chip again. Anyone who has designed or built electronic circuits around digital IC's can certainly relate to that situation.

You say to yourself, "I'll just put them in this ash tray and check them later *when I get more time*." But the only problem is that *the time* never seems to materialize. And all too soon you notice that you have an ash tray full of chips from other projects. Does that sound like a familiar tale to you?

The Solution

What is really needed is a simple checker that is able to handle all digital chips. The criteria for such a circuit might include: a zero insertion-force socket, so that all you'd have to do is drop the chip into the socket without damaging the IC pins, or having to do any soldering or breadboarding. There should be a way of applying power to any pin of the *C*hip-*U*nder-*T*est (CUT) regardless of its pin configuration, and you should also be able to apply a voltage to any pin simply by pushing a button.

In addition, it should also have status indicators so that you can tell to which pins voltage is applied and which pins are at ground potential. And how about a way to tell if the voltage on the pin is applied directly through a pushbutton switch, or if it's an output voltage from the CUT? Such a circuit would allow you to turn gates on and off, operate registers, apply pulses to counters, operate flip-flops, thereby enabling you to determine the merit of the chip merely by observing the output indicators.

Well the *Digi-lyzer Digital IC Tester* is just such a circuit, which, with the aid of a CMOS or TTL cookbook, any listed chip can quickly be tested. If that sounds like a handy thing to have around, hang in there—the best is yet to come.

About the Circuit

The circuit (see Fig. 1) is designed around two Zero-Insertion Force (ZIF) integrated-circuit sockets to handle both 14 and 16 pin chips. The two sockets are wired in parallel so that any voltage presented to a particular pin on one socket appears at the same pin on the other (except 15 and 16 on the 14-pin socket). In other words, if + V is applied to pin 14 of SO1, pin 14 of SO2 will be at the same potential.

Each pin of the two ZIF sockets is normally grounded via pull-down resistors (R17 to R32). There are 16 pushbutton switches (PB1 to PB16, which correspond to pins 1 through 16), which are used to apply a logic high to its associated pin. Each of the ZIF sockets' pins are also connected to a double inverting-buffer stage, consisting of six 4049 CMOS hex inverting buffers, U1 through U6. When a pin is at logic low (ground or zero potential), the output of the first buffer goes high and lights the green LED (the even-numbered LED's up to 32), indicating a logic low on that pin. And when a pin has a logic high applied to it, the output from the second buffer goes high and lights the red LED, indicating a logic high (or voltage) on that pin. However, if a red LED lights while you are *not* holding the button down for that particular pin, the LED indicates a logic high output from the CUT. What could be simpler?

The slide switches, S1 to S11, provide a method by which you can cover the power requirements for all of the popular TTL and CMOS chip configurations. Positive voltage can be applied to pins 1, 4, 5, 14, and 16. A direct ground can be made available to pins 7, 8, 10, 11, 12, and 13. The pins with the direct positive and ground connections are indicated by

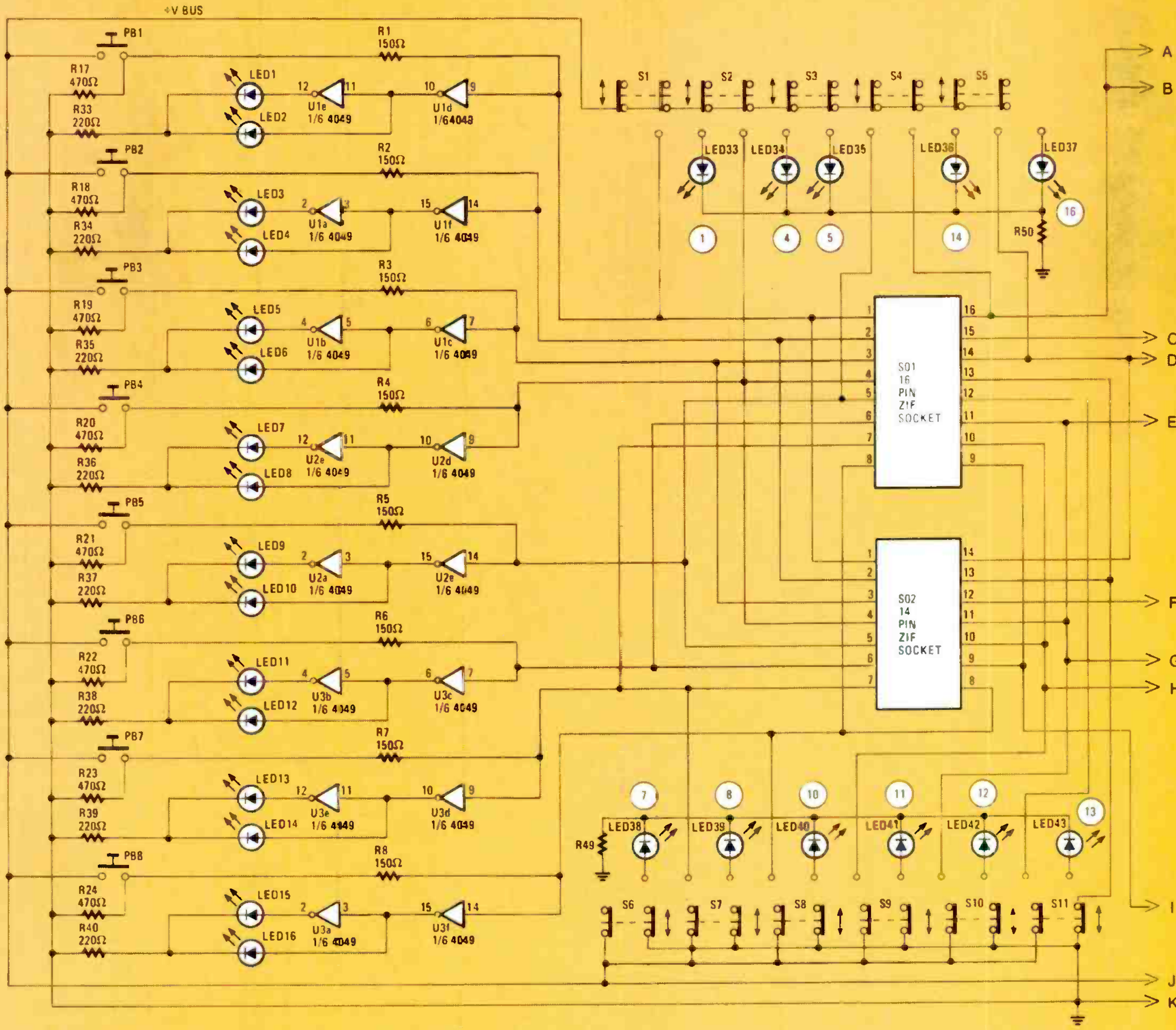


Fig. 1—The Digi-lyzer Digital IC Tester is designed around two zero-insertion force (ZIF) IC sockets wired in parallel. Each pin of SO1 and SO2 is normally grounded through pull-down resistors R17 to R32. Drawing continued on next page.

yellow LED's (LED33 to LED37 for +V and LED38 to LED43 for GND) located in front of each slide switch. Those LED's can be numbered with the pins they represent on the top of the printed-circuit board with a small typewritten number on a small piece of gummed label (see photos).

The chip is protected from possible damage by accidentally pushing a button and applying voltage to a directly grounded pin by series resistor (R1 to R16) connected between each pin of the sockets and the pushbutton switches. The circuit is powered by six ordinary "C" or "D" cell flashlight batteries.

The six batteries were split at 4.5 volts by inserting a piece of brass shim stock between the third and fourth battery from ground. Soldering a wire to the shim stock provides the 4.5 volt supply for checking TTL chips, while the 9-volt supply is used for checking CMOS chips. The two voltages are tied to a SPDT center-off, slide or toggle switch. Wired in that manner, the switch provides the voltage selection and on-off function of the unit.

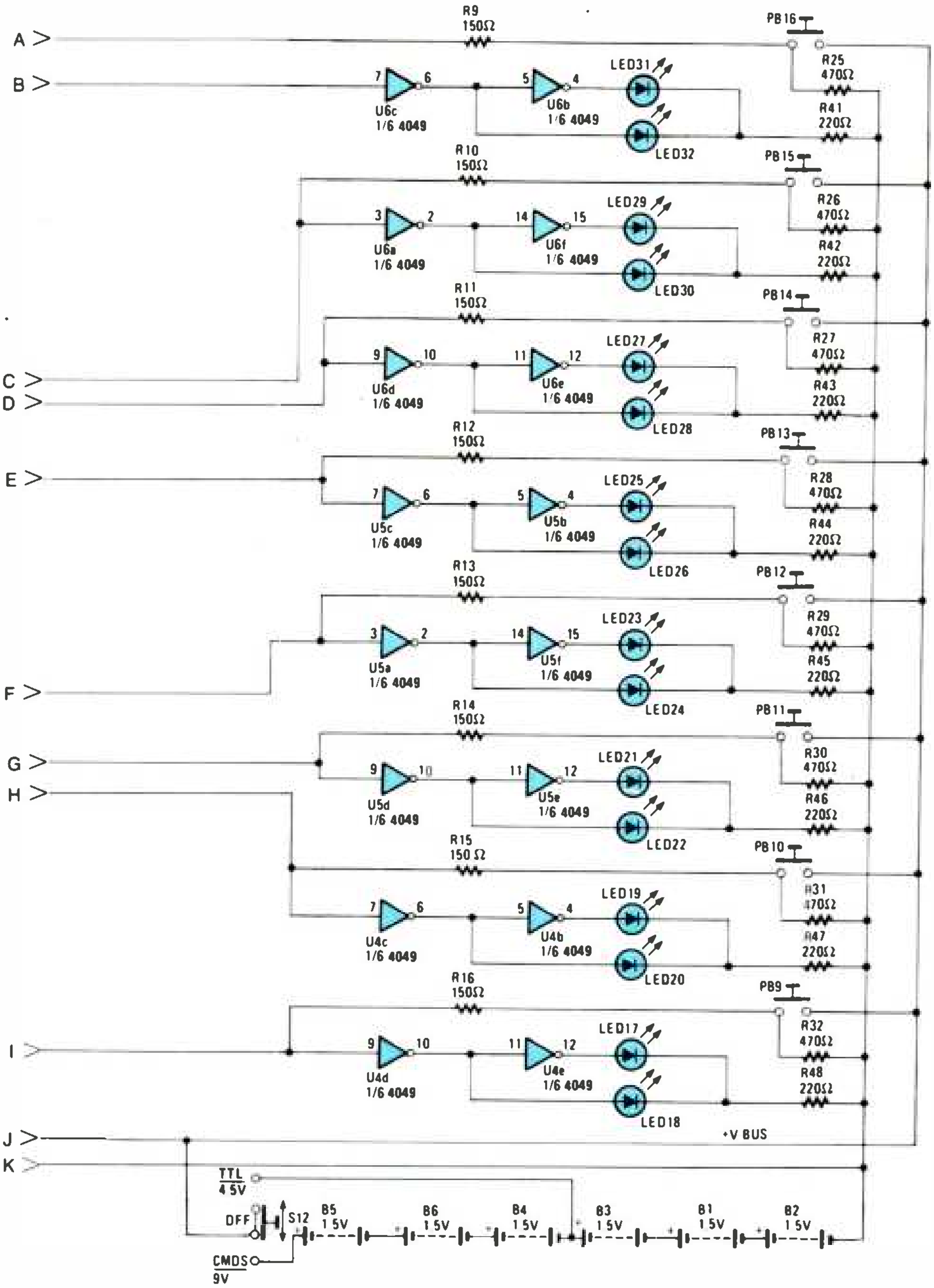
The author used eight "C" cells in his prototype, and wired them as shown in Fig. 2—which provides 4.5 volts for TTL chips and 12 volts for CMOS chips. Since CMOS chips have a much-wider power-supply range (typically from 3 to 15 volts) than do TTL units, the CMOS chips can be safely operated from the higher source voltage. Or a suitable dual-voltage AC-derived DC power supply can be developed and used to operate the Digi-lyzer as a bench model if desired.

Construction

The complete Digi-lyzer can be put together using the method of choice, but as always (well, almost always) it is recommended that the project be built on a printed-circuit board to simplify construction and virtually eliminate errors. Figure 3 shows a full-scale template of the Digi-lyzer's printed-circuit board. The board can be reproduced from the template or purchased from the supplier given in the Parts List that follows.

The large pads spaced lengthwise across the board are used to solder on a board stiffener (support), so that when you install a chip in the ZIF sockets or press a pushbutton switch, the board doesn't sag and possibly sever a trace or dislodge a solder connection.

The board stiffener can be made from a strip of PC-board material, cut to about ¼-inch to ⅜-inch wide and as long as the distance between the two outside pads. Lay the strip in position across the pads and mark the location of each pad on the strip. At the pad-position markings on the stiffener, cut about ⅛-inch into the edge of the board to form a sort of stand off, and strip off the excess leaving the points where pads are indicated. When the strip is placed on edge, and soldered to all of the pads, it will stiffen the board so that it will not flex in the middle when the pushbuttons are pressed down. Be sure



that the strip does not touch anything else on the bottom of the board except the pads provided.

Next install the parts on the board, beginning with the jumper connections (see Fig. 4, the parts placement diagram) and passive components—resistors, capacitors and switches. The pushbutton switches (PB1 to PB16) on the prototype unit shown in the photographs were numbered with small round tabs glued to the top of the push buttons. They can also be numbered adjacent to the LED pair that each pushbutton controls. For simplicity, the arrangement order of the pushbuttons are in the same configuration as the pins are on the chip when it is put into the ZIF socket, (i.e., pin one at upper left corner).

Moving right along, install the LED's—red (even-numbered LED's up to 32) for +V, green (odd-numbered LED's up to 31) for ground, and yellow (LED33 to LED43) for the power connections. The LED's chosen for the author's prototype are small rectangular units available from many electronic parts suppliers (including mail-order supplier Jameco Electronics, 1355 Shoreway Rd., Belmont, CA 94002; Tel. 415/592-8097) in a variety of colors. Of course, you don't necessarily have to use that type of LED; the common garden-variety (refracted lens) can be used—it's the builder's choice and up to you.

You'll note that all of the LED's have their cathodes facing toward the center of the board. Since we are dealing with so many LED's (provided that you are using the square units), it is recommended that you mark the cathode end of the package, prior to installation (see photos), to allow for quick visual verification of proper orientation of the LED's.

In the author's prototype, the integrated circuits were soldered directly to the board; however, it might be in your favor to use IC sockets, in the event that it becomes necessary to replace one or more of the chips. Finally, use either the Fig. 1 or Fig. 2 battery-wiring diagram to connect the power supply to the circuit.

Checkout Time

Once you've completed the unit and given it a visual inspection for possible trouble spots—such as solder bridges, cold-solder joints, misoriented components, and the usual battery of common construction defects—you can check out a few basic chips to get familiar with the Digi-lyzer's method of operation.

Let's start with a simple TTL quad two-input AND gate such as the 7408. That particular chip contains four two-input AND gates. Many of the TTL and CMOS chips share a

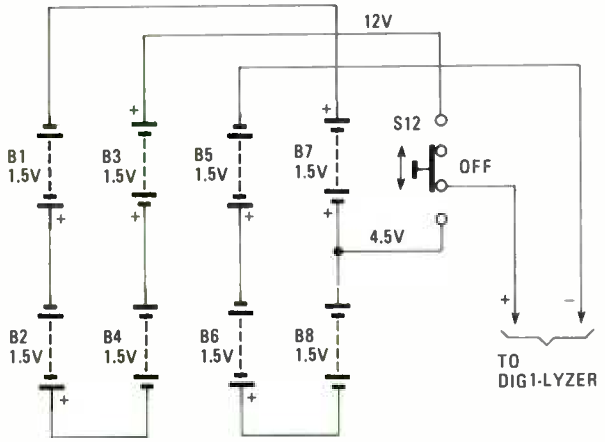
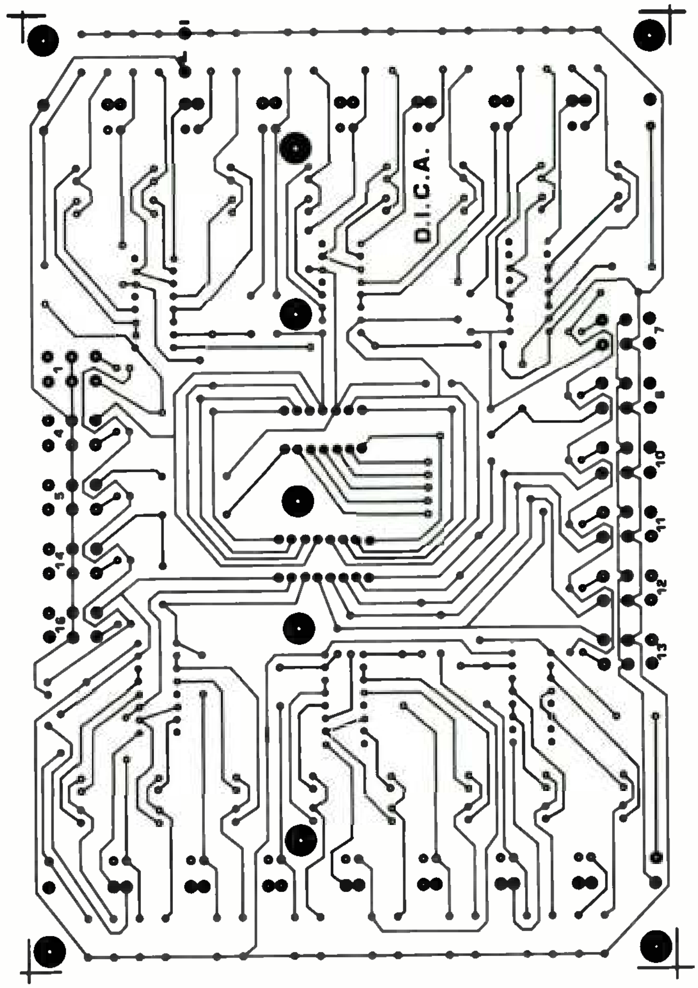


Fig. 2—The author used eight "C" cells in the prototype and wired them as shown to provide 4.5 volts for TTL chips and 12 volts for CMOS chips. A suitable multi-output AC-derived DC power supply can be used if a bench model is desired.

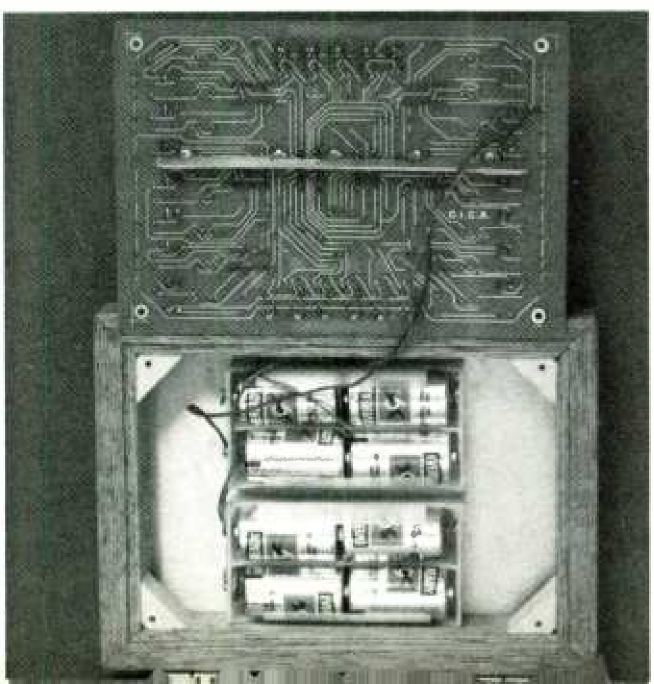
Fig. 3—This half-size template of the Digi-lyzer's printed-circuit traces can be used to produce your own board or, if you prefer, it may be purchased from the supplier given in the Parts List



common pinout diagram. And because of the nature of the two logic families, the CMOS version can replace its TTL cousin, but rarely vice versa.

By looking at the TTL cookbook, we find that the power supply pins for that particular chip are pins 14 for the positive supply and pin 7 is the minus (or ground) pin. We then turn on the slide switches representing pins 7 and 14. The positive supply slide switches are all located at the top of the board while the minus or ground switches are all located at the bottom. We are now ready to test the chip.

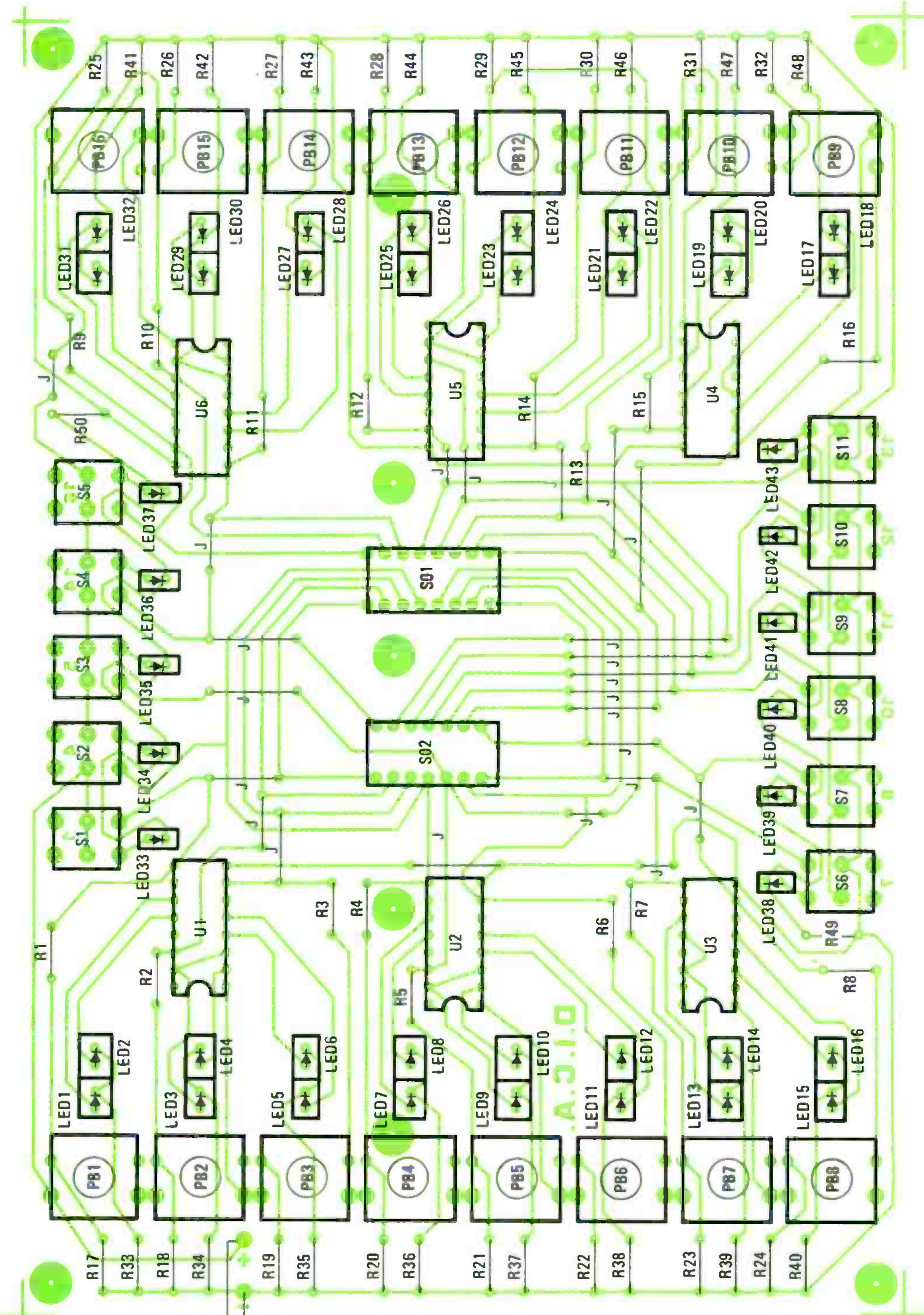
Drop the chip into the ZIF socket and lock it in place, with pin 1 of the CUT in the upper-left corner (notch pointing upward). Turn the power switch to the TTL position and the yellow lights will show that power is applied to the chip across pins 7 and 14. All the green LED's should be on except on pin 14, with a red LED lit. That indicates that all the pins on the chip are at ground potential, except 14, which has the supply voltage applied to it.



That is as it should be, inasmuch as the 7408 is an AND-gate circuit and no voltage should be present on any of the outputs unless both inputs of any particular gate have positive voltage applied to them. Start by checking the first gate of the chip. By referring to the TTL cookbook, we find that pins 1 and 2 are the inputs to this particular gate and pin 3 is the output. Hold pins 1 and 2 down and the red LED's will show on those two pins. When both of those pins have voltage applied to them, pin 3 will also show a red LED indicating an output from the chip. If an output is seen without buttons 1 and 2 down, or no output is seen when those buttons are pushed down, that particular gate in that chip is defective. You can then check the other three gates in the package the same way. With the information provided on the operation of the chip from the TTL cookbook, and by observing the LED's, you can either pronounce the chip sound and put it with your supply of good ones, or trash it. Either way, it's out of the ash tray. One note of caution: When you are checking TTL chips, never switch the analyzer to the CMOS power-on position. The full 9 volts applied to a TTL IC will prematurely smoke a good chip.

Let's take one more example. Suppose we are checking a CMOS CD4011. We set up the power pins on pins 7 and 14 just as before. We then drop the chip into the ZIF socket and

The author's eight "C"-cell power source (shown here) was wired as shown in Fig. 2 to provide 4.5 volts for TTL chips and 12 volts for CMOS chips, which have a wider power-supply range than do their TTL counterparts.



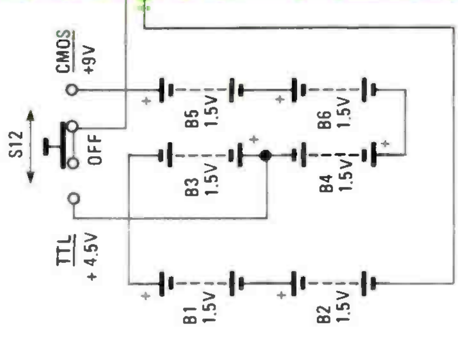


Fig. 4—Install the parts on the board using this parts-placement diagram as a guide. Begin with the jumper connections and then the passive components—resistors, capacitors and switches. Next install the LED's; red (even-numbered LED's up to 32) for +V, green (odd-numbered LED's up to 31) for ground, and yellow (LED33 to LED43) for the power connections.

lock it in place just as before. This time we switch the power on to the CMOS position, which applies the full 9 volts to the chip. This time we are checking a quad 2 input NAND gate. That is also a chip that has four such independent gates in one package. By referring to the CMOS cookbook, we see that on any one gate, with either or both inputs low, the output will be high. When the power is turned on, all the outputs will show voltage on them. That is just as it should be, because all the inputs are at ground potential. Checking the pin layout we find that the first gate has pins 1 and 2 as inputs and pin 3 is the output for one particular gate. By pushing down buttons 1 and 2, thus applying voltage to those pins, pin 3 should return to ground or show a green light. Any deviation from that operation indicates a defective gate. The other three gates are checked in the same manner. With a little experience on the simple chips, more complex chips can be analyzed. The CMOS and TTL cookbooks are invaluable aids when it comes to analyzing the operation of the more complex chips since they explain in advance what should happen under various input conditions.

After a little experience with the unit, you will be able to

(Continued on page 105)

GEE WHIZ BADGE

By W. Schopp

Make your statement to the world on a badge with marquee chase lights rotating around the edge

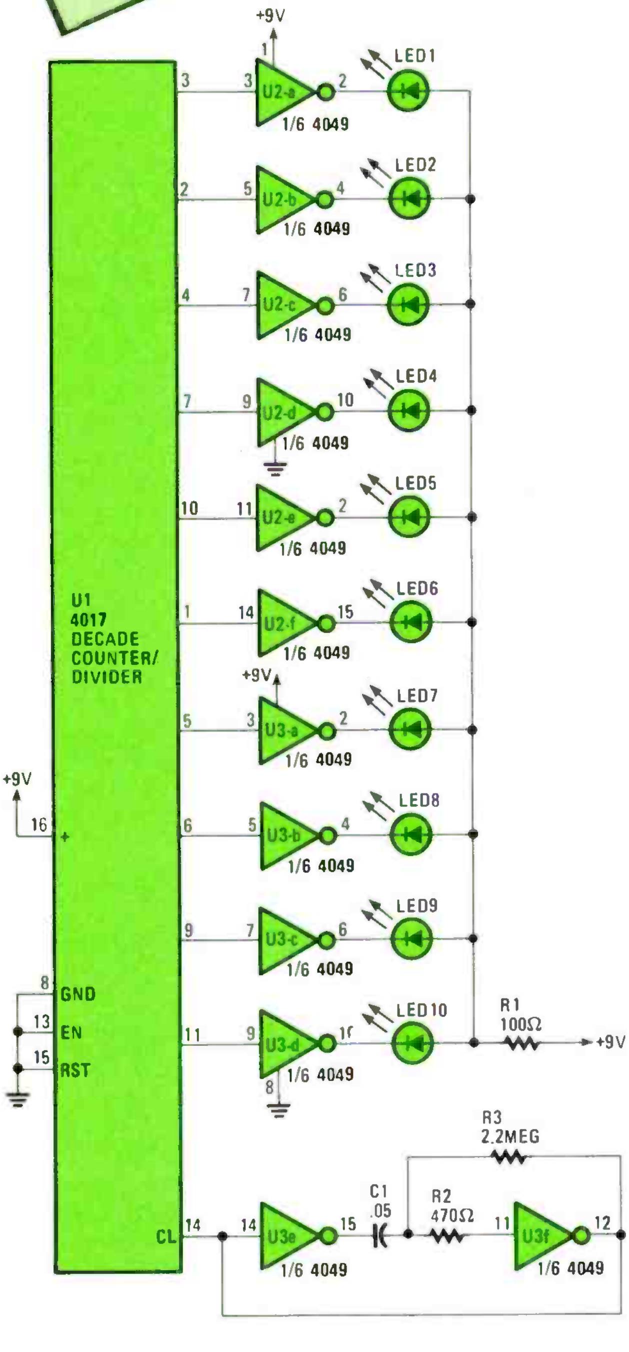


Fig. 1—The schematic diagram of the GEE WHIZ Badge shows that the circuit consists of a decade counter, (U1), with all outputs driving LED's through hex inverting buffers U2, and U3.

IF YOU HAVE A STATEMENT TO MAKE, AN IDEA TO PRESENT, or a product to sell, there is no better way than to put it on a badge, stick it in your lapel, and exhibit it to the world. Private clubs, small and large industries, fund raisers, and even politicians use them. The big problem is that badges are so common, no one ever takes notice or reads them anymore. At least, that *was* the case.

The badge, with its lights traveling around the edge is destined to change all that. It will definitely stand out among all other badges. It is a great conversation starter, and it will also make you very easy to locate in a dimly lit room. The badge has no other socially redeeming features other than to cause the casual observer to exclaim, "*Gee whiz!*" Thus, its name the *GEE WHIZ Badge*.

How It works

Figure 1 shows the schematic diagram of the GEE WHIZ Badge. The circuit consists of a simple decade counter, (U1), with all of its outputs driving LED's through 4049 inverting buffers, (U2, and U3). The two buffer chips contain twelve buffers. Since only ten buffers are required to drive the LED's, the remaining two are used to form a squarewave generator, which in turn, is used to drive the counter.

The ten decoded outputs of the counter (U1) are then fed through an equal number of inverting buffers to drive the LED's. By driving the LED's with a buffer, a full turn-on is accomplished, making the LED's flash quite brightly. Since only one LED is on at any given moment, one current-limiting resistor is shared by all the LED's.

As each output of the counter goes high (one at a time), the buffer output goes low, removing the reverse bias that had been applied to the cathode of the LED. The LED, now forward-biased, will glow momentarily; after which, the next counter out goes high (while the previous one goes low), turning on the next LED in the sequence. That sequence continues until all ten LED's have been lit and then the sequence starts all over again.

The frequency of the generator as shown is around two cycles per second (2-Hz to modern-day whiz kids). It can be sped up or slowed down to suit individual taste by changing the RC time constant of the oscillator (i.e., increasing or decreasing the values of C2 and R3). Power for the circuit is

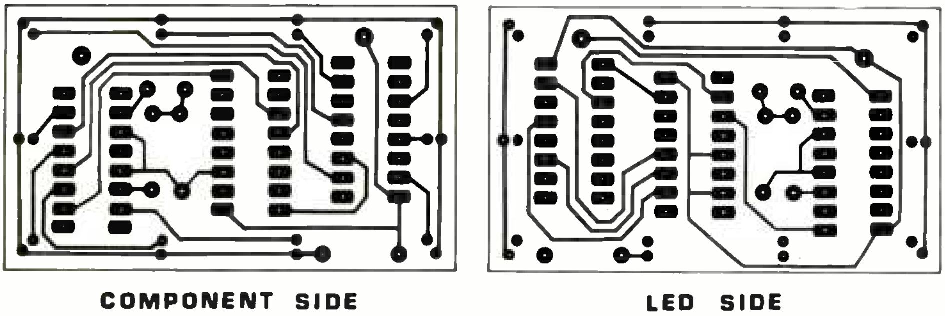


Fig. 2—The printed-circuit traces of the GEE WHIZ Badge's double-sided, printed-circuit board are shown full-scale. If you decide to do everything from scratch, use the IC pads to align the two PC board traces. You can avoid that bothersome chore by purchasing the kit of parts from the supplier given in the Parts List.

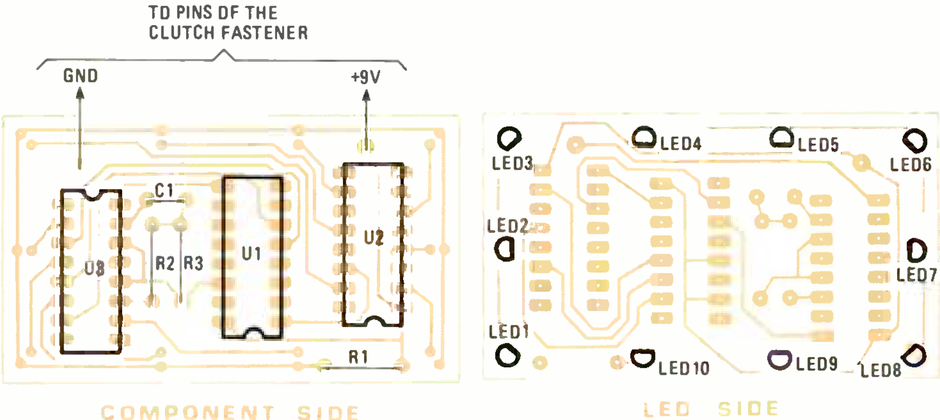


Fig. 3—Note that this parts-placement diagram shows that all of the parts (except the LED's) are mounted on the component side of the printed-circuit board (A). Soldering the components on both sides of the board eliminates the need for plate-through holes. The LED's are mounted flush against the opposite side of the board (B) and because of the short lead length, care must be taken when soldering so as not to overheat the LED's.

provided by an ordinary 9-volt transistor-radio type battery, which is easily concealed inside a shirt, vest, or coat pocket.

The GEE WHIZ Badge is constructed on a double-sided, printed-circuit board. The PC traces for both sides of the board are shown in Fig 2. Datum points are also provided for proper alignment of the two sides of the board, which are identified on the printed-circuit pattern as *component side* and *LED side*.

By soldering the components on both sides of the board, plated-through holes can be avoided. All the components, except the LED's, are mounted on one side of the board and the LED's are mounted on the other side (as shown in Fig. 3A and Fig. 3B).

The LED's are mounted flush against the printed-circuit board and because of the short lead length, care must be taken

(Continued on page 103)

PARTS LIST FOR THE GEE WHIZ BADGE

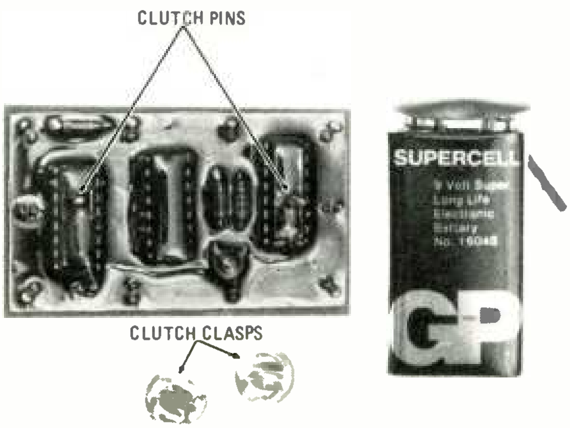
U1—CD4017 decade counter/divider, integrated circuit
U2, U3—CD4049 hex inverting buffer, integrated circuit
C1—0.05-µF, ceramic disc capacitor
R1—100-ohm, ¼-watt, 5% resistor
R2—470-ohm, ¼-watt, 5% resistor
R3—2.2-Megohm, ¼-watt, 5% resistor
LED1–LED10—Light-emitting diode, T1 size

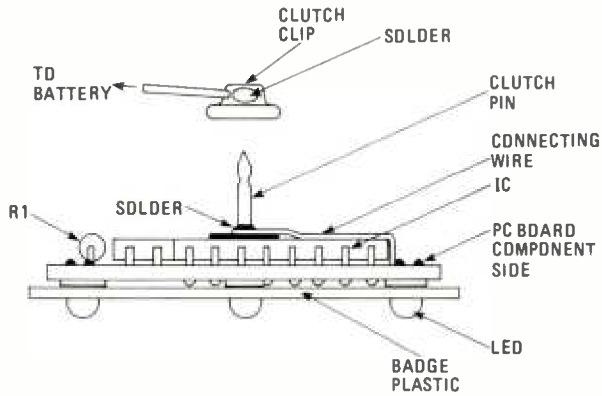
ADDITIONAL PARTS AND MATERIALS

Double-sided printed-circuit board (see supplier below), 9-volt transistor-radio battery, battery clip, badge plastic, clutch clips, small-gauge (flexible) hookup wire, etching solution, solder, etc.

Note: A kit of parts containing GEE WHIZ Badge's double-sided, printed-circuit board, two plastic badges pre-drilled for T1 LED's, and two clutch pins with clips is available (postpaid) in the USA and Canada for $12.50 from Electronic Enterprises, 3305 Pestana Way, Livermore, CA 94550. Please allow 6 to 8 weeks for delivery

Fig. 4—Battery connections to the Badge are made via clutch-clip pins (available from any engraving shop), which are epoxied to the tops of U2 and U3. The positive and negative power leads are then brought up from the board and soldered to the base of the pins, and battery leads are then soldered to the clutch clasps that engage the pins. ▶





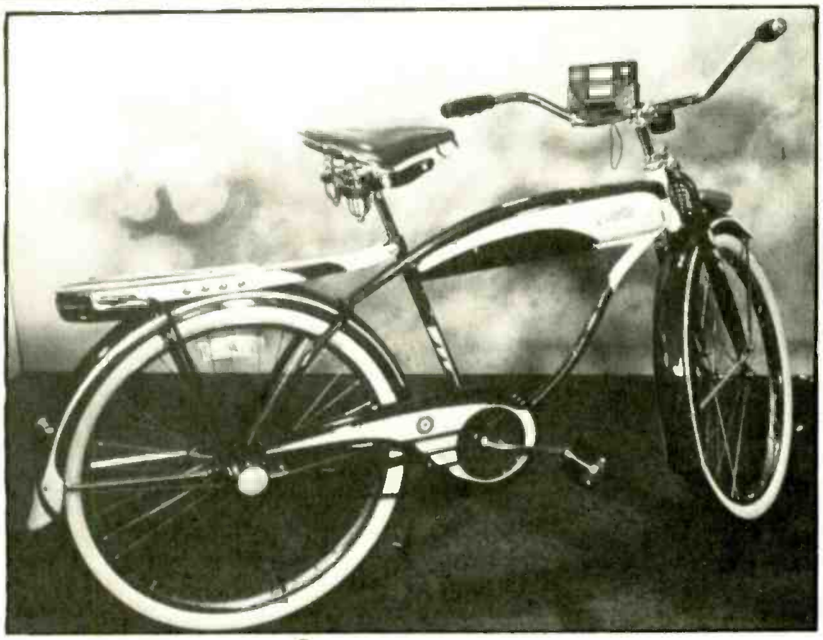
◀ **When assembled, the component side of the printed-circuit board becomes the back of the Badge. Because power is supplied to the circuit via the clutch pin/clasp assembly, it's recommended that the +V pin and clasp be marked with a dab of red nail polish so that power is not inversely applied.**

NUMBER 138

GADGET

AUGUST 1987 THE NEWSLETTER FOR GROWN-UP KIDS VOLUME XII/NUMBER VI

What's Inside . . .



