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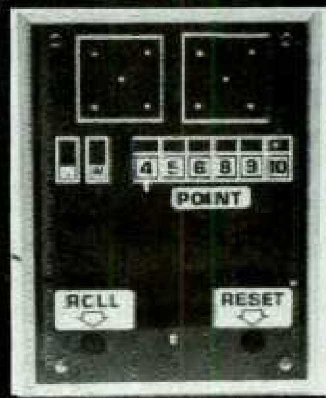
AUGUST 1988



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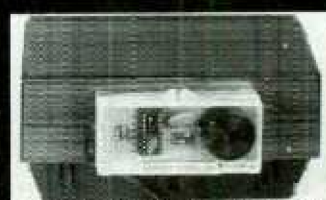

Low-Battery Alarm—page 70

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Ellis on Antique Radio—page 88

Hands-on Electronics®

The Magazine for the Electronics Activist!

Used computers have no tires to kick!

It had to happen sooner or later! They sell used cars, used clothes, used bicycles, used just about everything! Why not used microcomputers?

The National Association of Computer Dealers (NACD) has examined the used-microcomputer marketplace to determine the dollar volume—it was $1.2 billion in 1987. That amount includes all the known areas of the used-microcomputer market. With used-microcomputer sales on the rise and overall used values up, expect the amount to top $1.8 billion in 1988.

The survey indicates that computer stores account for less than six percent of the sales, indicating that used-microcomputer stores have not reached their potential. Computer brokers, the middle men who sell without taking possession of used computers, have an even smaller share of the market. Then, where is the market?

The major force remains the consumer, selling through classified ads and to friends and co-workers. The lucky buyers work for companies that sell outdated equipment to their employees before that gear is made available to the public.

As you can well expect, since the used car market has it's *Red Book*, the used computer market has the *Used Value Index* (UVI), a market indicator derived by taking the average selling price of Apple, IBM, and Compaq computers (to name a few brands), and comparing it to the average used selling price of the same equipment. Presently, the UVI is a high 67.86%, indicating the willingness of the public to buy used gear. IBM computers' UVI is 63.14%—a bit below the market value, but it is expected to rise once the PS/2 market stabilizes.

The NACD provides the used computer market data to Sybex, Inc., which publishes that information in the *Computer Blue Book*. Over 12,500 hardware and software items are listed there. That guide details the new and used values that are used in the survey.

So there you have it, an organized used-microcomputer marketplace that's growing, despite the fact that used computers have no tires to kick!

Julian Martin

Julian S. Martin, KA2GUN
Editor

STAFF

Volume 5, No. 7

July 1988

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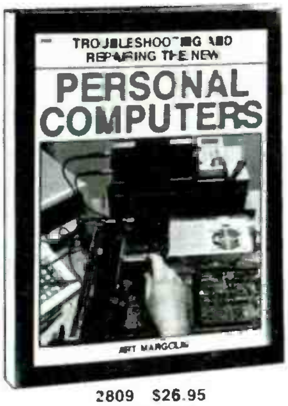

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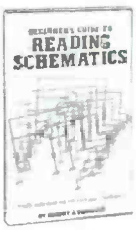

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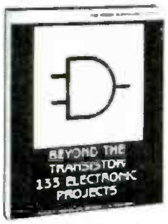

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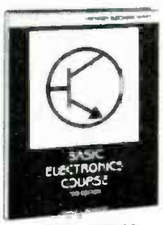

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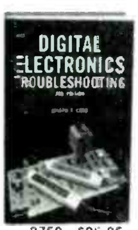

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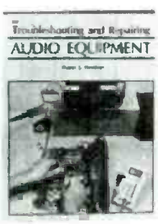

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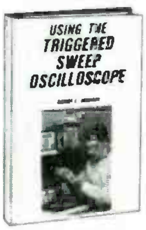

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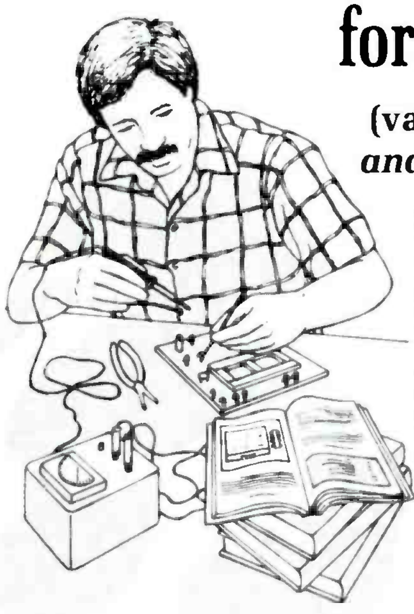

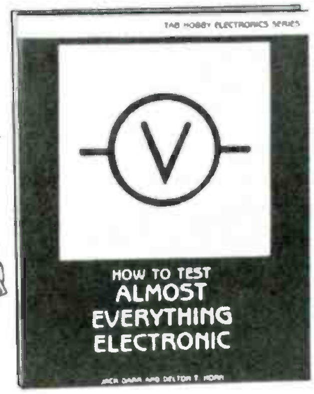

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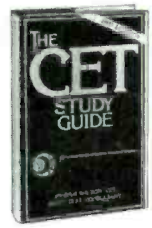

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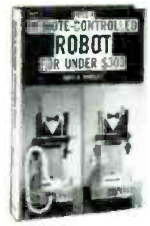

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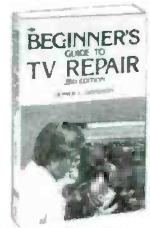

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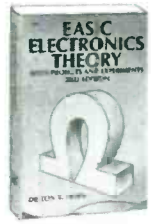

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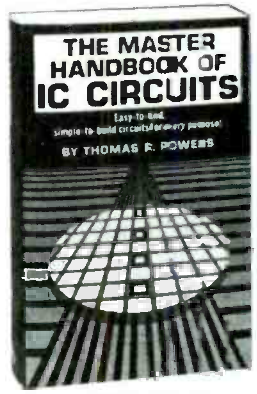

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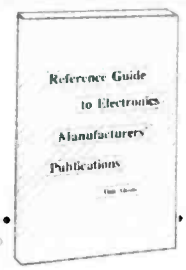

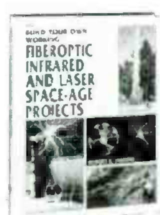

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LETTER BOX

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Haves and Needs

Each month we get a lot of requests for schematics, parts sources, and general information. Some of the questions are easy, and were happy to help out. Unfortunately, we lack the resources to track down every schematic for every piece of equipment ever manufactured, or to find exotic or obsolete parts.

But we do have one resource we can turn to to try to answer as many of the requests as possible. That resource is you, our readers. As space permits, we will publish as many of those requests as possible, complete with a return address. We ask that any readers with information contact the writer directly.

*Also, if readers have items or info that think would be of benefit to other readers, we invite them to let us know about it. We'll publish the information, and an address for furthur correspondence. One proviso: The space is **not for commercial purposes.** You can request a reasonable charge for photocopying, etc., offer to sell duplicate or unwanted gear for a nominal cost, propose trades of equipment or ideas, and so forth. But if you're in the business of selling or repairing gear, please use the Hands-on Marketplace that appears in each issue of this magazine to advertise your services.*

Without further ado, let's get to the first installment of "Haves and Needs."

I need a schematic for an RCA Victor Model 9-X-571. Also, were can you get the bayonet dial lights for the thing?

By the way, for those that need schematics for old Signal Corps radios, why not contact the Army Signal Corps at Ft. Monmouth, NJ. They might have some in their archives.

Bob Kenyan
POB 128
Tombstone, AZ 85638

I would like to hear from anyone interested in tube amplifiers. I've begun servicing those units for my friends and have found information hard to come by. Does anyone know where I might find a book describing the operating characteristics of audio tubes?

Richard E. Anderson
1432 Riverside Dr.
Pacific, MO 63069

I need a 6H5 tuning eye for a Silvertone 4470. Any idea of where I could get one, or what it would cost?

Sgt. J.J. Clarke, USMC
22 Grier St.
Jacksonville, NC 28540

Poetic License

This regards the article "Getting your FCC License," by John Gordon, in the February 1988 issue. Mr. Gordons makes a statement in this article that infers that there are two kinds of radio telephone licenses. At present I know of only a general radio telephone license, and that has been a fact for the last seven to ten years. If in fact that is true, I feel you owe at least a letter of explanation from you on the article.

—M.G., Van Nuys, CA

The misleading statement in question appears at the opening of the article. It is not only misleading it is down right wrong. That, however, was not Mr. Gordons fault as that sentence was not authored by him but by a misinformed editor. Please pardon the inaccuracy.

Pulse-Generator Address

I just got my copy of the May, 1988 issue of **Hands-On Electronics**. I was really impressed by the way you presented my article "A High-Voltage Pulse Generator," and was pleased that you thought enough of it to feature it on the cover.

Unfortunately, there were two major errors in the address you gave for the parts supplier, Maps and Zaps. The correct address is 1132 *Roseta* Dr., *Topanga*, CA 90290.

—Dale Hileman

Calorie Watch Lives!

I was greatly dismayed when I read the review of our *Calorie Watch*, entitled "R.I.P," in the December 1987 installment of "Gadget." I was astounded that so eloquent an author as the reviewer did not think to ask Synchronics' customer service for the phone number of the manufacturer, or to ask directory assistance for the phone number of the company occupying the address on the warranty card. You see, we changed our name to Elexis Corporation when we went public in February 1987.