Every Beat of Your Heart

1-2-3 HEART RATE MONITOR. Manufactured by: Heart Rate, Inc., 3001 Redhill Ave., Bldg. 5-106, Costa Mesa, CA 92626. Price: $295.

Given that it wasn't even a product category a couple of decades ago, the proliferation of electronic fitness equipment is sometimes astounding. Heart rate monitors, once an esoteric piece of medical equipment, today are considered a personal necessity in any upscale physical conditioning program.

One of the most popular is the simple-to-operate, simple-to-read, *1-2-3 Heart Rate Monitor*. A product of National Aeronautics and Space Administration-funded research, its sensor was developed as a replacement for the sensing electrodes used in "electrocardiographic data" collection in the space program.

Developed by two professors at Texas Technical University, the "advanced electrocardiographic electrode" the *1-2-3* is built around consists of a thin dielectric film applied to a stainless steel surface. The resulting sensor is unaffected by "conditions of heat, cold or light, perspiration, dry, rough or oily skin." The same electrode is found in the Lifecycle Aerobic Trainer's monitor (GADGET, May 1985, p. 3).

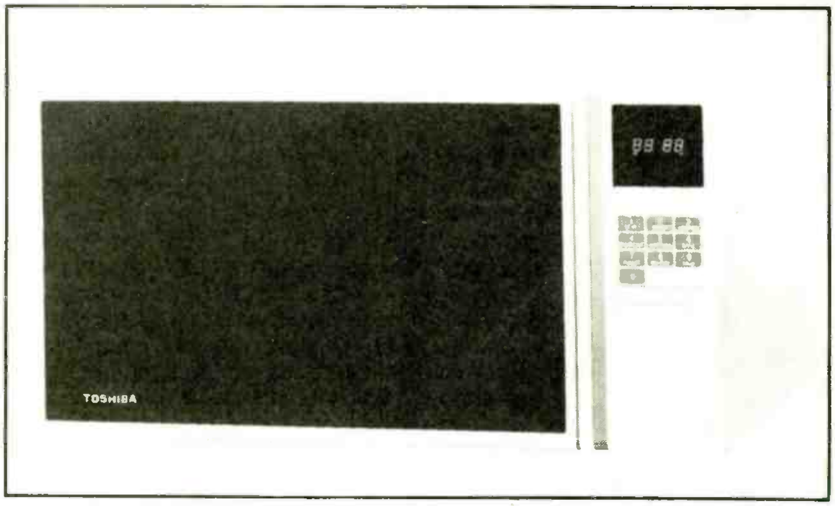
Available in no less than five configurations, the *1-2-3 Heart Rate Monitor* tested by GADGET is about the size of a Walkman-style tape recorder and comes equipped with a mounting bracket. The idea is to mount it on a piece of fitness equipment, or in an exercise area, so users can monitor their heart rate during peak periods of exercise.

GADGET's selected fitness apparatus was a bicycle, a classic in more ways than one. We mounted the monitor on the handlebars of Columbia's model RX5, a special commemorative edition of a bike the company manufactured in 1952, the Five Star. Reproduced in a limited edition of 5,000, this

(Continued on page 3)

Wave On

MICROWAVE OVEN (ERX-3610B). Manufactured by: Toshiba America, Inc., 82 Totowa Road, Wayne, NJ 07470. Price: $250.



The microwave (or should that be, microwavery?) has triumphed in its conquest of American kitchens. To an outside observer, the main battleground appeared to have been fast food establishments and convenience stores. Once the Seven-Elevens and Stop-and-Go's fell to this time-saving oven of the future, America's Main Streets and Anytowns were quick to follow.

So a decade plus down the road, the microwave oven has become an everyday appliance. Like other electronic products, the microwave is in danger of becoming a victim of its own success.

Once you've sold everyone who's interested an oven, what do you do for an encore? Especially when the item arrived on the market more or less fully developed. Certainly there have been modifications and advances (convection microwaves and in-oven turntables, for example), but none of the startling breakthroughs which bring customers back for a new generation of products.

America's microwave oven manufacturers did what other industries have done when faced with the same problem. They've fiddled with size, they've offered lots of different decorator colors and rebates and free microwave cookbooks.

GADGET began life just about the time microwave ovens were reaching the mass market. In our early years we tested and examined more than our share of the devices. But it's been some time since we've taken a look at the microwave world, culinary division.

So it was that we tested one of *Toshiba*'s current microwave ovens, the *EXR-3610B*, designed and promoted as an under-the-cabinet model. Compact and simple in design, it's sold with a special glass cooking tray, features 9 different power settings, a digital clock, audible cooking signals, timer and a frozen-food thawing cycle that *Toshiba* thinks is special enough to give a trademarked name to, "Jet Defrost."

We didn't try to create any eight-course microwave meals, but in our more modest tests, the *EXR-3610B* cooked a variety of frozen foods quickly and thoroughly. Its timer was easy to set and the oven door fit solidly, despite the fact that the door edge and its corresponding cabinet fitting were visibly not precisely parallel. The crack between door and cabinet was clearly wider at the top than at the bottom. That was enough to make us reach for our microwave meter.

Despite what our visual examination suggested, the meter indicated that there was close to zero microwave leakage from the unit. It barely moved the meter's indicator needle.

Perhaps our main objection to the *ERX-3610B* is to its designation as an under-the-counter model. In use, the oven's top side heated up to an uncomfortable degree, and we could imagine it leaving, over a period of time, a brown scorch mark (or worse) on the surface under which it was mounted.

Its size also gave us pause. The oven's floor measures 11" by 11", smaller than an LP record jacket, and that struck us as a real limitation of its utility. The cookbook furnished by *Toshiba* in one recipe illustrates a cut-up chicken being microwaved. Yet, looking at the supplied tray, it was difficult to imagine a bird much bigger than a parakeet comfortably fitting onto the utensil's surface.

For the reheating of leftovers, or as a unit used for snacks and frozen foods, the *ERX-3610B* might well fit the bill. But as a main microwave, or as the only microwave in a home kitchen responsible for feeding more than one or two people, we think this oven would soon demonstrate its limitations. The larger units on the market aren't that much more expensive (if you don't require the various extras with which manufacturers sometimes load their larger ovens). So why not go the few extra bucks for a more versatile appliance?

But the key to the marketing game often is filling a specific demand niche. We suppose *Toshiba* is unlikely to have released a new model without plenty of market research and targeting. So the *ERX-3610B* probably fills a consumer market niche—basic, small oven without a lot of frills for limited use—perfectly. But as to whether it belongs under a counter (remember that high-temperature top), GADGET has its doubts. —G.A.

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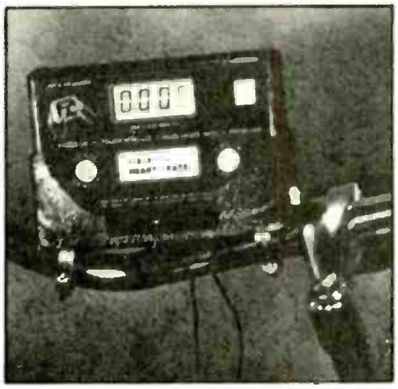
HEART RATE MONITOR

(Cont. from p. 1)

heavy-duty pavement cruiser was, we're sure, a feature of the childhood of many who—today—might be in the market for a heart rate monitor.

On the front of the *1-2-3 Heart Rate Monitor* is an electronic display, an on-off panel and two circular sensor areas. To take a reading, the user merely presses the "on/off" panel and then gently puts his or her thumbs over the sensors. The display shows the numerals 1-2-3 and then, within seconds, displays the heart-beat rate. After the first four-beat average is ascertained and displayed by the monitor, the device continues to "accumulate rhythmic beats and display an average of the last eight beats." If no data is picked up within eight seconds, three zeros are displayed and the whole pro-



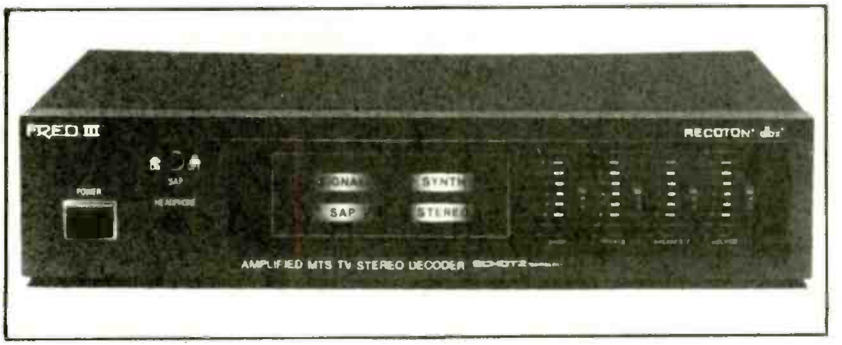
cess starts over, which for some reason reminds us of the Groucho Marx line, "either his watch has stopped or this man is dead."

The *1-2-3*'s directions caution, "a small percentage of the total population has a very small ECG signal at the finger tips." In which case, "the monitor may have a hard time starting up or may not start at all." Rather than display "an incorrect value," in those cases, the *1-2-3* merely will display triple zeros.

Power for the unit comes from a 9-volt battery. If the battery becomes too weak to power the monitor, the display will show "Lo," then "Off" and turn itself off.

We found the *1-2-3 Heart Rate Monitor* simplicity itself to operate. Especially convenient are its generous-sized display area and large numbers, easy to read even when huffing and puffing from pedaling the heavy-duty Columbia RX5 up a slight hill. We may not know much about heart rate monitors, but we know we had no problem operating the *1-2-3*, a monitor as simple to use as its name implies.—G.A.

Both Sides Now



F.R.E.D. III STEREO TELEVISION DECODER. Manufactured by: Recoton Corp., 46-23 Crane St., Long Island City, NY 11101. Price: $199.95.

The trend towards MTS—multichannel television sound or stereo TV for the uninitiated—has left in its wake thousands of households suffering from the "update or die" quandary common to consumer electronics. For the consummate gadget freak or electronics aficionado, the thought that there might be a stereo signal on the loose somewhere *which cannot be picked up on his equipment* sends him into agony. Then it sends him to his checkbook.

But before you go off and buy the latest stereo-compatible television set, *Recoton*'s add-on decoder warrants investigation. It is a sophisticated way of receiving the benefits of stereo television without the actual cost of buying a stereo TV. Most importantly, and unlike other decoders on the market, it is relatively hassle-free, in that it needs no second tuner to ensure the audio signal changes along with the picture.

When we reviewed the first *F.R.E.D.*, or "Friendly Recoton Entertainment Decoder" (GADGET, July 1986, p. 1), we pointed out a few flaws, primarily in the pick-up probe. This time around, we were able to use the probe with no glitches, and were also able to connect the *F.R.E.D.* directly to our television.

The other decoders on the market use a simple but frustrating method of changing the audio decoder signal when the channel is changed: They make you use an additional tuner. Changing channels, therefore, becomes changing channels twice, once for audio, once for visual—a "solution" which only makes the problem more complicated. *F.R.E.D.* solves this hassle by keying its audio signal to the television's picture, so both change simultaneously and obviate the need for a second tuner.

F.R.E.D. III adds two elements not found on *Recoton*'s first model: a built-in amplifier, and a second audio program (SAP) decoder for bilingual broadcasts. The amp precludes you from having to hook *F.R.E.D.* up to your stereo system, since the decoder can now drive the speakers directly (albeit at a low 12-watts per channel—at 8 ohms with a frequency response of 30 to 16,000 Hz). For present MTS purposes, however, and unless MTV gets hip and starts to come out in stereo, the power rating more than meets the needs of even the most discriminating listener/viewer.

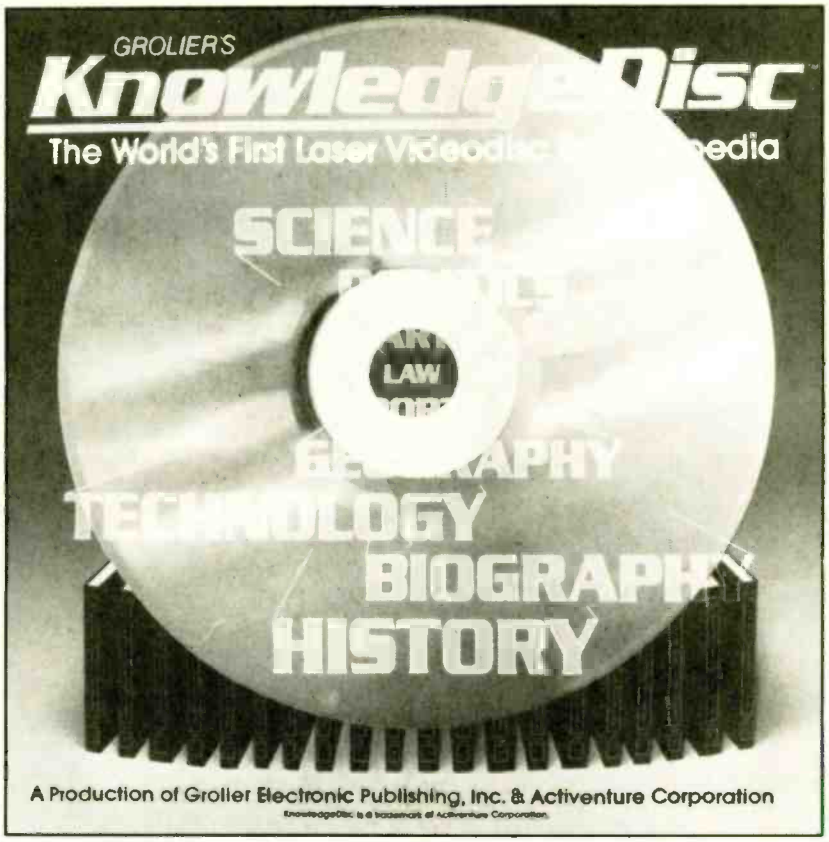
Since the cable system in GADGET's test area has refused to update its signal to feed MTS, we used a broadcast NBC signal to test *F.R.E.D. III*. Hearing Johnny Carson introduced by Ed McMahon, with their voices coming from two different speakers—well, it may not be the thrill that promoters of stereo TV promised, but it gave some slight indication of the possibilities. Even more effective were the band's numbers dished up during the show: These came through with full-blown stereo sound.

F.R.E.D. III also has its own bass and treble controls, status display and several jack connectors: line output jacks to patch *F.R.E.D.* into your stereo or VCR, plus a cable converter connector. The 14" x 8" x 3" unit has a sleek, handsome design and avoids the "homemade" feel of some add-on peripherals. *F.R.E.D. III* also offers SAP and MTS capability, but lacks the built-in amplifier.

In our GADGET test, *F.R.E.D. III* performed very well in supplying true stereo sound from a television signal. It offers another option, beyond the obvious but expensive one of buying a stereo-compatible television set, for those trendsetters who simply must be in on the ground floor of the MTS revolution—G.R.

Discopedia

KNOWLEDGEDISC LASER VIDEODISC ENCYCLOPEDIA. Manufactured by: Grolier Electronic Publishing, Inc., Activenture Corp., Sherman Turnpike, Danbury, CT 06816. Price: $89.95.



One of the enduring gee-whiz promises of the electronics era has been the videotext encyclopedia enormous amounts of information, electronically stored and accessible at the touch of a button or two. With the appearance of *Grolier*'s *Knowledgedisc*, an entire encyclopedia on a laser disc, the videodisc data revolution has arrived, sort of.

With approximately 400,000 videodisc players in the U.S., the *Knowledgedisc*'s market is definite, if limited. Produced by *Grolier*'s electronic publishing division and *Activenture Corp.*, the videodisc encyclopedia is being marketed by Pioneer, mainstay of videodisc promotion and the leader in player production.

The entire 20 volumes of *Grolier*'s *Academic American Encyclopedia* takes up only 20 percent of the disc's potential capacity (testimony to the laser disc's data storage potential). Some 9 million words altogether, *Knowledgedisc* is divided among 32 thousand entries and articles and 13 thousand bibliographies, on a single disc. This electronic encyclopedia features "fact boxes" and tables, but in embarrassing contrast to its printed counterparts, there are no pictures or maps of any kind. An obvious limitation, especially given the laser disc's superb graphic qualities.

As with conventional encyclopedias, there's also the problem of information becoming dated. The *Knowledgedisc* carries a 1985 copyright, meaning the information is no less than two years old and often older. In electronic encyclopedia utopia, of course, reference discs would be part of a self-updating system.

It also has to be admitted that although 9 million words and 32 thousand articles sounds like a lot of data, it doesn't begin to compare with the amount of information found, for example, in a standard, printed *Encyclopaedia Britannica.* The motivation behind selecting the *Academic American Encyclopedia* from among *Grolier*'s several reference sets remains cloudy.

Accessing an article is reasonably simple. There's a table of contents the user can scan through and, when an article of interest is found, the user enters a one-to-five-digit code number, presses search on the player's remote control and, in a few seconds, the requested encyclopedia entry appears on the television screen. Ease of reading is a function not so much of the *Knowledgedisc* as of the TV set it's displayed on. Used on a three-year-old, 19" Sony, we had no difficulty in reading the disc's material, although we would not suggest a TV screen smaller than 12".

We searched for the kinds of articles we'd expect to find in any conventional encyclopedia, and we were disappointed to discover they often weren't part of the disc's text. As a test of the disc's comprehensiveness, we were able to find roughly 80 percent of subjects selected at random. The remaining 20 percent of absent entries were a frustration, however.

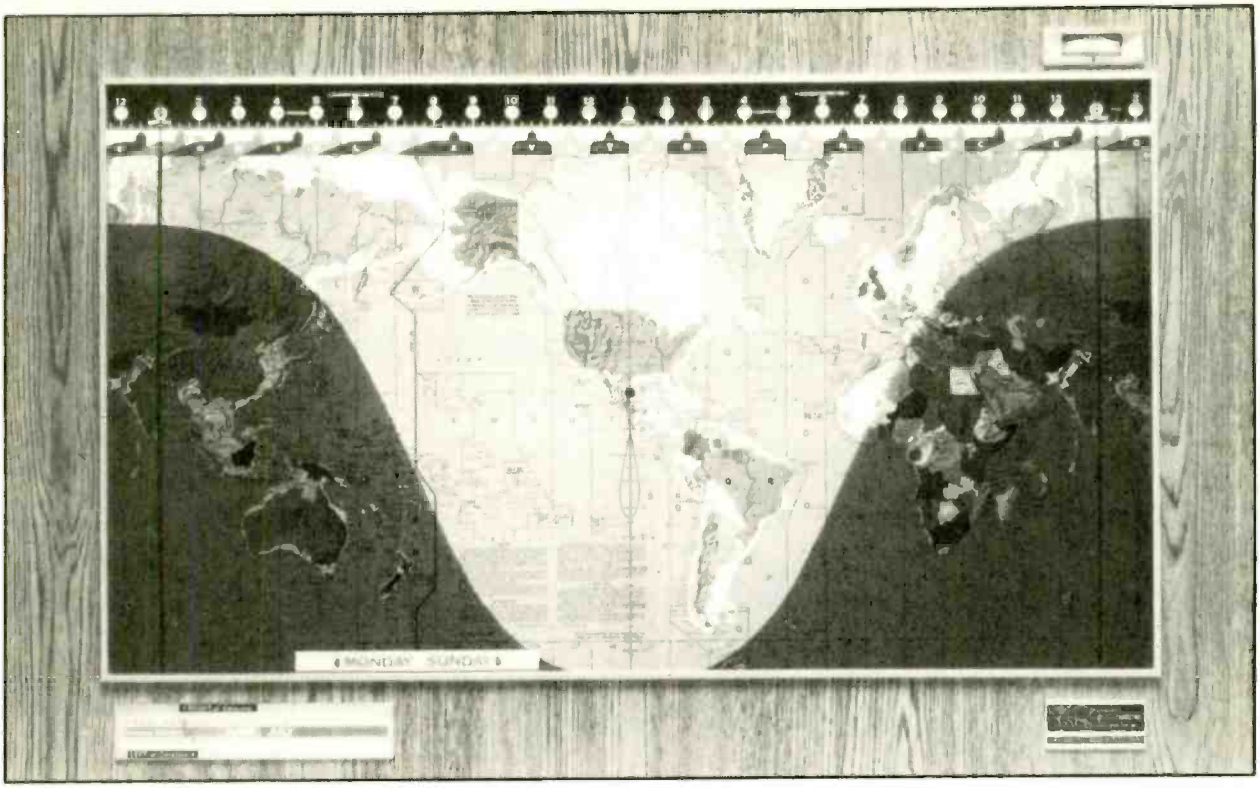
In a Pioneer promotion at the beginning of the year, laser disc player buyers were given the *Knowledgedisc* gratis after sending in the appropriate proof of purchase. Interestingly, Pioneer reported response was overwhelming, so they offered buyers an alternative selection, the disc version of the popular *Indiana Jones and the Temple of Doom* feature film.

Given the response to the Pioneer *Knowledgedisc* giveaway, it's clear that the laser disc encyclopedia is a product with a market. However, its present incarnation leaves plenty of room for improvement. The videodisc, particularly in terms of data storage and access, could well be (and should be) the wave of the future.

At present, the best reproduction of movies is the videodisc, with much higher resolution than videocassette systems are capable of delivering (although the recently announced "Super VHS" format could change that).

In terms of software, the *Grolier Knowledgedisc* is the first encyclopedia of any kind to be transferred to videodisc. It's kind of exciting to see the beginning of what we think will be a personal information revolution. Around the corner are more complete encyclopedias, including one which will take advantage of the laser disc's graphic capabilities. Already available are discs of artwork from the National Gallery in Washington, DC, footage from the National Aeronautics and Space Administration's space archives collection and, sometimes surprising to VHS users, many titles unavailable in any other video format.

As a first attempt at encoding an encyclopedia onto a disc, we give *Grolier* and its *Activenture* partner high marks for effort and commercial innovation. But we also look forward to a time (sooner, perhaps than anyone thinks) when anything available in print is also available on videodisc. The *Grolier Knowledgedisc* is only the opening volume in the at-home electronic information revolution.—S.G.



The Big Time

WORLD TIME INDICATOR. Manufactured by: Geochron Enterprises, Inc., 899 Arguello St., Redwood City, CA 94063. Price: $1,295.

Eventually, modern psychiatry will categorize an obsession with time as a specific mental disorder. We're not necessarily talking about this obsession's simple manifestations, or the person who must know what time it is at all points during his or her waking hours.

Even the occasional time obsessive with more clocks and timepieces in the home than most of us own in a lifetime—and who consequently expends enormous energy and care insuring that all of these instruments are in synch—isn't who we're thinking of here. Instead, we are talking about those rare individuals who want to know not only the precise time where they are, but proper times for points all over the globe. If you know (or are) such a person, do we have the gift item for them.

It's call the *Geochron World Time Indicator* and in the twenty years or so that it's been manufactured, it's emerged as perhaps the ultimate in global timepieces. According to the manufacturer, "government agencies of several nations have them, so does our CIA and military. NASA uses them for satellite tracking. Presidents and other government officials have their own for personal use." Having established its product's bonafides, *Geochron* goes on to claim, "in science and education, *Geochron* is an ideal visual aid to show time graphically. . . an excellent teaching tool."

Measuring 26" by 15" inside its simulated wood frame, the *Geochron* is a colorful Mercator projection map (based, according to the map legend, on Defense Department charting) which, in surprisingly simple ways, supplies an enormous amount of time-related information at a glance. Mechanisms built into the frame tick off minutes and show today's date, as well as indicating the day of the week on both sides of the international date line.

Backlit with a fluorescent tube, the *Time Indicator* also shows portions of the world in darkness and those in daylight. At the top of the map, which is clearly divided into vertical time zones, a double line of numbers shows the correct time for each zone—two sets of numbers are necessary to take daylight saving time into account.

Although the map moves, nearly imperceptibly, from left to right, the numbers at the top are stationary. The 360-degree circumference of the globe, on the map, is divided int 24 "equal hour periods," with midnight on the left, noon in the middle and midnight again on the right.

A chart near the map's center indicates the point on planet Earth where the sun is actually directly overhead. Also indicated and traced is the "analemma," the gradual shift of the sun's highest position in the course of the year.

Despite the ingenuity of the *Geochron's* design and multiple mechanisms, set-up is fast and simple. Three knobs, on the *Indicator*'s back, set time and date, after two shipping screws are removed. A button mounted on the frame's bottom turns on the light and, after a few minutes of examination and a read-through of the directions, we were ready to tell time, all over the world and nearly at a glance.

Sturdy and carefully fabricated, at this price we would have expected the *Geochron* to be a somewhat more elegant piece of work. As it is, it's a workmanlike piece of design in which form, in this case rather clunky, clearly followed function.

To put it in terms worn smooth (if not out) by commercial repetition, the *Geochron World Time Indicator* would make "a handsome addition" to anyone's living room, den or office. From what we've read about student comprehension of geographic concepts, it would also be a more-than-useful addition to the classroom.

Its steep price, we guess, is the reason school systems haven't embraced the *Geochron*. Price, of course, won't stop the true time freak, a class of consumers who must be an important part of the *Geochron* market—at least in those cases where the bill isn't being footed by taxpayers.—G.A.

New Smoothie

ELNAPRESS ELECTRONIC IRONING PRESS (EP 21). Distributed by: Elna, Inc., 7642 Washington Ave., S., Minneapolis, MN 55344. Price: $599.

Ironing seems to be universally accepted as a synonym for "domestic drudgery." Ironing nearly always tops those women's magazine polls of most disliked household chores, yet there haven't been many attempts to come up with some labor-saving replacement. We did read last year about a dryer being developed in Europe that will press and dry at the same time, but it has yet to appear on the market.

Also from Europe (Switzerland to be precise) and already on the market, the *Elnapress Electronic Ironing Press* supposedly makes "ironing obsolete." From the well-known sewing machine manufacturer, the *Elnapress* is also advertised as being "designed for people who have better things to do than stand over a hot iron . . . an ideal gift for anyone who hates ironing."

Weighing 22 lbs., and foldable for easy carrying, the *Elnapress* is a slimmed-down version of the pressing equipment found in drycleaning and tailoring establishments. The device's ironing surface measures 24½" long by 10" wide. Controls are grouped around the stem of the two handles which operate the press. The fixed handle on the left opens and closes it while, side-by-side, the right handle increases or decreases "automatic ironing pressure."

According to the manufacturer's specifications, the *Elnapress* in action applies an "average pressure" of nearly 97 lbs. on the pressing surface. In ordinary ironing, it's human muscle power which applies the pressure; here the machine does the work.

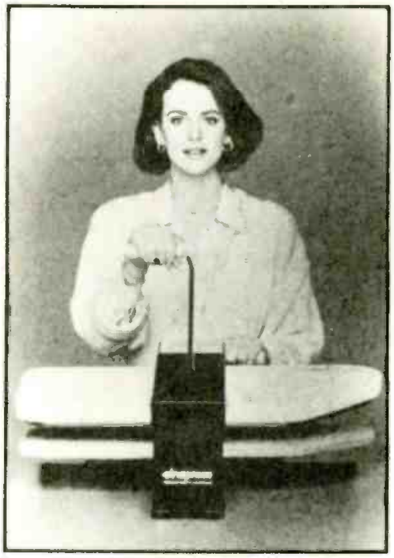
Controls include a "pressure guide mark." According to the device's instruction booklet, "by lowering the pressure lever (the right handle) until it is level with this mark, the user obtains the ideal pressure for very sheer or delicate fabrics."

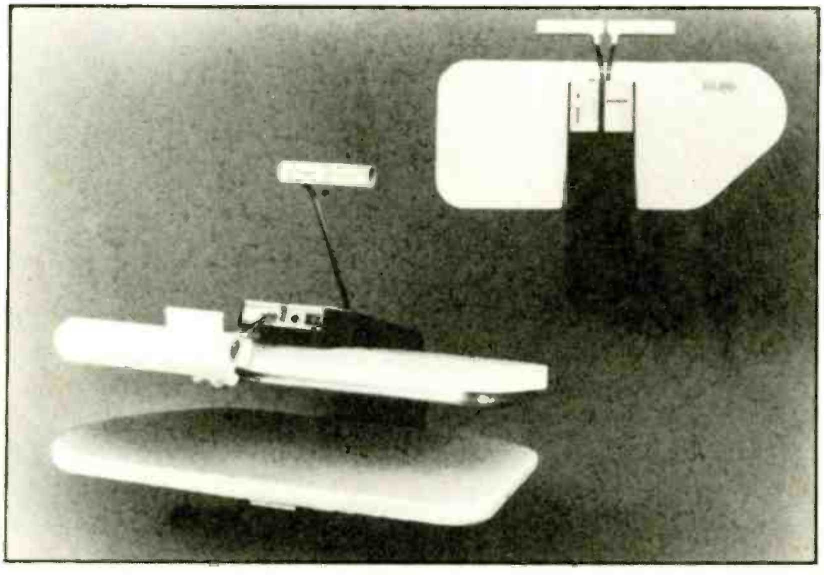
While the press is heating up, an indicator light glows, turning off once the desired temperature is reached. A thermostat controls temperature and there's a guide for matching fabric with the correct heat intensity. Finally, the *EP 21* features an electronic cut-off safety switch.

If the press remains closed for about 10 seconds, an electronic "beep" is heard, and the heat shuts off automatically. "If the press is then opened," according to the instructions, "no damage will have been done to the article pressed."

Also included with the *EP 21 Elnapress* is a "vap-o-jet system." A three-nozzle vaporizer, the accessory slides onto the fixed handle, dampening laundry while it's being pressed. *Elna* also supplies a soft ironing cushion, along with plenty of detailed information as to what kinds of fabrics require what sorts of pressing. For example, woolens, knit fabrics and the like require a pressing cloth, synthetic fabrics should be ironed dry and at a low temperature. Cottons, linen and blended fabrics call for a damp pressing.

In our tests, the *Elnapress* performed well, although a certain amount of fussy arranging of items on the ironing surface is required. Again, the instructions go into detail regarding techniques for pressing various items. Some 24 pages





are devoted to illustrations showing how to press pants, shirts, napkins, towels, embroidered items, pockets with flaps and so on.

Unfortunately, the *Elnapress* didn't seem to require much less work than an ordinary iron and ironing board approach to clothes pressing. The device can be operated sitting down and there's none of the monotonous back-and-forth of the standard iron. Instead, there's the monotonous up-and-down of the *Elnapress,* along with a good deal of heat generation.

Faster than ironing? Possibly with practice, the *Elnapress* would be quicker. The instructions contain some hints on pressing several matching small items simultaneously. As a novice user, however, our tester found the *Elnapress* to be as time-consuming as any session at the ironing board.

One claim, important perhaps in deciding to purchase an *Elnapress,* GADGET wasn't able to judge. The *Elna* company says the device is more gentle than ordinary ironing. Besides the model GADGET examined, *Elnapress* manufactures the more basic *EP 22,* priced at $499 in the U.S.

But basic or top-of-the-line, the *Elnapress* would seem to fit the ironing and pressing needs of rather select market segments: small scale dressmakers, for example, or people for whom clothes and their care is a major interest.

Perhaps those who have domestic help might want to install an *Elnapress* in their laundry room. And people who really do hate ironing might just find the *Elnapress Electronic Ironing Press* something of an alternative to board-and-iron drudgery. The rest of us, however, will just have to wait for that combo dryer-presser's eventual market appearance.—G.A.

Midget Vision

CASIO TV-6000. Manufactured by: Casio, Inc., 15 Gardner Rd., Fairfield, NJ. Price: $279.95.
CASIO TV-2000. Manufactured by: Casio, Inc. Price: (model discontinued).

In comparing the successful technology of the *Casio TV-6000* with the failed—and recently discontinued—*TV-2000*, we have a useful object lesson in product development, engineering hubris and the judgment of the marketplace.

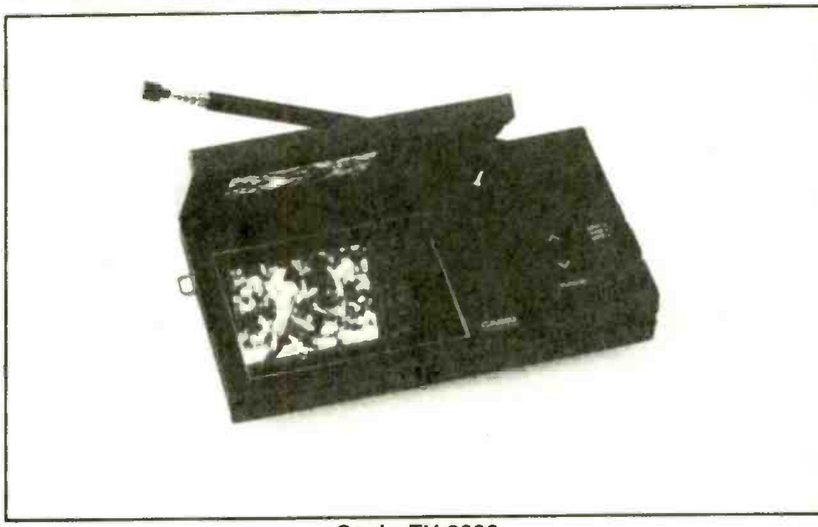
Using liquid crystal display (LCD) technology to develop tiny personal televisions was one of those "innovations" that crop up every once in a while, products which look spiffy on the drawing board but perform miserably in the marketplace—at least at first.

Around five years ago, LCD TV failed spectacularly in its bid to usher in the age of the "TV transistor." The flat, walkie-talkie-style prototype units had lousy picture resolution, muddy contrast and slow, surreally choppy movement (because the screens failed to "update" the picture rapidly enough). On top of that, they had to be viewed in daylight (preferably blinding sunlight) because LCD needs healthy doses of ambient light in order to be visible.

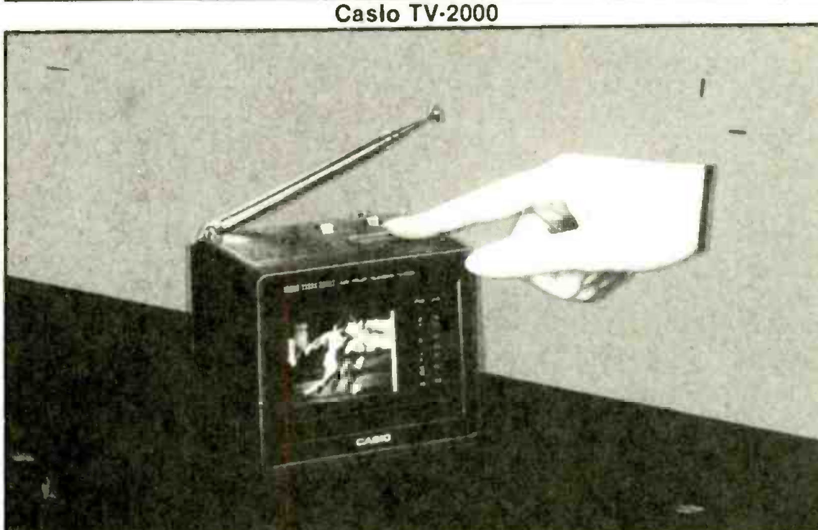
A flurry of recent activity on the LCD TV front has shown that the technology has taken great strides since the early days. The biggest innovation, of course, is the advent of color. The new entry from *Casio*, the cube-shaped *TV-6000*, proves that within its limitations, LCD color TV is now a supremely viable product, fitting snugly into its market niche.

The *Casio* unit is arrayed not only against other LCD-style products, but also personal televisions like Sony's Watchman, which used a condensed version of a conventional electron-beam picture tube. Employing LCDs allows for a more efficient utilization of power and a smaller overall product design, when compared to the portables which use a picture tube. LCD picture quality, however, might be labeled "viewable," up against the sharper resolution of the conventional TV.

A picture tube produces an image by exciting phosphor particles with an electron beam. An LCD, by contrast, consists of "liquid crystal" material sandwiched between glass polarizers. The liquid crystal cells are grouped in



Casio TV-2000



Casio TV-6000

trios of red, blue and green filters and activated electrically. Each liquid crystal is a "picture element" or pixel; the more pixels, the sharper the image.

Casio's *TV-6000* and *TV-2000* have equal numbers of pixels (46,656)—on the high end of the range, with only Seiko's LVD series and Citizen's 17TA ranking higher. Actual picture quality is fairly equal for both the *TV-6000* and *TV-2000*. Both models feature a screen with a slightly distracting purple band on the right side, along which a channel indicator moves. Both share an auto-tuning feature which appreciably eases the problem of fine-tuning.

The differences between the two units have more to do with packaging than with substance. The *TV-6000* is a boxy, miniaturized console television, with controls on top and side and an angled base which allows a stable viewing perspective. It is surprisingly light for its dimensions (it's about the size of a corsage box). The cube design gives it a sturdy, permanent feel.

Contrast this to the *TV-2000*, which has a flat, paperback-sized design that implies "on-the-go" portability—a design which also brings it head-to-head with the higher quality Watchman. The *2000* model has battery capability, unlike the *TV-6000*, which can run only off of an AC adapter. Earphone and carrying case complete *TV-2000*'s image as the television for the yupwardly mobile. Evidently, however, the marketing minds at *Casio* decided the flat body would kill the *TV-2000* by its association with early, poor-quality prototypes.

The *TV-6000* is a sturdy, middle-of-the-road LCD TV, lacking the splashy "extras" of some models (Citizen offers one with FM stereo), but performing very well in our limited GADGET test. If you had to make a distinction between the two models, the *TV-6000* is for the deck, the den or the workshop, while the *TV-2000*—if you can still locate one—is for the beach or the ballgame.—G.R.

Reasonable Facsimile

FAXPHONE 10 DESKTOP G3 FACSIMILE. Manufactured by: Canon U.S.A., Inc., 1 Canon Plaza, Lake Success, NY 11042. Price: $1,995.

The facsimile machine is a fixture of countless offices and businesses. But with the introduction of the *Faxphone 10*, *Canon* proclaims the beginning of the "personal" facsimile market.

We have our doubts about that development anytime soon, if only because nearly two thousand bucks is a stiff price for getting personal with a facsimile unit. And there's the question of what most, or even many, of us would do with our own facsimile transmission device.

Markets and marketing aside, the *Faxphone 10* is an impressive piece of electronic hardware. Those with experience in facsimile transmission may recall the process as balky and anything but foolproof. This *Canon* product, in contrast, is easy to operate (thanks in no small part to an intelligently written and arranged instruction manual), and it transmits with a crispness and legibility beyond the capacity of facsimile machines of only a few years ago. Its ease of operation seems the result of adapting innovations developed for other communication devices to facsimile use.

Canon in its promotion stresses this unit's desktop characteristics ("the first facsimile that belongs on your desk") and has designed it as a combination telephone-facsimile unit. A little larger than a console-style, multiline telephone, the *Faxphone 10* can be used like an ordinary phone.

As with any contemporary business phone, this instrument offers automatic dialing (16 "frequently called" numbers can be stored, complete with area codes and long-distance service access codes) as well as redialing, muting and a built-in "hold melody," not always a plus if you're on the receiving end. This is, as *Canon* boasts, "a full-featured executive telephone."

In its facsimile functions, the *Canon Faxphone 10* offers many of the same features, including automatic dialing of up to 16 stored fax numbers. Compatible with G2 and six-minute FM document transmission systems, the *Faxphone* can send a single-page business letter in just 17 seconds. For the technically minded, transmission speed is rated at 9,600 bits per second.

As a result of its clock and calendar functions, the *Faxphone 10* can be automatically set to receive or send a document at a pre-selected time, meaning that long documents (up to five pages since the unit also includes an automatic document feeder) can be sent after office hours to take advantage of lower long-distance rates in the evening. Despite the special fax numbers for sending and receiving documents, facsimile transmissions via phone lines are billed at the same rate as ordinary telephone calls.

This unit's liquid crystal display takes a lot of the mystery out of transmission. The display keeps users informed of each step in the process, signaling when transmission or reception begins and is completed or giving warnings when something isn't working. In a gesture towards double duty, *Canon* says, "the *Faxphone 10*'s contact image sensor and thermal printer can offer the added service of a backup copier."

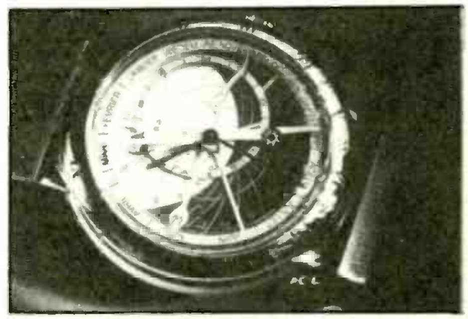
In GADGET's tests, conducted with the Rowland Company, which does public relations for this *Canon* product, transmission was quick, quiet and crisp. Something called "automatic background control" adjusts transmission of low-contrast originals for maximum legibility. The user can also manually control contrast.

Perhaps as a token of seriousness in marketing the *Faxphone 10* to consumers, the unit is being sold not only through *Canon* business equipment dealers but in consumer electronics stores as well. Prior to its actual market appearance, the suggested retail price was listed as $2,495. The modest reduction in the current suggested retail tag gives hope that perhaps prices on these devices will fall in the future.

If that's the case, then the *Faxphone 10* will have served to launch a new market for these long-established business and corporate tools. In the meantime, perhaps it's enough that this old warhorse of business communication has been smartly updated, a precursor perhaps of better (and cheaper) facsimiles to come.—G.A.

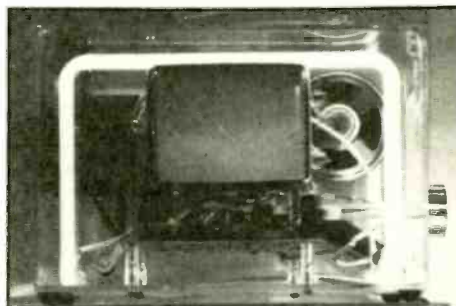
Bits & Pieces

An important element in the history of technology is represented by chronological design. Even with the electronification of time-keeping, this field has continued to be significant. Switzerland's prestigious, 140-year-old *Ulysse Nardin (3 rue du Jardin, CH-2400 Le Locle, Switzerland)* produces a wristwatch which combines ancient technology with modern precision, at a price which hardly any can afford. Called the **Astrolabium**, it's extraordinary enough that several museums have already purchased one for their collections. An Astrolabe is an instrument, widely used before the 17th century, which indicates the positions of the sun, moon and stars. Ulysse Nardin has combined this ancient instrument with a modern watch to produce a timepiece of exquisite beauty and performance. Besides showing ordinary time, the Astrolabium indicates local or solar time, month and date, dawn and dusk, moonrise and moonset, as well as sunrise and set, moon phases and signs of the Zodiac. Moon and sun eclipses, as well as directions, and longitude and latitude are also indicated. We may have missed something, Ulysse Nardin publishes a 21-page booklet on the Astrolabium, which must be among the most beautiful timepieces of the modern era. Price: $25,000-$37,000.



Ulysse Nardin Astrolabium

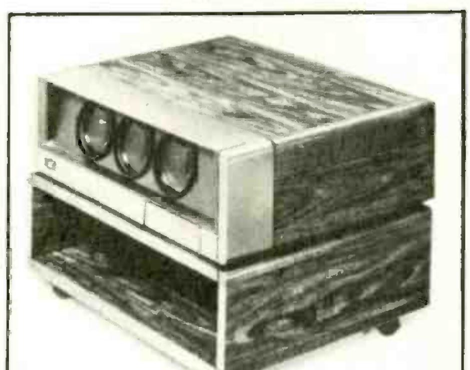
Nothing less than a "revolutionary flat motor design" is dubbed the "big news" in portable audio equipment from *Sanyo Electric, Inc. (Consumer Electronics Division, 1200 W. Artesia Blvd., Compton, CA 90220)*. The firm's CP 12 **Portable Compact Disc Player** has undergone "a significant reduction in size and weight," thanks not only to the compact motor, but because of a reduction in the number of parts, along with "high-density" mounting and "slimline plastic casing." Capable of playing up to 16 tracks in any order, the CP12 uses a three-beam laser pick-up for uniform tracking and correct focus. A built-in power saving switch helps "extend battery life." Power is supplied via an AC adapter, alkali batteries or an "ultra-thin rechargeable battery pack." Sanyo also offers an optional car adapter. The player is sold with lightweight stereo headphones, rechargeable battery pack, alkali battery pack, AC adapter, connecting cord and a soft carrying case with shoulder belt. Price: $279.99.



Dapy TV

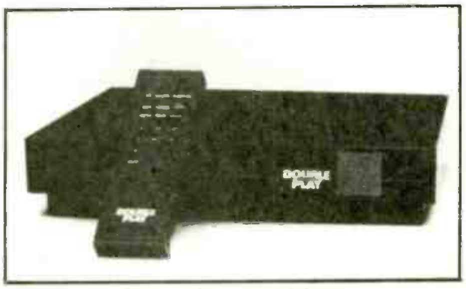
For devotees of the unique, television design in recent years has been somewhat barren. Now a French firm, *Dapy, Inc. (431 W. Broadway, New York, NY 10012)* has introduced a set which, at least to someone brought up on science fiction movies, looks out of this world. French-built, these sets have their innards exposed to view, with the screen surrounded by bright neon tubing. The effect is futuristic to say the least. The **Dapy TV** is available in two models, a small black-and-white set (unique enough in this day and age), with a 5" screen and a 20" color set. Both are cable-ready, with the 20-incher also equipped with remote control. These televisions will give viewers something to talk about even when the programming doesn't. Prices: $490 and $1,900, respectively.

In case you've been wondering, yes, large-screen projection TVs are still marketed for both home and commercial use. A one-time star in home electronic entertainment, these units have been eclipsed in recent years by other dramatic home electronic products and developments. Companies like *Zenith Electronics Corp. (1000 Milwaukee Ave., Glenview, IL 60025)* are still marketing these big-picture projection systems. Zenith recently announced its "first front-projection model with a built-in stereo TV tuner." The model PV 851P **Front-Projection TV** casts an 8' diagonal picture on a flat wall or screen and includes a 178-channel tuner with programmable scanning, a remote control, MTS stereo decoding, a stereo amplifier and stereo speakers. Shipped ready for floor installation, this Zenith can also be adjusted for ceiling mount or rear projection. System optics include "self-converging, liquid-cooled picture tubes and optically coupled lenses." Price: $2,495.



Zenith Front-Projection TV

Bits & Pieces



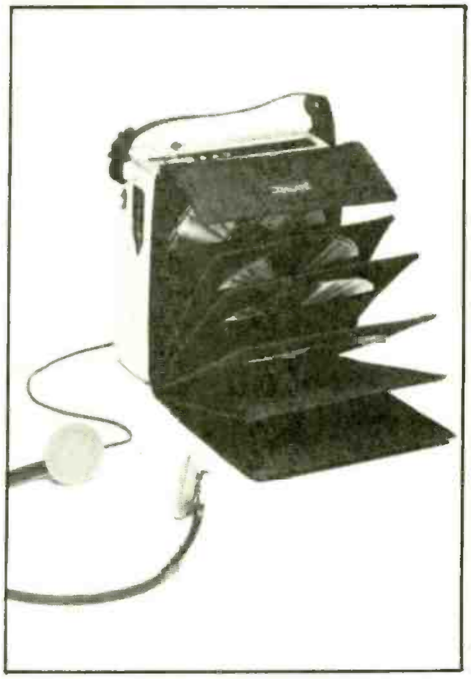
Rabbit Double Play

Hardly had GADGET reported on the VCR Rabbit and Multivision 3.1 (June, p. 1, 6) when *Rabbit Systems, Inc. (233 Wilshire Blvd., Santa Monica, CA 90401)* announced its new **Double Play**. You may have heard this before, but the Rabbit Double Play "adds a second screen to any TV set," one-eighth the size of the set's standard picture. Equipped with remote control, the unit allows the user to scan channels on the generated mini-screen, freeze the small screen image, switch images between the two screens and monitor a videotape while viewing broadcast or cable programming. The Double Play's small screen picture-in-picture can also be moved to any of the main screen's four corners and will display station identification. With the introduction of this product, price competition heats up in the TV digital transformer market. Price: $229.

Zapit Remote-Control Booster

Remote-control signal boosters, on the market for around a year, are becoming a standard item in many manufacturers' lines of TV and home electronic accessories. Latest to announce this addition to its product line is *Monster Cable (101 Townsend St., San Francisco, CA 94107)*. This power booster is dubbed **Zapit**, and it attaches to the front of any infrared remote control unit. A "special lens system" receives infrared light which in turn is amplified and retransmitted, allowing the beam to "bounce off walls and ceilings for ultra-fast activation" of TVs, VCRs and stereo systems, at distances up to 100 feet. Price: $24.95.

Here's an excellent consumer refinement in the miniaturized electronic storage of data. Dubbed **The Calling Card**, this 2,024 character-memory computer also functions as a calculator. From *International Telesis, Inc. (1140 Broadway, New York, NY 10001)*, the Calling Card achieves impressive thinness and compactness (it's less than palm-sized) without sacrificing either data clarity or functionality. Programming information into the memory is simple, with just about all the instructions needed printed on the back of the card itself. Besides storing phone numbers, addresses and appointment reminders, because of its design, The Calling Card can be used (in a pinch) as an electronic memo pad. There's even a security code which will deny access to others. Delicate in both its micro-processor circuity and its LCD, the product is sold with a fabric carrying case and instructions which warn, "should never be carried in trouser pockets or wherever it may be subject to pressure or bending damage." Price: $35.



CD/Mate

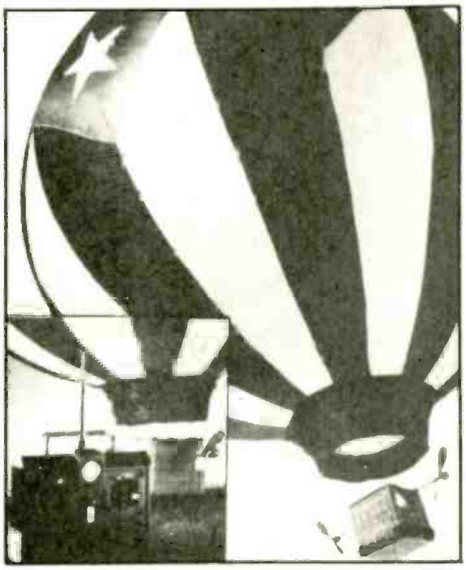
If portability is what attracted you to the CD in the first place, you might want to know about a new carrying case for the discs, handily designed to go with the portable CD player. Called the **CD/Mate** *(P.O. Box 1480, Burbank, CA 91507)*, the soft fabric case protects each disc in a "fleece-lined pocket," further protecting them with a padded cover on the carrier itself. Much more compact than the standard "jewel boxes" sold with CDs, the CD/Mate is outfitted with four Velcro tabs which can fasten the carrier to the top of your portable player. The company markets a six-pocket CD/Mate and plans to have a 12-pocket version on the market this summer. Price: $9.95.

Sanyo Auto Sound System

Remember when audio quality was the big issue in automotive sound systems? In the modern world, attention has shifted to security, namely how to keep the system from being ripped out of the car. *Sanyo Electric, Inc. (Consumer Electronics Division, 1200 W. Artesia Blvd., Compton, CA 90220)* has introduced a new system with built-in security. In addition to 200-watts-per-channel maximum output, an "FM optimizer, line outputs and Dolby Noise Reduction," the new Sanyo FT928S4 **Auto Sound System** "incorporates a universal security code." A triple-digit access code is entered into the system memory. Removed from the car, the audio system will refuse to operate unless the same code numbers are entered again. Decals warn "would-be thieves that the unit is inoperable," provided the miscreant can read, or has time to. Price: $219.99.

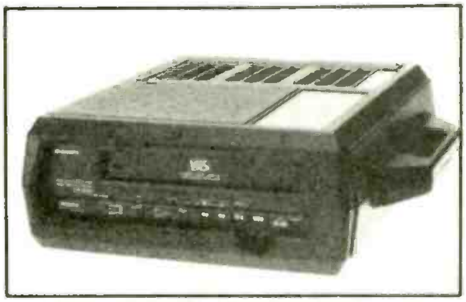
Bits & Pieces

Love the idea of lighter-than-air travel, but a bit afraid of heights? *The Sharper Image (650 Davis St., San Francisco, CA 94111)* may have the perfect solution, in the form of a **Radio-Controlled Helium Balloon**. Dual electric motors mounted in the authentically detailed gondola basket power this 4' diameter, brightly colored balloon featuring two-ply construction. A radio transmitter, complete with dual joysticks, servo reversing switches and a battery charge meter, guides your balloon on its flights, although Sharper Image does suggest use of a kite string or tether. Inflation requires 35 to 37 cubic feet of non-flammable helium, with about $10 buying 8 to 10 hours of buoyancy. The item is sold with a battery charger, instructions and an extra inner balloon. It's also covered by a 90-day warranty. Price: $308.50.



Radio Controlled Helium Balloon

A brand-new name entry into the already congested home video equipment market, *Shintom West Corp. of America (20435 S. Western Ave., Torrance, CA 90501)* is the U.S. branch of a Japanese firm, Shintom Co., Ltd. The company manufactures car stereo equipment for Audiovox and Sears and videocassette systems for PortaVideo International, among others. The firm's initial entry, in fact, is a front-loading **Videocassette Playback System (VP-2000)** with "visual search in fast forward and reverse, freeze frame with fine tuning control, automatic rewind and TV/VCP switching," with up to "8 hours of playback" in the extended-play mode. The VP-2000 is to be sold in the U.S. by United High Tech and Gleason Electronics, with particular emphasis on the "commercial and rental" markets. Price: $289.95.



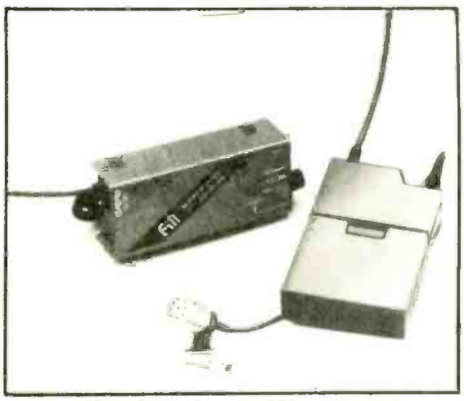
Videocassette Playback System

We have to wonder why these units aren't standard equipment with car-installed FM radios. It's an **FM Booster** which *Herrington (10535 Chillicothe Rd., Kirtland, OH 44094)* says will turn "weak, fading FM stations into clean stereo" reception. The Booster plugs into the car's radio antenna (a 13" cable is included with the product) and mounts under the dashboard with double-back foam tape. The result is audibly improved "FM reception in both urban and rural driving." Price: $38.50.

The manufacturer is calling it "a dramatic breakthrough in VHF/UHF radio technology," but for anyone who does a lot of highway driving, the new **Informant Mobile Receiver** (model INF-1) might just establish itself as an everyday necessity of travel. From *Regency Electronics, Inc. (7707 Records St., Indianapolis, IN 46226)*, the Informant Receiver is preprogrammed with local, state and national VHF and UHF police frequencies for all 50 states as well as frequencies utilized by the National Weather Service. With a single touch, the Informant will search these frequencies for a particular state at four times the speed of conventional scanners. A digital display shows the state and type of transmission being monitored, while a "hold" switch will keep the receiver on a single frequency. The Informant can be wired directly into a vehicle's DC system or can be used with a cigarette lighter adapter. Price: $369.95.

Informant Mobile Receiver

From the rock concert stage to the boardroom, family room or special event seems to be the route traveled by the wireless microphone. *Ambico, Inc. (50 Maple St., P.O. Box 427, Norwood, NJ 07648-0427)* is touting its V-0625 **Wireless Lapel Microphone**, with a 100-ft. range, as perfect for use with a camcorder. The system's electret condenser mic features "reversible clip for easy attachment to any piece of clothing," while its lightweight transmitter is equally as flexible. The "compact receiver mounts easily on camcorder, video camera or tape recorder" and features an on/off/volume control with LED. The plug output and RCA-plug adapter "will fit most audio and video recording devices." Price: $89.95.



Wireless Lapel Microphone

Bits & Pieces

Ergocycle II Exercise Bike

The fitness industry has not been slow in adapting electronic technology to the on-going boom in exercise and health equipment. *J. Oglaend, Inc. (40 Radio Circle, Mt. Kisco, NY 10549-0096)* has introduced the **Bodyguard 960 ErgoCycle II Exercise Bike** which includes an "electronic instrument panel" that displays "distance, speed, time and revolutions per minute." There's also a "simple, easy-to-reach workload adjustment knob" and an "electronically balanced, solid steel flywheel." The entire unit weighs 60 lbs. and measures 16" by 33" for portability and ease of storage. Price: $495.

Rechargeable batteries are becoming a bigger item in the marketplace, but why not get a jump on everyone with a flashlight that does away with the need for any batteries? Chronar's **Sunlite Flashlight** harnesses the sun via a solar panel which maintains the charge in three nickel cadmium batteries. The charge is good for a full three months, even if the Sunlite is kept in a dark drawer. *Free Market (1001 Connecticut Ave. N.W., Suite 638, Washington, DC 20036)* says they're also good for an average 1,000 full recharges. The flashlight carries a 10-year limited warranty on the solar panel, with the product covered for 90 days. Price: $41.95.

Personal Voice Messaging System

Although aimed primarily at the business market, we know there are households that could use the **Personal Voice Messaging System** (PVM-4260), a deluxe version of an answering machine from *Code-A-Phone Corp. (16261 S.E. 130th, Clackamas, OR 97228)*. Designed for use with a switchboard (which may leave even hyper-phone-active families out), the PVM-4260 will send a call back to the operator after a message has been left and can allow a caller to dial other internal extensions on the same phone system. Users are provided with 30 minutes or more of recording capacity, and the unit includes a digital call/message counter. A beeperless remote control, which can be activated from any touch-tone phone, offers some 15 functions, including announcement change, fast forward, backspace, memo record, announcement bypass and remote on/off. Price: $249.95.

Tap Detector III

There was a time when this kind of product wouldn't have had a very big market, and it certainly would not have been found in any but specialized mail-order catalogs. Today, however, a good many consumers might be interested in the service performed by the **Tap Detector III**. Offered by *The Sharper Image (650 Davis St., San Francisco, CA 94111)*, this device is easily installed between a phone and its wall jack. Detecting tiny changes in line impedance, an audible signal and a warning light alert a phone user to possible electronic eavesdropping or, less dramatically, someone listening in on an extension. The detector's sensitivity can be adjusted for individual phone lines, and it operates off the phone's own voltage. Pocket-sized, it can be used with any phone line, at home, at work or even at the U.S. Embassy in Moscow. Price: $52.

Coming in future issues of GADGET newsletter

- **Speaker Power—Acoustic Research's Powered Partners are high-quality sound you can take nearly anywhere and use with just about any source. GADGET does some mobile listening.**
- **High end, High tech—Electronic products from the Proton Corp. have a near cult-like following. We look at and listen to the firm's 625 Television Receiver/Monitor.**
- **Video Combo—GADGET tests two VHS video player/monitors, the Dukane Video Pro 7 and Citizen's VCP-5MU.**
- **Double-duty Danny—Not only do the stuffed animals from Phonetica One, Inc. respond to verbal commands, but the company says they also function as security sentinels. GADGET gets to know "Danny the Outback Bear."**

A Chassis of Another Kind

Almost anything that you might have laying around makes the perfect base for many of your electronics projects

By Homer L. Davidson

☐BESIDES BAKING YOUR FAVORITE CORN BREAD, THE METAL PAN Also served as the chassis for radios and transmitters before World War II. That aluminum or tin bread pan was easily drilled and sections cut out to mount the different components. Back in those days (or in the dark ages) ready-made chassis or plastic boxes were not available. Some were too costly for the beginner in electronics (Photo 1).

Today, there are many different containers in which to build that favorite project. Just walk down the aisle of a hardware, craft store, or shopping center and let your mind wander through the various containers. There are plastic boxes, metal pans, wooden plaque boards, sheets of metal, and many more to choose from.

You can roll your own from pieces of lumber, masonite, or metal found in the basement or at garage sales. The inverted "L" chassis can be constructed of a piece of masonite, metal, or pine board. Save those scrap pieces of styrofoam from packing boxes to mount small projects or solar cells upon. Reused plastic deodorant containers are great for mounting those small radio or CB projects.

The Bread Pan

During the first part of World War II, I built a one-tube radio while stationed as a T-Corporal, in Macon, Georgia. The radio consisted of a 117L7-GT tube, which plugged directly into the AC power line. The tube was mounted on the top, with a variable capacitor, and the broadcast coil mounted underneath the chassis. Yes, the chassis was a plain-metal, corn-bread pan that cost 17 cents in those days. (Later, *Mechanics Illustrated* magazine paid $40.00 for the write-up.)

The coil was hand wound on a discarded toilet paper cardboard roll. Although, the radio cost only a few dollars to build, it covered the entire broadcast band and brought us the latest news. Money was hard to come by and electronic parts were difficult to obtain, so you improvised. On local broadcast stations, the sound was loud enough, so the earphones hung down from the round brass bed post to provide for easy listening.

Now, the metal bread pan comes in many sizes and is made of aluminum, not the rusty-type metal. The containers are cheap and found everywhere. They are ideal for larger projects. The aluminum pans are easy to drill or mounting holes may be made with an ice pick. Take a look, they may fill your chassis needs.

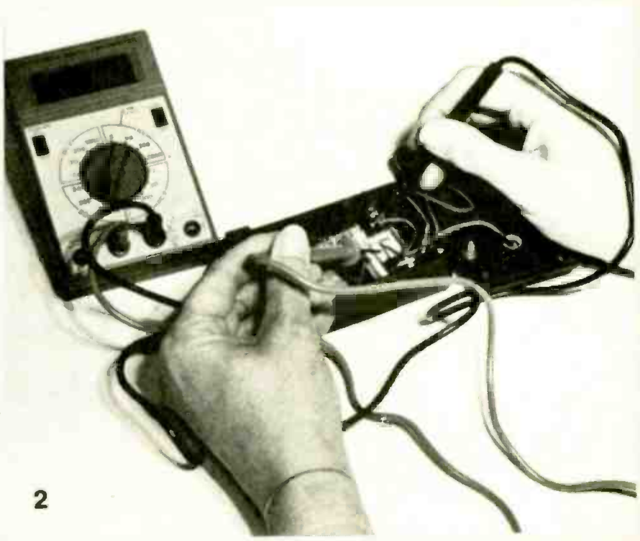
Plastic Boxes Everywhere

Many small plastic boxes can be found at electronics stores to construct your favorite project (Photo 2). But, don't forget to look in the hardware or hobby-craft stores for those odd and large plastic containers. Plastic bake pans and frozen-food boxes may accommodate that large electronic project. Some have plastic-fitted lids.

Be careful when drilling holes in clear plastic boxes or lids. Too much pressure may cause the plastic to crack (Photo 3). The plastic piece has a tendency to kick up when drilling.

1

A pocket-size solar-cell radio was built inside a throw-away deodorant container. The chassis consisted of a cut-to-shape styrofoam piece on which to mount the solar cells and all the other radio components in the circuit.



2

Commercial and hobby type plastic boxes are found at most hobby and electronic parts stores. Those containers may have metal or plastic lids. If you want to do so, perfboards or printed-circuit boards may be used as lids.

Hold the container down and apply light pressure from the drill. Wipe off the excess plastic pieces with a soft cloth.

Another method to make holes in a plastic surface is with the sharp point of the soldering iron. Make a circular motion to enlarge the hole for sockets and larger objects. Be careful not to apply too much heat. Clean the inside burr edges with a pocket knife after it has cooled. Holes made with the tip of the soldering iron very seldom chip or crack the plastic surface. Always work on a cloth or rug when drilling or mounting components on a plastic box to prevent surface scratches.

Plaque Boards

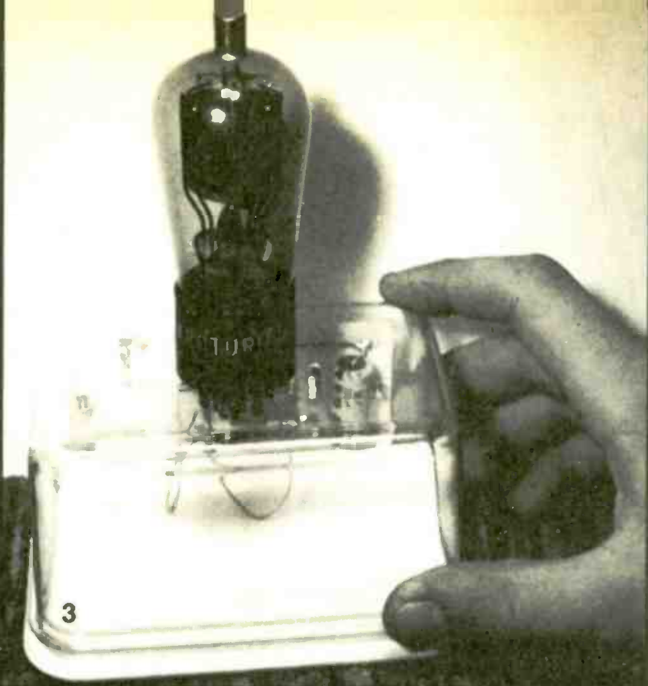
Cruise around in the hobby or craft stores for finished wood plaque boards to mount your project on (Photo 4). Those unfinished boards may be used to mount crystal set radios, solar cells and testing projects. You may choose from painted or unfinished board or cut the board to fit your own needs.

Most plaque boards are made from cedar or pine lumber. They are easy to drill and work with. Sand down or clean up all marks on the board before mounting any parts. A coat of clear lacquer spray found in most stores makes a shiny finish. Some projects may be dipped in liquid plastic for a clear finish that provides a very durable surface and enhances the appearance of the project (Photo 5).

Throw-Away Foam

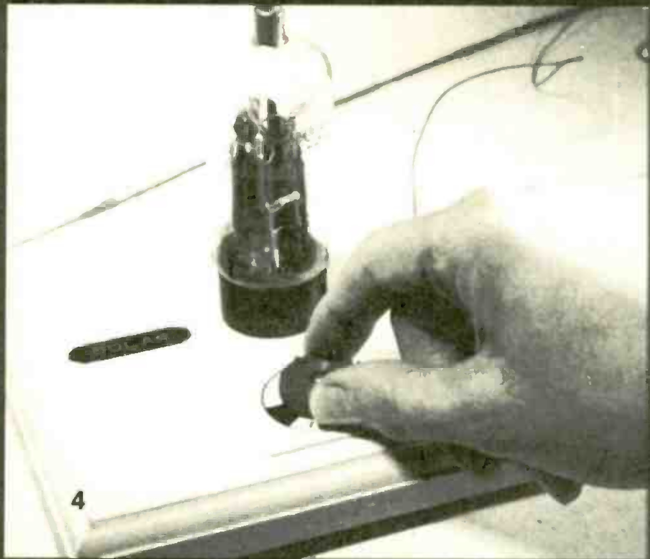
Don't overlook the discarded pieces of foam material to mount small parts or solar cell projects (Photo 6). Those pieces of styrofoam come in packing boxes, pieces of insulation or can be bought separately at most hobby-craft stores. Although, the material looks quite fragile, it may be protected with a coat of lacquer or mounted inside a plastic box.

The light foam material is easy to work with since it can be cut with a pocket knife. Use a metal awl or sharp instrument to make holes through the foam pieces. Regular hookup wire or capacitor and resistor leads may be poked right through the soft material for easy mounting. Larger components may be cemented to the foam with rubber silicone cement. Just



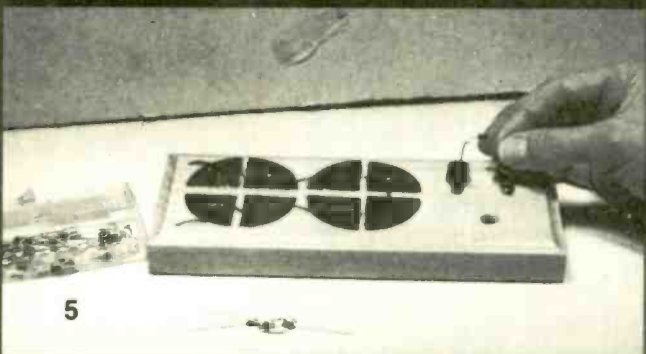
3

Clear plastic frozen-foods boxes may be used to house large electronics projects. Plastic boxes offer protection to small component parts and solar cells. Be careful not to crack the plastic sides when drilling small mounting holes.



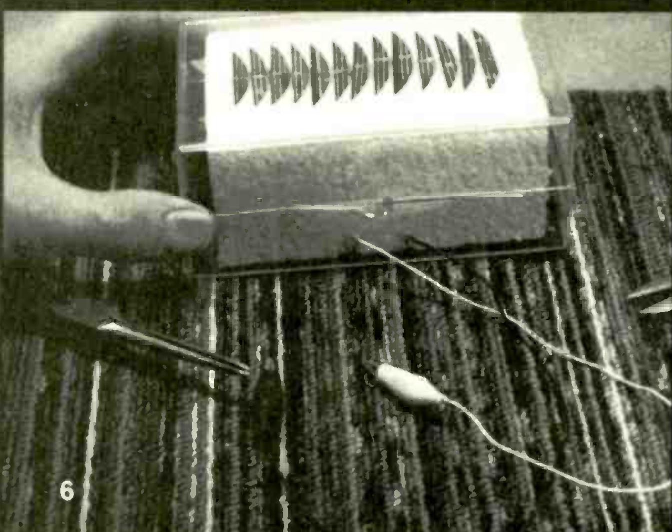
4

Small wooden craft boards may be used to construct radios or electronic testers. These boards may come unfinished. They may be cut down to fit your project. If you do your own wood-working, you should have an abundant supply.



5

The wooden plaque boards may be left unpainted with several coats of lacquer, varnish or clear plastic spray applied. After the project is finished and tested, it may be dipped in a clear liquid plastic for added protection.



6

Scrap pieces of foam material may be used to mount small projects parts on. Discarded foam packing pieces can be formed with a small saw or pocket knife. Place the foam assembly in a discarded component plastic box for protection.

place a dab of rubber cement under each cell when mounting solar cells to the soft styrofoam chassis (as shown in Photo 7), and you're home free.

Roll Your Own

Scout the hardware or lumber stores for decorative sheet metal to construct a large and deep chassis. You may also want to build your own cabinet enclosures out of that type of material. Aluminum sheet-metal comes in clear, polished, and brass finishes and may be cut with a pair of tin shears.

Make the sharp bends or edges on a desk or table edge. Place a board in a bench vise and make the required bends. Hammer the finished ends over a piece of angle iron clamped in the vise. Protect the metal finish with a work cloth or towel. You do not need a regular sheet metal bender to bend the chassis into shape.

The "L" Chassis

The inverted "L" chassis is very attractive and easily built from pressed wood and plastic. Odd pieces of soft pine may serve as the rear chassis. Cut the front mounting piece from plastic, masonite or painted metal (see Photo 8). Simply fasten the two pieces together with two or three wood screws.

Always, cut the rear board 1/2-inch shorter than the front panel. Sand down the rear board for a clean surface. Either mount the components directly on the board or use a printed-circuit or perfboard as sub chassis. The printed-circuit or perfboard may be fastened to the wooden chassis with a small dab of silicone rubber cement at each corner. Finish up the chassis with small rubber feet cemented to the bottom of the board.

The sides for the "L" chassis don't have to be brand new—almost any odd piece of lumber that you might have laying around will do. Short leftover pieces from the workshop may provide the perfect piece of wood for your radio project. Pieces of plastic may be picked up at garage sales. The masonite front panel may be knocked off that old TV cabinet. Just look around and you're bound to find the makings of an inexpensive chassis or cabinet.

Reuseable Containers

How about building that small radio or portable project in a throw-away deodorant plastic container? Those reusable containers are found throughout the home—in round, semi-round, and oblong shapes. With a little imagination and effort, those plastic containers can house your next electronic project, while relieving the pressure on your pocket.

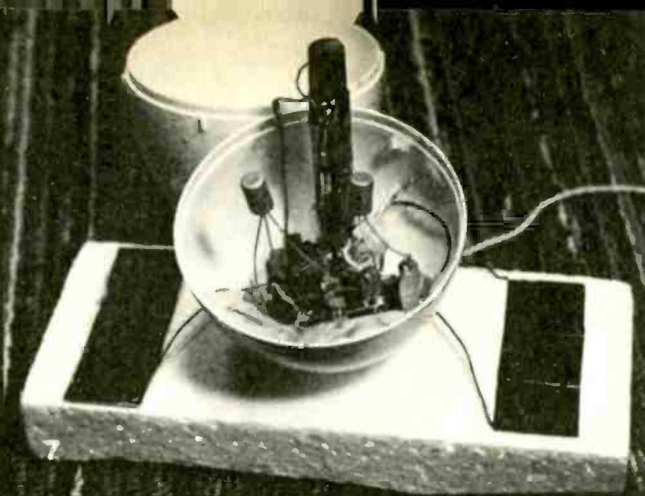
The throw-away container is ideal to hold a pocket radio, electronic tester, or some other gadget. Many have removable covers, and are unbreakable in many cases. Besides projects, they can store that extra set of test leads, small tools and electronic parts.

Do not overlook the surplus stores for low-priced electronic equipment. Discarded chassis or enclosures may be found in local outlets or advertised in magazines for less than a buck. Manufacturers' over-runs or discontinued merchandise can be picked up most anywhere. Scout around the garage sales for surplus or discarded electronic equipment.

The Finished Project

A wood cabinet provides a rich finished container for any electronic project. Often, hard woods such as oak or maple

(Continued on page 104)



7

A small broadcast-band radio was built inside a round plastic ball and mounted upon a piece of throw-away foam material that served as the chassis. A dab of rubber silicone cement bonded the plastic ball and solar cells to the foam chassis.

8

Two pieces of scrap material may be screwed together to form form an inverted L chassis. Plastic or metal scrap may form the front panel, while compressed or white pine wood is used as the base. Few tools are needed to build this type chassis.

9

Professional looking cabinets can be built from odd pieces of oak, birch or maple scraps. You may need a router and power sander to apply the finished touches. This antique oak cabinet was constructed from a piece of discarded oak mop board and the masonite front panel from an old TV cabinet.

ALL-BAND FIELD ST

An FSM is the most reliable indicator that a CB or amateur station is really putting

☐IN THIS AGE OF DIGITAL GIZMOS AND WHATSITS THAT measure everything with an accuracy out to the umpteenth decimal place, the old-fashioned FSM (*F*ield-*S*trength *M*eter) is still the most-reliable indicator of RF energy for CB and amateur transmitters and antennas. The reason it's the most reliable indicator is because an FSM indicates *radiated RF energy*. It doesn't tell you anything about the standing-wave ratio, transmission-line losses, the transmitter's efficiency factor, or anything else other than how much relative RF energy is being sensed at the meter's location. If you can increase the amount of energy radiated from the antenna, the FSM's reading will similarly increase. If the energy leaving the antenna decreases, the FSM's reading will similarly decrease. If you're using a directional beam and you swing it around so that the FSM is now off the back of the antenna, the meter reading should decrease—or you have a **BIG problem** with your antenna.

If someone talks you into blowing a week's wages on a new kind of low-loss transmission line, and the FSM—at the reference location—indicates no, or very little change in field strength, figure you most likely would have been better off wasting the money on wine, women, and song.

Its Usefulness

Since an FSM is sensitive only to the relative amount of radiated RF, it's an ideal indicator for almost any kind of transmitter or antenna adjustment that affects how your rig gets out. For example, let's assume that you have purchased one of those new pocket-size, quick-mount mobile-CB antennas that claim to outperform any "full-length" antenna. If you just swap antennas, the best you can hope for is some good buddy saying something to the effect that your new signal *appears* to sound louder today than it did a few days ago. Since the ear is a notoriously poor judge of signal strength, and also because a receiver's AGC (*A*utomatic *G*ain *C*ontrol) will automatically equalize moderate to strong signals, a signal report from anyone receiving your signal when it's stronger than a flea's whisper is worthless.

On the other hand, look what an FSM will do for you. If it's a super-sensitive model, such as the one shown in the photographs, you set it up well out of range of the antenna's "shock field." (Say a quarter to a half a block away). You leave your old antenna on the Detroit Iron, key the transmitter, and note the meter reading. (Use binoculars if your vision isn't all that good, or have someone else read the meter.) Next, you install the new antenna and tune it; first following the supplied instructions on adjusting the antenna for lowest VSWR, and then tweaking the antenna tuning adjustment for the highest (strongest) reading on the FSM. If the new antenna is truly a better performer, the FSM's reading should be higher than it was for the old antenna. If it isn't, either you have done something wrong, or have made a poor choice (a nice way of saying you've been "taken").

You will most likely be surprised to discover that the lowest VSWR might not correspond to the highest FSM reading. Within reason, always go for the highest FSM reading when adjusting an antenna or tuning a transmitter: Low VSWR readings and minimum RF-output current don't necessarily guarantee maximum RF output. As long as the antenna and final-amplifier parameters are within their safe or rated range, use an FSM indicator when optimizing RF output.

Two Kinds

There are basically two kinds of field-strength meters: tunable and untunable. Both types are available in amplified and unamplified models. Both types have their advantages and disadvantages. The basic tunable FSM circuit is shown in

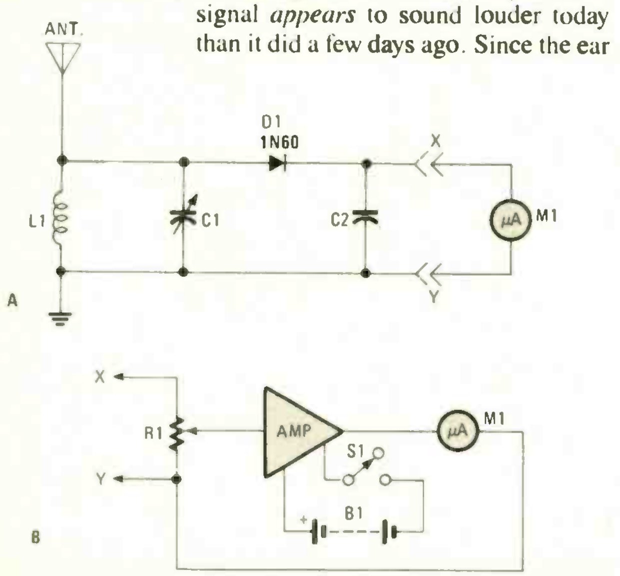


Fig. 1—The basic tuned FSM circuit is shown in 1A. The amplified meter in 1B sharply increases overall sensitivity.

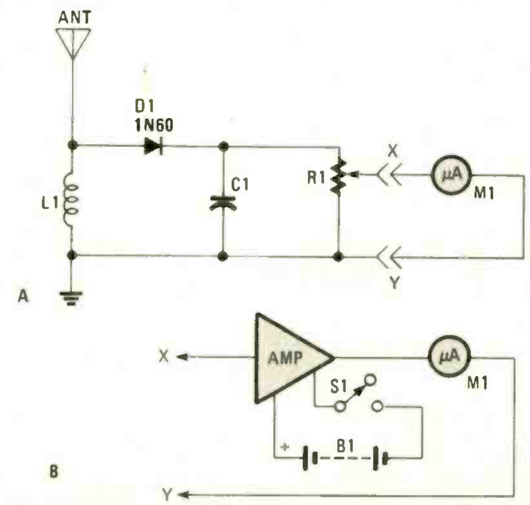


Fig. 2—An untuned field-strength meter is shown in 2A. An amplified version of the meter module is shown in 2B.

RENGTH METER

out the soup! **By Herb Friedman**

Fig. 1A. Coil L1 and variable capacitor C1 comprise a tuned circuit at the operating frequency of the transmitter or RF source. Naturally, a high voltage (at extremely low current) is developed across L1-C1. The RF voltage is rectified by D1—which should be a germanium diode such as the 1N60 because its breakover voltage is less than that of a silicon diode. The RF is filtered by C2, a small capacitor whose value is usually .001 µF below 30 MHz, or 100 pF from 30 MHz to 148 MHz. The resultant DC appearing across C2, which is proportional to the amount of RF received by the antenna, is indicated by meter M1.

If the signal is so strong that the meter pointer is "pinned," the sensitivity can be reduced by detuning C1. Unfortunately, in order to get any decent amount of sensitivity, meter M1 must be a 0–50 µA or a 0–100 µA model, both of which are rather expensive.

It's often much less expensive to use the circuit shown in Fig. 1B—a DC amplifier driving a less sensitive 0–200 µA or a 0–500 µA meter. The amplified meter is connected at the points labeled X and Y. The amplifier usually makes the overall sensitivity so great that tuning-control C1's adjustment becomes excessively critical, and literally breathing on its shaft will "pin" the meter. Instead, we use R1 as a "volume" control for the amplifier. It provides a broad range of adjustment.