I am happy to report that the Calorie Watch is alive and living on the shelves of about 3000, chain-store outlets. With over 50,000 units sold, we consider the product a success, and will continue to sell the unit for some time to come.

Now as to the problem with the instructions: It seems the reviewer fell prey to the frustrations that face many frenzied "Gadgeteers" when they rush to use a product without *carefully* reviewing the instructions. All of the questions pertaining to use, including how to bring up the calorie display, can be found in the instructions. But properly using the watch requires overcoming your impatience and completely reading the instructions and trying them out. After all, a three-button watch with 16 modes and five programmable data inputs is a bit much to comprehend in one sitting.

The Electronic Industries Association/Consumer Electronics Group has recently completed the first in a series of videocassette training tapes.

EIA/CEG ANNOUNCES COMPLETION OF NEW "BASIC CAR AUDIO INSTALLATION" VIDEO TAPE

If you are thinking of "cashing in" on the profits in the ever growing car audio service business, the troubleshooting–service–installation–and removal of car audio products is a large, non-competitive profit center for your service facility. This thirty minute video introduces you to the ever increasing complex world of car stereo installation. It guides the new installer or owner in the correct layout and design of a car stereo installation facility, covering basic as well as specialized tools needed for the installation business.

This informative videotape is also an excellent aid to the electronics technician in that it gives the correct procedure for removing and replacing "any" car radio from the dashboard of any car and shows the installer's, salesperson's and customer's role in the installation and sale of car audio products.

KEY TOPICS COVERED IN THIS VIDEO

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The cost of the videocassette is $30.00. Use the order form below to order yours now!

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LETTERBOX

In fairness, however, there appears to be some problems with instruction clarity. We were concerned enough about it to do a survey, which revealed that about a third of users had some degree of difficulty with them. As a result, we have revised the manual and have added a short-form instruction sheet. And we are working on a new version of the watch for 1989 that will be less complex, and easier to program.

Frank J. Bianco, President
Elexis Corporation
7000 N.W. 46 Street
Miami, FL 33166

We were glad to learn that the Calorie Watch and its manufacturer are still around. The short-form instruction sheet you provided does seem to answer some of the serious reservations our reviewer raised; we've sent a copy to him so that he can do a more thorough review of your product at some future date.

Dot's All

I have enjoyed building several of the outstanding projects that you've presented in the pages of **Hands-on Electronics**. I have even enjoyed the occasional printing miscues that crop up, since they spur me on to educate myself in basic electronics.

One that has me stumped, however, is the "Power Play" bench-top supply that appeared in the February 1988 issue. I can't seem to vary the 0- to 30-volt output. All other parts of the circuit seem to work fine. What gives?
—J.K.R., Cooperstown, NC

One of those occasional miscues! It seems that the artist left out a rather important connecting dot in the schematic (Fig. 1). Notice that the line between the anode of D2 and the wiper of R2 crosses the line between the U1/C3 junction and the R1/R2 junction. There should be a connection at that crossing point. Add it and everything should work as intended

*By the way, while you're at it, there two other typographical errors we should point out: in the schematic, C8 should be a 0.33-µF unit, while in the Parts List, C2 should be a 0.1-*µF unit.

Indexes Available

I've been reading your magazine for over two years now. One thing that has always impressed me is how well you respond to your readers' needs.

I've noticed that you run advertisements for your Reprint Bookstore on occasion. I'm sure that I would be interested in some of the articles in your back issues, but I have no way of knowing what appeared in a specific issue. Is it possible to obtain a comprehensive bibliography of all back issues to date? I'm sure that other readers would be interested in that information as well.
—K.J., St. Louis, MO

Annual indexes for 1986 and 1987 are currently available to all **Hands-On Electronics** readers at no charge. To get one, just send a self-addressed stamped business-size envelope to **Hands-On Electronics,** *Annual Index, 500-B Bi-County Blvd., Farmingdale, NY 11735. Be sure to tell us which year you are interested in.*

Wrong Division

First of all, I would like to say that you have a great magazine; please don't change a thing. However, I believe that you've got a couple of errors in the May 1988 installment of "E-Z Math."

On page 79, when you calculate the power gain of a circuit, you state that Gain = 70/.005 = 1400; of course, the actual result of that division is 14,000! That's probably simply a typo, since when you calculate the gain in terms of dB, the results are correct if you assume you meant 14,000 everywhere you say 1400.

Right below that, again on page 79, you use a 100-milliwatt signal in an example. But when you do the math, you use 1 milliwatt (.001) signal instead. Following through on your original problem, the gain should have been 1000/*0.1* = *10,000*, not 1 million as you state.
—R.S., Jackson, MO

Pen-Pal Wanted

I am an electronics engineer, 28 years old, living in Poland. I am interested in audio and video devices, new technical solutions, and particularly in applications of digital components and techniques.

I want to enter into correspondence with somebody who is interested in the same fields. If you make it possible for me, I will be very grateful.

Maybe someone will hold out a hand to me across the ocean.

Jacek Lasota
Starowarszawska 6 M 29
97-300 Piotrkow Trybunalski
Poland

Hints for Builders

Your idea of using carbon paper to transfer simple PC designs to the board isn't bad, but ordinary carbon paper, especially pencil carbon, uses a wax binder that may interfere with proper adhesion of the resist. That can lead to flaking or bleeding of the etchant under the resist. Also, the waxy lines are hard to draw over.

A better technique would be to use the tracing paper used by seamstresses to transfer patterns to cloth. That tracing paper uses chalk to transfer the design. Since chalk is water soluble, it will wash out. That allows the resist ink to flow more freely and penetrate better, which means that it will adhere better to the substrate. Seamstress tracing paper can be bought in most sewing shops, as well as in the notions department in many variety, craft, and department stores.

Those shops also carry another item that can prove handy for the electronics builder: molded nylon mesh that's intended for use as backing for needlepoint projects. I've found that the mesh also makes an outstanding perfboard for electronics projects.

The mesh is usually sold in sizes ranging from 2- to 12-inches square, and can be cut to a desired size or shape using ordinary scissors. It is flexible enough that it can be curved for use in space-saving designs, yet it is stiff enough that even a fairly large piece is self-supporting; for extra large "boards," strips of sheet plastic can be glued around the edges for additional support. Standard mesh has seven holes to the inch, which doesn't readily lend itself to use with ICs, but it works great with discrete components. Simply feed the component leads through the holes, twist them over, and interconnect them using point-to-point wiring.

The mesh can also be used as grillwork over ventilation holes, speaker openings, etc. Or, to make cages to keep fingers away from high-voltage points or components in circuits.
—B.P., Lake Havasu City, AZ

You've got two great ideas there, B.P., and thanks for sharing them with us and our readers.

Now, how about the rest of you? If you've discovered something that makes your electronics experimenting or building easier, especially if its something that's a tad on the unusual side, why not share it with your fellow hobbyists. **Hands-On Electronics** *is a great fo-*

rum for the exchange of electronics ideas, whether these ideas be in the form of short letters, like the one from B.P., or in the form of full-length feature articles.

Pet Peeve

I have a pet peeve with too many of the circuits presented in your magazine and others: It seems that the bulk of the circuit will use readily available components, but there is one "tough dog" that no one stocks, no one sells in quantities of less than a boxcar load, or that no one has ever heard of. Nothing is more frustrating than getting excited about a project and gathering most of the parts, only to find that one part is unobtainable.

While I'm writing, here are a couple of suggestions that your readers might find helpful:

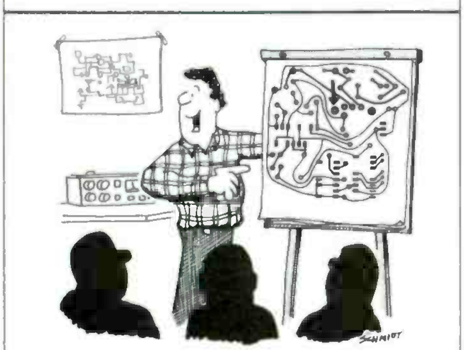
I have found that a Pilot Photo Graphic Marker (available only from exotic sources, like K-Mart!) works much better and costs less than photoresist pens in preparing printed-circuit boards for the etching process.

Second, one of your readers suggested mixing rosin and acetone to create a rosin flux for soldering. I suggest using alcohol instead; it is less expensive, and less volatile.

—W.H., Knoxville, TN

We agree with your peeve. We try to make sure that all components can be readily found, or, when an unusual part must be used, we provide a supplier. Unfortunately, every once in a while one does get by us, and it causes headaches all around. We promise that we are going to re-double our efforts to keep impossible-to-build projects from our pages.

And, by the way, thanks very much for the suggestions! They, and anything else that might help our readers, are always welcome. ■



Ok guys, here's the map to the club picnic.

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NEW PRODUCTS

Car Stereo Speaker Systems

Ultimate Sound has unleashed its updated *Turbo* line of self-contained car-speaker systems. The Turbo line is designed for use in trucks, cars, pick-ups, vans, RVs and boats.

The Turbo models are complete speaker systems that include multiple drivers mounted in rugged carpet-covered cabinets with carrying handles and press-on connections. The Turbos are designed for specific placement within the vehicle, but they may be carried and used outside the vehicle for picnics and parties.

The Turbo models feature tuned, ported cabinets to insure full-frequency response and deep bass. Three Turbo models are two-way systems while the fourth model is a bass-augmentation system. All Turbo models are finished in durable, gray carpeting for a handsome appearance, to minimize scratches or damage to a vehicle's interior and to insure stability.