Untuned FSM

A basic untuned FSM is shown in Fig. 2A. Essentially, the tuned circuit has been replaced by L1, an RF choke. (It's also possible to use a 10,000- or 20,000-ohm resistor instead of L1.) As you might imagine, the RF voltage developed across the choke is considerably less than that developed across a tuned circuit, so meter M1 must be extremely sensitive: 0-50 µA is almost a universal value. But even with so sensitive a

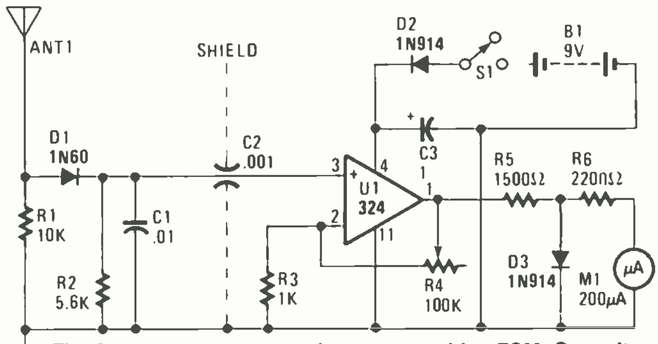


Fig. 3—This is the untuned, super-sensitive FSM. Capacitor C2 can be a conventional axial-lead ceramic capacitor instead of the feed-through type used in the circuit.

The Field-Strength Meter Kit is an old-fashioned type. Nothing is pre-assembled. Even the meter's special pre-calibrated scale must be installed by the builder.

PARTS LIST FOR THE ALL-BAND FIELD-STRENGTH METER

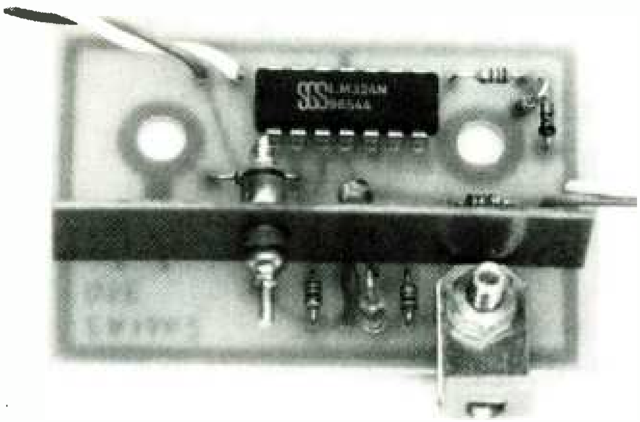
SEMICONDUCTORS
D1—1N60 germanium diode
D2, D3—1N914 silicon diode
U1—LM324 quad op-amp, integrated-circuit

CAPACITORS
(All capacitors rated 16-WVDC minimum.)
C1—0.01-µF ceramic disc
C2—0.001-µF feed-through, see text
C3—1-µF, Tantalum

RESISTORS
(All fixed resistors are ⅛-watt, 10% units.)
R1—10,000-ohm
R2—560-ohm
R3—1000-ohm
R4—100,000-ohm trimmer, audio, or liner potentiometer
R5—1500-ohm
R6—2200-ohm

ADDITIONAL PARTS AND MATERIALS
ANT1—Telescopic antenna
B1—9-volt battery
M1—200-µA DC meter
S1—SPST switch
Cabinet, wire, solder, printed circuit materials.

A complete kit of parts except for B1 (order #K-6321) is available for $39.95 from Dick Smith Electronics, PO Box 8021 Redwood City, CA 94063. Phone 800/332-5373 for details and shipping information. Please allow 6-8 weeks for delivery.



This is the completed printed-circuit assembly. The metal L-bracket at the lower right is the mounting for the telescopic antenna. It is secured to the board with a screw.

meter—the overall sensitivity is low, and the FSM is best used with relatively powerful RF sources.

Still, not having to tune the FSM is advantageous, so what's often done is to substitute an amplified meter, as shown in Fig. 2B, for the "barefoot" meter.

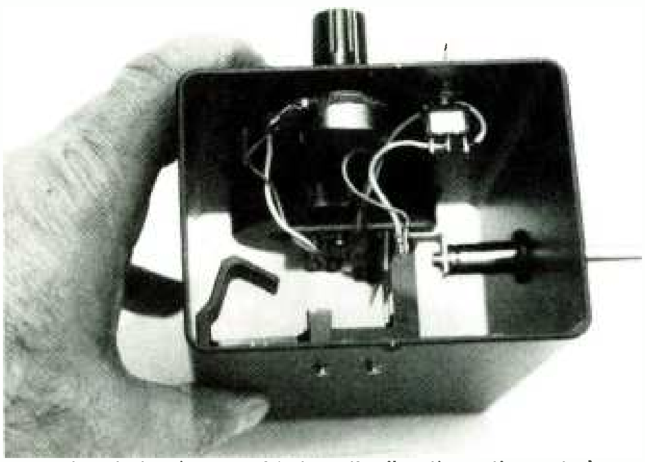
Notice that the Fig. 2B amplifier circuit is very similar to the one shown in Fig. 1B. The difference is R1. In Fig. 1B, it's part of the add-on amplifier. In Fig. 2B, the potentiometer is a part of the basic meter circuit.

Our Circuit

For most applications, the untuned but amplified FSM is the best choice because it has high gain, yet covers a broad range of frequencies without the need for plug-in or band-switched tuning coils. In fact, with a good amplifier design such as the one shown in Fig. 3, the FSM can almost sense that mythical flea's whisper—from 3 through 148 MHz no less—and yet, it is so immune to overload that, the meter pointer won't pin.

The key to the circuit is the amplifier, a type 324 quad op-amp, of which only one section is used. Why are we wasting three sections? Because, A) the 334 is cheap and easy to get; B) it's designed for a single-ended power supply (one, not two batteries); C) it will provide at least 20-dB DC gain; D) its output current is self-limiting—the pointer can't be pinned.

The photographs show an all-band FSM that uses the



The printed-circuit assembly installs directly on the meter's terminal screws. The board is slightly narrower than the meter; it can slip through the meter opening in the cabinet.

circuit shown in Fig. 3. Other than using the specified integrated circuit (U1) and providing a small shield to separate the RF detector from the amplifier, just about anything goes in the way of parts and assembly. However, a large, sensitive meter, a metal cabinet, and a good-quality telescopic antenna will probably cost you more than the same project in kit form from Dick Smith Electronics, so we'll describe the assembly of Dick Smith's Model K-6321 Field Strength Meter. If you want to homebrew your own FSM simply use our circuit and photos as a guide. But you'll have to make your own printed-circuit board.

Construction

The kit comes completely knocked down; even the meter's scale and its mounting hardware are separate. The first step is to install the scale and put the meter aside; which sounds easier than it is because the clear faceplate doesn't snap off. (It's supposed to snap off, but ours didn't.) Very carefully, work a thin knife blade between the face and the meter's body dead center on the top edge. Rock the blade carefully—so you don't break the face. When you feel the face suddenly "give," it's loose. You can then remove the face, install the scale, and then snap the face back into position.

Next, assemble the printed-circuit board. It contains both the RF detector and the amplifier, and it mounts directly on the meter's terminals.

First, install a small shield across the length of the board, as shown. It's really a small strip of copper-clad board with a hole for feed-through capacitor C2. Small pins connect the copper foil of the shield through the top of the main board to the ground traces on the foil side. The feed-through capacitor must be soldered, as shown, to the shield. But if you're going to homebrew all the way and can't locate a feed-through capacitor, simply substitute an axial-lead ceramic type. Slip a short length of sleeving over one lead and pass that lead through the hole in the shield.

As shown in the photos, install the remaining board components, as well as a small metal L-bracket that will support the antenna. Connect the wires for sensitivity control R4 and for power switch S1 to the board, and then install the board on the meter's terminals. Make certain the board is installed so that the connections to the meter are the correct polarity. If the meter was supplied with a thin shorting wire across its terminals, be sure to remove the wire before installing the board.

Install the battery holder inside the cabinet, then slip the meter assembly into position. But before securing the meter, pass the antenna through a grommeted hole in the top of the cabinet and attach the bottom of the antenna to the L-bracket. Only when you have completely secured the antenna should the meter's mounting nuts be tightened. Then complete the remainder of the wiring to the panel-mounted components.

Meter Use

No adjustments are needed. Simply set power switch S1 to OFF, install the battery in its holder, and the meter is ready for you to use.

When you want to indicate the relative value of RF from an antenna, simply pull out the telescopic antenna, set S1 to ON, and advance R4 until you attain a convenient meter reading. Don't worry about a sudden increase in RF pinning the meter. Although the meter can read right up to the top of the scale, and perhaps even ease against the pointer's stop pin, it won't slam into the pin and damage the pointer, or knock the pointer's driving coil off its bearing. ■

TV RECEPTION in MOUNTAINOUS REGIONS

By Sam Allen

Here's an article for the city dweller and friendly mountain folk alike who are without cable

CABIN FEVER SETS IN QUICKLY WHEN YOU SPEND THE WINTER snowbound in a small cabin like mine; the only cure is a healthy dose of TV. I know from experience, because I spent six winters as a site manager at a mountain camp. When I took the job, I was told that TV reception was impossible in that location. The camp was in a small valley totally surrounded by mountain peaks. Since electronics had been my hobby for years, I couldn't let a challenge like that pass. I decided that I would find a way to pull in the local TV stations.

Every fall as the squirrels gathered nuts, I would prepare for the winter by trying new ideas on my antenna system. It took two years of trial and error before I succeeded in getting an acceptable picture, but I did it! If you're in a similar situation, you can learn from my experience and save time and money.

A Crooked Straight Line

The most important thing I learned about receiving TV signals in the mountains is that you can forget about direct line-of-sight antenna aiming. But there are other ways to get a TV signal; reflection, diffraction, and scattering are all ways that a signal can get around an obstacle. Reflection plays the most important role in a mountainous region, but diffraction and scattering can also have an effect.

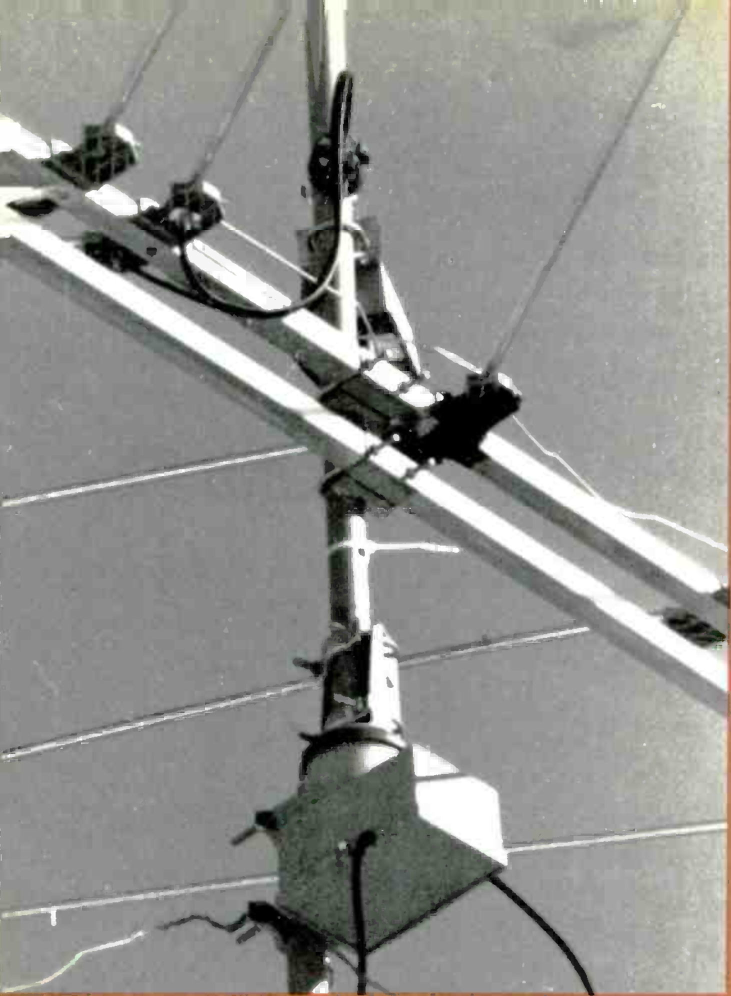
TV signals behave a lot like a beam of light; they can be reflected like light is reflected by a mirror, or bent like light is bent by a lens. In a mountainous region, the high peaks may have a direct line-of-sight to the transmitter. When the TV signal hits one of those peaks, some of the signal will be reflected in another direction. The direction depends on the angle of the signal and the reflector. Since a mountain peak is a rough, irregular surface, not a smooth reflector, it will have an unpredictable effect on the TV signal.

When a signal passes over the top of an obstacle such as a mountain peak, it can be bent downward again by diffraction. When a signal reaches the upper layers of the atmosphere and the ionosphere, it can be bent back to Earth making long-range reception possible; but there is a skip zone between the transmitter and the point of reception that makes that type of propagation unsuitable for extending local reception. However, a related phenomenon known as *scatter* spreads a weak signal throughout the skip zone. In a mountainous region, you may be able to pick up scattered signals with a sensitive enough antenna system.

You will probably find that the most useful signals in a mountainous region come from reflection because they are more constant and reliable than signals that depend on atmospheric conditions. However, I found that the atmosphere will still play tricks with the signal. When the weather was just right, Canadian stations would block out the local Utah stations I was aiming for; and every time a large airplane flew overhead, it would act as a reflector, and I would briefly see signals from Colorado or Nevada, so getting TV in the mountains can teach you a lot about radio propagation.

A Site Survey

To receive reflected signals, antenna placement is very critical. The valley where I lived was crisscrossed with many narrow beams of TV signals. A shift of a few feet in antenna location can make the difference between a good signal and no signal at all. Some beams were strong and some were weak. Some locations were better for a particular station, while others were equally good for all stations. Before I learned that fact, I wasted a lot of effort using continually larger antennas and higher masts in a location close to the



A rotor positions the antenna by remote control. It allows me to stay warm and dry on cold winter nights; instead of walking to the antenna on snowshoes. All I needed to do was adjust the control knob inside the cabin.

cabin that was not in a favorable spot. So the first step that you should take is to conduct a site survey to find the best antenna location.

To conduct a site survey, you need a small battery-operated TV and an antenna. The antenna should be small enough to carry around, but capable of picking up weak signals. An antenna designed for use on campers and motor homes is ideal. Mount the antenna on a broom stick to act as a handle and connect the antenna to the TV with a short piece of lead-in wire. Tune the TV to one of the stations that you are looking for and start walking around in a systematic pattern.

Start your pattern close to the house and spiral outward. Continually rotate the antenna in different directions as you walk. Watch and listen for any change in the static pattern on the TV. When a change occurs, stop and slowly rotate the antenna for the strongest signal; then move slowly side to side to try to increase the signal strength.

Change to other stations while you are in that location. If you get a picture, mark the location with a stake or other type of marker. Make a rough map of the area and note the locations along with information about signal strength and channels received. At this point, note any signal at all despite picture quality; later you may be able to get an acceptable picture with a larger antenna and signal amplifiers. Keep surveying the area until you have covered every spot that would be practical to place an antenna mast. The site I decided on was 300 feet from the nearest building located on the side of a hill.

Think it Out

Now analyze the data you have accumulated; you may decide to compromise on the antenna site after weighing the following factors:

•**Distance from nearest building.** The farther away from the building the antenna is, the more cable it will take to reach it. That increases the cost of the installation and lowers the signal received at the TV set because of line losses. Thus, a site that is closer to the building, but with slightly lower signal strength, may actually deliver more signal to the set than one that is stronger but farther away.

•**Ease of installation.** If it will be difficult to carry the mast and antenna along with concrete and other items needed to the location, then you may want to choose a secondary location. For instance, I found a strong signal on a steep side hill composed of loose gravel, but it was practically impossible to work there without sliding down the hill, so I chose another site.

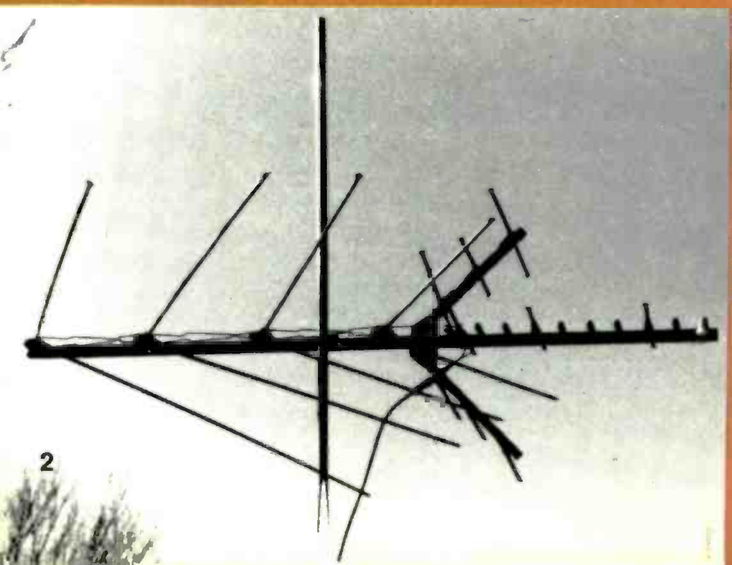
•**Number of channels received.** The installation will be much simpler if you can use one antenna for all of the channels, but that may not be possible. In my installation I was able to get all of the VHF channels in one location and UHF channels in another location. However, I could have received a clearer signal on a few VHF channels by adding a second VHF antenna in a another location.

•**Aesthetics.** A large TV mast and antenna is not very pretty in any case, but in a rustic mountain setting it can really look out of place. I chose a location that kept the antenna hidden behind a grove of trees; you will have to decide how important this factor is for yourself.

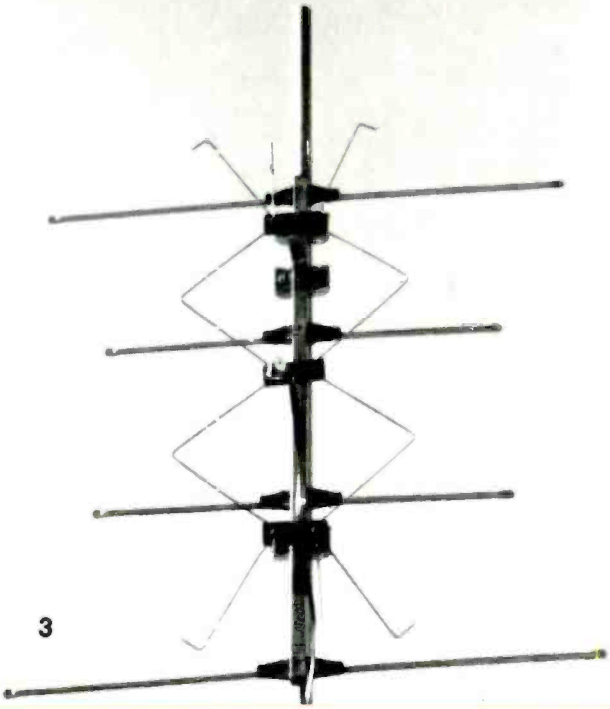
Mast

Unless you're lucky enough to have a strong signal at the site of a building, you are going to need to put up an independently supported antenna mast.

Pay special attention to the location of overhead power lines in selecting the site for your antenna. The power lines pose a safety hazard and they can be a potential source of interference that will deteriorate the TV signal. Do not erect a TV mast close to an overhead power line. The mast is an electrical conductor. If you should touch the mast to the



This type of antenna combines a VHF antenna with a UHF corner reflector. It is useful in locations where both signals are available in the same location, but in my case I needed a separate UHF antenna in a different location.



3

This odd looking four-bay, bow-tie, UHF antenna proved to be the best of the different types I experimented with.

wires while you are installing it, you could be killed. The mast location must be separated from a power line by a distance greater than the total height of the mast.

Normally in fringe-area reception, the rule is "the higher the mast the better," but in mountainous terrain that doesn't always hold true. When working with reflected signals, you will find that the signal beam has an upper and lower limit as well as a side to side limit. If the mast is too high, the antenna may actually be outside of the signal beam. The beams come in at an angle from the top of the reflecting peak to the valley below.

Since you received the signal with an antenna on a broomstick, you know that the signal beam is close to the ground at that location. To get the antenna into the strongest signal area in the center of the beam, the mast needs to be a little higher than the broomstick; the mast also needs to be tall enough to keep the antenna out of the reach of people and animals. About 10 to 15 feet is a good average height.

Several types of commercial masts are available. The important thing is to make sure that they are firmly anchored if you expect the mast to survive the winter. Heavy snow accumulations on side hills tend to creep down the hill like a glacier. The pressure of the moving snow may be great enough to shear off the mast mounting, so it is a good idea to use a base set in concrete.

To strengthen the critical first few feet of mast that will be buried under snow in the winter, I set a piece of 1-1/2 inch steel pipe 2 feet deep in concrete, and extended it above the normal snow level. I attached the mast to the pipe with clamps made to attach an antenna mast to roof plumbing vents. For the mast I used 1-1/4inch dia., 16-gauge steel mast supported with guy wires.

Rotor

If you found during your site survey that the optimum antenna direction varied from one station to another, then an antenna rotor is a good investment. A rotor uses a remote-controlled synchronous motor mounted on the top of the mast. The antenna attaches to the rotor and its position can be changed by remote control from the house. I found that the best position also varied according to the amount of snow cover or vegetation on the reflecting peak, so I had to aim in different directions during different seasons. Before I added a rotor, I had to put on snowshoes and walk to the mast to change the antenna position; so you can see why I appreciated the remote control feature.

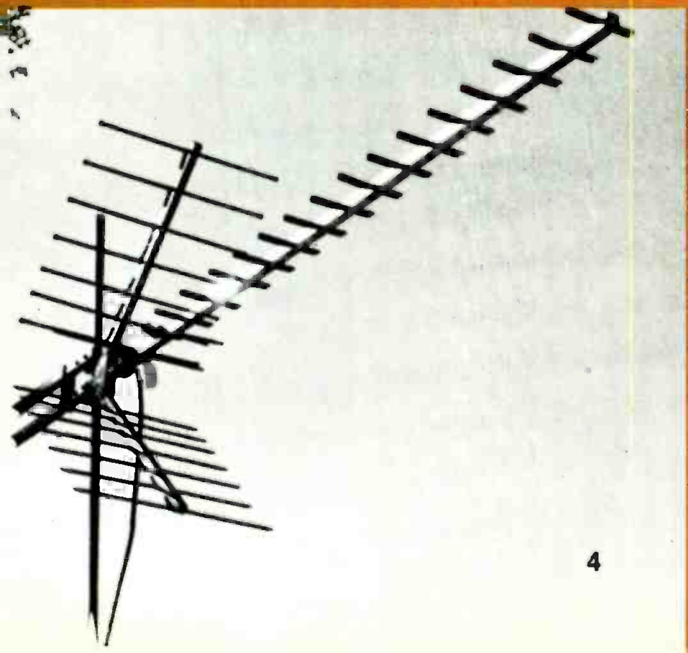
To avoid straining the rotor, mount the antenna close to the rotor. If you mount the antenna high on a mast attached to the rotor, a heavy snow load on the antenna will create enough leverage to damage the rotor.

A three- or five-conductor cable is used to connect the rotor to the control unit. The type shown in Photo 1 uses a three conductor cable. For runs up to 280 feet, 20-gauge wire is recommended; for longer runs use heavier gauge.

Selecting An Antenna

The first antenna I used (see Photo 2) was a combination UHF and VHF type. I found that a separate UHF antenna was necessary anyway; and since a VHF-only antenna of similar size offers more gain at a lower price, you should probably consider getting that type.

In an effort to improve the picture quality, I bought a very large 34-element, VHF-only antenna with a boom length of 160 inches. Although it did improve the signal somewhat, I don't think the improvement justified the additional cost. I found that proper antenna placement is much more important than antenna size. The large antenna is also more susceptible to wind and snow damage. If you look closely at the photo of the complete unit, you may notice that some of the elements are bent; and later you will see where I repaired one of the insulators that attach the elements. Your best bet would probably be something between the two extremes, for example, a VHF-only model with a boom length of about 80 inches to 100 inches.



4

This large corner reflector Yagi would provide a strong signal under normal fringe conditions, but in the special conditions of a high-mountain valley it proved unsuitable.

5

This black polyethylene pipe is made to be used in sprinkler systems, but it makes an inexpensive conduit for antenna cables. It comes in 100-foot rolls so it's easy to install. A piece of stiff wire pushed through the pipe will act as fish tape to pull the cables into the conduit.

I also experimented with two types of UHF antennas and found that a four-bay, bow-tie type (see Photo 3) costing about $12 outperformed a $40 Yagi. The Yagi (see Photo 4) had such a narrow beam width that it was difficult to aim at the small reflecting surface and a slight change in conditions threw the aim off.

Look at the general construction of the antenna before you buy it. It should be strong enough to handle the effects of snow, ice, and wind.

Lead-in

When the antenna is in a remote location, the lead-in wire becomes an important consideration. Flat, 300-ohm, twin-lead wire can actually have less signal loss than coaxial cable under the right conditions, but it is usually impractical for such a long run. Twin lead will be affected by rain or snow, and it must be insulated from supports by stand-offs. It also deteriorates faster in the sun and weather, and is more susceptible to interference.

Generally, coaxial cable will be your best choice. RG6/U offers lower signal loss than RG59/U and it only costs a few cents more per foot. Also the 18-gauge center conductor offers less DC resistance than the 22-gauge of the RG59/U. That becomes important if you use the coax to power a mast-mounted amplifier as described later.

During the experimental phase of my installation, I simply laid the coax on the ground. I found out during the first winter that coaxial cable is a gourmet delight for squirrels and other rodents. When the cable was buried under four feet of snow, I totally lost the signal. The next spring I found the cable chewed to pieces along its entire length.

I solved that problem by using 1 inch dia. black polyethylene pipe as a conduit as in Photo 5. That type of pipe is made for use in sprinkler systems. It comes in 100-foot coils. You can use the lowest grade you can find because it doesn't need to carry any water pressure. The pipe is very inexpensive; you will probably be able to get a 100 foot coil for less than the cost of the 100 feet of coax that goes inside it. I buried the pipe 18 inches underground.

Connection Boxes

If the run is greater than 100 feet, you will need to join sections of the pipe. I found that it is difficult to pull the cable through lengths greater than 100 feet, so I built connection boxes as shown in Photo 6. The boxes extend about four feet out of the ground so that they are accessible even when there is snow on the ground. They should be made of redwood to prevent decay.

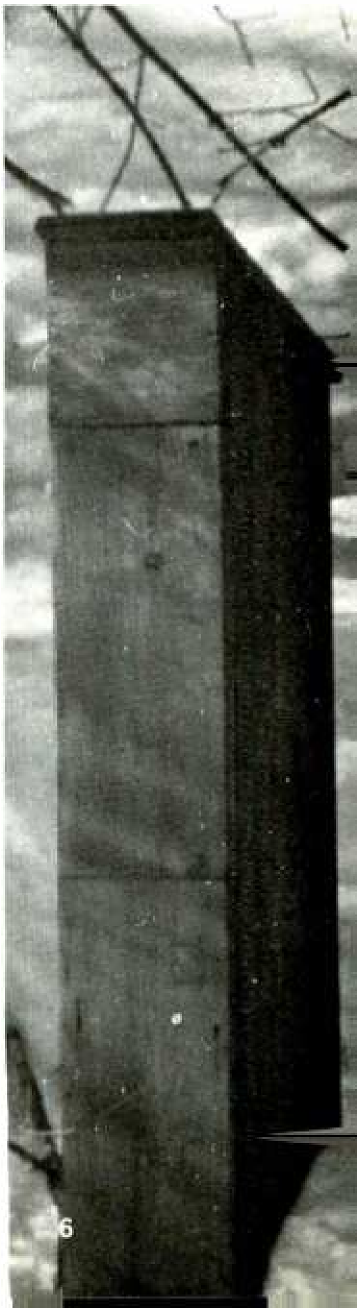
The boxes are simple to make. Refer to Fig. 1 for plans. Use 6-foot long redwood 1 × 8-inch boards. Cut the top end of the sides at a 30° angle to promote drainage. The front is cut into three sections so that the middle section can be removed as an access door. Use screws to attach the front and back to the sides, then attach the top. Where the two sections of pipe meet, bend the pipe up and place the box over the ends. Allow enough pipe so that the ends will be near the top of the access opening. The pipe is flexible enough to be bent up into the box, but be sure to make the bend gradual to avoid kinks that would make it difficult to pull the cables. If you wanted to avoid the above-ground box, you could use underground sprinkler-control valve boxes to make the connections; but if you needed to repair the cable in the winter, you would need to stake the box location so that you could dig through the snow to find it.

Attachment to the Mast

At the mast, the pipe is joined to an 8-foot length of PVC conduit that extends up the mast. Use "U" bolts or hose clamps to attach the conduit to the mast. A weather head on the top of the conduit keeps water out (see Photo 7).

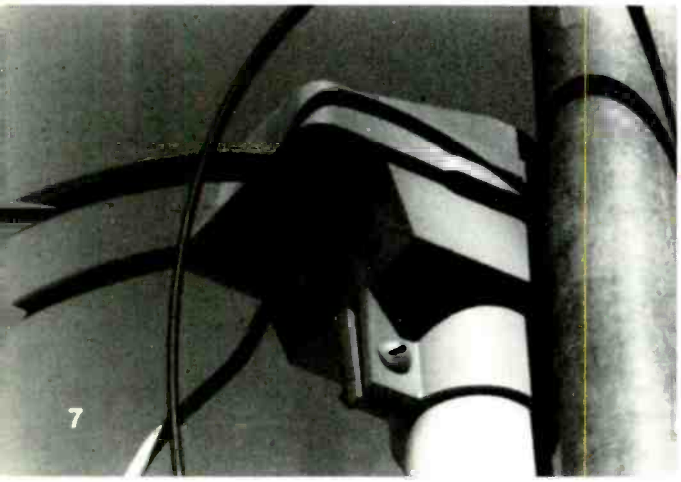
When the conduit is all installed, pull the cables through. The 1-in. pipe is large enough to handle several cables, so there is plenty of room for the rotator cable and more than one coaxial cable if needed for multiple antennas.

If you have access to a 100-foot long electrician's fish tape, feed it through the conduit then attach the wires to its end and pull them through all at once. If you don't have a fish tape, some stiff wire will work. It may be easier if you lay the conduit on the ground alongside the trench and push the wire through before burying the conduit; that way you can

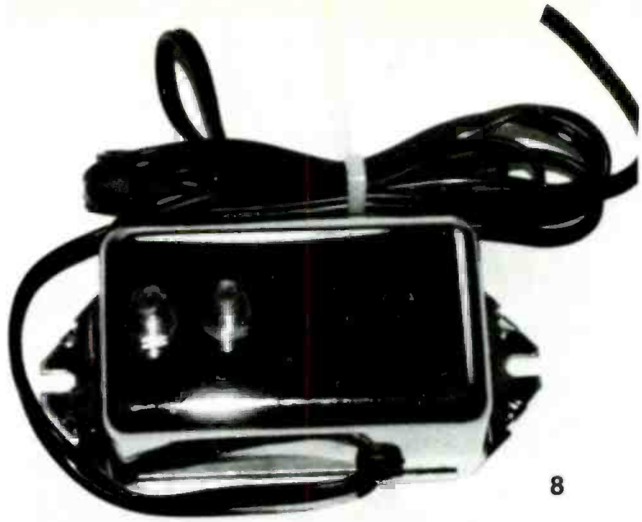


6

Where lengths of conduit meet, a wooden connection box is used. The design of these boxes was inspired by the metal pedestals used by the telephone company to make connections on their underground cables. The box is high enough to allow access to the connections even in deep snow.



At the mast, the black pipe is joined to a piece of PVC conduit that extends up the mast. At the top, a PVC weather head is used to keep water out of the conduit.



This amplifier is strictly for indoor use. Because it can't be mounted near the antenna, it will amplify noise from the lead-in as well as the signal.

move the pipe around to remove bends that may make it difficult to move the wire through, then leave the pull wire in place and bury the pipe.

When you are ready to pull the cables, attach them to the end of the pull wire and pull them into the conduit. To attach the cables to the pull wire, first twist a loop in the end of the pull wire then loop the cables through and cover the entire connection with plastic tape. It helps if you have someone to feed the cables into the conduit as you pull to keep them from tangling.

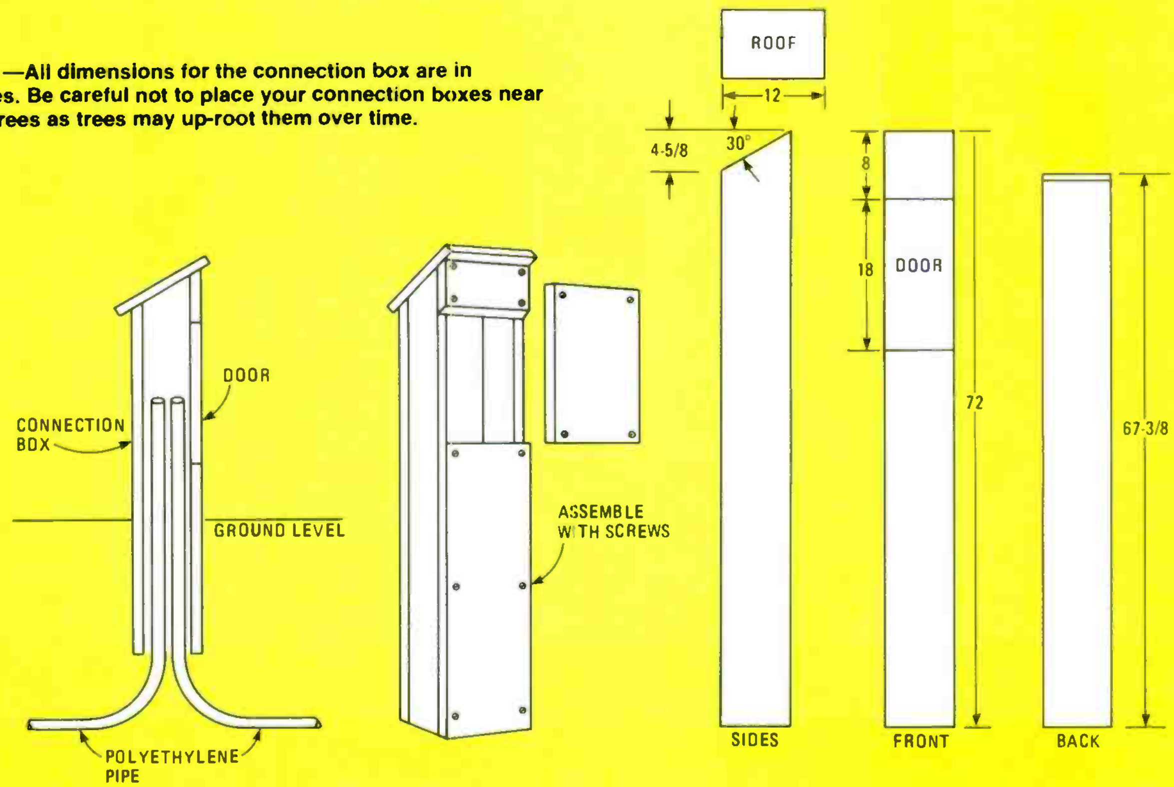
Use type "F" connections to join sections of the lead-in. Cover all connections with sealant tape. That is a sticky substance that has the consistency of modeling clay and comes in a roll. Wrap it around the joint like regular tape then squeeze it with your hand until it blends into a jointless cover that tightly conforms to the cable and connectors. You can also use silicon in a tube to seal the connection.

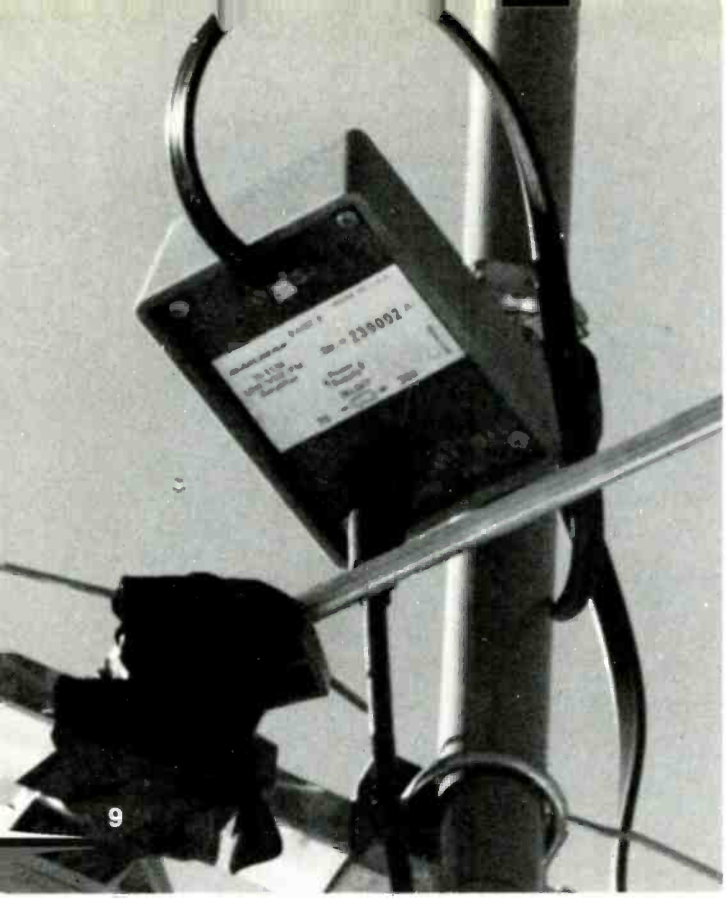
A VHF Amplifier

When dealing with weak signals and long cable runs, amplifiers are a necessity. There are several types that can be used with your antenna system. The amplifier can be the type that mounts outdoors on the antenna mast or the indoor type (see Photo 8). I found that a mast-mount type is best with the VHF antenna. That is an amplifier that mounts on the antenna mast near the antenna (see Photo 9). A mast-mount amplifier boosts the weak signal near the antenna before additional noise is introduced in the lead-in, so it is superior to an amplifier that mounts inside the building.

The power supply for the amplifier mounts inside the building. Power for the amplifier is carried by the same coax that carries the signal, so no additional wires are needed (see Photo 10). Inside the power supply there is a transformer to power the amp, and a network of RF chokes and capacitors to keep the RF out of the transformer and to allow only the

Fig. 1—All dimensions for the connection box are in inches. Be careful not to place your connection boxes near any trees as trees may up-root them over time.





9

This mast-mount amplifier mounts outside close to the antenna so there is less likelihood amplifying interference picked up by the lead-in. Also notice the taped insulator on the antenna. That shows what a heavy load of ice and snow can do to an antenna. I had to glue and tape the insulator together after it snapped under the weight of a heavy snow.

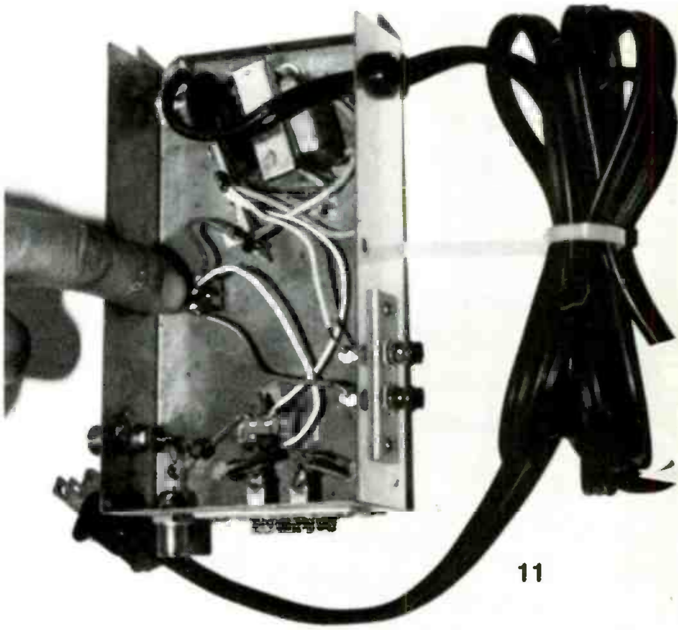
RF signal into the cable that attaches to the TV.

For best amplifier performance, mount the power supply in the building closest to the antenna even if that isn't where the TV will be. The longer the cable is between the amplifier and its power supply, the lower the voltage will be that reaches the amplifier. When the cable run is long, be sure to use the thicker gauge RG6/U to keep the resistance low. Some amplifier power supplies have a variable output to compensate for line length. A multi-position switch can be set to the appropriate line length and the voltage is increased accordingly.

Battery Power

I modified the power supply to allow it to run on battery power. That is desirable in the mountains where power outages are frequent or when you use a generator for power. A 6-volt lantern battery will power the amplifier continuously for several months. To make that modification, cut one of the wires from the secondary side of the transformer and install a SPDT switch (see Photo 11). Attach the wire that connects to the RF network to the common terminal of the switch, and the wire that connects to the transformer to one of the other terminals. Attach the remaining switch terminal to the battery.

Since the power supply had a provision for 300-ohm operation, it had a set of screw terminals that were not needed for use with coaxial cable, so I disconnected the terminals from the RF network and used them for battery terminals. Attach the other battery terminal to a tie point that the other transformer secondary wire attaches to.



11

An interior view of the power supply shows how the switch was added. The unused 300-ohm terminals were used as connections for the wires that lead to a six-volt lantern battery. A SPDT switch is used to select battery or AC operation.

If the amplifier uses a half-wave rectifier like the one I had, then the battery will only power it if it is connected with the correct polarity; however, reversing the polarity won't damage the unit, so just try the battery one way and reverse the connections if it doesn't work.

Bullet Amplifier

For UHF, I found that a type of amplifier called a bullet amplifier worked best (see Photo 12). That type is similar to the mast mount in its operation, but is much smaller.

10

Power for the mast-mount amplifier is provided by a power supply located indoors. Note the switch I added to allow it to run on battery power. A battery-powered TV is no good during a long power outage if the amplifier requires AC.

12

A bullet amp can be placed anywhere in the line to boost the signal. The projection on the end of the amplifier is a DC block. It can be removed to allow DC power to pass to other amps on the line. The power injector is placed inside the building; it can power three bullet amplifiers.

Bullet amps are available in models that have been optimized for the higher frequencies of the UHF band. The bullet amp must be attached to a 75-ohm to 300-ohm matching transformer to connect it to the antenna terminals. The mast-mount amplifier used for the VHF antenna has a 300-ohm input and a 75-ohm output, so no matching transformer is needed.

One useful feature of the bullet amp is that it has a removable DC block that allows more than one amplifier to be placed in the line and powered by the same power supply. That means that you can compensate for line losses by placing additional amplifiers in each connection box along the line. I also found out that with the DC block removed, the bullet amp can be attached directly to the output of a mast-mount amplifier to increase its output.

The power supply provided with the bullet amp will power both. Don't use the mast-mount unit power supply to power the bullet amp since it provides AC and the bullet amp requires DC. However, the DC from the bullet-amp power supply will power the mast-mount amp. The mast mount amp contains a half-wave rectifier to convert the AC from the power supply to DC. The half wave rectifier will also allow DC of the correct polarity through, and happily the polarity of the bullet amp is correct.

Distribution Amps

If you are only feeding one TV from the antenna, then the mast mount or bullet amp may be all that is needed; but if you want to use more than one TV or a VCR, a distribution amp will help (see Photo 13). Ordinary splitters decrease the signal to each outlet; when you have plenty of signal strength that isn't a problem, but when the signal is weak you can't afford much signal loss.

The distribution amp mounts inside the building. It boosts the signal from the lead-in and divides it into several outputs that can be used for TV's or VCR's. Connect the input of the distribution amp to the output side of the mast-mount amplifier's power supply. If you are wiring several rooms for TV, the distribution amp can be mounted in a central location and cables run from there to the other rooms.

14

In a multiple antenna system, a high-isolation coax switch is a good way to select the proper antenna for each channel.

Switching Signals

If you use more than one antenna in your system, you are faced with the problem of how to connect the various antennas to the TV. You could use a signal combiner, which is a splitter in reverse, to combine the signals from all of the antennas into one lead-in cable.

In practice, that doesn't work too well in weak-signal areas. I experimented with additional antennas and found that if I used a combiner all of the signals deteriorated. Strong signals from one antenna were combined with weak signals from the other, introducing ghosts and noise. I found that it was much better to use a coaxial switch to select the antenna that was best for a particular station (see Photo 14). The switch isolates the various antennas, preventing interaction between the signals.

In the case of separate UHF and VHF antennas, the prob-

13

A distribution amplifier compensates for the losses that occur when you split the signal. It is mounted inside the building. The connector marked ANT is attached to the connector marked TO TV on the power injector for the bullet amp or the power supply of the mast-mount amp.

lem is simplified since many TV's have separate antenna terminals for VHF and UHF. In that case, simply attach the antennas to the appropriate terminals.

Lightning Protection

Although proper antenna grounding is important in every situation, it is of increased importance in an isolated mountain location where the antenna mast may be the best lightning path around. The long cable run also increases the likelihood of induced voltage spikes. Voltage spikes are not as dangerous as a direct lightning strike, but they can still damage equipment like a TV or VCR.

Section 810 of the 1987 National Electrical Code covers the installation of TV antennas. It is wise to follow the code completely.

The mast should be grounded by driving a copper-clad grounding rod into the earth near the mast and connecting the mast to the grounding rod with No. 10 gauge, or heavier, copper wire. Use approved grounding clamps to make the connections. The wire should run in as straight a path as possible; avoid sharp bends.

The mast should extend above the antenna to act as a lightning rod. Add an extra 5-foot section of mast above the antenna to accomplish that. To protect the antenna and amplifier, install a static-discharge unit in the 300-ohm lead between the mast-mount amplifier and the antenna. The static-discharge unit should be grounded to the mast.

Induced Spikes

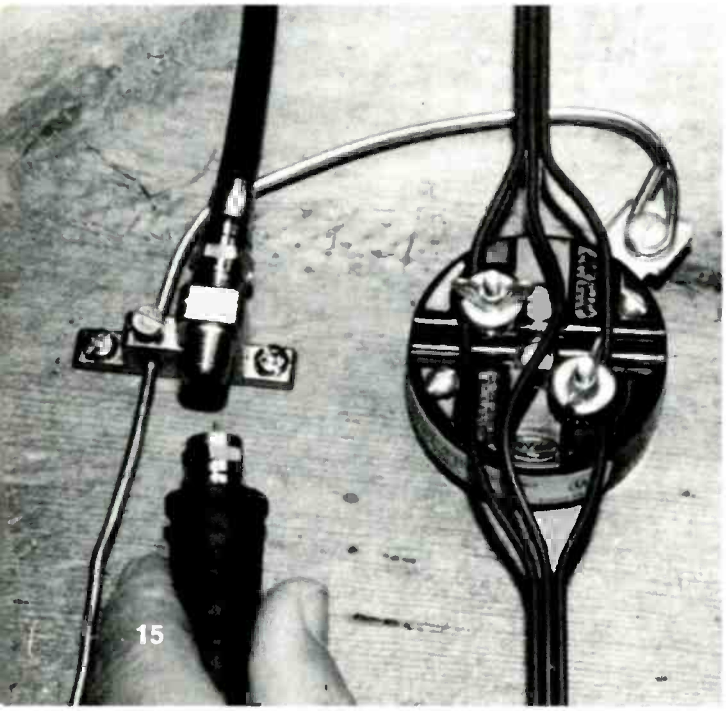
When lightning strikes, it can induce a voltage spike in any conductor nearby. The longer the wire is, the greater the induced voltage will be; so even if a lightning strike misses your antenna, the induced voltage can still cause damage to your equipment. To protect your equipment from damage by induced voltage spikes, the outer conductor of the coaxial cable should be grounded at the point that it enters the building. A grounding block is used for that purpose. Use "F"-type connectors on the cable ends to attach them to the grounding block (see Photo 15). Connect a No. 10 gauge copper wire to the ground connection on the grounding block and attach the other end of the wire to the same ground as the electrical system of the building.

That is an important and often overlooked point. If a separate ground rod is used, induced voltage spikes can still damage your equipment. The 1987 National Electrical Code specifies that the grounding conductor should be attached at the nearest accessible location to the building-grounding electrode system, the grounded interior metal water-piping system, the metallic power-service raceway, the service-equipment enclosure, the grounding-electrode conductor, or the grounding electrode conductor metal enclosures. Usually that boils down to either attaching the grounding conductor to the metallic conduit that brings power into the electrical service panel, or to the same grounding electrode that the electrical system uses, whichever is closest to the point where the lead-in enters the building.

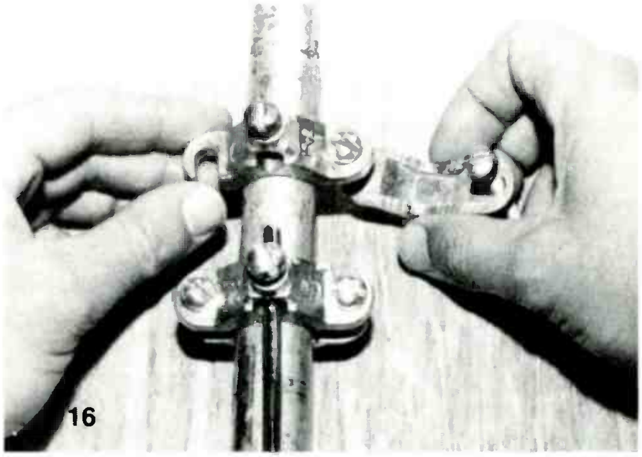
You can find the ground connection of the building electrical system by following the heavy ground wire that leads from the fuse or circuit breaker box to a ground clamp located on a cold water pipe or grounding rod. Attach a clamp next to that clamp to connect the antenna-grounding conductor (see Photo 16).

The rotator wire also needs to be protected against induced voltages. At the point that it enters the building, connect the two outside conductors of the cable to a UL-listed static-discharge unit. Ground the static-discharge unit to the ground wire that attaches to the ground block for the coaxial cable. The grounding block and the static-discharge unit may be mounted outside or inside the building, but do not locate them in an area where flammable materials are stored or used or near combustibles.

When I started my antenna system home satellite receivers were out of my price range. When the price came down, I eventually got a satellite dish; but I was still glad I had a way to get local TV. It is particularly important for getting local weather forecasts and news; and now, as more satellite stations scramble their signal, local TV is again becoming the best bet for free programming. The antenna system is also useful for receiving FM radio. Without the antenna, I was completely cut off from FM reception. ■



A grounding block for the coaxial lead-in and a static-discharge unit for the rotor cable should be located near the point where the cables enter the building. It is important that the No. 10 gauge copper grounding conductor be connected to the same ground as the building electrical system.



The electrical system ground will usually be found on a cold water pipe. Attaching a grounding clamp to the pipe to connect the antenna grounding conductor.

VOX BOX

Voice-operated relays (VOX) are a thing of the past now that semiconductors have taken over! But VOX is too good a term and concept to relegate to antiquity!

By Jay Glowacki

THERE IS NO WAY TO PROVE BEYOND DOUBT THE TRUTH of the following statement: Radio amateurs popularized the *voice-operated relay* by use of those devices and the catchy name "VOX." Those early radio buffs were the first modern electronics experimenters; far be it for us, their successors and heirs, to allow the term VOX to fall into non-use.

Thus our plan is obvious. This article presents an easy-to-build voice-operated project—which we call the *VOX Box*—that can be used for a variety of purposes about the home and work area. VOX Box is a multi-functional voice-operated relay device. It can be used to control a tape recorder, switch on an amateur transmitter, or control a slide projector. It can be used with any low- or high-impedance microphone, or a high-level audio source such as a pocket tape recorder.

You may be familiar with the press-to-talk communications microphones used by PA system and amateur-radio operators. The VOX Box avoids the need to depress the press-to-talk switch every time the announcer or operator speaks. When the VOX Box controls a tape recorder, it eliminates long gaps of background hiss when the program material is missing. I could continue on and on about the virtues and applications of the VOX Box, but then we will never get down to the construction details.

Circuit Description

The electronic circuit in VOX Box consists of three parts (see Fig. 1): a microphone preamplifier, a Schmitt trigger, and a relay driver. Input signals (MIC INPUT terminals) to the microphone preamplifier (U1) are amplified and fed to a THRESHOLD control (R8). When the preselected threshold voltage level is exceeded, the output of the Schmitt trigger (U2) immediately goes high. The signal from U2 is rectified and the voltage developed across C7 turns on the relay-

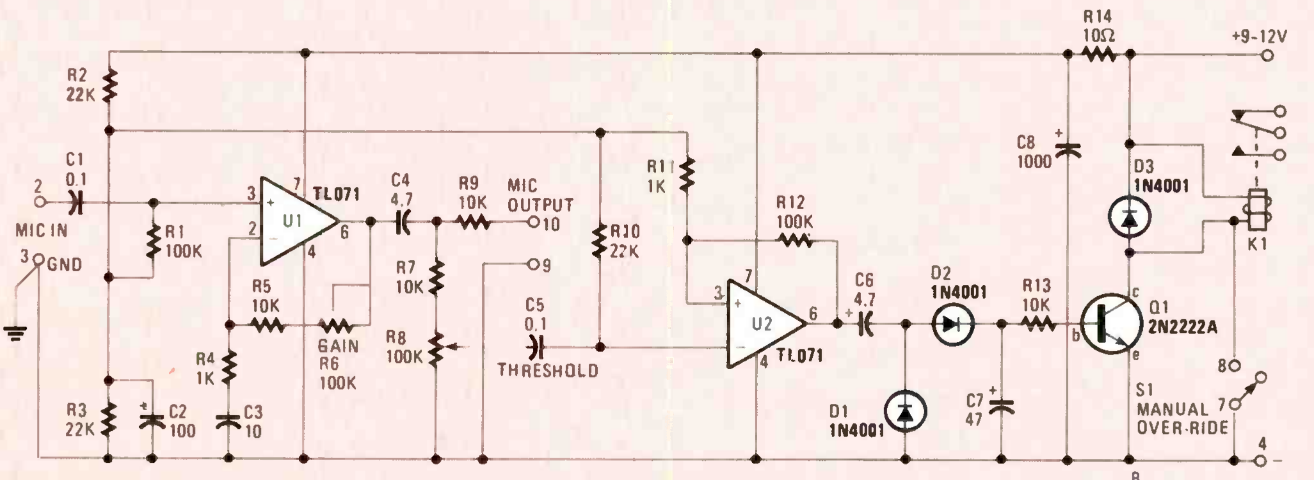
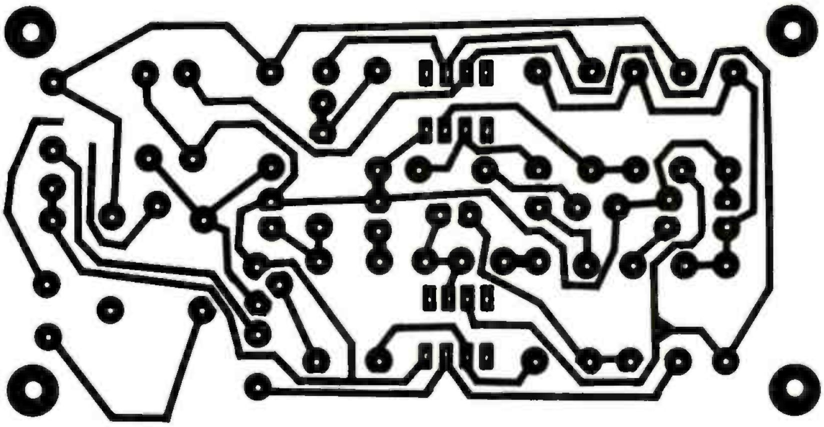


Fig. 1—The schematic diagram for the VOX Box can be divided into three basic sections: The preamplifier circuit centered about U1, the Schmitt-trigger circuit centered about U2, and relay driver/relay circuit centered about Q1 and K1. The microphone preamplifier circuit may not be needed in some applications and it may be omitted. Refer to Fig. 4 for details.

Fig. 2—Copy this same-size template to make your printed-circuit board of the VOX Box. Should you decide to use a perfboard, insert flea clips where component leads would enter the PC board. Then hard wire everything.



energizer transistor (Q1). That transistor action passes pull-down current through the coil of relay K1. The changing of the relay STDP contacts can be used to either make or break an external AC or DC circuit.

The Bottom Line

The above is a simplified signal-flow discussion of the VOX Box circuit operation. You could skip ahead to the construction portion of this article or continue reading for a more detailed circuit analysis in the following paragraphs.

Chip U1, (a Texas Instrument TL071 integrated-circuit op-amp) functions as the microphone preamplifier. It is connected as an inverting amplifier with AC signal gain that is variable between 10 and 110. A potentiometer (R6) in the feedback circuit provides the means to vary the gain.

The preamplifier's frequency roll-off below 20 Hz is set by capacitor C3, which also sets the DC gain of the preamplifier at unity.

The MIC IN signal from the microphone is coupled by capacitor C1 to the non-inverting input of U1. A voltage divider consisting of R2 and R3 sets the bias to the non-inverting input of U1 and to both inputs of U2 to half the battery supply voltage so that those two op-amps can operate at the same bias voltage. Decoupling of the voltage divider is provided by capacitor C2.

The output signal from U1 is coupled by C4, R7, R8, and C5 to the input of the op-amp Schmitt trigger. The reason for selecting a large value capacitor for C4 is to provide adequate audio-signal coupling to the MIC OUTPUT terminals via resistor R9. The Schmitt trigger requires only a differentiated signal to kick it off, so C5's value is small by comparison. Potentiometer R8 adjusts the threshold signal level to the trigger as desired by the user. The microphone output signal passes through R9; that signal can be used to drive a high-level input on a tape recorder, PA system, transmitter, etc.

The signal from potentiometer R8 is coupled to the inverting input of the Schmitt trigger (U2). A positive feedback through R12 to the non-inverting input determines the hysteresis activity of the Schmitt trigger. For small signals to the inverting input, there is no AC output and pin 6 of U2 remains at its prior state—either high or low.

When the signal to the inverting input of U2 rises above .07-volt peak-to-peak, the output of the U2 switches to the stage's limiting condition—a *squareish* wave at the input frequency. The peak-to-peak amplitude of the "squared" wave is just less than that of the power supply's voltage.

The output signal from U2 is rectified by a half-wave, voltage-doubler consisting of diodes D1 and D2; capacitor C7 is then charged. The voltage across C7 raises the bias supplied to transistor Q1, causing Q1 to turn on. The current passing through Q1 energizes the coil of relay K1, and the relay's armature (the movable part of the switching contacts) makes the external circuit.

Rectifier diode D3 reduces inductive kickback developed across the coil of K1 to almost zero. If spike quenching were not done, the voltage spike created to maintain the suddenly-interrupted current in the coil could destroy relay-driver transistor Q1.

If you were to measure the attack time (from first activating input-signal voltage rise to relay closing), it would measure between 8–14 milliseconds. The time interval varies with the audio signal's rising slope. The delay time for relay drop-out

PARTS LIST

SEMICONDUCTORS
D1–D3—1N4001 1-A, 50-PIV silicone rectifier diode
Q1—2N2222A general-purpose NPN transistor
U1, U2—TL071 low-noise, BIFET op-amp, integrated circuit

RESISTORS
(All fixed resistors are ¼-watt, 5% units unless otherwise noted.)
R1, R12—100,000-ohm
R2, R3, R10—22,000-ohm
R4, R11—1000-ohm
R5, R7, R9, R13—10,000-ohm
R6, R8—100,000-ohm trimmer potentiometer, PC mount
R14—10-ohm

CAPACITORS
C1, C5—0.1-µF, Mylar
C2—100-µF, 16-WVDC, PC-mount, electrolytic

TABLE 1—VOX BOX PIN CONNECTIONS

Pin No.	VOX Box Circuit Connection
1	Positive power-supply connection (9-12 volts DC)
2	Microphone input signal
3	Microphone ground
4	Negative power-supply connection
5	Armature on relay contacts
6	Normally-open relay contact
7	Manual override switch connection (gnd)
8	Manual override switch connection (hi)
9	Preamplifier output ground
10	Preamplifier output signal

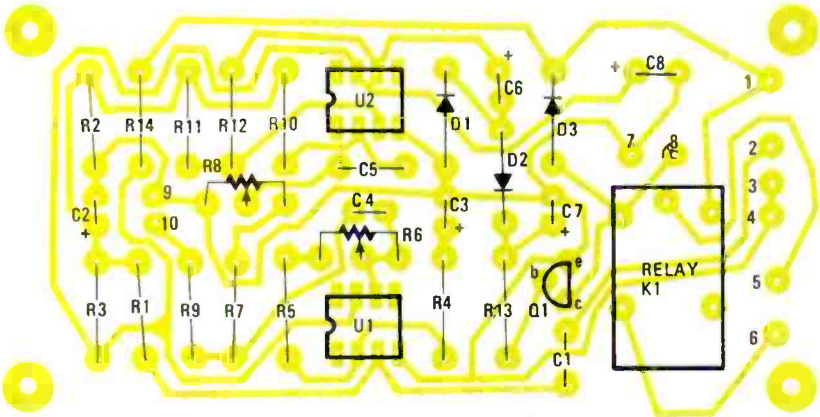


Fig. 3—The diagram locates parts on the printed-circuit board while showing an X-ray view of the board's foil leads in color. The relay purchased with the kit mentioned in the Parts List fits the predrilled holes in one position only.

FOR VOX BOX

C3—10-µF, 16-WVDC, PC-mount, electrolytic
C4, C6—4.7-µF, 16-WVDC, PC-mount, electrolytic
C7—47-µF, 16-WVDC, PC-mount, electrolytic
C8—1000-µF, 16-WVDC, PC-mount, electrolytic

ADDITIONAL PARTS AND MATERIALS

K1—Relay, miniature, SPDT, 12-volt coil
S1—switch, SPST, toggle (optional—see text)
Printed-circuit board, PC pins, experimenter's plastic chassis box—4⅛-long × 2½-in. wide × 1½-in high (see text), transistor-radio battery or wall power-plug pack, wire, solder, etc

A complete kit of parts, including a pre-etched printed-circuit board and all the necessary components, for the VOX Box is available (priced at $15.00, plus $2.00 shipping and handling) from Imtronics Industries Ltd., 11931 31st Court, St. Petersburg, FL 33702,. Please allow 6 to 8 weeks for delivery.

(from last activating input-signal voltage rise to relay de-energizing and the releasing of the armature) should be adjusted to 1 to 5 seconds by potentiometer R8. People who pause a lot while speaking should have the latter setting. Rapid speakers require less relay drop-out time.

What causes transistor Q1 to drop-out the relay is the discharge of capacitor C7; that loss of charge reduces the DC bias on the base of Q1. The larger in value capacitor C7 is, the longer the time it takes to discharge through R13 and the base-to-emitter resistance of Q1.

Manual override is provided by a SPST switch (S1) wired across the relay-driver transistor, Q1. Closing S1 connects the coil of K1 directly across the power supply, keeping it energized until the power is removed or S1 is opened.

The method of powering the circuit is dependent on the materials on hand and the circuit's application. A surplus plug-in power-supply pack rated at 9–12-volts DC at 200 mA is more than adequate. (See our comment about battery use at the end of this article.)

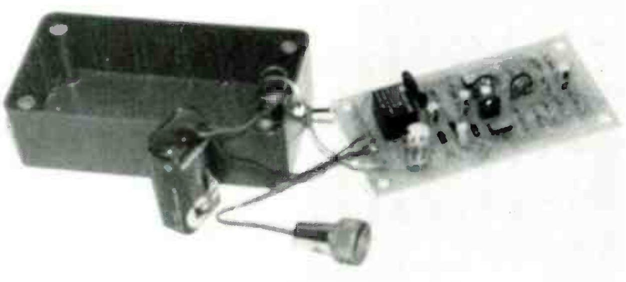
Putting It Together

The best assembly method for the VOX Box is to use the pre-etched, printed-circuit board (see Parts List) and kit of parts that are available. Assembly time will be only one evening—this writer took three hours, which included picture taking and circuit measurements. Another way to go is to make your own circuit board and buy only those parts that are missing from your junkbox inventory. If that is the case, make your printed-circuit board from the same-size circuit pattern shown in Fig. 2.

The next obvious step is to mount the parts onto the board using a low-wattage soldering iron. Take care that the positioning of polarized parts, such as integrated-circuit chips, diodes, and electrolytic capacitors are done correctly. The relay pins permit mounting of K1 only one way (the correct way). Refer to Fig. 3 for parts-placement information.

The sequence of soldering parts to any printed-circuit board is simple to understand: First connect those parts that are rugged and not damaged easily. Those parts are resistors, capacitors, relays, terminals, most coils, sockets, jumpers, etc. The parts that are mounted last are diodes, transistors, integrated-circuit chips, and fragile parts that break easily. In some rare instances, large components are mounted last no matter how rugged they are, because they block access to mounting holes in the board for parts that are located underneath or near by. With that in mind, assemble the printed-circuit board by first mounting the resistors, terminal pins, diodes, potentiometers, capacitors, relay, transistor, and

(Continued on page 104)



The VOX Box was mounted on a plastic box for testing purposes. The 9-volt DC transistor-radio battery resides inside the box and the power switch (not shown in Fig. 1) is on the box's side panel. The output from the preamplifier is not used, nor is the override switch S1 connected. The latter was not required—it is optional. The audio-type connector in the photo was used to connect and test the VOX Box circuit operation with several standard microphones.

IBM builds a 4 MEGABIT RAM CHIP

Computer technology makes RAM's multiply, placing more bits than angels in an area the size of a pin head!

By J. Sienkiewicz

☐IF YOU ARE THE TYPE THAT ENJOYS READING TECHNICAL JOURNALS and attends engineering conferences, you are apt to come across interesting developments before they hit the consumer press. At a recent industry-wide conference I saw a knot of engineers talking in hushed, but excited, tones in a corridor outside a seminar room. Inquiry produced the following information: IBM engineers had just described the design of a computer memory chip that can store more than four-million bits of data. That is four times the capacity of any memory chip used in computers today. So, realizing that todays developments result in improvements of tomorrow's personal computer, consumer products, and surplus marketplace for experimenters, I probed deeper to get some more facts.

The Important Stats

The four-megabit chip operates at very high speed, accessing a bit of data from one of its storage cells in only 65 nanoseconds (billionths of a second), compared to 80 nanoseconds for IBM's most advanced one-megabit chip. At that speed, all of the chip's 4,194,304 storage cells could be *read* in less than one quarter of a second.

How much memory is four megabits? A four-megabit chip can store the equivalent of about 400 pages of double-spaced typewritten text. That amounts to more pages than the term papers a student writes during the first two years of college.

A combination of CMOS technology, advanced photolithography techniques, and a novel memory-cell innovation makes the four-megabit chip significantly faster and denser than its one-megabit predecessor. At 65 nanoseconds access time, the new chip is the fastest of its type in the world.

The chip is IBM's first dynamic random-access memory chip developed in CMOS (*C*omplementary *M*etal *O*xide *S*emiconductor) technology. CMOS technology inherently uses less power than NMOS technology, allowing for substantially cooler operation.

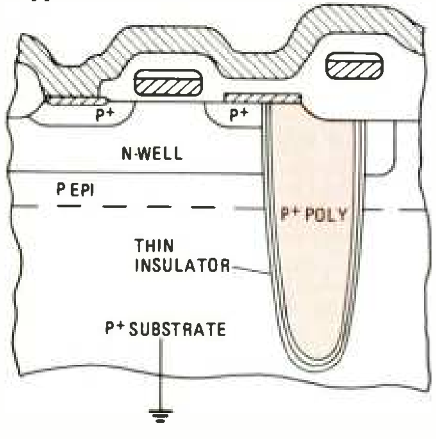
The chip operates on a single 3.3-volt power supply. That results in substantial power savings compared to the 5-volt supply that is conventionally used with NMOS technology.

The four-megabit chip is being developed and samples have been fabricated on the same manufacturing line used for volume production of one-million-bit chips at IBM's semiconductor facility in Essex Junction, Vermont. Fabricating the chip on an existing production line demonstrates the chip's feasibility in the manufacturing process and the potential for volume production of the chip.

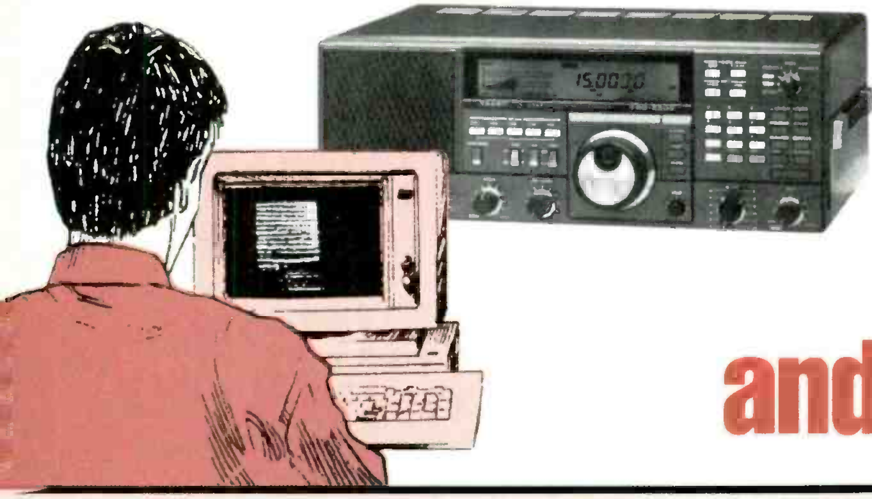
The new chip—a four-megabit DRAM (*D*ynamic-*R*andom-*A*access-*M*emory) chip—occupies an area of silicon just 35-percent larger than IBM's one-megabit chip.

Being Small Is Big

The smallest geometric features in the circuit patterns on the chip have dimensions as small as 0.7 micrometer. (One micrometer is about one-hundredth the thickness of a sheet of ordinary typing paper.) The four-megabit chip, which measures 6.35 millimeters by 12.3 millimeters (about 1/4 inch by 1/2 inch), occupies 78 square-millimeters (about 1/8 square-inch) of silicon area. *(Continued on page 108)*



This diagram illustrates the trench geometry that makes possible the higher capacitance that can be had over the planer type that limits the chip's size reduction.



W. Clem Small, KR6A/1, CET

COMPUTERS and HAM RADIO

A union of past and present technologies

FOR MOST HISTORIANS OF COMMUNICATIONS TECHnology, radio dates back just about 100 years to the discovery of radio waves by Heinrich Hertz in 1886. Or we could date it from Marconi's first trans-Atlantic radio message, around the turn of the century. Whichever event is referenced as the starting point, since that time the world has seen the development of many new electronic devices and inventions, such as vacuum tubes, transistors, and integrated circuits.

Those inventions have, of course, added greatly to our ability to send radio's amazing signals flashing through space. It is obvious to most of us that, if we couldn't call on those radio waves, many of today's important communications services would literally disappear! We all realize that our AM, FM, and TV-broadcast industries are based on radio technology. And let's not forget that long-distance telephone links, satellite weather reports, cable-television programming, communication with ships at sea or aircraft in flight, and even our space-program communications are all examples of important areas of application that are dependent upon the technology that has evolved within the burgeoning field of radio communications.

Certainly radio is a major and vital part of our overall communications technology today. And yet today, interest in the fascinating hobby of amateur radio involves a smaller portion of our population than has been true in the past. Ham radio was once the hobby that attracted most of the youngsters or adults who had an interest in electronics and communications. It also induced many of those same persons to continue in the field to become engineers and technicians in the various areas of radio communications.

Enter Computer Technology

But, as the world of technology developed, a totally new area of electronics and communications evolved. And that area—computer application and technology—has now literally revolutionized the communications industry. Both computer technology and applications have taken the technical world by *storm*, as it were.

Computers, in one form or another, have become either a profession or a major passtime for millions of people today. And let us not forget that the technology that has developed to support the computer revolution is, in large-part, responsible for the "hi" in today's hi-tech society.

In the past two decades or so as computers have evolved, the hi-tech aspect of communications has been obvious to those with an interest in electronics. The diversity of opportunity for pursuing one's technical interests within the field of computer application and/or computer technology has become tremendous. In those fields, the youngsters and adults who enjoy the intrigue of working with technical ideas or equipment readily find an outlet for their unbounded energy and ambitions.

Many persons who in the past would have gone into ham radio as a hobby, or into some area of radio communications as a profession, have chosen instead to join the computer revolution. Here they happily enjoy the fascinating opportunities for fun and/or professional growth that the computer field has to offer.

Computers handle various chores for us. And depending on which of their applications you are most familiar with, you might not think of computers as part of our contemporary communications technology at all. For instance, you might use them for writing letters, keeping records, or drawing pictures. Those applications obviously aren't part of electronic communications. On the other hand, many persons use computers in applications that *are* very much a part of the big-picture that electronic communications represents.

We will review a number of those applications as they apply to ham radio. In addition, we will see that radio technology is not outmoded by modern electronic design. In fact, radio is actually experiencing renewed growth due to the infussion of both digital-design technology and the high performance components developed within the constantly-growing computer field.

Computerized Learning Aids

In order to become licensed as an amateur radio operator, it's necessary to learn to transmit and receive in Morse code. That code, in which "dit" and "dah" sounds are combined to represent letters of the alphabet, has long been used in radiotelegraphy. It's not surprising then that a number of training programs have been developed, which allow a computer to generate Morse code characters automatically, as an aid to learning code.

Some of those aids are totally software generated, you just feed the program to the computer—and presto—out comes the code through the computer's speaker. No other hardware is needed. Other versions are hardware-dependent. They're usually built into a *keyer* that's a relatively modern variation on the Morse-code sending key. Those microprocessor-based keyers send code to you automatically and are great for practice at receiving code. You can also use those keyers manually, allowing you practice sending Morse code.

For many of us, one of the most fascinating learning-oriented computer applications to ham radio is *Dr. DX*, a program cartridge that allows your computer to emulate the airwaves! That's right! When you plug the Dr. DX cartridge into your computer, out of the speaker come the dits and dahs of the Morse code, along with static and interfering stations just as you'd hear on the air. It's hard to realize that you are not actually on the air!

With Dr. DX in operation, the computer screen shows the dials for your transceiver. Through the computer's keyboard, you can tune across the band with total realism. Experienced hams, when introduced to Dr. DX unawares have been completely fooled into thinking that they were operating an actual communication system! And no small wonder, for you can call the stations that you hear on your computer "station," and they'll answer you!

You can hold short, amateur-radio type conversations with them, in which they call you by your call sign, give signal-strength reports, etc. It appears to be a great way to build up your code speed and ability to operate on the ham bands. And it's so much fun that it could almost be called a computer game! But they never QSL!

General Applications

Most radio operators keep *logbooks* (records) of their contacts with other stations. A number of radio-station logbook computer programs are available for use in amateur radio. Those programs permit the recording of information, such as the callsigns of stations that have been worked, when they were worked, band conditions during contacts, and so forth. Just like the real thing.

Some of the logbook programs even have features that automatically indicate the number of foreign countries that have been worked, or other special information that the operator may wish to keep a running account of. A few of those programs will even print out QSL post cards for mailing to stations as a contact verification.

Some ham operators participate in a radio-sport known as *contesting*, in which operators pit their skills against one another to determine who can make the most contacts during the contest. The rules for those events are rather stringent, and keeping a log of operations during a contest is particularly important. There are several contest-log programs available, which take much of the drudgery out of contest log work. They're a particular blessing for an active contestant, as it can often take hours of work to get a log into acceptable shape without the aid of a computer!

Another area of application currently receiving a good bit of attention in ham radio is *computer aided design* or CAD. A number of CAD programs are available that assist the radio technician or engineer in the design of new equipment. Those programs range in complexity from those that help solve simple algebra problems in Ohm's law for electrical circuits, to others that assist in defining the parameters of complex electronic filters and other advanced circuitry.

The model MFJ-1225 RTTY/CW Receiver-Computer Interface from MFJ Enterprises can be used to connect your computer to a ham-radio to decode Morse code and radioteletype signals. For more information circle No. 84 on Free Information Card.

Antennas and Propagation

Moving from the radios themselves, on up to the antenna, we find a number of programs that help to calculate the appropriate dimensions for communications antennas of various designs. At least one program is available that not only helps design the antenna, but also simulates the performance of the antenna that it has just designed, and draws graphic displays of the radiation (and reception) pattern that the antenna will produce!

Another popular area of ham radio computer-program application is signal-propagation prediction. Such programs assist the amateur operator in determining when the various frequency bands are likely to perform best for communicating with particular areas of the world. Some programs even give the optimum compass heading to use in orienting the antenna to receive signals from any desired location around the globe.

Interfacing

Probably the area where computers have had the greatest impact on ham-radio operations is in CW and RTTY reception and decoding. Hardware devices, such as MJF's model 1225 RTTY/CW Receive Computer Interface shown in Photo 1, which allow home computers—operating in conjunction with special software programs and the interface—to decode over-the-air transmissions are now available. And with the hardware/software combination, you can even make a *hard-copy* (printout) of the message via your printer.

Using the computer and interface (along with its special software), you simply tune in a Morse-code transmission and the computer decodes the message, and provides a read out on the computer monitor. The programs are quite popular with radio-monitoring buffs. The same type of program (which allows the decoding of received signals, and the generation of code by the computer for transmission over the air) has been specifically designed for hams.

With such programs, the operator merely types the message on the computer keyboard, and the computer converts the typed words on its monitor to Morse code. Those programs also make it possible for two operators, neither of whom knows any code at all, to hold a conversation in Morse code! It's enough to rotate Hiram Percy!

Somewhat similar programs are also available for reception only, or for transmission and reception of radioteletype (RTTY) and also the modes called ASCII, AMTOR, and packet radio. Those programs convert plain language text to the appropriate code for transmission, and decodes the transmission when receiving. AMTOR, and packet benefit by the use of advanced computer techniques for error correction. And they have a reputation for extremely reliable readouts, even through heavy interference.

Packet radio has an amazing capability to route its message automatically through a variety of stations to reach its assigned destination. As a matter of fact, without computers we'd have no AMTOR or packet radio. Those modes are just too sophisticated to realize, in any practical sense, with pre-computer technology. For many amateurs, those computer-

Advanced Computer Controls' RC-850 Repeater Controller is made more attractive to the serious-minded communications hobbyist through microprocessor enhancements.
For more information circle No. 85 on Free Information Card.

dependent modes are some of the most exciting areas of ham radio today!

Some programs are also showing up in the visually-oriented communications modes of ATV (amateur TV) and SSTV (slow-scan TV). ATV, the amateur radio version of television, is technically similar to the transmission systems used by commercial TV stations. SSTV makes possible the transmission and reception of still-picture TV on the HF bands, whereas ATV requires VHF or higher frequencies for implementation.

Those television modes are usually relatively sophisticated and expensive for the average amateur. But using the home computer as a major part of the system requirement in either of them makes owning such a station considerably less expensive.

There are also programs available for receiving FAX, the *facsimile* or *radiophoto* mode. Via FAX—using only a very simple interface, and the appropriate computer program—one can receive a variety of interesting graphic material (including weather maps) right out of the air!

Many computer owners now enjoy telecommunications via a device called a *modem*, which allows ordinary telephone-lines to be used to communicate with other modem-equipped computers. In that way, you can dial up computer-equipped friends and leave a message with their computer, even when they're not at home!

On-the-air versions of such telecommunications are becoming popular on the ham bands. Some amateur-radio operators even maintain "bulletin boards" for use by other amateurs. The bulletin boards give hams on-the-air access to message services, radio-related computer programs, and other information of interest to hams.

The Ultimate Program

As we realize that computers can control so much of the functioning of a radio station, the thought may occur to us that perhaps we could even do away with the operator altogether! Why not have the computer in complete control of the station? Actually, that's not a far-fetched *sci-fi* idea; it's a reality in contemporary radio-operating practice. Fully-automated control of radio stations by computer is relatively common today.

Perhaps the most-frequently found examples of computer station-control are the VHF and UHF repeater stations. Repeaters—like the small personal version—may be considered to be automated transceivers, in that they pick up signals from low-power local amateur stations, boost and then re-transmit the signals. In order to provide extended coverage, a repeater is usually located at some elevated site, such as on a tall building or hill. They also generally have more power than the stations that they serve.

The re-transmitted signal then has much greater coverage than the original low-power station could command. Not only do those stations operate under computer control, they often have the ability to announce the time of day, and give signal reports via computer-generated speech. Some even have the capability of dialing into the local telephone system. Using such a repeater, a ham can call home on the telephone from the amateur radio in his automobile!

But complete station-automation is not limited to repeaters. Some available programs and interface devices allow an amateur to automate his home station. For instance, an amateur with such a system up-and-running can program his computer to automatically turn the station on, orient its antenna properly for the desired direction of communication—which is but one of the features packed in the Yaesu FT-767GX All Mode Transceiver—send a call, and listen for and record any reply.

In other automated-station applications, computer-supported systems are used to allow the operator to remotely use his home station via his handheld transceiver, giving the amateur the ability to control and use the home station while miles away. The advantages here are that the home station is usually more powerful, has its antenna mounted higher, and may be used on HF. Each of those factors give the home station a greater range than any of the handheld UHF or VHF transceivers.