CIRCLE 40 ON FREE INFORMATION CARD

The four Ultimate-Sound Turbo models are as follows: *The UBC Hatchback Turbo* is a two-way system that features dual 8-inch Polycarbon woofers and two 3-3/4-in. piezo tweeters. The UBC Hatchback System is designed to fit perfectly in a Camarro, Corvette, Trans-Am or Firebird, although the system can be used in a wide variety of vans and recreational vehicles such as Troopers, Broncos, Blazers or station wagons.

The *UBC Pick-up Turbo* is the perfect size and shape for behind the seat in full-sized pick-ups and vans. That model is only 6-1/2-in. deep, therefore it is ideal where a full rich sound is desired but space is limited. The UBC Pick-up Turbo features dual 8-inch Polycarbon woofers and two 3-3/4-in. piezo tweeters.

The *UBCP Bass Turbo* features dual 8-inch Polycarbon woofers in a compact, ported cabinet. This Turbo model is designed for bass reinforcement and is especially effective when used in concert with a high-quality, built-in, full-range sound system. As with the other Turbo models, the UBCP Bass features a carpet-covered cabinet with carrying handles and press-on connections.

The newest member of the Turbo family is the Samurai Turbo. That model is specifically designed as a two-way system for use in a Suzuki Samurai. It features dual 8-inch Polycarbon woofers and two 3-3/4-in. piezo tweeters.

Suggested retail prices for the Turbo models are: $249.95 for the Pick-Up and Hatchback Turbos, $239.95 for the Bass Turbo and $259.95 for the new Samurai Turbo.

For complete information on these and the new Turbo line, contact Ultimate Sound, 19330 East San Jose Avenue, City of Industry, CA 91748; Tel. 714/594-2604.

Portable Static Meter

A fully automatic, hand-held static meter with an easy-to-read analog voltage meter, an audio alarm, and a red LED to indicate when charges exceed 500 volts, is available from *Charleswater Products, Inc*.

CIRCLE 41 ON FREE INFORMATION CARD

The *Charleswater Static Surveyor CP911* operates over a zero to 5,000 volts range with ± 10% accuracy and repeatability within 5% at a 1 inch distance from the target. Featuring audio and visual alarms which indicate charges over 500 volts, lower voltages are read directly from a built-in analog meter.

Simple to operate, just hold the Static Surveyor within an inch of the test object and press the button. It is non-nuclear and uses a rechargable 10.8 V battery. Measuring 4.7″ × 2″ × 1.25″ and weighing 5 oz., this is the smallest and lightest static meter available, claims the manufacturer.

The Charleswater Static Surveyor CP911 is priced at $275 (list). For more information contact: Charleswater Products, Inc., A Subsidiary of Armstrong World Industries, Inc., 93 Border St., West Newton, MA 02165; Tel. 617/964-8370.

Logic Monitor

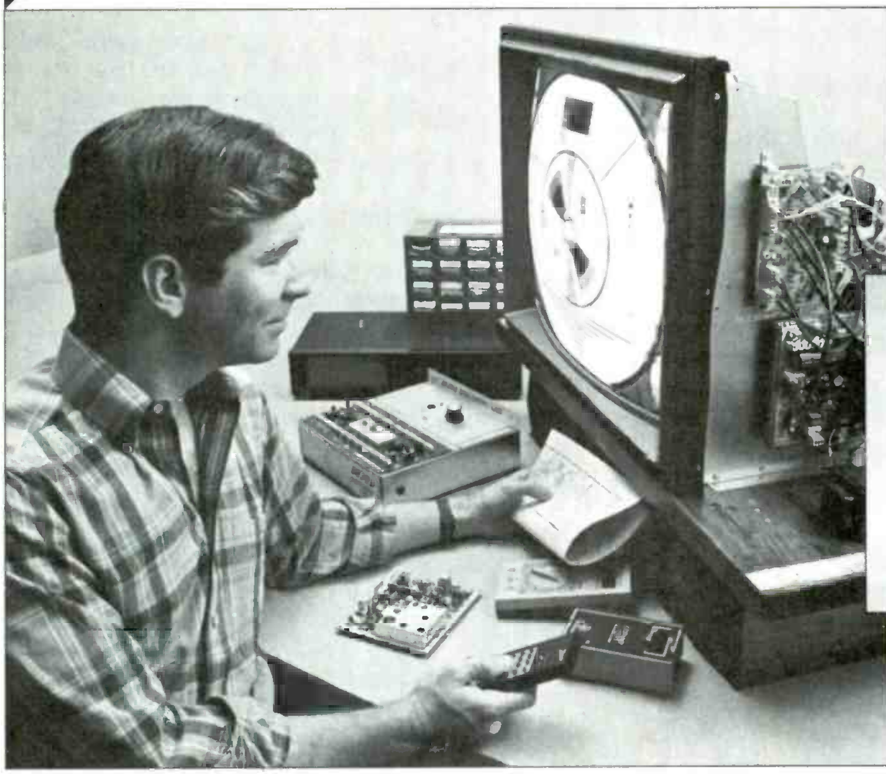
With state-of-the-art design, and innovative custom-IC construction, the *AR-80LM* brings high-end logic monitor performance within the reach of the average user.

The unique, custom-IC design provides autodetection of both power and ground pins, making instrument usage an easy, clip-on-and-view operation. Additionally, the unit also autodetects both TTL and CMOS logic levels.

CIRCLE 42 ON FREE INFORMATION CARD

Only NRI gives you a 27" high-resolution stereo color TV you build to prepare you for today's video servicing careers.

NEW



You Build a 27" Stereo TV

During the assembly process of your state-of-the-art Heath/Zenith 27" TV, you learn to identify and work with components and circuits as they actually appear in commercial circuitry. Then through tests, adjustments, and experiments you quickly master professional troubleshooting and bench techniques.

Inside Your TV

The Heath/Zenith 27" TV has all the features that allow you to set up *today* your complete home video center of the future. Flat screen, square corners, and a black matrix to produce dark, rich colors . . . even a powerful remote control center that gives you total command of video and audio operating modes.

NRI has purposely designed your training around equipment that has the same high-tech circuitry you'll encounter in commercial equipment. That means your training is real-world training.

Become one of America's most sought-after technicians . . . put your talents and spare time to work for you in the "explosive-growth" world of home entertainment electronics.

Train in state-of-the-art video/audio servicing and become a fully qualified service professional the uniquely successful NRI way. It's hands-on training, at home . . . designed around the latest electronic equipment you build and keep as part of your training.

The High-Tech Revolution in the Home Is Just Starting

Sweeping changes are taking place in our homes, changes brought about by the phenomenal growth of home entertainment electronics. Already available are high resolution TV, TVs with stereo sound, simultaneous multi-channel viewing, projection TV, Camcorders, 8 mm video cassettes, and compact disc players.

And the revolution has spread to the business sector as tens of thousands of companies are purchasing expensive high-tech video equipment used for employee training, data storage, even video conferencing.

Join the Future or Be Left Behind

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Today's consumer electronics revolution is creating huge servicing and repair markets that are just starting to boom.

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NEW PRODUCTS

The unit provides indications for logic high, low, and even pulsing inputs. For pulses with repetition rates over eight hertz, the unit flashes the LED at an 8Hz rate. That allows use of the unit at clock rates to up to 40MHz.

The AR-80LM sells for a suggested user price of $79.00, which includes a storage case and operator's manual. For further information contact ARI Media, 9241 E. Valley Boulevard, Suite 201, Rosemead, California 91770; Tel. 818/287-8400.

Brochure From Fluke

An application note on automotive electric troubleshooting, "*Beat the Book with Fluke Multimeters*," is now available from *John Fluke Mfg. Co., Inc.* Designed for the professional mechanic, the 16-page color brochure describes and illustrates time-saving procedures for servicing electrical systems safely, accurately and cost-effectively with Fluke analog/digital multimeters. The brochure includes general information on the multimeter as a tool for troubleshooting auto electrical systems, as well as specific techniques for using a DMM to test automotive charging, starting, ignition, and cooling systems, and to locate current drains, shorts, and bad grounds. It also contains a section on testing automotive on-board computers, and a quick-reference application chart listing the measurement type that is required for each auto electric system or component.

CIRCLE 43 ON FREE INFORMATION CARD

To obtain a copy of "Beat the Book with Fluke Multimeters," contact your local Fluke distributor in the U.S. For more information on the application notes or Fluke Multimeters in North America and other non-European, countries write to John Fluke Mfg. Co., Inc., P.O. Box C9090, Everett, WA 98206; Tel. 800/443-5853. In Europe, contact Philips Test and Measurement, Building HKF, 5600 MD Eindhoven, The Netherlands.

VCR Cleaning Cassette

Memtek Products now has a whole family of video-cleaning products. In addition to the ever popular *Memorex* brand *Video Head Cleaner*, the line also includes the *Memorex Video Cleaning System* and the *Deluxe Video Cleaning System*.

The Memorex Video Head Cleaner ($7.99) is a low-friction, dry-cleaning cassette that safely and effectively cleans all video, audio, control track, and erase heads. The product is designed for consumers who want an easy-to-use, economical system.

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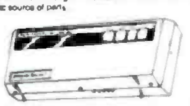
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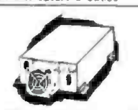
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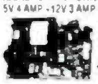
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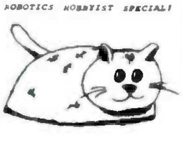
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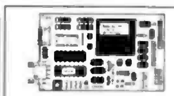
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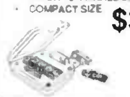

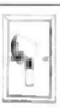
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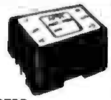
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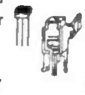
Center-tapped photo resistor mounted in plastic case (can be easily removed). 700 ohms light, 36K dark, 1/4" diameter.

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CIRCLE 7 ON FREE INFORMATION CARD

The Memorex Video Cleaning System ($14.99) is a non-abrasive, wet, cleaning cassette that thoroughly cleans the entire tape path and all tape heads using the Particle-Lock material exclusive to Memtek.

The Deluxe Video Cleaning System ($19.99) boasts all the outstanding cleaning capabilities and technology of the standard Memorex Video Cleaning System. The system tells the user when the VCR is completely clean and also offers a Memtek exclusive—TV color-adjustment capability. Color bars appear on the screen to assist the consumer in adjusting his television set to obtain the best possible color.

The two wet cleaning-systems feature the unique Particle-Lock cleaning system that delivers top quality cleanting because of the following features: custom-designed, woven-laminate cleaning tape is non-abrasive and will not be shredded by video heads eliminating potentially hazardous debris; cleans crucial areas most other head cleaners miss thanks to full video tape width for 100% machine interface compatibility; the unique Particle Lock design that gently traps oxide, dust, and other debris particles and permanently holds them to prevent redeposit on heads; it can be used in all types of video equipment, VCRs, portables, and camcorders; requires low machine torque to operate requiring less power than other VCR cleaning products.

For more information contact Memtek Products, P.O. Box 58118, Santa Clara, CA 95052-8118.

Space-Age Speakers

The ZSE-380 is the first active full-range enclosureless loudspeaker design resulting from the Zero Stored Energy design criteria. The design employs a dipole, bass, transducer module and monopole, treble, transducer module separately mounted to a three-point stance floor stand.

CIRCLE 45 ON FREE INFORMATION CARD

The system's 6-ohm minimum impedance and 91 dB sensitivity allow easily compatible tube amplifier drive as well as solid-state. The 115-dB, peak sound-level capability and highly reliable transducer and associated components makes the ZSE an entirely new alternative for those who demand accurate sound reproduction in the home.

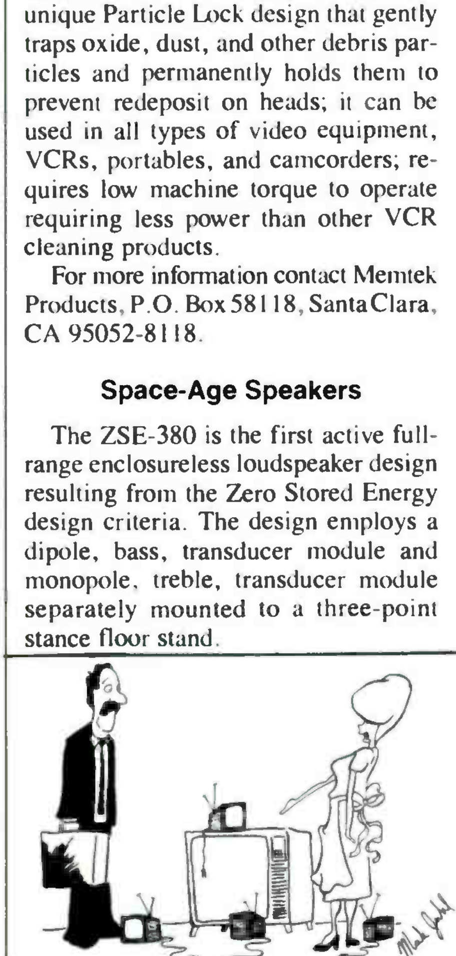
The major emphasis in the ZSE design has been to reduce all forms of stored sonic energy to the absolute minimum. The elimination of all internal cavities and flexible mounting structures was key to attaining that goal. The use of inherently inert transducer components, which remain unaffected by external vibrations and environmental conditions, further insures neutrality and unit-to-unit and room-to-room consistency in performance.

The crossover is a linear-transition type at 1200 Hz and the system's directivity index remains constant (within ± 1.5 dB) from 100 Hz to 10 kHz for consistent tonality to every listening position and an uncolored reverberant field. The speakers are 34 inches high, 12-1/2" wide and each weighs 45 pounds. The complete system has a suggested retail price of $1800.00 with the active electronic processor.

For further information contact The Mitek Group, One Mitek Plaza, Winslow, IL 61089-0038.

Auto-Reverse Cassette Receiver

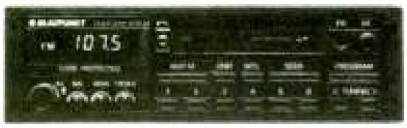
The *Portland SQR 28* is the least-expensive *Blaupunkt* AM/FM auto-reverse cassette receiver ever equipped with an electronic, security-code, theft-prevention circuit. The Portland SQR 28 has the usual tuner, tape, and amplifier performance for which Blaupunkt is famous, plus the new UniFit installation system that makes the radio look



"I thought you said you had the television set fixed?"

CIRCLE 21 ON FREE INFORMATION CARD

NEW PRODUCTS



CIRCLE 46 ON FREE INFORMATION CARD

like it was factory installed. It also provides for an optional removable Quick-Out mounting.

The built-in security-code circuit will disable the radio if the power leads are disconnected from the car's electrical system. The radio will not function until the power is reconnected and the correct four-digit code number is entered. Window stickers and permanent markings on the radio chassis alert potential thieves that this radio will not function without the code number. An integrated 10-year lithium battery maintains the code memory when the radio is disconnected or used in a Quick-Out system. The 12 preset-stations are retained by a non-volatile solid-state memory.

The Portland SQR 28 uses the ORC II tuning system for sound quality and multipath distortion rejection. In weak-signal conditions the signal blends gradually from stereo to mono to maintain optimum reception. Tuning accuracy is assured by a phase-locked loop, digital-synthesis system for easy manual and seek tuning. It has a last-station memory feature. The two-color transflective LCD display/clock can be switched between green and champagne, and is easy to read at any time of day or night.

The hard permalloy tape heads are extremely durable and deliver a wide frequency response of 30–16,000 Hz at ±3 dB. Other tape features include a metal (normal/high bias) tape switch, track-selector switch, track indicator, and locking fast forward and rewind. The power-off, pinch-roller release feature prevents damage to tapes playing if the ignition is switched off.

The Portland SQR 28 has a built-in 7.5-watts per channel stereo amplifier, with a front/rear fader and outputs for four loudspeakers. The volume knob has 36 detent positions for subtle level adjustment. Other features include automatic loudness contour, separate bass and treble controls, detented balance control, DNR (for use on tape, FM and AM), and a power-antenna lead.

The Portland SQR 28 carries a suggested retail price of $359.95. For more information contact Blaupunkt, P.O. Box 4601, North Suburban, IL 60198.

7-Mode Data Controller

MFJ Enterprises, Inc. announces the *MFJ-1278 Multi-mode Data Controller* that lets you work seven (7) digital modes: Packet, ASCII, RTTY, CW, WEFAX, SSTV, and Contest Memory Keyer modes. The MFJ-1278 retails for $249.95.

The MFJ-1278 features high performance HF/VHF/CW modems, software-selectable dual radio ports, precision tuning indicator, 32K RAM and an AC power supply.

All you need to operate MFJ-1278 is a standard HF or VHF rig and any computer with a serial port and terminal program.

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MFJ also offers a Starter Pack to get MFJ-1278 users on the air instantly. The Starter Pak includes computer interface cable, terminal software and friendly instructions. It is available for the Commodore 64/128, VIC-20 (MFJ-1282, disk; MFJ-1283, tape) and for the IBM or compatible (MFJ-1284), $19.95 each.

The MFJ-1278 automatically sets itself to match your computer baud rate. In all modes it features printing, threshold control for varying band conditions, tune-up command, lithium battery backup, RS-232 and TTL serial ports, watch-dog timer, FSK and AFSK output-level control, speaker jack for both radio ports, test and calibration software, Z-80 microprocessor running at 4.9 MHz, 32K EPROM and socketed ICs.

It is FCC approved and measures 9″ × 1-1/2″ × 9-1/2″. It operates on either 12 VDC or 110 VAC.

The MFJ-1278 comes with MFJ's double guarantee. If ordered from MFJ, it may be returned within 30 days for a full refund, less shipping. MFJ also backs this product with a one-year unconditional guarantee. For more information, contact MFJ Enterprises, Inc., P.O. Box 494, Mississippi State, MS 399762; Tel. 800/647-1800, or 601/323-5869.

Ortofon X5-MC Phono Cartridge

Ortofon's X5-MC Moving Coil Phonograph Cartridge brings a higher standard of performance to the company's

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high-output X-Series MC cartridge line. On old, well-played records, where the upper groove walls have been polished smooth by conventional stylii, the X5-MC's radical new stylus reads deep into the groove to extract subtle musical details that have remained untouched since the day the record was pressed. The cartridge offers an incredible frequency response of 20 to 45,000 Hz, +4/–1.5 dB.

The Ortofon X5-MC phono cartridge uses the proven high-output moving-coil drive system and aluminum-tube cantilever from its predecessors, the X1-MC and X3-MC. However, by adding the radical new Fritz Gyger II stylus, the new X5-MC cartridge delivers incredibly accurate reproduction of subtle details, more focused imaging, and greatly improved tracking ability.