With some of those systems (such as the ShackMaster 100 from Advanced Computer Controls, Inc.), it is even possible to call home on the telephone, and then use the phone's touch-tone buttons to control the home-radio station. Once the amateur has the home station up-and-running, the handset of the telephone serves as a microphone and speaker for transmitting and receiving.

Not long ago, a prominent ham-radio journal reported that the first totally automated field-day operation had been successfully attempted. On a field-day, hams take their stations to the fields and hills, and operate on emergency power to emulate an emergency situation. The report just mentioned indicated that the computer-controlled field-day station was able (without operator assistance) to tune the band looking for signals, give a call when it found an appropriate signal, respond if answered, and log the contact. I must say folks, things have really changed since the crystal-set and early spark-gap days!

Literature and Information Networks

There are a few magazines that cater specifically to the amateur-radio operator who's interested in computers. Among those are: *CRM: for Computerists and Amateur Radio*—which subscriber testimonials tout to be very useful

The FT-767GX All-Mode Transceiver (Yaesu USA) is one example of an advanced-design computer-aided transceiver (CAT).
For more information circle No. 86 on Free Information Card.

The ShackMaster 100 control system (from Advanced Computer Controls) allows an amateur-radio operator to capitalize on his home station via a portable, mobile, or handheld transceiver, or even the via the telephone line. For more information circle No. 87 on Free Information Card.

to hams—1704 Sam Drive, Birmingham, AL, 35235; $18.00 for a 1 year subscription, or $3.50 for a sample issue.

Another is *Spec-Com* (short for specialized communication), which covers fast- and slow-scan TV, facsimile, amateur-satellite communications packet radio, computers, and more. The Spec-Com Journal's (P.O. Box H, Lowden, Iowa, 52255) yearly subscription rate is $20.00 (10 issues), and a special issue is available at $3.00.

Gateway, a newsletter from the American Radio Relay League (225 Main St., Newington, CT 06111) for packet radio is published every 2 weeks, and is available to non-members $9.00 (25 issues). *Monitoring Times* (PO Box 98, Brasstown, NC 28902) has a regular computers-in-radio column, as well as other occasional articles for computer-radio buffs. Its subscription rate is $14.00 per year.

The standard ham journals, such as *CQ*, *Ham Radio*, *QST*, and *73*, frequently carry good articles on computer-radio topics. And, at infrequent intervals, ham radio-computer articles even find their way into the regular computer journals. Keep your eyes open!

There are also now a number of books on the use of computers in ham radio. Among them are: *Computer Networking Conferences* (a collection of papers on packet radio, published by the ARRL); *Amateur Radio Software* (86 programs in BASIC and 6 in assembly language for such areas as radioteletype, AMTOR, packet, antenna design, propagation, antenna bearing calculation, utilization of communication satellites, and more) published by the Radio Society of Great Britain. Howard W. Sams publishes *Commodore 64/128 Programs for Amateur Radio and Electronics* with 23 ham-radio programs and 19 electronic programs. Continuing and frequent publication can be expected in that popular area.

Radio Networks and SIG's

As you might guess, when hams are interested in something, it is usually not too hard for them to get on the air and

This new-age communications system—consisting of a Commodore C-128 computer, an AEA CP-1 interface with AEA software, and Kenwood TS-960S transceiver—can receive and transmit Morse code, AMTOR, ASCII, and RTTY.

find others with similar interests. Something that makes it even easier to find others with similar interests is the existence of *special interest nets*. A net (network) is a meeting, on-the-airwaves, of several radio stations.

Activity on such a net is usually comprised of discussions on topics of interest to the net participants. A variety of special-interest nets exist to allow hams to share information on many different special ideas. Special interest nets with such names as "Computer Nut's Net," and "Amateur Computer Experimenters Net," exist to provide contact between hams who are also involved with computers and their applications to amateur radio. Operating frequencies and meeting times of such nets are contained in the *ARRL Net Directory*, available from the American Radio Relay League, Newington Connecticut, 06111.

There are "computer-users groups" in many cities across the country today that meet and share ideas and information on computing, publish newsletters, hold computer fairs and swapmeets; and provide various other useful services for their members. One of those useful services is the formation of special-interest groups (SIG's) for members within the group who have special computer-related interests. Amateur radio SIG's exist in some computer user's groups, and are a great source of help and information for the ham just getting started in the application of computers to radio.

Check the listings in your favorite computer magazine for the address and phone number of computer-user's groups near you.

Summary

And so, as you can see, there are many computer applications that amateur radio operators now use to maximize the enjoyment of their hobby. Much of the on-the-air communication today originates from stations using some degree of computer control. Many other tasks around the hamshack, such as log-keeping, predicting signal-propagation conditions, and circuit design, are frequently facilitated by computers. As a matter of fact, I believe that if the father of radio, Guglielmo Marconi, could see his computer-assisted offspring as it has grown today, he would most likely say: "You've come a long way, Baby!" ■

Many modern transceivers—such as the Yaesu unit pictured here along with a computer and other communications hardware— contain microprocessor-controlled send/receive circuits, along with provisions that allow your computer (under software control) to take over the "dirty" work.

HANDS-ON REPORT

Dremer 3950 Moto-Tool

Why not use a Moto-Tool for those delicate electronic problems that your regular tools just can't handle?

☐You've just spent an entire evening making a printed-circuit board for a project and discover that you have an extra foil trace; or perhaps that several closely-spaced foils are shorted—the copper between them didn't etch away. Not only must you cut several precision notches in the board to fit the enclosure, but the holes for the components range from hair-thin to about ⅛-inch.

While you could remake the board and then spend an evening or two trying to notch the board without causing it to break or shatter, an easier way to resolve all your problems is with a Dremel model *3950 Moto-Tool Kit*. Yes, Yes! We know a Moto-Tool is usually used by model builders—for things like miniature cars, planes, and even miniature house furniture. But, in the case of the Dremel 3950 Moto-Tool, it seems more like it was originally intended for the electronic hobbyists and experimenters.

Features

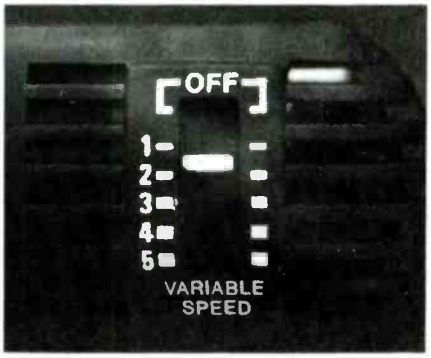
The 3950 is really a complete kit consisting of a variable-speed Moto-Tool; a 40-piece accessory assortment that contains grinding wheels, miniature high speed cutters, and cut-off wheels (abrasive discs); a toolbox that manages to keep everything more or less where it belongs even when turned upside down.

The Moto-Tool itself is Dremel's top-of-the-line: a variable-speed model with a speed-adjustment control built into the handle and functions as both the power switch and as a 5000-30,000 rpm controller. The tool is double-insulated so that only a standard (ungrounded) outlet is needed. Also, the power cord is the *Koil-Kord* type, whose springiness keeps it out of the way. A U-clip on the back of the Moto-Tool allows it to be hung from a wall or ceiling hook.

The tool is supplied with two collets (chucks) that fit the spindles of the supplied cutter and grinder accessories. If needed, a continuous-range keyless chuck can be substituted for the collet holder. And it will clamp just about anything from a ⅛-inch drill bit all the way down to a hair-thin wire. The smallest bit we have is a #60 wire gauge—thinner than the tip of a sharpened pencil—and the chuck holds the bit as though it was welded in place.

A shaft lock, in the form of a sliding-red button, is built directly into the front of the tool. When the shaft is locked, it takes only finger pressure to change or tighten the keyless chuck, or a small wrench to tighten and loosen the collet.

(Continued on page 102)



A single switch built into the handle serves as both the power switch and the speed control. If power control is extremely critical, the tool can be connected to an optional foot controller.

The plastic case is compartmented with a matching top so that everything stays where it belongs even if the case is turned upside down when closed.

By Joseph J. Carr, K4IPV

CARR ON HAM RADIO

Installing store-bought trap verticals

DESPITE CONTINUOUS (AND MOSTLY untrue) stories of very-poor performance, the four- or five-band, commercially-manufactured trap-vertical antenna remains one of the most popular amateur-radio "antlers" in the high-frequency bands. They are economical compared with directional rotating-beam antennas, easy to erect and don't have to occupy a lot of real estate (the "footprint" of the vertical can be very small, especially if you bury the radials).

Unfortunately, a misinstalled vertical is both dangerous and a very poor performer. So this month we'll spend our time dealing with both problems in order to give you a good shot at success.

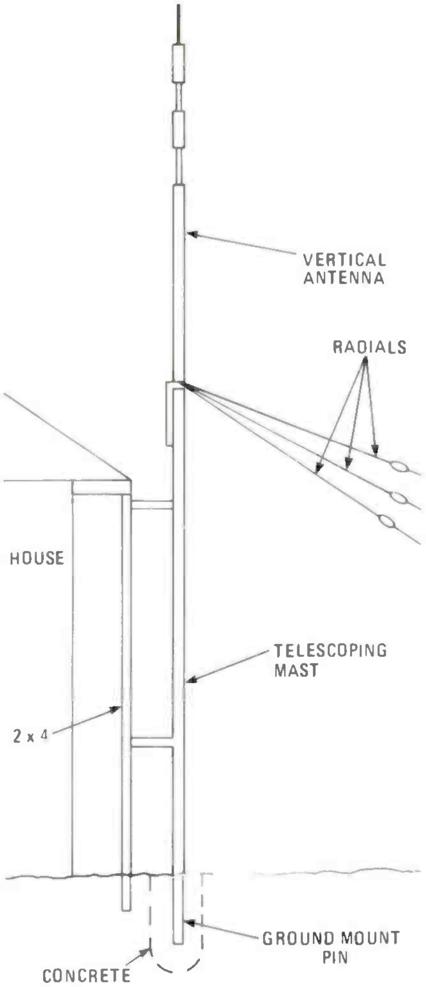


Fig. 1—My 25-foot tall trap vertical is installed atop a 15-foot Radio Shack telescoping antenna mast set on a ground-mounting pin/plate, with the top end of the mast secured to the roof overhang of the house—which was beefed up with a piece of lumber bolted between two 24-inch centers of the roof rafters.

Safety First

Before dealing with the radio and performance issues, let's first deal with safety matters: we don't want you hurt during installation or the next wind storm. Two problems present themselves: reliable mechanical installation and electrical safety.

Every year we read sad news in the ham magazines of a colleague being electrocuted while installing or working on an antenna. In all of those tragic cases, the antenna somehow came into contact with the electrical power lines. Keep in mind one dictum and make it an absolute: *There's never a time or situation when it's safe to let an antenna contact the electrical power lines!* That includes dipoles and long wires "thrown over" supposedly insulated lines, as well as antennas built from aluminum tubing. The excuse that the lines are insulated is hogwash—old insulation crumbles on contact with even a thin-wire antenna. Don't do it....we'd like our readers to come back next month. The word is **NEVER**!

Consider a typical scenario involving a four-band trap vertical. It will be 18–26 feet tall (judging from ads in magazines), and will be mounted on a roof or mast 12 to 30 feet off the ground. At my QTH in Virginia, a 25-foot tall trap vertical is installed atop a 15-foot Radio Shack telescoping TV antenna mast (Fig. 1). The total height above ground is the sum of the two heights: 15 ft + 25 ft = 40 ft. The tip of the vertical is 40 feet above the ground.

I had to select a location on the side of my house at which a 40-foot aluminum pole could fall over and *not* contact the power lines. While that requirement limited the selection of locations for the antenna, neither my father-in-law (who helped install the thing) or myself was injured during the work session. Neither will a wind storm cause a shorted or downed power line should that antenna happen to fall over.

In some jurisdictions, there might be another limitation on antenna location. Some local governments have a requirement that the antenna be able to fall over and land entirely on your own property. About 25-years ago, a county in Maryland required the antenna to be installed double its own length, plus 50-feet, from the nearest property line ...until a local ham club sued on the grounds that about 99.99 percent of the rooftop TV antennas in the county were not in compliance. Before installing the antenna check local building codes.

When installing a trap vertical, especially one that is not ground mounted, make sure that you have help. It takes at

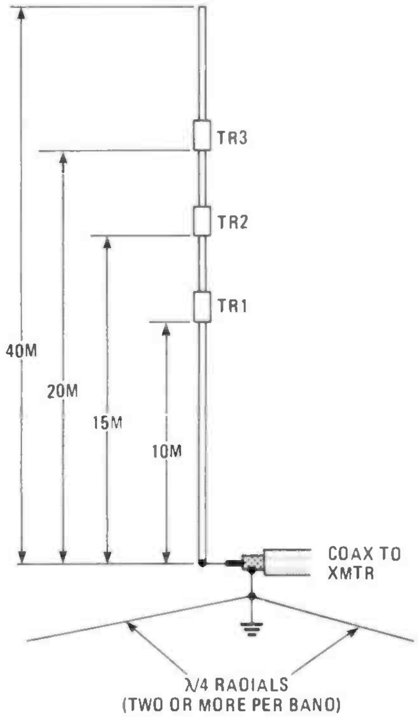


Fig. 2—Adjust each segment of the antenna for resonance, starting with the 10-meter band, working each lower-frequency band in succession: 10, 15, 20, 40, etc. After each lower band is adjusted, recheck the higher bands to make sure nothing shifted because there might be a little interaction between bands.

least two people to safely install the antenna. If you feel like the *Lone Ranger*, then go find *Tonto* and get him to lend an arm or two. Wrenched backs, smashed antennas (and house parts), and other calamities won't succumb to silver bullets ...so go get help. (If you're old enough to remember 807's, then you understand how a fridge-full of 807's go a long way toward encouraging local hams to help in an antenna party).

Mechanical Integrity

The second issue in installing vertical antennas is old-fashioned mechanical integrity. Two problems are seen. First, you must comply with local building regulations and inspections. Even though the courts seem to forbid local governments from prohibiting amateur-radio activity (on the grounds that it's a Federal prerogative), the local government has a reasonable interest and absolute right to impose reasonable engineering standards on the mechanical installation.

The second issue is that it is in your own best interests to make the installation as good as possible. View local regulations as the minimum acceptable standard, not the maximum; go them one better. In other words, build the antenna installation like a brick outhouse.

Both of those mechanical integrity issues become extremely important if a problem develops. For example, suppose a wind or snow storm wrecks the antenna, plus a part of your house. The insurance company will not pay off in most cases if your local government requires inspections, and you failed to get same. Make sure the mechanical or electrical inspector (as required by law) leaves a certificate or receipt proving the final inspection was done ...it could come in handy when dispute developes with the insurance company over damage.

A quality installation starts with the selection of good hardware for the installation. Any radio/TV parts distributer who sells TV-antenna hardware is sure to have what you need. I used Radio Shack standoff brackets, ground pin and a 19-foot telescoping mast. Wherever you buy, select the best quality and strongest material that you can find. Opt for steel masts and brackets over aluminum, no matter what the dude (or more truthfully, dud) behind the counter tells you.

In my own case, I found that the mast was sturdier at 15-feet, so I opted to use less than the full length because the installation is unguyed. Because I have never trusted the little cotter pin method of securing the mast at the slip-up height, I drilled a single hole through both bottom and slip-up segments (which telescope together) and secured the antenna mast with a 5/16-inch steel bolt. The bolt was "double-nutted" in order to ensure that it did not come loose over time.

The TV mast is set on a ground-mounting pin/plate that's set into a 20-inch deep (local frost line regulations required only 18-inches) fence-post hole filled with concrete. The top end of the mast was secured to the roof overhang of the house (see Fig. 1). That overhang was beefed up with a piece of 2 × 8-inch kiln-dried lumber that was bolted between two 24-inch center roof rafters. I felt it necessary to do that

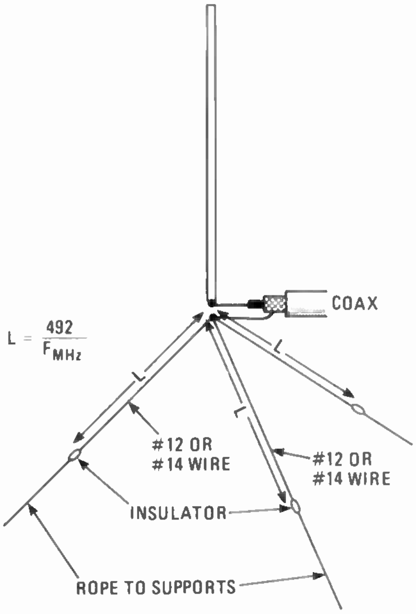


Fig. 3—For amateur work, it is recommended that not less than two and preferably four radials per band be equally spaced around the antenna.

because the roof is only plywood, the gutter guard is only 1 × 6-inch lumber (and is old), and the soffits were aluminum (not enough strength to support a 40-foot lever-arm whipping around in a 35-knot wind).

Wind can be a terrible force, especially when acting on the "sail area" of the antenna through a 25–40 foot leverarm. A shabby installation tears apart in wind, causing the antenna to be damaged, damage to the house, and destruction of the installation....and puts you off the air for awhile (sob). That's why I recommend brick outhouse construction methods. Over the 28-years that I have been in amateur radio, I've seen a lot of verticals toppled over. Except for a few shabby models that were so poorly built that they should not have been on the market in the first place, all of those failed installations were due to either poor installation, design, or cheapskate materials.

Electrical Installation

Figure 2 shows the usual form of multiband trap vertical antenna. Each trap (TR1–TR3) is a parallel resonant L-C tank circuit that blocks a certain frequency, but passes all others. In Fig. 2, TR1 is the 10-meter trap, TR2 is the 15-meter trap, and TR3 is the 20-meter trap. No 40-meter trap is needed because the antenna resonates the entire length of the tubing when used on the 40-meter band.

Each section (except perhaps the 10-meter section) is actually a little shorter than might be expected from the standard quarter wavelength formulas. That is because the traps tend to act inductively, and so lessen the length required to resonate on any given band.

The vertical manufacturer may give suggested lengths for the various segments between traps. *Do not* make the mistake of assuming that those are absolute numbers. They're only recommended starting points, even though the literature packed with the antenna may suggest otherwise. Loosely (meaning, don't tighten the clamps too much), but safely install the antenna and then adjust each segment for resonance.

Start with the 10-meter band, and then work each lower-frequency band in succession: 10, 15, 20, 40, etc. After each lower band is adjusted, recheck the higher bands to make sure nothing shifted because there might be a little interaction between bands. Once the antenna is properly resonant, tighten the clamps and make the final installation. I know that's a pain in the neck, and means putting the antenna up and taking it down a couple of times, but it pays dividends in the end. I failed to to that procedure once, and found that the 15-meter band was useless: it resonated at 19.2 MHz.

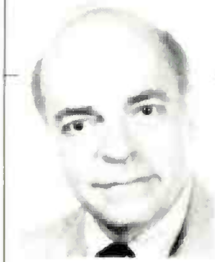
Radials—which form the ground plane for the antenna—make or break a vertical antenna. AM broadcast stations typically use vertical antennas, and must have up to 120 radials for the ground plane. Professional antenna-reference texts usually contain a graph plotted to show the effectiveness of radials, and demonstrate a decreasing return on investment about 32 radials.

For amateur work, I recommend not less than two radials per band and preferably four, arranged so that they are equally spaced around the antenna. If you can't space them correctly, never fear: they'll work anyway. On a four-band antenna, that means we would need 16 radials, which really isn't a lot.

The radials are made of #14 wire, and must be quarter wavelength ($246/F_{MHz}$). Figure 3 shows how to mount the radials on a mast-mounted or roof-mounted installation, while Fig. 4 shows radials in a ground mounted situation. I *do not* recommend radials on the surface for ground mounted antennas. It's all too easy for a guest, or even a trespasser, to trip over the radials and that could land you in court.

Wire radials can be buried using a spade tip to cut a 3- to 4-inch slit; and may

(Continued on page 105)



By Marc Ellis

ELLIS ON ANTIQUE RADIO

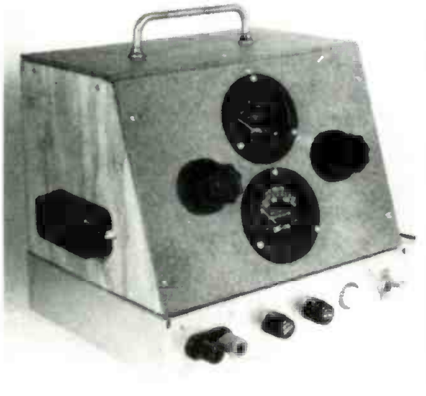
Starting up those old AC sets

A COUPLE OF MONTHS AGO WE finished up a two-part series on electrolytic capacitors. We discussed some of the factors that cause power-supply electrolytic capacitors to fail—in particular, deterioration of the dielectric layer that insulates the electrodes of the capacitor. That results in loss of filtering action, causing a loud, signal-obscuring hum. Or, even worse, a short circuit within the capacitor stops reception completely and even causes the failure of other power-supply components.

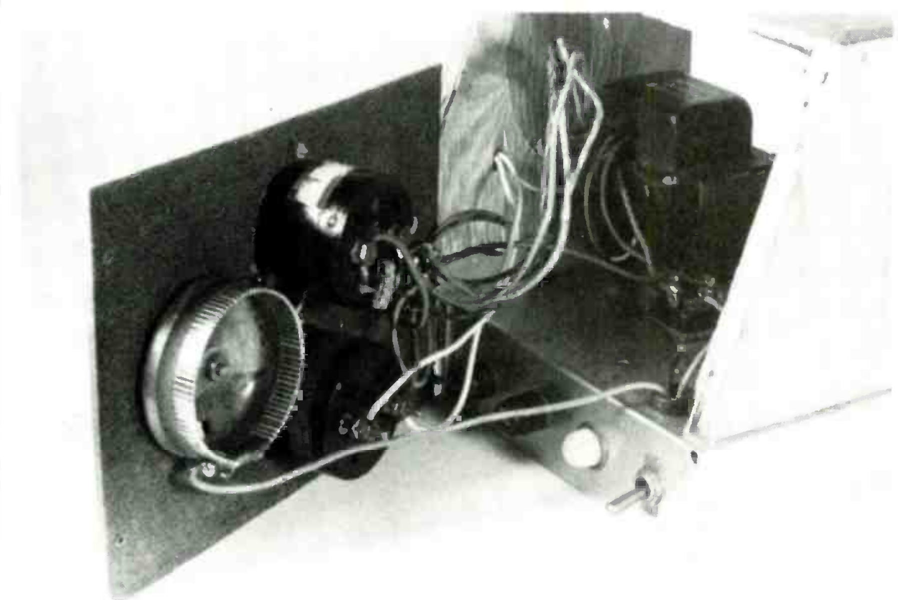
Power-supply electrolytic capacitors aren't necessarily expected to last for the life of the set; occasional replacement is routine. But as an antique-radio collector, there is one type of electrolytic failure that you can anticipate and sometimes avoid.

Taming the Tiger

When a set has not been turned on for many years, the dielectric material may deteriorate through disuse. If that happens, the capacitors may short out and self-destruct the very-first time that the set is powered up after a long storage period. However, as long as the chemical paste (electrolyte) that's responsible for dielectric formation hasn't completely dried out, there is a chance of re-forming the deteriorated dielectric.



The completed "start-up control console" has an AC-voltmeter; DC ammeter; transformer tap switch; charging rate rheostat mounted to its sloping front panel. On the chassis below are the fuses, power switch, pilot light, and charger terminals. An AC outlet, into which the set being tested is plugged, is mounted on side of unit.



With the console's front-panel swung open, the isolation/control transformer can clearly be seen at the rear of the chassis. The panel-to-chassis connecting leads are kept long, making it easier to remove the front panel for servicing.

Dielectric reformation is accomplished by operating the set at reduced voltage for several minutes. The dielectric layer can then be regenerated and slowly build up again. Soon it becomes almost as good as new, and full voltage can be applied to it without any danger of short-circuiting the capacitor. That saves you the trouble of finding and installing replacements, and permits you to keep the original capacitor in service rather than substituting something more modern.

Start-Up Control Console

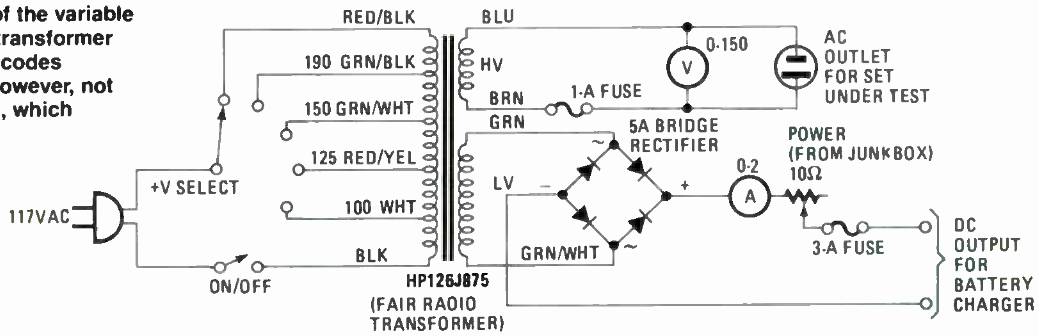
In an earlier column, I also mentioned a surplus 100-watt, isolation/voltage-control transformer—listed as part No. P-126J875 in their current catalogue—offered by Fair Radio Sales (1016 E. Eureka St., Lima, OH 45802), priced at $7.95 plus shipping. That unit seemed to offer a very inexpensive solution to the problem of providing low start-up voltages for old sets—while at the same time isolating the sets from the AC line (which is an excellent safety measure).

In a later column, I tested the transformer, found that it performed as advertised, and promised to wire it into a control console that would assist in the process of old set start-up and testing. The result of that endeavor can be seen in the photos. I don't think my console will win any industrial design prizes, but it was built at negligible cost using a recycled chassis, junkbox parts, and scraps of building materials. The parts layout is unconditionally non-critical. So if you decide to build your own version of the console, choose an arrangement that suits the parts and materials that you happen to have on hand.

For wiring details, look at the schematic diagram shown in Fig. 1. First, let's deal with the battery-charging circuit that's connected to the transformer's low-voltage winding (green and green/white wires). That fills a special need for me, inasmuch as I maintain a small 6-volt, lead-acid battery for powering the filaments of pre AC-operated receivers.

The low-voltage transformer winding, with the help of a surplus bridge rectifier from the junkbox, easily supplies the necessary 1.8 amperes of charging current. Since I was putting the console together

Fig. 1—Schematic diagram of the variable power-supply console. The transformer leads are marked with color codes observed on my own unit. However, not shown is an extra white lead, which seems to have no function.



anyway, it was a simple matter to add the few extra components necessary to make a simple charger. If you don't need a small charger, or you already have one, leave the charger circuit out.

Now let's look at the rest of the circuit. The transformer's high-voltage winding (blue and brown wires) is connected to an AC outlet for the set under test, as well as to an AC voltmeter, which is optional. (I installed it because I happened to have one on hand.) The meter is used to monitor the voltage level provided to the AC outlet. In that way, shorted and open-circuit conditions can quickly be detected before they can do further damage.

The connections to the primary of the transformer require some explanation. As you look at them, keep in mind that the transformer was apparently originally designed to provide an (approximately) 120-volt output from inputs of 220, 190, 150, 125 or 100 volts. It accomplished that end by providing appropriate taps in the primary winding. As received, the transformer include a selector switch already wired to the taps and marked with the five possible input voltages.

The switch on my transformer was defective and, in any case, was of a type that would have been very clumsy to mount. So I removed it and substituted a standard single-pole, five-position (SP5P) rotary switch. However, for your ease in identifying the correct wires, I've labeled each one with its original switch-position designation, as well as its color code as observed on my transformer. I should mention, also, that my unit came with a wire lead (white) of unknown function. It has no continuity to any other lead on the unit, and may be connected to some type of internal shield. I simply taped it up and tucked it out of the way.

Before leaving the schematic, note the fuses in both the AC and DC circuits. They're are important and should not be left out. They'll protect your console in the event of accidental short circuits. In addition, the AC fuse protects the "radio-under-test" in the event that it develops a short. That one-ampere fuse blows out a lot faster (thus preventing burn-out of irreplaceable components) than the 15- or 20-ampere fuse you'd be depending on if the set were plugged directly into the AC line.

After completing my unit, I observed the following voltages on its meter with a measured 117-volt input and a 60-watt load plugged into the AC outlet: 65, 77, 98, 125, 151. The lowest voltage was obtained from the 220-volt tap; the next lowest from the 190-volt tap, etc. You might want to consider eliminating the connection to the 100-volt (151-volt output) tap. Such a high voltage might endanger the components in your old radio if you were to switch the console to that position accidentally.

However, you'll have to keep that tap if you're using the battery-charging circuit. It's needed to boost the nominal 6.3-volt output of the low-voltage winding to about 8 volts—which is required to overcome losses in the bridge rectifier, so that adequate charging current can be supplied to the battery.

When you're starting up an old set for the first time, plug it into the console. Select the lowest voltage and slowly work your way up to 125, allowing the set to remain at each voltage level for perhaps ten minutes. It's a good idea to monitor the DC output of the power supply within the set during this period (a voltmeter connected across one of the filter capacitors will do). If the output falls to a negligible value, or never rises above one, one of the capacitors has probably shorted out. Shut the power off immediately and check it.

But if you reach 125 volts on the console without causing a short—and if there's no indication of objectionable hum in the radio's speaker—congratulations. You've just beaten the odds and given an old electrolytic a new lease on life! The console can handle AC loads of up to 100 watts, which is enough to power almost any old set that you're likely to be working with.

The Readers Speak!

Quite a lot of reader mail has come in since I last had some space in the column to acknowledge letters. I've enjoyed the mail, but haven't been able to share it with you for a while. So let's dig in to the old mailbag and look at some of it now. If you should be able to handle any of the requests for parts or information, please contact the requester directly. He or she will certainly appreciate it!

Art McComas (5 Hilltop Trail, Denville, NJ 07834) collects old/odd radio tubes and encloses a snapshot showing part of his attractively-displayed collection (see photos). He's also wondering if anyone can supply a schematic and/or information about a 1-tube (1D8GT) radio kit sold in the mid 1940's. The set was

(Continued on page 103)

A portion of reader Art McComas' collection of old and oddball tubes.

By Charles D. Rakes

CIRCUIT CIRCUS

Analyze voice-scrambling techniques using two simple circuits

IN THIS MONTH'S "CIRCUS OF CIRCUITS," we're going to explore the altered state of voice communication, or how to foul up speech so that no one can tell who's speaking, without destroying the contents of the message. You can have fun with your friends when you use one of the circuits to disguise your voice by making it sound higher or lower in pitch. And by adding another circuit (a very low frequency amplitude modulator), you can add a tremolo effect.

The circuits can be used singularly or in tandem, and the modified speech can be coupled to the telephone line for extra fun. Just think what the circuits can do for next year's Halloween party. But enough of the verbal prelude; let's get to the real heart of the matter.

Voice Scrambler

I'm sure you've seen and heard those national news telecasts, wherein a secret government witness, speaking with a spaced-out high or low-pitched voice, tells all. Well a similar effect can be obtained with the circuit shown in Fig. 1.

That circuit uses two interconnected, balanced-diode mixers to obtain the dual-frequency shift that's necessary to add special effects to any audio that is coupled to the circuit's input. If we cut the circuit in half at the output of transformer T2, and include the U1a tone-oscillator circuit, we have a single mode inversion circuit that shifts the frequency of all input signals to a new higher- and lower-output frequency. The actual amount of frequency shift is determined by the frequency of the carrier oscillator (U1a) circuitry.

With a carrier frequency of 3.5 kHz, and a 2.5-kHz input tone, two new frequencies appear at the output of T2: the sum frequency set at 6 kHz, and the difference frequency at 1 kHz. The difference frequency is the one that we'll use to mix with the second single-mode inversion circuit to produce the desired effect.

The sound of your voice at the output of the single-inversion circuit would definitely be disguised to a point that no one could recognize it but neither would anyone be able to understand anything you said. That's because all of the low-voice tones would be shifted to higher frequencies, and all of the high-voice tones would be shifted to lower-frequency sounds. The same basic single-mode inversion circuit is used on a daily basis across the country by many police departments, as a voice-scrambling system.

The audio heard from a receiver without a descrambler sounds somewhat like an off-tuned single side-band signal on a communication receiver, or Donald Duck with a bad cold.

If the audio from the single-inversion circuit is fed into a second such circuit, operating with a carrier oscillator on the same frequency as the first, the output sounds normal. And here's why: The 2.5-kHz input tone came out of the first inver-

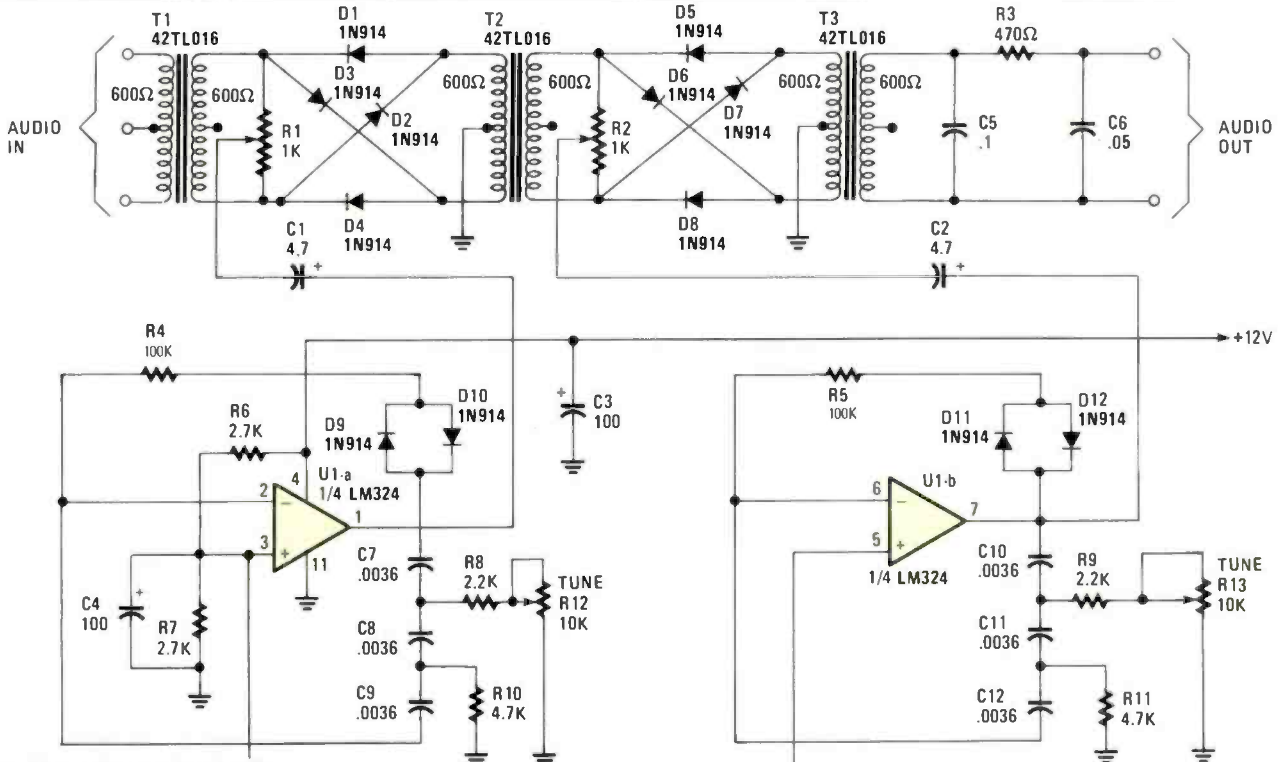


Fig. 1—Voice-Scrambler circuit

sion stage at a new difference-frequency of 1 kHz. The 1-kHz signal is fed into the second stage. The difference-frequency at the output of the second stage is 2.5 kHz, (3.5 kHz minus 1 kHz brings us back to the original 2.5 kHz).

Why, you might ask, go through all of that trouble to get back to where you started from in the first place? The point is that we don't want to get back to the *exact* starting place, but instead to be off enough in the frequency of the second carrier oscillator to produce a voice output sound that's either a few cycles higher or lower than your normal voice. When the second carrier oscillator is tuned to 3.6 kHz (or 100 Hz higher than the first carrier oscillator), the frequency of the voice output will also be shifted 100 Hz higher.

If you have a frequency counter, use it to make a rough calibrated dial for each of the carrier oscillators. That helps in repeating a given sound effect. Since the circuit is intended for experimental use, and subject to a number of modifications, perfboard construction would be a good way to go. The 1N914 silicon diodes used in the two inversion circuits can be matched for their *forward-on-resistance* by using almost any VOM.

By matching the four diodes in each of the circuits, the mixing of the voice signals and the balancing of the carriers will be much easier to accomplish.

Two op-amps, from an LM324 quad op-amp chip, are used as the active devices for the two-phase, shift-carrier oscillators, with each output feeding its own mixer circuit. Both oscillators can be tuned above 3.5 kHz and below 2 kHz, and produce a near-sinewave output. If either of the oscillator circuits refuse to *wiggle* an output, try raising the amplifier's gain by increasing the value of R4 or R5 until the circuit takes off.

A quick check to see that both op-amps are properly biased is to measure the voltage at pin 1 and pin 7. Both should measure about 6-volts.

To set up and check out the altered-state circuit, tune each of the carrier oscillators to about 3.5 kHz, and set the two balancing potentiometers, R1 and R2, to mid range. Connect a high impedance set of headphones, or an audio amplifier with a speaker output, to the audio output of the circuit. Locate a talk show or newscast on a local radio station, or a pre-recorded tape on a cassette recorder, and patch the audio to the input of the circuit.

With the audio circuit connected, but with no audio coming out (volume turned down), listen to the output and adjust both R1 and R2 for a minimum tonal output. That's the fine adjustment for both of the carrier balancing potentiometers. Bring the volume up until a suitable listening level is obtained and play with the setting of R13 to obtain the desired sound effect.

Let's Go Tremolo

The tremolo circuit in Fig. 2 can be fabricated on the same piece of perfboard to share the unused op-amps of U1 and the power source. The tremolo circuit can be connected to the output of the frequency shift circuit in Fig. 1 to add another dimension of change to the audio sound.

The tremolo circuit adds an amplitude modulation effect, at a sub-audible rate, to the audio as it passes through, giving it a wavering effect. Operation is very simple and goes like this: U1c is connected as an inverting amplifier, with a gain of less than 2. A portion of the gain-setting feedback resistor R3 is connected in parallel with an N-channel TMOS FET transistor identified as (Q1).

The FET, operating like a variable resistor, is driven by the output of the VLF phase-shift oscillator to cause the ampli-

(Continued on page 105)

PARTS LIST FOR THE VOICE SCRAMBLER

CAPACITORS

C1, C2—4.7-µF, 25-WVDC, electrolytic
C3, C4—100-µF, 16-WVDC electrolytic
C5—.1-µF, 100-WVDC Mylar
C6—.05-µF, 100-WVDC Mylar
C7–C12—.0036-µF, 100-WVDC Mylar

RESISTORS

(All resistors are ¼-watt, 5% fixed units unless otherwise noted.)
R1, R2—1000-ohm potentiometer
R3—470-ohm
R4, R5—100,000-ohm
R6, R7—2700-ohm
R8, R9—2200-ohm
R10, R11—4700-ohm
R12, R13—10,000-ohm potentiometer

ADDITIONAL PARTS AND MATERIALS

D1–D12—1N914 silicon diodes
T1–T3—600-ohm to 600-ohm center-tapped audio transformer (Mouser part No. 42TL016, or similar)
U1—LM324 quad op-amp, integrated circuit
Perfboard or printed circuit material, IC socket, pins, etc.

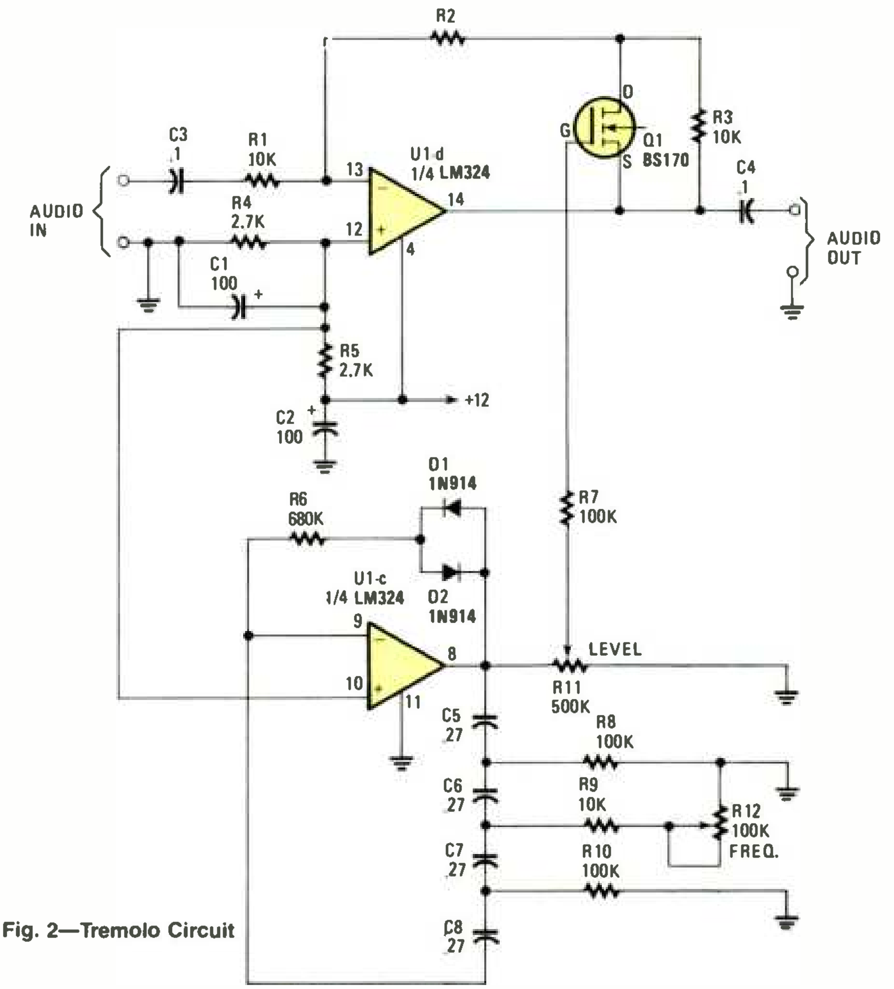


Fig. 2—Tremolo Circuit

By Byron G. Wels

WELS' THINK TANK

Many electronic accomplishments are attributable to experimenters!

☐JUST IN CASE YOU DON'T KNOW; AN awesome amount of our present-day electronic marvels were discovered by experimenters. It's no secret that in the early days of radio, some government official said "Amateur radio operators? Let's give 'em 200 meters and down. They'll never get out of their own backyards!"

Well, the *hams* did get out of their own backyards on those high frequencies, lighting the way for those who were to follow! And I want to tell you that experimenters—people just like yourself—with limited knowledge, an insatiable curiosity, and a need to stick their noses into new areas, have pioneered today's technology and will continue to spearhead tomorrow's.

It's true that a lot of the so-called "big inventions" needed the backing of a major corporation to at least fund the work. But if you could read the letters I've been getting, from people just like you, then (like me) you'd be amazed and impressed with the kind of thinking and creativity that you guys are capable of!

Auto-Power Adaptor

I've begun a self-improvement course that comes on cassette tapes. The idea is that I listen to these motivational tapes while driving to and from work in my car. The problem is that I've been buying batteries for the cassette recorder. Now I know there's 12 volts or so right there in the car's cigarette lighter. But just exactly how do I break that 12 volts down to the supply voltage that my cassette requires?—K.D., St. Cloud, MN

Take a gander at Fig. 1. Connect the input leads of the circuit to a cigarette lighter plug (available at most electronic-supply houses) and the output voltage will provide a suitable level for your cassette recorder.

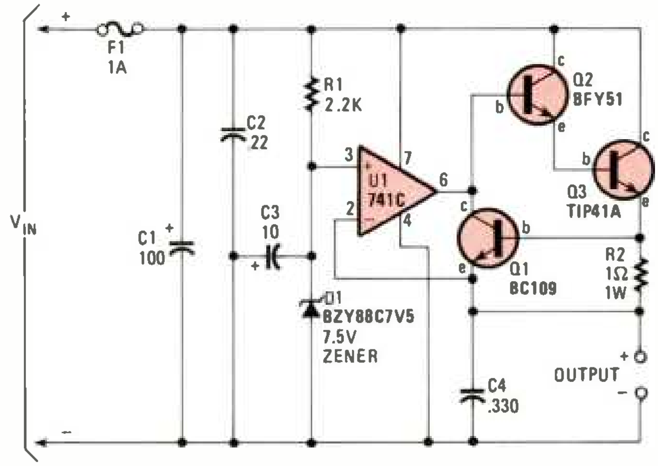


Fig. 1—When the auto-power adaptor circuit is connected to a cigarette-lighter plug (available from most electronic supply houses), it provides (via the 7.5-volt Zener, D1) a level of voltage suitable to power your cassette recorder.

Voltage from the car battery, after going through fuse F1, is sent to smoothing capacitors C1 and C2, and decoupled by C3. The fuse is included even though the unit incorporates current-limiting circuits. It's possible that in a positive-ground system a short might take place between the positive input and negative output, or directly across the 12-volt supply. Should that happen, F1 would blow, side-stepping any really serious damage.

Since the source impedance of the supply is low, it's a good idea to include that fuse. Keep in mind that there's likely to be a lot of noise, which capacitors C1 and C2 help reduce. The op-amp (U1) is configured to provide unity gain, so its output voltage is stabilized at exactly the same level as its input.

Transistors Q1 and Q3 form a discrete emitter-follower output stage so the necessary output currents can be provided. R2 and Q2 are used in a simple, conventional state-of-art current-limiting arrangement providing a maximum output current of about 600 mA.

Using a 7.5 volt Zener diode as shown, a nominal output voltage of 7.5 volts is obtained. Change the rating of D1 to a 6.2-volt or 9.1-volt unit and get an output of six or nine volts. Make sure in putting the circuit together that Q3 is mounted on a heatsink—a small, commercially-available, finned, bolt-on type is the best. Select an anti-surge (slow-blow) fuse for F1; a quick-blow unit will probably say *good-bye* after being hit with the high turn-on surge of C1.

Battery Charger

I've got a schematic for an electronic flash, and want to modify it. I want to build in a fast charger for NiCd batteries and not have to worry about them any more. Got something for me?—D.A., Kean, NH

Check out the circuit in Fig. 2. That circuit will provide a rapid charge for AA-size cells requiring a charge current of 150 mA. T1, D1, D2, and C1 produce a DC supply of about 9 volts from the AC line. T1 has a center-tapped secondary with six volts at each side. The secondary current rating of T1 should be 500 mA or better.

D1 and R3 form a regulator that provides about 0.7 volt to the non-inverting input of U1. Negative feedback from the emitter of Q1 to the inverting input of U1 stabilizes the voltage across R_e at the same voltage. The emitter current of Q1 can therefore be set at the required potential by giving a value to R_e that provides the desired amount of current with an applied voltage of 0.7. The approximate current of 150 mA can be had by using a 4.7-ohm resistor for R_e. The NiCd cells are actually connected in the collector circuit of Q1, but that's acceptable because the emitter and collector currents for any high-gain devices are the same.

You can use any of the plastic battery holders that are available, as they automatically connect in series. And use a heat sink on Q1. Increasing the value of capacitor C1 will improve the circuits efficiency by filtering the power supply, thus reducing ripple.

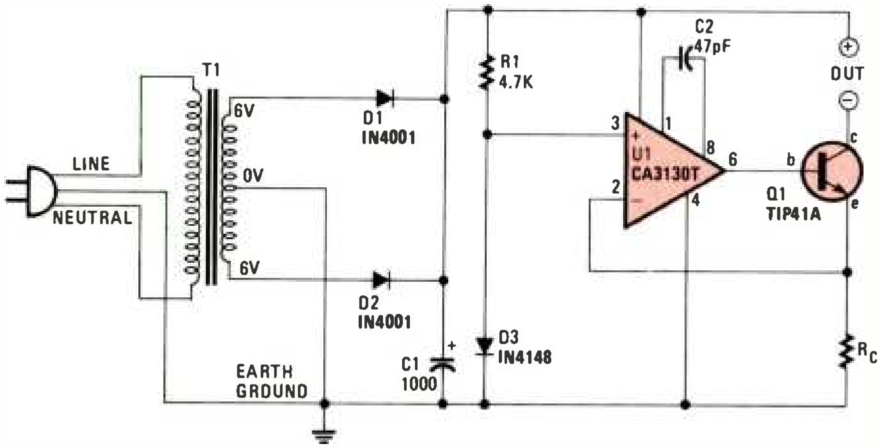


Fig. 2—In this battery charger, T1 (a 12-volt, center-tapped transformer), D1, D2, and C1 form a 9-volt DC power supply. R1 and D3 together supply 0.7 volt to the non-inverting input of U1, whose output feeds the base of Q1.

Audio Fader

I operate a DJ show and occasionally, during the music, somebody wants to make an announcement over the public address system. The only problem is that when I throw the switch to kill the music, I get a loud pop. Somebody told me to get a "Fada." But now I understand that company went out of business some time ago. Can you help?—R.K., Livingstone, NJ

Wait a minute....You were told to get a *fader*, not a *Fada*. The Fada Radio Company produced receivers in the 1920's and '30's. It was named for the founder, Frank A. D'Andrea. A fader is a device that automatically reduces the volume of the music at the throw of a switch, and brings it back the same way.

Check out the schematic diagram in Fig. 3. Transistor Q1 is configured as a common-emitter amplifier which, with the inclusion of unbypassed emitter resistor R4, produces a large amount of negative feedback. Therefore you'll find that the amplifier has a voltage gain of about 6db (two times).

However, with switch S1 in the up position, JFET Q2 has a gate-to-source voltage of zero, and is biased into conduction. At that point, Q2 shows a drain-to-source resistance of only about 200 ohms, reducing the amount of feedback to provide a voltage gain of about 25.

Switching S1 to the down position causes capacitor C3 to charge by way of R5 and R6, which in turn causes an increasing reverse bias on Q2. As the reverse bias increases, Q2 gradually switches off, returning the full amount of negative feedback to Q1 as the drain-to-source resistance of Q2 rises to several megohms. The voltage gain of Q1 is gradually reduced, thereby reducing the amount of output audio.

Returning switch S1 to its original position causes capacitor C3 to discharge through resistor R5, and the signal is gradually returned to its original level. R6 should be adjusted for the highest wiper voltage that gives the fading action. The up/down fade times should be reasonably well matched.

White Noise Generator

I don't like the idea of taking drugs, even those prescribed by a doctor. But I've been having trouble sleeping lately. I was told by a friend that a "white noise" generator will help bring back the Sandman. Can I actually build one of those? If so, how?—R.J., Fresno, CA

We won't make any sort of medical claims for this circuit—after all we're not doctors, nor can we afford to pay for medical malpractice insurance. However, the circuit shown in Fig. 4 is a schematic diagram for a white noise generator that provides an output of about 100 mV rms with the accuracy of the figure varying from unit to unit.

The actual noise generating device is a germanium transistor, Q1, with load resistor R1 connected to Q1's emitter. Note that Q1 has no bias voltage or input signal applied to its base. That means that the only current flowing through Q1 is leakage current. The rate of current flow varies randomly and rapidly to produce the noise signal. The amount of noise produced var-

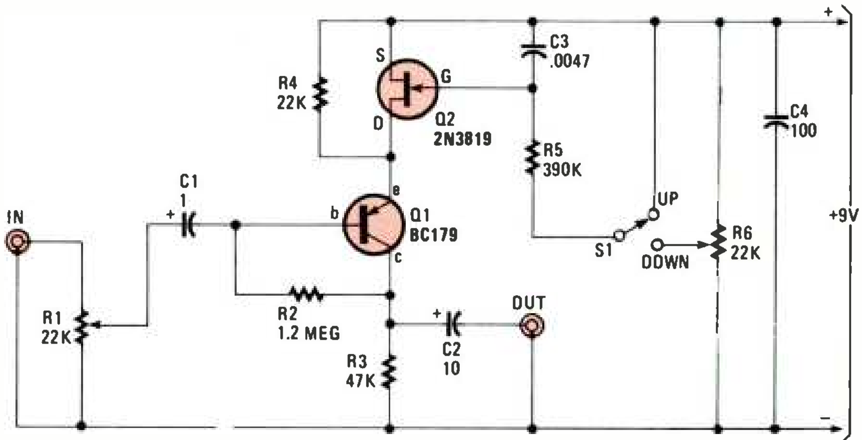


Fig. 3—Transistor Q1 is used as a common-emitter amplifier in the fade-out circuit. With switch S1 in the up position, Q2 has a gate-to-source voltage of zero, and shows a drain-to-source resistance of only about 200 ohms. With S1 in the down position, capacitor C3 charges, increasing the reverse bias on Q2; thereby gradually switching off Q2 and causing the audio to fade.

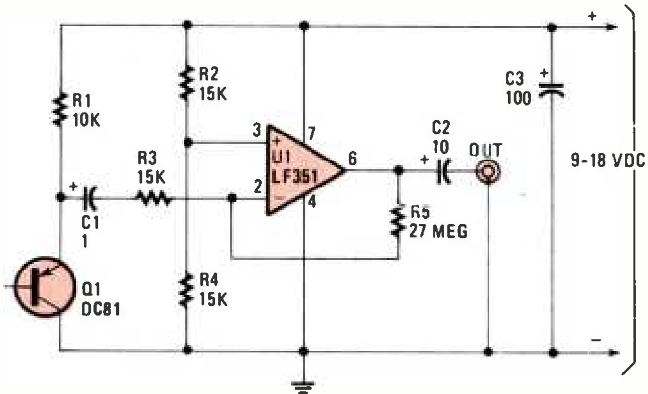


Fig. 4—The white noise circuit uses germanium transistor, Q1, as the noise-generating device. Its output is fed to U1 (an LF351 BIFET op-amp), which provides a voltage gain of about 180. For additional amplification add another op-amp.

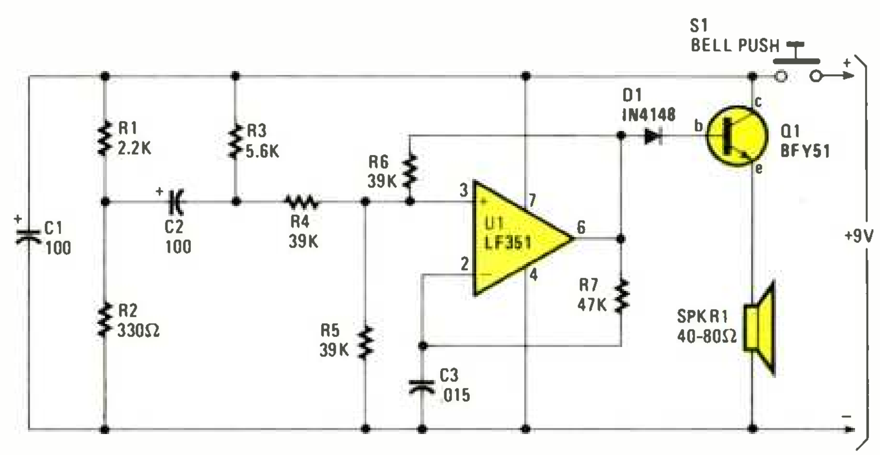


Fig. 5—This novel door buzzer circuit provides an attention-getting sound (producing a low note that rises to the maximum pitch over a few seconds); producing a wide range of audio frequencies that are not easily masked out.

ies from circuit to circuit depending on the circuit elements used. Several germanium transistors were tried and all gave a reasonably-high output level. You'll probably find a suitable transistor or two in your junkbox.

The output signal of Q1, although strong, isn't adequate to drive a loudspeaker, so instead the noise signal is fed to a LF351 BIFET op-amp (U1), configured in the inverting mode, for a boost in power. Q1 provides a voltage gain of about 180, which raises the output to a suitable level for practical use. If it's needed, additional amplification can be provided.

Buzzer

I was watching television, and my doggone door chimes went off. When I got to the door, nobody was there. That's when I realized it was the TV set chiming to announce an actor at the door of their set. Do you have circuit that can be used as a doorbell that puts out an unusual sound? But please, nothing too raucous.—R.T., Franklin Square, NY

Well, R.T., if you'll cast your eyes on Fig. 5, I believe you'll find just what you seek. That circuit produces a low note, which then rises to its maximum pitch over a few seconds, so a wide range of frequencies is covered that are not easily masked over by background sounds.

Note that bias resistor R4 is not connected directly to the positive supply, but rather to a simple R/C circuit comprised of resistor R3 and capacitor C2. The negative side of C2 is coupled to a voltage divider formed by resistors R1 and R2, so that at turn-on, a small voltage is fed to the junction of resistors R3 and R4, even though C3 is uncharged. That small voltage appears at the non-inverting input of U1, causing it to oscillate at a relatively low frequency.

When power is supplied to the circuit by a press on S1, capacitor C2 quickly starts to charge, causing the voltage at the junction of resistors R3 and R4 to rise towards the positive supply potential. The rising potential causes a similar upward sweep in the output signal frequency of U1. That signal is then applied to the base of transistor Q1, which with each positive-going pulse of the output signal, turns Q1 on. And finally the a sound is heard at SPKR1.

Phone Amplifier

Can I build an amplifier for my telephone? I've seen them advertised for what I consider to be high prices. I'm sure that I'd save money by building my own, but am I capable of putting such a unit together?—E.G., Sioux Falls, SD

E.G., did you ever hear the story about the guy who cut a few of his fingers off in a power-saw accident? After some delicate microsurgery, the doctor told him he was as good as new. "Doc," he asked, "will I be able to play the piano now?" The surgeon assured him that he would. "That's wonderful," he said. "I didn't know how to before!"

All of that goes to say that I'm unable to assess your skills, but I can assure you that if you have the ability to read and follow a schematic diagram, and work with reasonable care, there's no reason why you shouldn't be able to put together the unit shown in Fig. 6.

The simplest and safest way to couple that unit to your telephone system, is via an inductive pickup—you know the type with a suction cup. That avoids ripping off the cover to tamper with the phone's internal wiring. Of course, the the signal plucked from the telephone line will be extremely weak. Therefore, that signal is fed to an LF351 BIFET op-amp (U1)—which is configured as a preamp, providing minimum noise and distortion levels—at its inverting input. U1 provides a voltage gain of about 670, as determined by resistors R1 and R4.

The output of U1 is coupled via capacitor C4 and potentiometer R5 (volume control) to the non-inverting input of U2, an LM380N audio power amplifier. No DC-blocking capacitor is needed at the input of U2, if the input is referenced to the negative supply. The inverting input (pin 6) is connected to the negative supply rail to avoid picking up stray noise. Capacitor C5 couples the output signal—on the order of 150 to 200 milliwatts—to the speaker. That output level should prove more than adequate to drive any high-impedance speaker.

Well, that all she wrote for this issue. But let's make a date for next month. If you have any requests, observations, or suggestions, write to Byron G. Wels, *Wels' Think Tank*, **Hands-on Electronics**, 500-B Bi-County Blvd., Farmingdale, NY 11735. So, until next we meet, may the flow—electron flow, that is—be with you. ■

*The material for this month's column was taken from Popular Electronic Circuits Book 1 by R.A.Penfold, Published by Bernard Babani Publishing Co. Ltd. It is available for $5.00 from Electronic Technology Today, PO Box 240, Massapequa Park, NY 11762-0240, which also publishes an extensive technical book catalog.

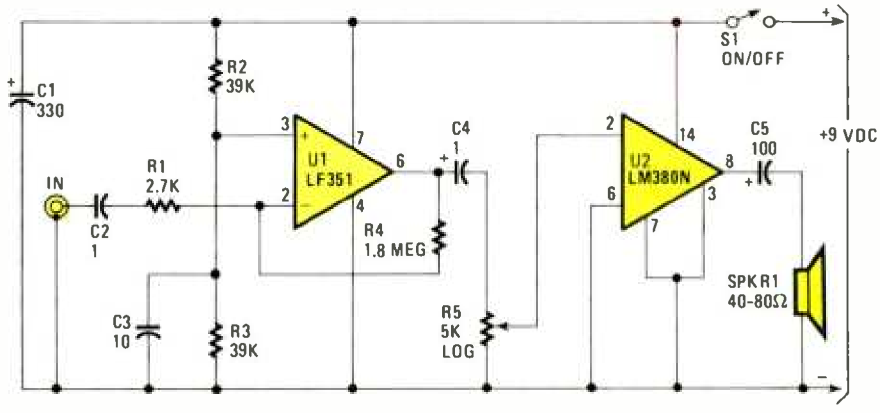


Fig. 6—The simplest and safest way to couple this amplifier—which, with the values shown, provides a gain of about 670—to your telephone system is via an inductive pickup, eliminating the need to break open your telephone.

LEARN BY DOING

All About Static RAM's

By Louis E. Frenzel, Jr.

Static RAM's are not shocking sheep, they're memory units you'll learn about the Hands-On way in this new series

THEY SAY THAT THE BEST WAY TO LEARN ANYTHING IS TO do it. As it turns out, that happens to be quite true when it comes to electronics. Electronics is such a hardware-intensive field that you simply cannot appreciate the potentials, as well as the problems, until you actually get your hands on the hardware. The whole purpose of this new series is to introduce you to a wide range of electronics components, circuits, and techniques. But instead of simply having you read about these subjects, we want to get you involved.

Many of the projects in this magazine involve the construction of specific pieces of hardware. This article will do the same, but in a different way. Instead of asking you to build some useful end object, the series presents you with a hands-on experiment involving a particular component, circuit, or technique. We will present a step-by-step experimental procedure that will teach you how the component or circuit works and how it is used. We will begin by giving you a background tutorial, but the bulk of the project will direct you step-by-step in performing various tests, measurements, demonstrations, and observations that will make the subject perfectly clear.

What You'll Need

The electronics components you will need to implement each experiment are commonly available at local electronics stores or from one of the many mail-order companies. But to perform the experiment, you will need a few additional items. For example, we recommend using a breadboarding socket for assembling the test circuits. Breadboarding sockets are widely available from a number of sources and make the building and testing of circuits fast and easy. You will also need a power supply. That is something you can build yourself from previous magazine articles or you can simply use batteries. Voltages of +5 and ±12 will be needed.

Finally, you may need some test equipment. To make tests and measurements, you will need a volt/ohmmeter (VOM) or a digital multimeter (DMM). In many of the experiments, we will recommend the use of an oscilloscope.

We hope that you will enjoy these hands-on learning experiments. There is no faster or better way to learn about electronic components and circuits. If you like the concept, let us know what other topics you'd like to see covered.

In this first experiment, we shall introduce you to semiconductor memories. Specifically, you will demonstrate the operation and application of a common static RAM. So, let's begin.

Learning Objectives

When you complete this experiment, you will be able to: Explain the operation of a typical static random-access read/write memory; wire up a standard RAM memory chip, and perform addressing, read, and write operations.

Background Tutorial

Electronic memories are circuits used to store digital data. Digital data consists of multiple-bit binary words. A very common form of memory is one used to store 8-bit words called bytes. Such electronic memories are found primarily in digital computers and microprocessor-based equipment.

Most electronic memories today are implemented with semiconductor circuits used to store binary bits. For example, an ordinary flip-flop is widely used to store one bit of information. If the flip-flop is set, it stores a binary 1. If the flip-flop is reset, it stores a binary 0. By using multiple flip-flops, complete words and multiple words can be stored. Memories using flip-flops for data storage are referred to as static memories.

Another type of semiconductor memory is dynamic memory. In a dynamic memory, the basic storage element is a capacitor. If the capacitor is charged, a binary 1 is stored. If the capacitor is discharged, a binary 0 is stored. Various electronic support circuits are used to charge and discharge the capacitor as well as determine the state of the capacitor.

In this experiment, you are going to learn about static RAM's. Those semiconductor circuits use flip-flops to store binary data. The basic static-RAM storage circuit is illustrated in Fig. 1. That storage cell is made up of enhancement-mode metal-oxide semiconductor field-effect transistors (MOSFET's). The basic flip-flop consists of Q1 and Q2, with drain resistors R1 and R2. In some static RAM's, the resistors are replaced by other MOSFETs that are connected as active-load resistances.

Recall that a flip-flop circuit has two states: Q1 conducting and Q2 cut off, or Q1 cut off and Q2 conducting. Those two states are defined as the set state (storing a binary 1) or the reset state (storing a binary 0) respectively.

There are a couple of important things to remember about enhancement-mode MOSFETs. First, the devices are normally cut off if their source to gate voltage is zero or some value of voltage below the threshold value (usually about +1.5 volts). If the gate-to-source voltage is above the threshold value, the MOSFET will conduct and will act as a very low resistance.

Second, the gate-to-source is physically a very small capacitor. It is the charge on the gate-to-source capacitance that determines whether the transistor is cut-off or conducting.

Flip-Flop Operation

Referring to Fig. 1, assume that the gate capacitance of Q1 is charged to the supply voltage. In that case, the conduction threshold of Q1 will be exceeded; therefore, it will conduct. Current will flow through Q1 and R1. The very low on resistance of Q1 will cause point X in the circuit to be very near ground.

Point X is connected to the gate of Q2. Since that voltage is near ground, it will be below the conduction threshold of Q2, so it will be cut off. Its drain voltage at point Y will be approximately the supply voltage V_{dd}. Resistor R2 keeps the gate-to-source capacitance of Q1 charged; therefore, Q1 continues to conduct. The circuit remains in that stable state until some outside signal is applied to cause the circuit conditions to change. The other stable state of the circuit is where Q2 is conducting and Q1 is cut off.

With the flip-flop in one of its two states, a binary 0 or a binary 1 will be stored. However, there are two conditions that we wish to implement. The first is that we want to determine the state of the flip-flop. That is called a *read* operation. Alternately, we may want to store information in the flip-flop. We may want to either set or reset the flip-flop to cause a binary 1 or binary 0 to be stored respectively. That is called a *write* operation.

Reading and Writing

To initiate a read operation, a binary 1 is applied to the row-select line in Fig. 1. That signal is usually supplied by the AND gate in an address decoder. That causes MOSFET switches Q3 and Q4 to conduct. That connects the flip-flop outputs X and Y to the DATA and $\overline{\text{DATA}}$ outputs.

A binary 1 is also applied to the column-select line by an AND gate in the address decoder. That causes switches Q5 and Q6 to turn on. As a result, the flip-flop outputs pass through Q3 and Q4, as well as Q5 and Q6, and appear at the inputs to a differential-sense amplifier. The sense amplifier buffers the flip-flop output and generates either a binary 0 or binary 1 output depending upon the state of the flip-flop.

To perform a write operation, the row- and column-select lines are again made binary 1 with the address decoders. MOSFET's Q3 through Q6 conduct. The bit to be stored in the flip-flop is applied to the data in input line. That drives write-amplifier #1 and write-amplifier #2 through an inverter. The resulting complementary signals are applied through Q3 through Q6 to the flip-flop. For example, assume that we want to store a binary 0. The output of write amplifier #1 is low and the output of write amplifier #2 is high. That will cause the output of Q1 to be forced low and, as a result, the gate capacitance on Q2 is discharged. FET Q2 is therefore cut off. As a result, the gate capacitance of Q1 is charged through resistor R2 keeping Q1 on.

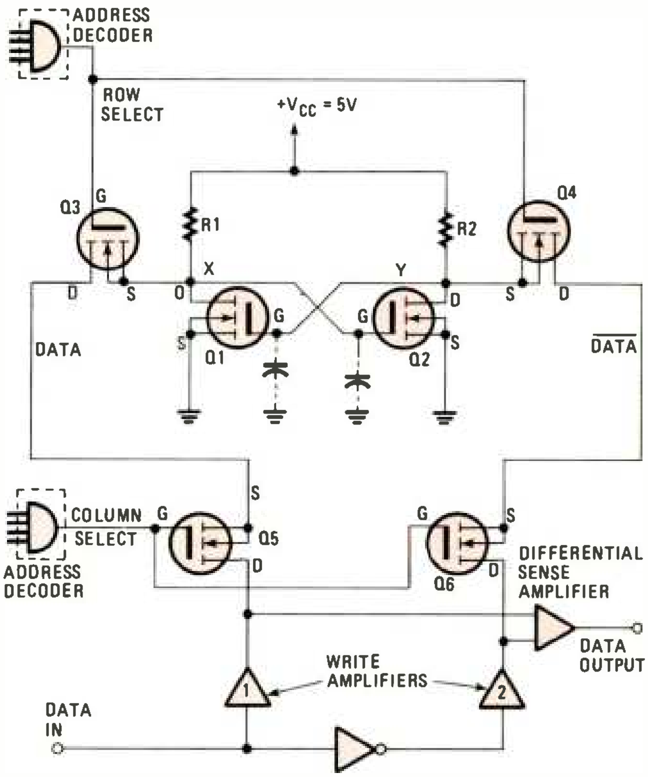


Fig. 1—This simple flip-flop circuit forms the heart of all static RAM memory chips. The address decoders actually consist of a number of AND gates, only one of which is shown connected to the row and selection lines.

Memory Arrangement

Integrated-circuit memories have thousands of those flip-flop storage cells on a single chip. Usually, they are organized into memories of individual storage locations for single-bit binary words. For example, a 1K memory chip, where 1K = 1024 storage locations, contains a flip-flop for each 1024 one-bit binary word. Such an organization is called a 1K × 1. Each of those words is individually selectable with a 10-bit address. The address is a binary number assigned to each bits storage location so that it can be identified and selected. Even

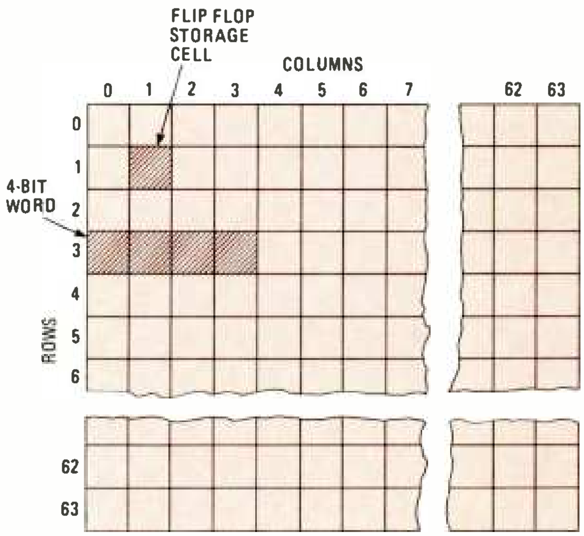


Fig. 2—RAM-chip storage locations are arranged in matrix form. That means the addresses of the memory locations correspond to rows and columns like those in this chart.

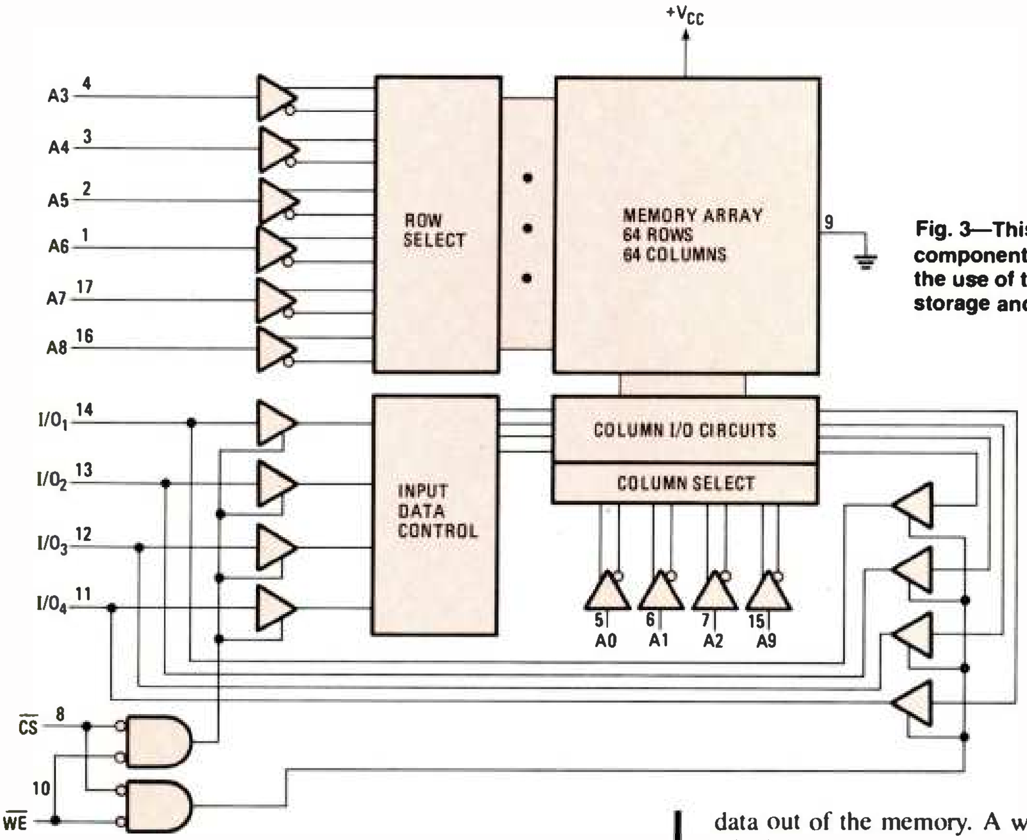


Fig. 3—This block diagram of the functional components of the 2114 should make clear the use of the package pins in memory storage and retrieval operations.

larger memory chips are available with 4K, 16K, 64K, and 256K storage locations.

To use such memory chips to store multibit binary words, one chip is used for each bit in the word. For example, in order to create a 16K-byte memory, eight 16K chips are used. The address lines are all connected in parallel, thereby making each of the 16K words independently and randomly addressable.

Another type of memory chip is one in which multibit words can also be stored. For example, a popular static RAM is the type 2114, which is capable of storing 1K of four-bit words. The flip-flop storage cells in the memory are organized as a matrix of 64 rows and 64 columns as illustrated in Fig. 2. A total of $64 \times 64 = 4096$ bits can be stored as 1024 4-bit words. Each square represents a flip-flop storage cell; AND gate decoders look at the input address and enable the appropriate rows and columns for addressing a desired word. For example, in order to address the location highlighted in Fig. 2, row 3 would be enabled as well as columns 0 through 3.

The 2114 Chip

Figure 3 shows a complete block diagram of the 2114 memory chip. The 2114 contains 1K (1024) four-bit words and, therefore, is designated as a $1K \times 4$. Since it can address 1K words, a 10-bit address is used. Those address lines are designated A0 through A9. Note in Fig. 3 that address bits A3 through A8 are applied to the row-select decoder. Those six lines permit a total of 64 rows of storage elements to be addressed: rows 0 through 63 as indicated in Fig. 2. Address bits A0, A1, A2, and A9 are fed to the column-select decoder. Those four address lines enable sixteen 4-bit column groups.

The I/O lines in Fig. 3 are used to apply data to and read data out of the memory. A write-enable ($\overline{WE}$) line controls whether a read or write operation is performed. When $\overline{WE}$ = 0, a write operation is performed. With $\overline{WE}$ = 1, a read is performed. The chip-select ($\overline{CS}$) line is used to enable the entire memory chip. When the $\overline{CS}$ line is binary 0, the chip is selected and the memory will operate as designated. If $\overline{CS}$ is binary 1, the chip is disabled and the I/O lines are effectively disconnected from any external circuits.

When the write-enable line is low, a write operation will be performed. A 4-bit word applied to the I/O lines will be stored in the memory location designated by the 10-bit address word.

A read operation is performed when the $\overline{WE}$ line is high. The I/O lines will display the binary word stored at the memory location selected by the input address.

The 2114 $1K \times 4$ static RAM is contained in an 18-pin dual in-line package. Figure 4 shows the pin configuration with all

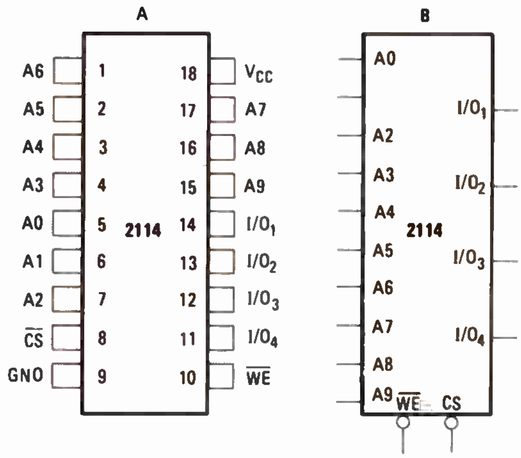


Fig. 4—Instead of drawing the pin package of the 2114 (A), there is a standard functional drawing used (B). Note the separation of address, I/O, and control lines.

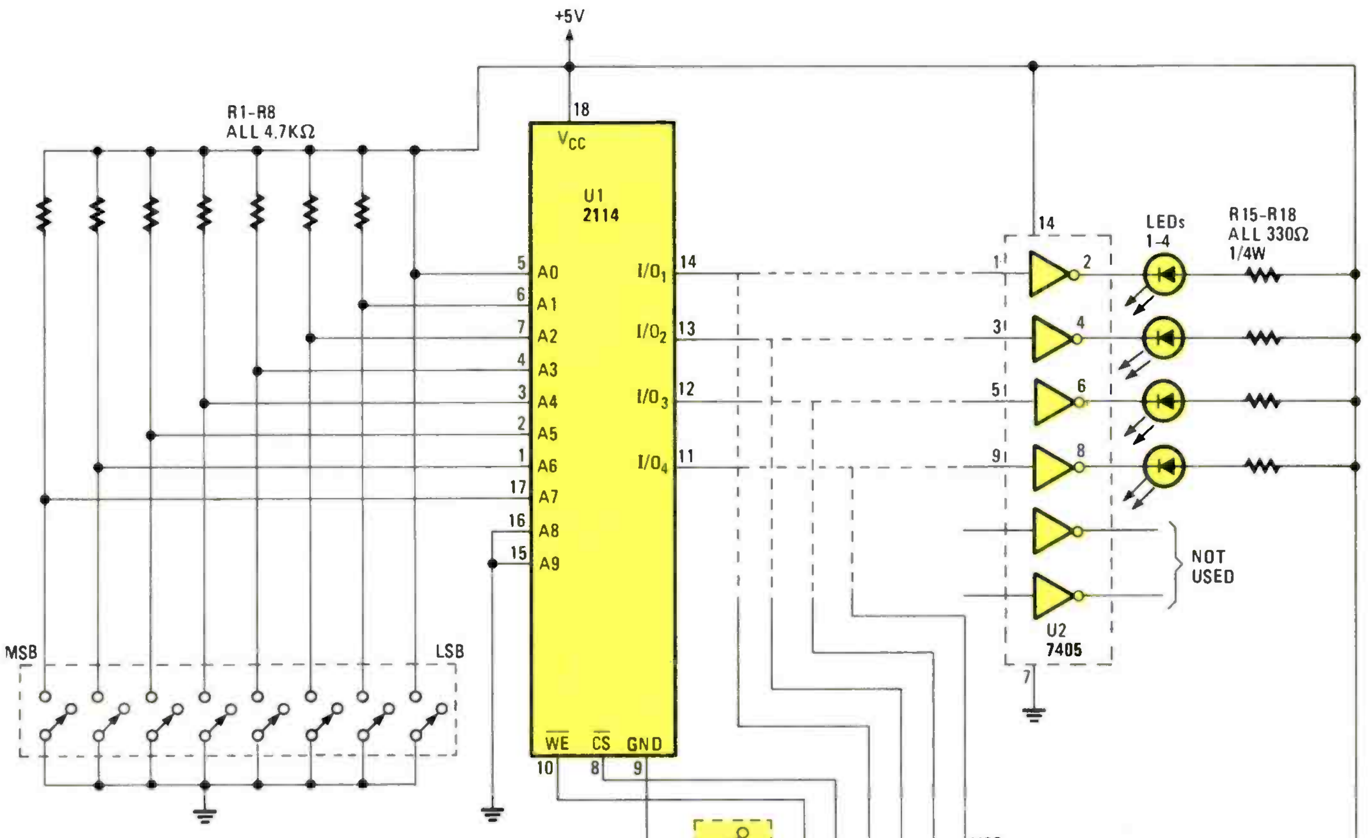
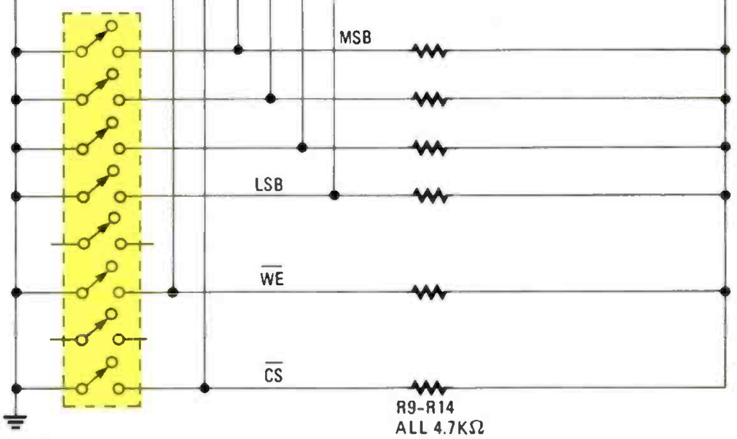



Fig. 5—Although this circuit looks long winded it is functionally very simple. The left bank of switches set the address to be operated upon while the right bank sets the control functions and input data.

lines designated. The simplified logical symbol for that chip is also given.