The X5-MC enjoys all the key sound quality advantages of moving coil design with none of the practical disadvantages. It benefits from an extremely low moving mass for optimum high-frequency performance and a low internal impedance to avoid possible cable/preamp problems.

The cartridge is manufactured using a proprietary Ortofon coil-winding machine that winds wire that is much thinner than would be possible to wind by hand. The coils are wound on a high, rigid X-shaped armature with hollow arms that weighs a mere 0.0012 grams. Those factors enable the X5-MC to have a larger number of windings than a conventional moving coil, yet achieve a significantly lower moving mass. Other important features include Ortofon's wide-range damping system for accurate control of the moving parts.

The Ortofon X5-MC carries a suggested retail price of $300. All three of the X-Series cartridges are now also available in P-Mount versions. For more information on the cartridges contact Ortofon, 122 Dupont St., Plainview, NY 11803.

Modern Classic Radio

In 1932, the typical table radio had a wooden cabinet, weighed 40 pounds, consumed 100 watts of electricity, required a 50-ft. outside antenna, and was the focus of most American living rooms. Today, *GE* has recreated its classic living-room radio of the '30s with the *Model 7-4100J*—a 3/4-scaled replica of the 1930 GE J100.

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Though the classic styling has not changed, the 7-4100J radio consumes 1/20th the power of its predecessor, has two built-in antennas (AM and FM), and weighs only five pounds. Gone are the glass vacuum tubes of the '30s—replaced with integrated AM/FM circuits for smaller size, improved performance, and reliability.

In 1932, the GE radio was an investment at $99, or $817 in 1987 dollars. In 1987, the optional retail price is $75, and the radio comes with a full one-year warranty.

The wooden cabinet houses a high-performance radio chassis, including a 5-in. heavy magnet, high-sensitivity speaker and 700-mw RMS audio output. In addition, a loudness-type volume control boosts bass response at low listening levels.

For more information contact GE Consumer Electronics Products, Manager Consumer Relations, P.O. Box 1976, Indianapolis, IN 46026.

Home/Auto Mini Speakers

To provide virtually unlimited placement options for the Model 55 indoor/outdoor acoustic-suspension mini speakers, Altec Lansing has designed two unique mounting brackets. One, the

swivel bracket that is shown in the photo, mounts the mini speaker to a ceiling or wall of a room or patio. The second, is an "L" bracket to mount the weather-proof mini speaker to the side wall or rear deck of a car or van.

The Model 55 mini speakers, which measure just 7" × 9-3/8" × 5-5/16", can be used outdoors on a deck or patio. Indoor applications include placement in a kitchen or bathroom, in addition to use as extension speakers anywhere in the home where small loudspeaker size is desirable.

Prior to the development of the new brackets, the speakers could be used free-standing, placed on a bookshelf or cabinet, or be wall mounted by using the keyhole slot at the back of each loudspeaker. With the new swivel-mount bracket, the Model 55 speaker system can be attached to walls and ceiling and positioned for optimum audio performance. Suggested retail price for the home bracket set is $39.95 per pair.

The "L" bracket, allows the Model 55 acoustic-suspension loudspeaker to be used in automotive applications for the very first time. Suggested retail price is $24.95 per pair.

The materials used for the drivers are impervious to moisture and will withstand temperature extremes with no deterioration of performance. Each 4" woofer cone is constructed of carbon-fiber cloth reinforced with epoxy and a 20mm polyimide dome tweeter. Strontium magnets are used for the drivers.

Specifications include: Frequency response per speaker is ±3 dB, 85Hz–20KHz, power handling is 40 watts nominal and 80 watts maximum, impedance is 4 ohms.

For additional information contact Altec Lansing Consumer Products, Milford, PA 18337; or call 1-800-ALTEC 88. ■

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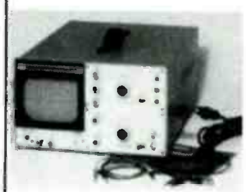

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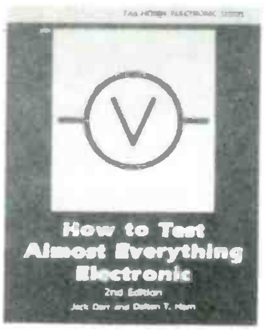
BOOKSHELF

How to Test Almost Everything Electronic—2nd Ed.
By Jack Darr and Delton T. Horn

This very popular book sold more than 35,000 copies in its first edition. Now it has been revised to cover the changes that have taken place in the world of electronics in the twenty years since the first edition was published.

Electrical voltage, current, and resistance cannot normally be heard, seen, or touched, but measuring them is still very important. The book describes how to perform tests and measurements with all kinds of test equipment, and how to interpret the results. Test instruments can do just about anything—if the tester knows how to use them, how they work, and precisely what their limitations are.



CIRCLE 98 ON FREE INFORMATION CARD

The new edition retains the most useful parts of the first edition: detailed description of the various pieces of test equipment and the necessary electronics fundamentals. New sections cover the basics of digital electronics, exploring special testing procedures and equipment for working with digital circuitry. The new sections include discussions of: using logic probes and analyzers, operating frequency counters and capacitance meters, signal-tracing digital circuits, identifying unknown ICs (integrated circuits), digital-signal shaping, identifying load and power problems in digital circuits, and monitoring brief digital signals.

Every section includes easy-to-follow instructions for using test equipment with the various types of circuits readers are likely to encounter. Plus the new edition includes some simple test-analyzer circuits readers can build to aid in troubleshooting other equipment.

How to Test Almost Everything Electronic—2nd Ed., order No. 2925, retails for $8.70. It contains 190 pages, from TAB Books Inc., P.O. Box 40, Blue Ridge Summit, PA 17294-0850; Tel. 717/794-2191.

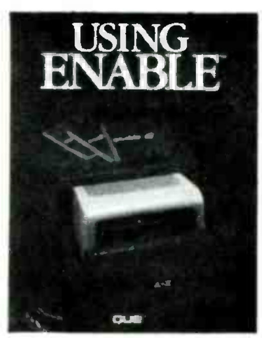
Using Enable—2ND Ed.
By Charles Spezzano

Enable is an integrated software program that combines spreadsheet, work processing, database management, graphics, and telecommunications in one package.

Using Enable—2nd Ed., helps readers get the most effective use of this powerful program. Readers will learn to use the new features of Enable 2.0 to link a related database, create tables of contents, quickly recalculate spreadsheets, and transport data between other programs and applications.

The book leads readers step-by-step through each Enable module, using a Quick Start lesson to demonstrate a sample integrated application. Both a comprehensive tutorial and a lasting reference, this book presents the most efficient methods to accomplish tasks with Enable.

With *Using Enable—2nd Ed.*, readers will learn to: get up and running with all five of Enable's application modules; tap the power of the Master Control Module; Streamline operations with timesaving macros; use windows to work



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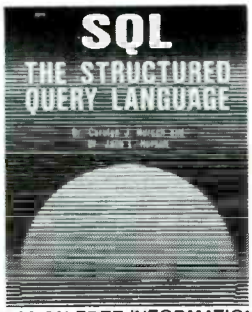
with more than one application at one time; bypass cumbersome menues with "fast command" shortcuts; produce dazzling two- and three-dimensional graphs and charts with the new Perspective graphics package.

Using Enable—2nd Ed. costs $21.95 and contains 700 pages. Que books can be found in most bookstores and computer stores. To order directly from Que, call 800/428-5331 and ask for a sales representative.

SQL: The Structured Query Language
By Dr. Carolyn J. Hursch & Dr. Jack L. Hursch

Recently a need has developed for a flexible database language that is user-friendly enough for the casual user, yet powerful enough for the programmer and applications builder. SQL has been developed by IBM to fill that need. Because of its ingenious Query-by-Example feature, SQL is learned and understood easily by novices. It is now being implemented on both micro- and mainframe-based systems by major companies.



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The book presents the complete picture of SQL. Although aimed toward computer science professionals, its hands-on approach, with many examples of each concept, make the book equally appropriate for database operators who simply want to understand and use SQL. Since SQL is rapidly becoming a part of current research into artificial intelligence applications, its use in knowledge bases and expert systems will also be explained. A further sampling of topics includes: the components of SQL, data definition statements (DDS), data control statements (DCS), aggregate functions, SQL at work, table expressions and predicates, data manipulation statements (DMS), logical connectives, subqueries, views, indices, and queries, relational algebra and SQL, logic and SQL, relational calculus and SQL, embedded SQL.

Exercises (with solutions) at the end of each chapter allow readers to test what they have learned, and make the book ideal for classroom use. A complete bibliography provides many sources of further reading for those who become interested in particular topics, and an index makes finding information in the book simple and quick.

SQL: The Structured Query Language, order No. 3016, costs $18.95, and contains 200 pages. You can order from Tab Professional and Reference Books, Division of Tab Books Inc., Blue Ridge Summit, PA 17294-0850; Tel. 717/794-2191.

Communications Receivers: Principles & Design
By Ulrich L. Rohde & T.T.N. Bucher

A "one-stop" guide to the theory and design of all types of communications receivers—short-wave, military, broadcast (AM-FM), radar, aeronautical, marine,

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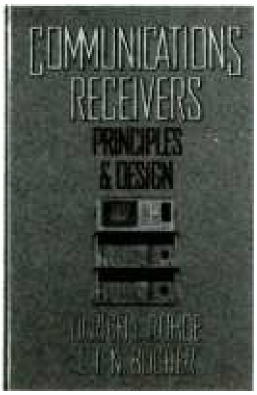

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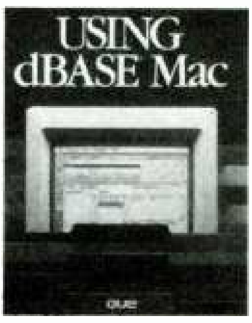
and direction-finding—this is just right for communications designers, design and system engineers, and radio engineers, particularly those involved with military projects. Providing thorough coverage of total systems, including receivers, accessories, and peripheral equipment, this useful book discusses basic concepts such as selectivity and dynamic range, proven design techniques, circuitry, and components, the use of microprocessors and logic devices in receivers, and communications modes such as pulse and data. It also includes several design programs in the BASIC language, as well as an appendix listing spectrum-occupancy computations.

Communications Receivers: Principles and Design contains 583 pages; costing $59.50; from The McGraw-Hill Book Company, 11 West 19th Street, New York, NY 10011; Tel. 212/337-5945 or 337-5951.

Using dBase Mac By Paul Springer & Ralph DeFranco

dBASE Mac is Ashton-Tate's long-awaited database for the Macintosh. Making full use of the Macintosh graphics interface, dBASE Mac is a powerful program that lets users organize and track large amounts of data.

With this power comes a degree of



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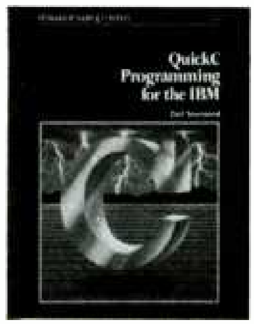
complexity. Using dBASE Mac, the book from Que Corporation, is designed to help users learn and master dBASE Mac. Written by a Senior Software Analyst and by a Technical Writer at Ashton-Tate, *Using dBASE Mac* contains a wealth of information that will help us become more proficient with this popular program.

Functioning both as a comprehensive tutorial and a lasting reference, Using dBASE Mac leads users step-by-step through the program's detailed operating procedures. Using a series of Quick Start tutorials, the book shows readers how to: create, display, and print files, define a personalized view, print complex reports, program with dBASE Mac, and develop custom applications.

Using dBASE Mac contains 400 pages, costing $19.95. Que publishes many books on Macintosh programs and applications. Que books are sold in bookstores and computer stores. To order directly from Que, call 800/428-5331, ext. 899.

QuickC Programming For the IBM By Carl Townsend

This book is written for the introductory C-programming audience. It introduces the basic aspects of programming in C while providing hands-on interaction between the high-speed, low-cost compiler and the IBM PC.



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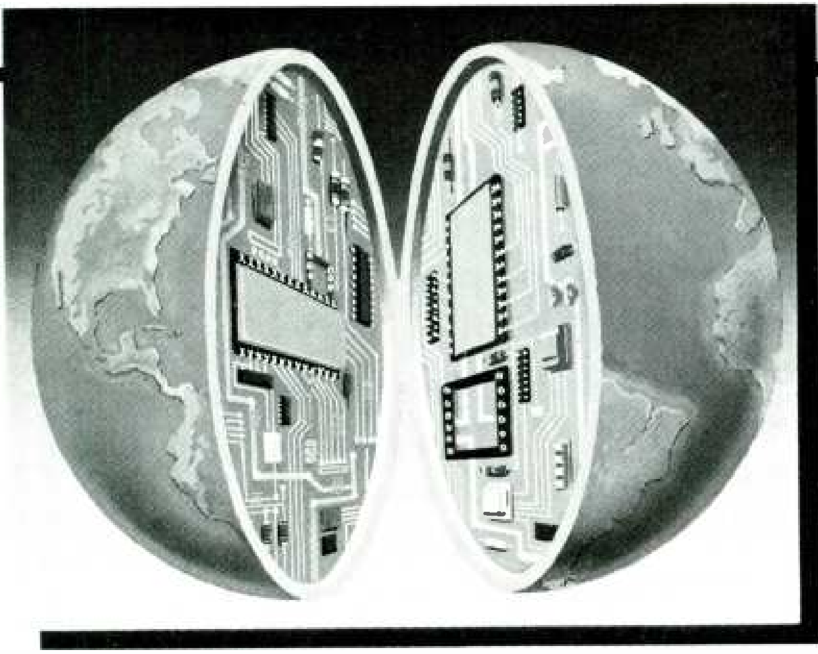
Organized into three parts, the first is a basic introduction and overview of C for the novice. An in-depth language tutorial comprises part two, including exercises and review questions. Finally, additional intermediate-level concepts such as structured programming, managing databases, and high-level design using menus are explained.

Topics covered include: getting started, representing data, basic input and output, arithmetic operations, program control, IF, CASE, and iteration structures, using functions and macros, managing the storage of variables, ar-



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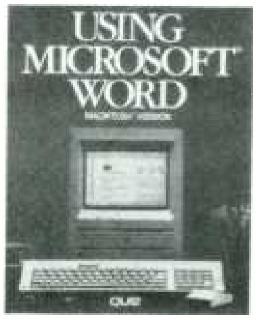
rays and pointers, using character strings, data structures, files and other I/O, and graphics, introduction to structured programming, developing programs with QuickC, managing database with QuickC, high-level design: menus, adding database records, editing and deleting records, reporting, and processing programs.

QuickC Programming for the IBM retails for $22.95 and is available at bookstores, computer stores, or direct from Sams, the publisher, by calling 800/428-SAMS.

Using Microsoft Word Macintosh Version By Steve Lambert & Marsha L. Miliman

Microsoft Word, Version 3, is one of the most powerful word-processing programs available for the Apple Macintosh. Now, with Que's *Using Microsoft Word: Macintosh Version*, users can harness that power for their word-processing needs.

Both Word novices and experienced users will find Using Microsoft Word packed with useful information. More than just an introduction to Word, this



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book presents valuable tips and techniques that help users get the most from this powerful program.

With Que's popular step-by-step approach, Using Microsoft Word shows users how to: familiarize themselves with basic Word functions, customize Word's menus, easily format documents with Word's style sheets, bypass the Macintosh mouse with keyboard shortcuts, insert frequently used text and graphics with convenient glossaries, organize their writing with Word's outlining features.

Using Microsoft Word also examines Word's desktop publishing features and includes a handy Quick Reference Guide to Word commands.

Que Corporation publishes many personal computer books, including several other books for Macintosh users. Que books can be found in over 7,500 book and computer stores or can be ordered directly from Que by calling 800/428-5331, ext. 899. You can order Using Microsoft Word: Macintosh Version; from them for $19.95.

Using the Triggered Sweep Oscilloscope By Robert L. Goodman

The wideband, triggered-sweep oscilloscope is one of the most essential pieces of equipment needed by electronic service technicians today. Sophisticated microprocessors and other integrated circuits found in modern equipment now require scope test-performance ability that is beyond that obtainable from a conventional narrow-band service scope.

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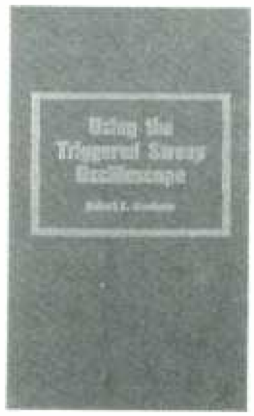

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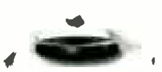

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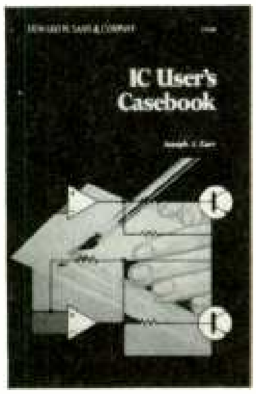

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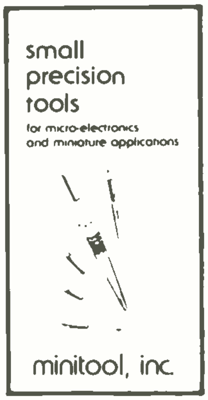

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4051	.69	74HC86	.45	74HCT393	.99
4052	.69	74HC138	.45	74HCT4017	1.19
4053	.69	74HC139	.45	74HCT4040	.99
4060	.69	74HC151	.59	74HCT4060	1.49

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CIRCLE 24 ON FREE INFORMATION CARD

CAPACITORS

TANTALUM

1.0µf	15V	.12	1.0µf	35V	.45
6.8	15V	.42	2.2	35V	.19
10	15V	.45	4.7	35V	.39
22	15V	.99	10	35V	.69

DISC

10pf	50V	.05	.001µf	50V	.05
22	50V	.05	.005	50V	.05
33	50V	.05	.01	50V	.07
47	50V	.05	.05	50V	.07
100	50V	.05	.1	12V	.10
220	50V	.05	.1	50V	.12

MONOLITHIC

.01µf	50V	.14	.1µf	50V	.18
.047µf	50V	.15	.47µf	50V	.25

ELECTROLYTIC

RADIAL			AXIAL		
1µf	25V	.14	1µf	50V	.14
4.7	50V	.11	10	50V	.16
10	50V	.11	22	16V	.14
47	35V	.13	47	50V	.19
100	16V	.15	100	35V	.19
220	35V	.20	470	50V	.29
470	25V	.30	1000	16V	.29
2200	16V	.70	2200	16V	.70
4700	25V	1.45	4700	16V	1.25