In this experiment you will demonstrate the operation of the 2114.

Parts Required

In addition to the breadboard and a +5-volt power supply, you will need: A 2114 static-RAM IC chip; A 7405 TTL, hex-inverter IC with open-collector outputs; four LED's; four 330-ohm, ¼-watt resistors; fourteen 4700-ohm, ¼-watt resistors; two 8-bit DIP switches.

Experimental Steps

1. Construct the circuit shown in Fig. 5. An 8-bit DIP switch is used as a binary-number source to supply an address to the 2114. The 2114 has ten input address lines, but two of them will not be used.

Another 8-bit DIP switch is used as a data source of binary numbers for storing information in the 2114 during write operations and for supplying the $\overline{WE}$ and $\overline{CS}$ control signals. The first four switches will be used for data. Two of the remaining four switches in the DIP switch will be used to generate the write-enable and chip-select signals.

Four LED indicator circuits will be used to read output data stored in the 2114. For the first part of the experiment, the LED indicators will be connected to pins 11 through 14 of the 2114. The connections from the second 8-bit DIP switch will be removed. Do NOT connect the data switches and the logic indicator circuits to the IC pins at the same time. You will be told when to make that change.

Finally, be sure to connect the 2114 and 7405 chips to a source of power.

2. *Look at the circuit shown in Fig. 5. Note that only eight of the ten address lines (A0-A9) are used. The number of binary words that can be addressed in the 2114 as a result is* ____________.

3. Apply power to the circuit. Set the write-enable switch so that it is binary 1. That means setting the DIP switch to the open or off position. The switch used to control the chip-select line should be set to the closed or on position to supply a binary 0.

4. Set the input address to 0000 0000. Observe the 4-bit output word displayed on the LEDs. Record it in the place provided in Table 1. Then proceed to set the address selector switches to the first sixteen addresses of the memory. In sequence, apply the address numbers 0000 0000 through 0000 1111. For each of those settings, record the binary number stored in each location.

5. *Examine the information that you've recorded in Table*

1. Try to explain the reason for the binary numbers recorded.

6. Remove the power from the circuit and disconnect the LED indicators from the I/O lines. Then connect the four data lines from the second DIP switch to the I/O lines (refer to Fig. 5). Those switches will be used as a source of binary data that you will store in the RAM.

7. Apply power to the circuit. Set the eight address switches to 0000 0000. Also set the 4-bit data switches to the 0000 state. Then, momentarily move the DIP switch connected to the write-enable line from its binary-1 to its binary-0 position and then back again. That will cause the number set on the data switches to be entered into the memory location designated by the 8-bit address.

8. Set the address switches to the remaining sixteen states shown in Table 1. At each of those addresses, set the corresponding 4-bit data word shown in Table 1. Each time you change the address and then set the new data word, move the $\overline{WE}$ switch to the binary 0 position and back again in order to store the data.

9. Rewire the circuit replacing the data switches with the LED indicators. It is important that you not remove the power to make that change. You should have no difficulty in making those new connections and it will not damage the circuit as long as you are careful not to accidentally touch adjacent pins or wires.

10. Set the DIP switch connected to the write-enable line to the binary 1 position. That will put the memory in its read state so that the data that has been stored will be displayed on the LED indicators.

11. Now, set the address switches to the address words shown in Table 1. At each address, observe the 4-bit number stored in that location. Write it into the blanks provided in Table 1.

12. *How do the data words you stored in steps 7 and 8 compare to those you are reading out in step 11?*

13. Set the DIP switch connected to the chip-select line to the binary 1 position. Then, repeat step 11 setting the address switches to the values in Table 1, taking note of the output at each address.

14. *How do your outputs in step 13 compare with those in step 11?*

15. Set the DIP switch connected to the $\overline{CS}$ line back to binary 0. Then again spot check several of the addresses to see that the data stored there corresponds to that which you stored in steps 7 and 8.

16. Next, remove power from the circuit. Leave it off for several seconds and then reapply it.

17. Again, using the procedure described previously, set the address switches to the addresses given in Table 1 and note the binary numbers stored at each location. Record your information in the column provided in Table 1.

18. *What differences did you note between the readings in Step 11 and Step 17?*

TABLE 1
INPUT AND OUTPUT DATA

ADDRESS	OUTPUT STEP 4	INPUT STEPS 7/8	OUTPUT STEP 11	OUTPUT STEP 13	OUTPUT STEP 17
0000 0000		0000			
0000 0001		0001			
0000 0010		0010			
0000 0011		0011			
0000 0100		0100			
0000 0101		0101			
0000 0110		0110			
0000 0111		0111			
0000 1000		1000			
0000 1001		1001			
0000 1010		1010			
0000 1011		1011			
0000 1100		1100			
0000 1101		1101			
0000 1110		1110			
0000 1111		1111			

Review of the Experiment

In this circuit, you used an 8-bit DIP switch to provide the binary address to the 2114 RAM chip. Since the 2114 contains 1K (1024) 4-bit words, ten address bits are required to identify all 1024 locations. Remember that the number of states that can be represented with a binary number is determined by the simple formula: 2 raised to the Nth power. 2 to the 10th power, of course, is 1024. With eight bits of address, then 2 to the 8th power or 256 of the memory locations can be addressed with the DIP switch used here. The remaining two address bits are connected to ground so they will appear as binary 0.

When you examined the first sixteen memory locations from 0000 0000 to 0000 1111, you should have found them to contain random information. All of the memory locations could have been set to zero or all binary 1's or any random pattern of binary 1's and 0's. When the power is first applied to the circuit, the flip-flops can come up into either their set or reset state. In general, the contents upon power up is totally random and without meaning.

Manual Reading and Writing

In Step 6 you removed the LED indicators and replaced them with the 4-bit data switches. In a real-world circuit, three-state logic chips on a bus would be used to allow several devices to be connected to the I/O pins at the same time. Here, rather than complicate the circuit, we elected to simply make that change manually when required.

Using the address and data DIP switches, you applied an address and entered a binary number equal to the address value in the locations between 0000 0000 and 0000 1111. That was kind of a slow process, because you had to set the switches manually. In a practical circuit, the address and data signals would come from a microprocessor or some other circuit. Each time you changed the address and the data value, you moved the write-enable switch to a binary 1 to binary 0. It is that action that causes the data to be stored in the desired location.

In step 9, you removed the data switches from the I/O lines and reconnected the LED indicators. You were then able to examine the contents of the memory locations where you previously stored data. If all the switches were set correctly, you should have found that the LED indicators displayed a binary number corresponding to the lower 4-bits of the address word.

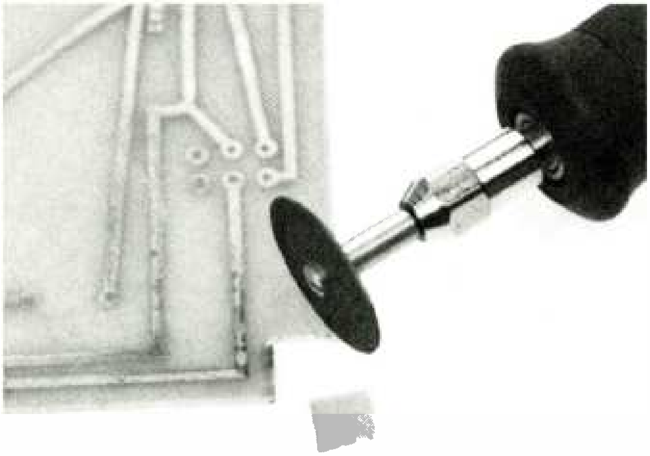
Disabling the Chip

In Step 13, you set the chip-enable switch to the binary 1 state. That completely disabled the 2114. With the $\overline{CS}$ line

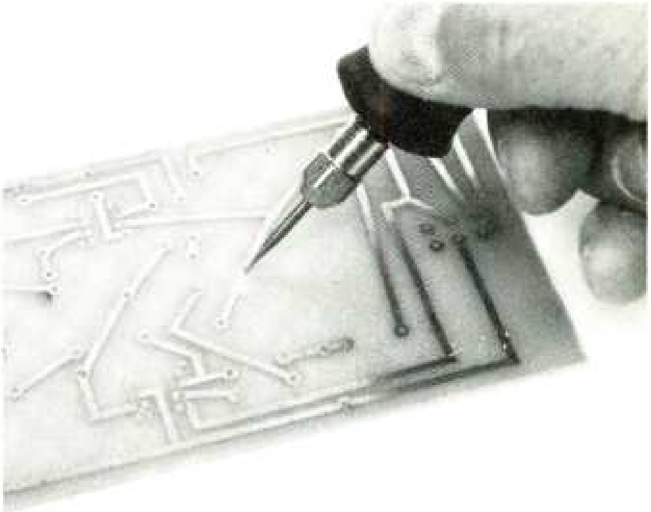
(Continued on page 104)

DREMEL MOTO-TOOL KIT

(Continued from page 85 *)*



When equipped with an abrasive cut-off disk the *Moto-Tool* can cut perfect notches or shapes in any hard material. It makes it very easy to custom fit a printed-circuit board into a cabinet.



Using a fine milling cutter, a copper foil or unetched foil bridge can be literally shaved off a printed-circuit board, leaving the plastic undamaged.

There is a seemingly endless assortment of optional accessories: grinding wheels of various shapes and sizes, cutters, engraving cutters, abrasive wheels, router bits, polishers...and just about anything else you can think of. The kit comes with a small assortment of accessories, of which several are *dynamite* for the electronic hobbyist. For example (see photo), a small engraving cutter running at 30,000 rpm can remove a foil trace and barely make a mark on the plastic substrate. When tilted at a sharp angle, it can shave off the copper foil that's shorting two holes or traces, without leaving a mark on the substrate to show that there was anything between the holes.

And if you need to cut small or odd-shaped notches in a printed-circuit board, just install one of the small (about 1-inch in diameter) abrasive cut-off discs. (See photos) It can notch out the board without fear that anything will crack. The abrasive disc will slice through anything that's hard, whether it's made of metal or plastic. That includes potentiometer shafts; edge and header connectors; rusted nuts, bolts, and antenna clamps; and it will even salvage damaged screws. If too many turns have worn away the slot in a screw, simply use the Moto-Tool and an abrasive disc to wear a new slot into the new head.

A slide button on the front of the tool locks the shaft so that different size collets can be installed.

Applications

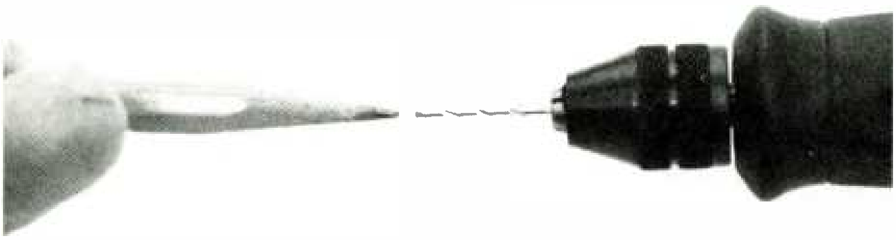
And how's this for a typical repair problem: A 10-cent resistor in some electronic gadget has blown, but you can't get at it because the cabinet is held together with conventional (peened) rivets—which are almost impossible to drill out. No problem! Put a small grinder bit in the Moto-Tool and simply grind off the rivet's head.

In all truth, most of the accessories for the Moto-Tool are really intended for the model builder, but the few that can be used by electronic hobbyists have no substitutes, and they are often literally worth their weight in gold.

Several Models

There are actually three different Moto-Tool kits. Since they are often heavily discounted, our prices show the manufacturer's retail price range. Even the lowest price in each range might be discounted in your area. One kit contains a single-speed, 28,000-rpm tool and is priced at $39.95–$59.95.

Another, priced at $59.95–$79.95, has a two-speed (15,000- and 28,000- rpm) tool. Finally, there's the 3950 kit with the 5,000–30,000 rpm tool, the one that we're talking about. It is priced at $79.95–$101.95. But for electronic work, we suggest that you take a chance on the full-blown model 3950 kit. ■



A collet can be replaced with a keyless chuck that will hold drill bits ranging from ⅛-inch down to almost the size of a hair. This bit is actually finer than the tip of a sharpened pencil.

ELLIS ON ANTIQUE RADIO

(Continued from page 89)

powered by a 45-volt B-battery, a 1.5-volt A-battery, and a C-battery (voltage unknown).

Peter Jelemensky (2867 Oak St., Sarasota, FL) once read of a technique for fabricating duplicate antique-radio knobs by taking impressions in epoxy—then making a cast after the epoxy "mold" had hardened. Does anyone out there have any more details?

Paul Gunzenhauser (Garden Grove, IA) has restored several 1920's battery sets. He's had to replace a bunch of 01A tubes, and says that the going rate for used ones is about $5.00. He also has an old Crosley set with 199 tubes substituted for the 01A's through use of adapters. And he says it works just fine.

The following readers need parts or service information: Tod A. Nunes (37 Lawrence St., New Bedford, MA 02745) needs a source of information and parts for an Atwater Kent Model 55. Michael A. Kimpton, (18664 Mumford Rd., Garrettsville, OH 44231) wants a schematic for an RCA Model 33 and information on refinishing metal radio cabinets.

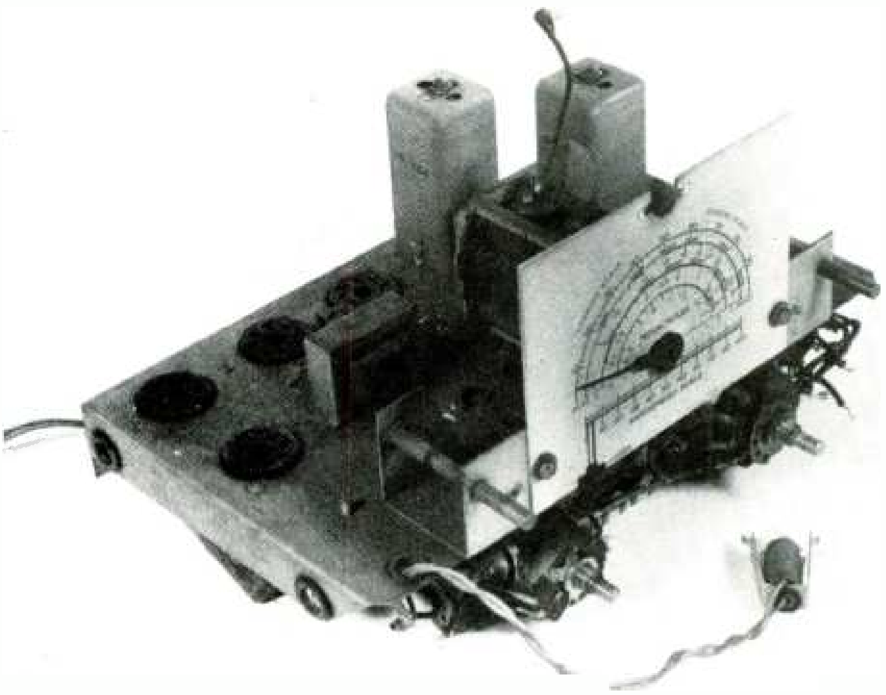
Lyman S. Stewart (7035 Silver Glen Way, Rio Linda, CA 95673) needs information on Philco Models 116, 121 and 151. A. N. Peaona (PO Box 1082, Middleton NS, CANADA BOS 1P0) would like to get his hands on a 45 tube. Salvatore J. Capozzi (111 Horse Tavern Rd., Trumbull, CT 06611) needs an 80 tube (preferably the old pear-shaped style). John Nelson (2603 So. 8th, Council Bluffs, IA 51601) needs information on Stewart-Warner radio Model R-1441-AS, Admiral television chassis series 20H and Precision tube tester series 912.

By the way, if anyone answers the queries on knob duplication or metal cabinet restoration, I'd sure appreciate receiving a copy. They would be excellent topics for future columns!

Brief Note on the Echophone

I promised to include more information on the ongoing restoration of the Echophone EC-1 (see last month's column) in this issue. But, alas, I have all but run out of space. To keep my word, however, I'm including a picture of the radio (see photos) in its present condition (partially disassembled for cleaning). I also expect to remove the dial and the tuning capacitor. The top of the chassis is about as filthy as I've ever seen one get!

More on the Echophone next time. Meanwhile, let me hear from you. Give me your input! Write Marc Ellis, *Ellis On Antique Radio*, C/O **Hands-On Electronics**, 500-B Bi-County Blvd., Farmingdale, NY 11735. ■



The Echophone EC-1, which we had begun to restore in an earlier column, is now partially disassembled, and the tuning capacitor and dial will probably have to be removed before effective cleaning can be accomplished.

GEE WHIZ BADGE

(Continued from page 48)

not to overheat them while soldering. And they need not have to be soldered on both sides of the board. Battery connections to the Badge are made with clutch-clip pins available from any engraving shop.

The clutch pins are epoxied to the top of U2 and U3 (see Fig. 4). The positive and negative power leads are then brought up from the board and soldered to the base of the pins. The battery leads are then soldered to the clutch clasps that engage the pins. Be sure that you make your leads long enough to reach the inside pocket where you want to carry your battery. Painting around the positive pin and the mating clutch clip of the positive lead with red fingernail polish makes sure that it is polarized properly each time it is reconnected. When the pins are pushed through the shirt or coat—and the clutch clasps put on the pins from the back—power is applied through the clutch pins and hidden from view.

A 1/16-inch thick piece of badge plastic laminate (also obtained from an engraving shop) is cut to 1½ by 2½ inches. Using the printed-circuit board pattern, mark and drill the ten holes around the edge of the badge, through which the LED's will project. The board can then be engraved with your favorite message and put over the circuit board with the LED's pushed through the holes. A small spot of silicon adhesive will secure the laminate to the circuit board. Be sure that you select good quality LED's to ensure that all the LED's flash with uniform brightness. The T1 size LED (available from Digi-Key Corp.) is a good choice for the LED—the color is up to you. A finishing touch is to paint the component side of the board with epoxy used for decoupage. The epoxy covers all the sharp corners of the solder connections and prevents the lead in the solder from discoloring the material of the garment on which the Badge is worn.

A kit of parts containing the printed-circuit board, two pieces of the 1½-inch × 2½-inch badge plastic (predrilled for T1 LED's), and the two clutch pins and clips are available from the source shown in the Parts List. All other parts are standard and can be obtained at any electronics supply house.

You can have a lot of fun and meet a lot of different people who will just stare at the badge and say "GEE WHIZ". The best part is that you can say anything you want and you know it will be seen. The advertising space on your chest is one of the things that is truly yours alone and it's free for you and you alone to use. ■

A CHASSIS OF ANOTHER KIND

(Continued from page 63)

can be found at garage sales or in your own basement. A piece of old oak mop board or trim can be refinished into a sharp-looking cabinet. Pieces of scrap wood from another wood-workers saw may be all that is needed. Discarded maple doors from an old kitchen cabinet may provide pieces for a radio or test instruments.

Access to a sander, bench saw and router can provide professional looking cabinets (Photo 9). Of course, a planer can do wonders to a used or new piece of wood.

Easy Does It

Be careful not to crack or poke too-large holes in the thin plastic or metal chassis. Apply pressure to the thin sheets of plastic to prevent cracks while drilling. Be careful when working with the soldering iron around plastic containers. Improper holes (Lop-sided or too large) may be filled with epoxy or rubber silicone cement.

You can dress up the front panels with spray paint. Use auto spray paint for a different finish. Add several stripes to the front panel with bright auto stick-on trim. Check the hobby-craft stores for different kinds of paints and finishes. Remember, the inexpensive chassis can be constructed and finished from discarded material. Just look around and you're bound to find a chassis of another kind. ■

ALL ABOUT STATIC RAM's

(Continued from page 101)

high, the chip is disabled and the I/O lines are internally disconnected from their pins. During that time, the memory still retains the data stored there. However, with the I/O lines disconnected from the LED displays, the display will simply be off. It may appear as though 0000 is stored in each location when actually the I/O lines are simply disconnected.

The chip-select line is used in memories that employ multiple 2114's. Usually an address decoder is used to operate the chip-select line to enable that chip when the desired portion of memory implemented by that chip is required.

In Step 16, you turned off the power and then reapplied it. When you examined the memory locations 0000 0000 through 0000 1111, you should have found that the data previously stored there had disappeared. That step proves conclusively that all electronic memory chips are volatile. That means when power is turned off, even momentarily, all data stored in them will be lost. When you reapplied power, the flip-flops in the RAM chip again came up in a random pattern of 1's and 0's.

Static RAM's form the basis of computer memory, and understanding their use in the storage of information is essential for the computer-hardware hobbyist. In next months installment, we will present another important but clear subject: how to use timer IC's (and not just 555's either.) ■

BUILD THE VOX BOX

(Continued from page 79)

IC's. No provision is made to mount the override switch S1 on the circuit board. Should you decide that it is needed for your application, mount it on the box. Since the project is very light, use a toggle switch and not a slide switch—the former will be easier to operate with one finger.

The terminal pins are numbered from 1 to 10 in the schematic diagrams (Figs. 1 and 4) and the parts-placement diagram (Fig.3). They are listed with their related circuit connections in Table 1.

Before the Test Flight

Check your work very carefully as you follow through to completion of the project. In particular, check the polarity and pin placement of the IC's, transistor, diodes, and electrolytic capacitors by comparing your work to Fig. 3.

If the VOX Box is to be controlled by signals with an amplitude of 100 millivolts or more, there is no need for the microphone preamplifier stage. Just omit all the components to the left of C4 *except* for resistors R2 and R3, and capacitor C2. Refer to the details given in Fig. 4. The impedance of the audio-signal source used as an input in Fig. 4 must be less than 5000 ohms. That output impedance is typical of many cassette and tape decks.

The threshold potentiometer, R8, may be replaced with a panel-mounting volume control of the same rating should you want to *spiff* up the VOX Box's appearance and utility.

To test VOX Box, connect the microphone and power supply, and set the R8 threshold control to maximum sensitivity. Connect an oscilloscope to the MIC OUTPUT and check the hum level in the event the preamplifier (U1) is used. Vary the setting of the GAIN control (R6) at high levels of amplification. If the hum is excessive, check the filtering capacity of the power supply. You may need 100-µF, or more to kill the ripple in the AC line-operated, power supply. If that doesn't work, then you must resort to a metallic enclosure. The VOX Box circuit should be grounded only at the microphone-input ground return.

Adjusting the two controls on the VOX Box is a simple procedure. The GAIN control (R6) is set to obtain the desired signal level at the MIC OUTPUT pin, while THRESHOLD control R8 is adjusted to provide reliable triggering. If you wire the circuit in Fig. 4 (not using the microphone output), set R8 to its mid-setting (50,000-ohms) and adjust R6 for reliable triggering.

Transistor battery operation is only possible for limited periods, because of the circuit's large current drain when the relay coil draws current. I used a transistor-radio battery during the test procedure and found that it provided sufficient power for about half an hour until I shut it down. How long will it operate under that type of power supply? It depends on the relay used and the total period it is on. Why not try it out and determine whether or not the VOX Box can be powered from a battery for the time intervals that you plan to use it. ■

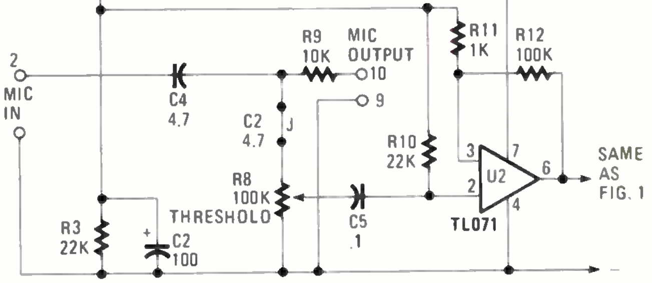


Fig. 4—Here is the revised partial schematic diagram of the unit with the preamplifier section omitted as described in text.

DIGI-LYZER IC TESTER

(Continued from page 46)

check out the more complex chips such as counters, registers, one shots, and flip-flops. The parts count for the unit is minimal, and the cost is modest compared to its usefulness on your test bench. After you are thoroughly familiar with its operation, you can tackle that ash tray full of questionable chips that we all know you have hidden somewhere around your workbench. ■

PARTS LIST FOR THE DIGI-LYZER IC TESTER

RESISTORS
(All resistors ¼-watt, 5% fixed units)
R1–R16—150-ohm
R17–R32—470-ohm
R33–R50—220-ohm

SEMICONDUCTORS
LED1, LED3, LED5, LED7, LED9, LED11, LED13, LED15, LED17, LED19, LED21, LED23, LED25, LED27, LED29, LED31—Light-emitting diode, red
LED2, LED4, LED6, LED8, LED10, LED12, LED14, LED16, LED18, LED20, LED22, LED24, LED26, LED28, LED30, LED32—Light-emitting diode, green
LED33, LED34, LED35, LED36, LED37, LED38, LED39, LED40, LED41, LED42, LED43—Light-emitting diode, yellow
U1–U6—4049 CMOS hex inverting buffer, integrated circuit

SWITCHES
PB1–PB16—Normally-open pushbutton switch, Digi-Key part No. P9951 (Digi-Key Corp., PO Box 677, Thief River Falls, MN 56701; 1-800/344-4539)
S1 to S11—Two-position slide switch, CK Part No. 1201 M2 CQE (C and K Components, 15 Riverdale Ave., Newton, MA 02158-1082; for nearest stocking distributor call: 1-800/243-8160)
S12—Single-pole, double-throw (SPDT) center-off switch

ADDITIONAL PARTS AND MATERIALS
B1–B6—Battery, "C" or "D" cell
SO1—Zero-Insertion Force (ZIF) socket, 14 pin, Part No. 214-3339 (Jameco Electronics, 1355 Shoreway Road, Belmont, CA 94002; Tel. 415/592-2503)
SO2—Zero-Insertion Force (ZIF) socket, 16 pin, Part No. 216-3340 (Jameco Electronics, 1355 Shoreway Road, Belmont, CA 94002; Tel. 415/592-2503)
Printed-circuit board (see below for supplier), enclosure, batteries, battery holders, hardware, wire, solder, etc.

Note: An etched and pre-drilled printed-circuit board is available priced at $18.50 (including shipping and handling) from Electronic Enterprises, 3305 Pestana Way, Livermore, CA 94550.

CIRCUIT CIRCUS

(Continued from page 91)

fier's gain to vary at the same rate. The depth, or modulation level is controlled by the setting of R11, and the frequency is adjusted via R12.

There's only one way to have fun with those two circuits, and that is, of course, to dig in and experiment with each one until you obtain the sound effect that you desire. And there is no rule against adding your own circuitry to what we have offered. So get to it, and good Luck. ■

PARTS LIST FOR THE TREMOLO CIRCUIT

RESISTORS
R1–R3, R9—10,000-ohm
R4, R5—27-ohm
R6—680,000-ohm
R7, R8, R10—100,000-ohm
R11—50,000-ohm, potentiometer
R12—100,000-ohm, potentiometer

CAPACITORS
C1, C2—100-µF, 16-WVDC electrolytic
C3, C4—.1-µF, 100-WVDC Mylar
C5–C8—.27-µF, 100-WVDC Mylar

ADDITIONAL PARTS AND MATERIALS
D1, D2—1N914 general-purpose silicon diode
U1—LM324 quad-op-amp, integrated circuit
Q1—BS170 N-channel TMOS, (Radio Shack part No. 276-2074 or similar)
IC socket, perfboard or printed circuit materials, etc.

CARR ON HAM RADIO

(Continued from page 87)

even make for a better ground. I remember one amateur who built a home in the late 50's. He went out there and erected an extensive ground-wire grid and radials system before the sod went down (ah, heaven is a low-resistance ground system!).

Well, that about all the space apportioned to us this month. Tune in same time, same station next month. In the meantime, those of you out there with tips, comments, and suggestions to contribute to this column, write to Joe Carr, K4IPV, PO Box 1099, Falls Church, VA 22041. ■

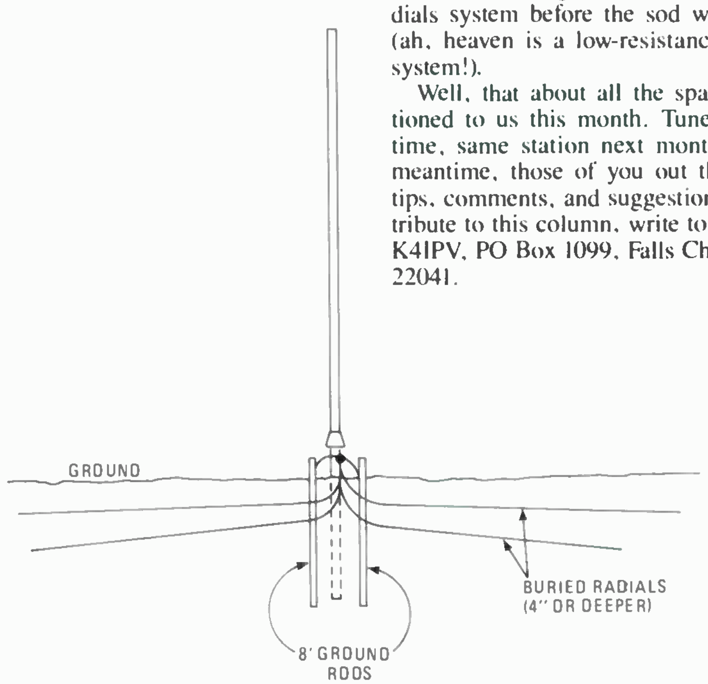


Fig. 4—Shown here are the radials in a ground-mounted situation. The wire radials can be above ground (a common sight in rural areas) or buried using a spade tip to cut a 3- to 4-inch slit, which may make for a better ground.

HANDS-ON MARKETPLACE

PLANS/KITS

ELECTRONIC fisherman, pocket size. Brings fish to top. Easily netted. Plans $9.95. **HILLS**, Box 391, Wynne, AR 72396.

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.

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To run your own classified ad, put one word on each of the lines below and send this form along with your check to:

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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.**

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6	7	8	9	10
11	12	13	14	15 ($21.00)
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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.):

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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 (20% premium).** Entire ad in boldface, **add 20% premium** to total price. **TINT SCREEN BEHIND ENTIRE AD: add 25% premium** to total price. **TINT SCREEN BEHIND ENTIRE AD PLUS ALL BOLD FACE AD: add 45% premium** to total price. **EXPANDED TYPE AD: $1.85 per word prepaid.** All other items same as for STANDARD COMMERCIAL RATE. **TINT SCREEN BEHIND ENTIRE EXPANDED TYPE AD: add 25% premium** to total price. **TINT SCREEN BEHIND ENTIRE EXPANDED TYPE AD PLUS ALL BOLD FACE AD: add 45% premium** to total price. **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. Hands-on Electronics** is published monthly, therefore copy to be in our hands for Aug. 87, 4/19; Sept. 87, 5/19, Oct. 87, 6/19.

STRANGE stuff. Plans, kits, items. Build satellite dish $69.00. Descramblers, bugs, adult toys. Informational photo package $3.00, refundable. **DIRIJO CORPORATION**, Box 212-H, Lowell, NC 28098.

COLOR computer, security devices. Temperature, sound, intrusion alarm. Plugs into cassette and joystick sockets. Plans, programs cost $10.00. **BROWN'S**, 119 Skyline Drive, R.H., Granbury, TX 76048.

CATALOG: Hobby circuits, licensed/unlicensed broadcasting, transmitters, antennas, books, scramblers, bugging devices, science projects, more! **PANAXIS**, Box 130-HO8, Paradise, CA. 95967.

CABLE -Television converter, descrambler amd wireless remote control video equipment accessories catalog. Free. CABLE DISTRIBUTORS UNLIMITED, 116-PHO Main Road, Washington, AR 71862.

DETECTIVE Equipment micro (voice) transmitter. UHF band (highly sensitive and tuneable). Will fit inside an asprin box, including battery, 1 inch antenna. Micro (telephone) transmitter FM/VHF band (tuneable). Powerful, clip-on type. All parts available at local Radio Shack store. Detail plans $10.00 ea. or $15.00 for both when purchased together. Free catalog listing many other devices of this nature with order. Catalog only, $5.00 (refundable). **WILSON**, P.O. Box 5264 Augusta, GA 30906.

VOICE disguisers! FM bugs! SWL active antenna! Receivers! More! Catalog $1.00 (refundable): **XANDI ELECTRONICS**, Box 25647, 32D, Tempe, AZ 85282.

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TUBES 59 cents. Year guarantee. Free catalog. Tube Tester $8.95. **CORNELL**, 4219 University, San Diego, CA 92105.

CABLE-TV converters. Scientific Atlanta, Jerrold, Oak, Zenith, Hamlin. Many others. "New" **VIDEO HOPPER** "The copy killer". Visa, M/C & Amex. accepted. Toll free **1-800-826-7623. B&B INC.**, 10517 Upton Circle, Bloomington, MN 55431.

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IS it true you can buy jeeps for $44 through the U.S. government? Get the facts today! Call 1 (312) 742-1142 Ext. 7173.

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NIGHT VISION equipment, lasers, computer parts and surplus electronic equipment. 68 page picture catalogue $1.00. **MESHNA, INC.,** Nahant, MA 01908.

VIDEO copier (89.95) will copy all protected movies, including microvision. For order/information write or call **VIDEO VIBES**, 657A Allerton Ave, Bronx, NY 10467. (212) 653-4644. Not a kit.

MICROCONTROLLER clock-timer MCT 200 two programs: A.–24hr battery back-up clock with 4 time switches. B.–Countdown timer with 4 outputs. A&T $68.00, kit $48.00 manual only $2.00 **L.S. ELECTRONIC** 2280 Camilla Rd., Mississauca, Ontario, Canada L5A 2J8.

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INTEL, RCA, National, OKI, SGS, and more. Factory prime and surplus parts catalog. **LYNBAR INDUSTRIES**, 205 Main, Box 822, St. Joseph, MI 49085-0822.

CABLE Television converter, descrambler and wireless remote control video equipment accessories catalog. Free. CABLE DISTRIBUTORS UNLIMITED. 116-HO Main Road, Washington, AR 71862.

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JERROLD equipment including new Jerrold Tri-Mode and Dorzin systems, Hamlin, SB-3, N-12, Mini-code, Zenith, Z-Tac and more. All products enable you to pick up most cable stations. Best prices around! For information, send $1.00 plus S.A.S.E. or call (312) 658-8643. **SWENSENS ELECTRONICS**, 518 North Harrison Street, Suite C, Algonquin, IL 60102. No Illinois orders accepted!

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BEST JOBS/HIGHEST PAY

NEW easy method. Guaranteed. **Free** report reveals secrets, tells how. **NOVA SYSTEMS**, 6901-B North Lamar, Austin, TX 78752.

NEW PRODUCT SHOWCASE

(Continued from page 23)

obvious problems, they do trigger the player's error correction and concealment circuits. Those circuits create a noise signal to bridge the missing music. When this happens, experienced listeners often sense a dissatisfaction with the music—it sounds technically correct but has a *clinical* edge, and seems less musical.

CD Saver is a must for owners of CD players who insist upon maximum enjoy-

CIRCLE 92 ON FREE INFORMATION CARD

ment of their music. Used as directed, CD Saver will cure the problems caused by light scuffs and scratches—problems conventional cleaners can't help.

CD Saver is easy to use. Wipe on, let dry, and buff away the residue with a soft cloth. It pays for itself with the first restored CD, yet one 30 mililiter bottle is good for hundreds of applications. CD Saver will not react with the plastic in CD's and is totally harmless to the discs.

CD Saver has a suggested retail price of $9.95. For further information contact Buff Stuff, Inc., PO Box 43128, Upper Montclair, NJ 07043. ■

ADVERTISING INDEX

HANDS-ON ELECTRONICS magazine does not assume any responsibility for errors that may appear in the index below.

IBM BUILDS A 4-MEGABIT CHIP

(Continued from page 80)

The chip is based on the use of a unique memory cell. The cell—the area on a chip which stores a 1 or a 0—occupies just 10.6-square micrometers, about one-third the area of the memory cell in IBM's one-megabit chip. The cell is so small that almost 24,000 of them fit in an area the size of the period printed at the end of this sentence.

Technical Background

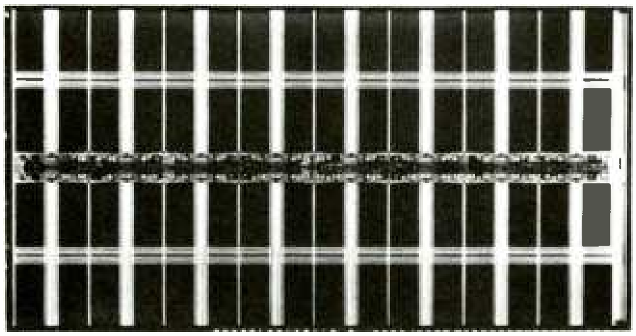
Key to the development of IBM's four-megabit chip is the use of an advanced design for the chip's individual storage cells. The memory cells conventionally used in DRAM chips—whether they hold 64,000 bits or four million—are composed of one transistor and one capacitor. Information is represented by the presence or absence of charge on the surface of the capacitor. The charge is stored or released by switching the transistor on or off, and the flowing charge produces an electrical signal that can be amplified and read by circuits on the chip. An important problem for chip designers is to provide a memory cell that is as small as possible but still includes sufficient room for a capacitor large enough to generate a strong signal. A strong signal is needed to produce fast operation and reliable performance.

IBM's four-megabit memory chip uses a new method for constructing the individual storage cells that make up the entire chip. In that method, a hole is etched deep into the silicon at each storage location on the chip, the sidewalls of the hole are covered with an insulating material, and the hole is then filled with a conductive material to form a capacitor. That method provides a three-dimensional *trench* capacitor which has a surface area large enough to hold a substantial amount of charge, but which does not make a large *footprint* on the surface of the chip.

The three-dimensional, trench-capacitor structure contrasts with the two-dimensional *planar* structure conventionally used to form capacitors in memory chips. As implemented in the four-megabit chip, the trench capacitor allows three times as many cells to be packed into an area equivalent to the size of IBM's one-megabit chip.

In the new chip, IBM engineers have fabricated circuit elements with dimensions as small as 0.7 micron. Those extremely fine lines make it possible to produce transistors with very narrow *gate* electrodes. That has led to very fast switching times for the transistors. Memory access times as fast as 65 nanoseconds have been recorded.

To provide system designers with flexibility in selecting versions of the chip that best suit their needs, the chip is organized to read data either in groups of four bits at a time or one bit at a time. Strobe circuits on the chip also provide the ability to write data into the chip in groups of from one to four bits at a time.



The new four-million-bit chip is shown here before it is encased in a conventional package. The chip measures about 1/4-inch by 1/2-inch. The chip can read the data in all of its 4,194,304 memory cells in only one-fourth of a second.

Dollars Are Important

The ability to put more and more circuits into smaller and smaller areas plays a key role in reducing the cost of manufacturing computer components, and, over the years, has led to dramatic reductions in the cost of computing. More important to the readers of this magazine, the resulting developments have greatly lowered the cost of home desk-top computers. It also leads to improvements in the performance of data processing equipment.

Within the last year, IBM has made substantial progress in bringing advanced memory technology out of the laboratory, onto the plant floor, and into the marketplace.

The chip also includes 96,000 spare, or *redundant*, storage cells—one and one-half times the number of cells in an entire 64K-bit chip, which IBM began manufacturing in 1978. Those extra cells are used to substitute for defective cells discovered during the manufacturing process. Redundancy can substantially increase manufacturing yields during the early phases of production—thus significantly reducing manufacturing costs.

To increase the flexibility of the chip for potential use in a variety of systems, two different packaging options are provided. In one option, the chip can be mounted on a 3/4-inch square ceramic substrate containing an array of pins for connecting the substrate to the next level of circuit packaging. The other option is a package 0.35-inch wide with *J*-shaped leads that allow it to be mounted at high density on the surface of the next level of packaging.

The speed at which multi-megabit memory chips are being developed and manufactured today looks good for the personal computer tomorrow. When? Your guess is as good as mine, but look to the end of 1988 for dramatic developments in personal computer RAM growth. ■