BYPASS CAPACITORS

.01 µf	CERAMIC DISC	100	$5.00
.01 µf	MONOLITHIC	100	$10.00
.1 µf	CERAMIC DISC	100	$6.50
.1 µf	MONOLITHIC	100	$12.50

25 PIN D-SUB GENDER CHANGERS $7.95

EMI FILTER $4.95

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3 conductor 99¢
3 conductor w/ female socket $1.49

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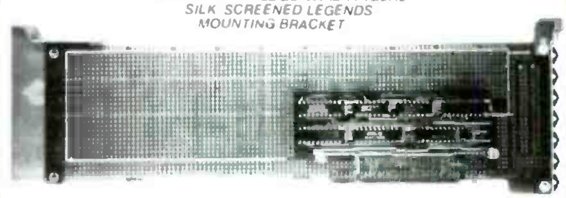
EXT-80286 $39.95

SHORTING BLOCKS 5/$1.00

WIREWRAP PROTOTYPE CARDS

FR-4 EPOXY GLASS LAMINATE
GOLD-PLATED EDGE-CARD FINGERS
SILK SCREENED LEGENDS
MOUNTING BRACKET



FOR PS/2

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FOR XT

IBM-PR1 WITH +5V AND GROUND PLANE $27.95
IBM-PR2 AS ABOVE WITH DECODING LAYOUT $29.95

FOR AT

JDR-PR10 16 BIT WITH DECODING LAYOUT $34.95
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SIP	8 PIN	7 RESISTOR	.59
DIP	16 PIN	8 RESISTOR	1.09
DIP	16 PIN	15 RESISTOR	1.09
DIP	14 PIN	7 RESISTOR	.99
DIP	14 PIN	13 RESISTOR	.99

38 PIN CENTRONICS

IDCEN36	RIBBON CABLE	3.95
CEN36	SOLDER CUP	1.85
IDCEN36/F	RIBBON CABLE	4.95
CEN36PC	Rt Angle PC Mount	1.85

EDGECARD CONNECTORS

100 Pin ST	S-100	.125	3.95
100 Pin WW	S-100	.125	4.95
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50 Pin ST	APPLE	.100	2.95
44 Pin ST	STD	.156	1.95
44 Pin WW	STD	.156	4.95

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7808T	.49	7905K	1.69
7812T	.49	7912K	1.49
7815T	.49	78L05	.49
7905T	.59	78L12	.49
7908T	.59	79L05	.69
7912T	.59	79L12	1.49
7915T	.59	LM323K	4.79
7805K	1.59	LM338K	6.95

DISCRETE

1N751	.15	4N28	.69
1N4148	25/$1.00	4N33	.89
1N4004	10/$1.00	4N37	1.19
1N5402	.25	MCT-2	.59
KBP02	.55	MCT-6	1.29
2N2222	.25	TIL-111	.99
PN2222	.10	2N3906	.10
2N2907	.25	2N4401	.25
2N3055	.79	2N4402	.25
2N3904	.10	2N4403	.25
4N26	.69	2N6045	1.75
4N27	.69	TIP31	.49

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PRECUT ASSORTMENT IN ASSORTED COLORS $27.50
100ea: 5.5", 6.0", 6.5", 7.0"
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500ea: 3.0", 3.5", 4.0"

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100 feet $4.30 — 250 feet $7.25
500 feet $13.25 — 1000 feet $21.95

Please specify color: Blue, Black, Yellow or Red

IDC CONNECTORS/RIBBON CABLE

DESCRIPTION	ORDER BY	CONTACTS 10	20	26	34	40	50
SOLDER HEADER	IDHxxS	.82	1.29	1.68	2.20	2.58	3.24
RIGHT ANGLE SOLDER HEADER	IDHxxSR	.85	1.35	1.76	2.31	2.72	3.39
WIREWRAP HEADER	IDHxxW	1.86	2.98	3.84	4.50	5.28	6.63
RIGHT ANGLE WIREWRAP HEADER	IDHxxWR	2.05	3.28	4.22	4.45	4.80	7.30
RIBBON HEADER SOCKET	IDSxx	.63	.89	.95	1.29	1.49	1.69
RIBBON HEADER	IDMxx	---	5.50	6.25	7.00	7.50	8.50
RIBBON EDGE CARD	IDExx	.85	1.25	1.35	1.75	2.05	2.45
10' GREY RIBBON CABLE	RCxx	1.60	3.20	4.10	5.40	6.40	7.50

FOR ORDERING INSTRUCTIONS, SEE D-SUBMINIATURE CONNECTORS BELOW

D-SUBMINIATURE CONNECTORS

DESCRIPTION		ORDER BY	CONTACTS 9	15	19	25	37	50
SOLDER CUP	MALE	DBxxP	.45	.59	.69	.69	1.35	1.85
	FEMALE	DBxxS	.49	.69	.75	.75	1.39	2.29
RIGHT ANGLE PC SOLDER	MALE	DBxxPR	.49	.69	---	.79	2.27	---
	FEMALE	DBxxSR	.55	.75	---	.85	2.49	---
WIREWRAP	MALE	DBxxPWW	1.69	2.56	---	3.89	5.60	---
	FEMALE	DBxxSWW	2.76	4.27	---	6.84	9.95	---
IDC RIBBON CABLE	MALE	IDBxxP	1.39	1.99	---	2.25	4.25	---
	FEMALE	IDBxxS	1.45	2.05	---	2.35	4.49	---
HOODS	METAL	MHOODxx	1.05	1.15	1.25	1.25	---	---
	GREY	HOODxx	.39	.39	---	.39	.69	.75

ORDERING INSTRUCTIONS:
INSERT THE NUMBER OF CONTACTS IN THE POSITION MARKED "xx" OF THE "ORDER BY" PART NUMBER LISTED. EXAMPLE: A 15 PIN RIGHT ANGLE MALE PC SOLDER WOULD BE DB15PR

MOUNTING HARDWARE 59¢

IC SOCKETS/DIP CONNECTORS

DESCRIPTION	ORDER BY	CONTACTS 8	14	16	18	20	22	24	28	40
SOLDERTAIL SOCKETS	xxST	.11	.11	.12	.15	.18	.15	.20	.22	.30
WIREWRAP SOCKETS	xxWW	.59	.69	.69	.99	1.09	1.39	1.49	1.69	1.99
ZIF SOCKETS	ZIFxx	---	4.95	4.95	---	5.95	---	5.95	6.95	9.95
TOOLED SOCKETS	AUGATxxST	.62	.79	.89	1.09	1.29	1.39	1.49	1.69	2.49
TOOLED WW SOCKETS	AUGATxxWW	1.30	1.80	2.10	2.40	2.50	2.90	3.15	3.70	5.40
COMPONENT CARRIERS	ICCxx	.49	.59	.69	.99	.99	.99	.99	1.09	1.49
DIP PLUGS (IDC)	IDPxx	.95	.49	.59	1.29	1.49	---	.85	1.49	1.59

FOR ORDERING INSTRUCTIONS, SEE D-SUBMINIATURE CONNECTORS ABOVE

SPECTRONICS CORPORATION EPROM ERASERS

Model	Timer	Chip Capacity	Intensity (uW/Cm²)	Unit Cost
PE-140	NO	9	8,000	$89
PE-140T	YES	9	8,000	$139
PE-240T	YES	12	9,600	$189

DATARASE

- ERASES 2 EPROMS IN 10 MINUTES
- VERY COMPACT, NO DRAWER
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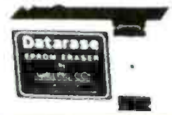

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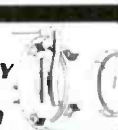
FND-357(359)	COM CATHODE	.362"	1.25
FND-500(503)	COM CATHODE	.5"	1.49
FND-507(510)	COM ANODE	.5"	1.49
MAN-72	COM ANODE	.3"	.99
MAN-74	COM CATHODE	.3"	.99
TIL-313	COM CATHODE	.3"	.45
TIL-311	4x7 HEX W/ LOGIC	.270"	10.95

DIFFUSED LEDs

		1-99	100-UP
JUMBO RED	T1¾	.10	.09
JUMBO GREEN	T1¾	.14	.12
JUMBO YELLOW	T1¾	.14	.12
MOUNTING HDW	T1¾	.10	.09
MINI RED	T1	.10	.09

3 VOLT LITHIUM BATTERY $1.95

HOLDER $1.49



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14	IDWRAP 14	10	1.95
16	IDWRAP 16	10	1.95
18	IDWRAP 18	5	1.95
20	IDWRAP 20	5	1.95
22	IDWRAP 22	5	1.95
24	IDWRAP 24	5	1.95
28	IDWRAP 28	5	1.95
40	IDWRAP 40	5	1.95

PLEASE ORDER BY NUMBER OF PACKAGES (PCK. OF)

SWITCHES

SPDT	MINI-TOGGLE ON-ON	1.25
DPDT	MINI-TOGGLE ON-ON	1.50
DPDT	MINI-TOGGLE ON-OFF-ON	1.75
SPST	MINI-PUSHBUTTON N.O.	.39

DIP SWITCHES

4 position	.85	7 position	.95
5 position	.90	8 position	.95
6 position	.90	10 position	1.29

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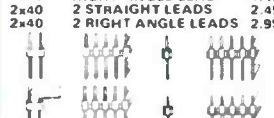
2x40	2 STRAIGHT LEADS	2.49
2x40	2 RIGHT ANGLE LEADS	2.99



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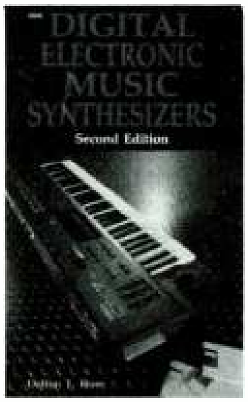
BOOKSHELF

(Continued from page 25)

cuits. Here hobbyists can learn how to build their own music synthesizers, so they can begin exploring this versatile and important instrument on their own.



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Digital Electronic Music Synthesizers—2nd Edition order No. 2695, carries a price of $14.95, for its 272 pages, and can be purchased from Tab Books Inc., PO Box 40, Blue Ridge Summit, PA 17214; Tel. 717/794-2191.

The Microphone Manual: Design and Applications By David Miles Huber

This book bridges the gap between the equipment manufacturer and the microphone user by clearly introducing and explaining microphone design, characteristics, and theory.

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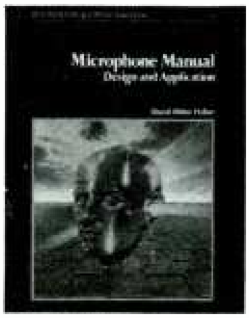
Topics covered include: basic theory of operation, the microphone transducer, microphone characteristics, electrical interface-cable/connector, microphone accessories, fundamentals of single-



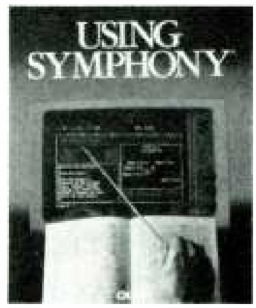
CIRCLE 95 ON FREE INFORMATION CARD

microphone techniques, fundamentals of stereo-microphone techniques, applied microphone techniques in music production, applied microphone techniques in video/film production, speech and music reinforcement, appendices: the use of omnidirectional microphones for modern recording, microphone techniques for predictable tonal balance control, the PZM boundary booklet, listing of popular professional microphones, glossary of microphone terms.

Order No. 22598, *The Microphone Manual* retails for $29.95 and is available at bookstores, computer stores, electronics distributors, or direct from the publisher by calling 800/428-SAMS.

Using Symphony—2nd Ed. By Rebecca Bridges

Using Symphony, has been revised and updated for new Symphony Version 2.0. The original edition of the book was the #1 best-selling title on Symphony 1.0; the new edition promises to be every bit as popular.



CIRCLE 94 ON FREE INFORMATION CARD

Using Symphony, 2nd Edition, includes a wealth of information on the new features of Symphony Version 2..0, including the Spelling Checker and Text Outliner. Readers will also appreciate this edition's new and expanded features, such as: hands-on practice sessions—to help the novice user get up and running with Symphony's various applications; introduction to Symphony Macros and the command language—explains how to create, use, and debug macros, and provides in-depth coverage of Symphony's programming language; troubleshooting section—serves as a valuable reference to common Symphony problems and offers a variety of solutions.

Using Symphony, 2nd Edition costing $24.95, contains 800 pages and is published by Que Corporation. Que books can be found in over 7,500 bookstores and computer stores, or can be ordered directly from Que by calling 800/428-5331, ext. 899.

dBase III Plus Workbook and Disk
By Michael J. Clifford

Learning to use dBASE III Plus is now easier. *dBASE III Plus Workbook and Disk*, is a first-class learning aid that teaches students the features and functions of Ashton-Tate's popular database program.

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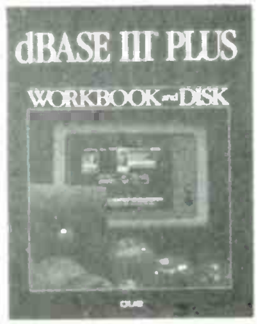
Also available from Que is the *dBASE III Plus Instructor's Kit*, designed for classroom use. Each kit includes one copy of dBASE III Plus Handbook, 2nd Edition; dBASE III Plus Workbook and Disk; and dBASE III Plus Instructor's Guide. The dBASE III Plus Instructor's Guide contains suggestions for lesson presentation, tips for classroom training, and masters for overhead transparencies. The dBASE III Plus Instructor's Kit includes everything needed for a dBASE training course.



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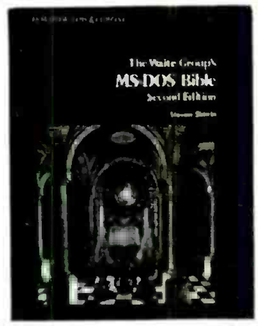
MS-DOS Bible
By Steven Simrin

This comprehensive tutorial emphasizes the new features found in DOS 3.3 and provides expanded coverage of batch files, device drivers, memory management, and network commands.

New in this edition, is expanded batch language, disk structure, terminate and stay-resident programs (TSRs), and the Lotus-Intel expanded memory, model 4.0. New commands are explained in detail, and a unique "Information Jump table" is included and enhanced for easy reference. Another unique feature is the coverage of the keyboard and system-configuration commands for foreign countries and code-page switching for foreign language conversion. Topics covered include: starting MS-DOS, MS-DOS files and batch files, directories, paths, trees, installing a fixed disk, extended keyboard and display control, undocumented features, and much more.



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MS-DOS Bible, Revised Edition is 568 pages, retails for $22.95 and is available at bookstores, computer stores or direct from the publisher by calling 800/428-SAMS.

(Continued on page 101)

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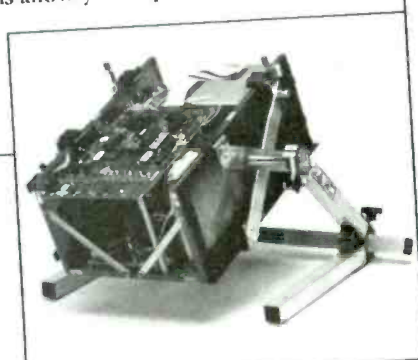

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PANAVISE

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CIRCLE 23 ON FREE INFORMATION CARD

COMPUTERIZED CASINO

All the thrills and excitement of the tables of Reno, Las Vegas, and Atlantic City—but without some of the consequences

By Walter W. Schopp

GAMES OF CHANCE ARE AS OLD AS CIVILIZATION AND, among the games that fall into that category is Craps. You can win a bundle or lose your shirt, as many have learned during jaunts to Reno, Las Vegas, or Atlantic City. And it's unlikely that there will ever be a shortage of "high rollers" to play the game.

But there is a way that you can get all the thrills of casino action tonight, without having to face the music tomorrow—build the *Computerized Casino Dice Game*—which we'll refer to as *Casino Craps*. Because of the gambling aspect of this adult game, you're not likely to find it in the toy stores.

The game is referred to as *Casino Craps* because it's not only electronic dice, but a complete crap-table setup that keeps track of the "point" that you are shooting for and takes the dice from you if you throw craps. It does everything that the dice-table croupier does, and the only thing missing is the noise of the clicking dice.

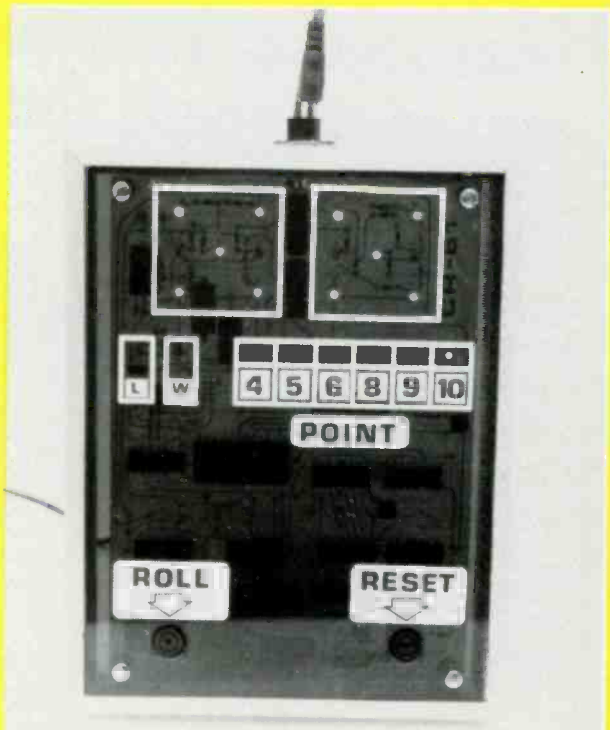
The rules of the game are simple. Place your bet and get someone to cover it. Roll out a couple of dice and if the two dice total 2, 3, or 12, you lose everything that you've bet. If you throw a seven or eleven, you become an instant winner. If you roll any other number, that number then becomes your "point." You then keep rolling the dice until you either make your point (by rolling the same number again) and win, or throw a seven and lose.

You have to admit, your chances are better than the lottery and the game provides a lot of entertainment if you don't run short of cash.

At the push of a "roll' button, the circuit generates two random numbers from 1 to 6. The numbers rolled are displayed with LED's in the form of dice spots at the top of the panel. If the first number rolled is 2, 3, or 12, the LOSE lamp lights. If you should roll a seven or eleven on the first roll, the "win" lamp comes on. Point numbers—4, 5, 6, 8, 9, and 10—are displayed by individual LEDs representing each number on the front panel.

The "point" is stored in memory until it's rolled again and you win, or you roll a seven and lose. On the first roll, if you "win" or "lose," the WIN or LOSE lamp comes on and the roll button is disabled so you can not roll again until the game is reset. If you should roll a point number and roll again and make your point, the dice are not taken from you. You can continue shooting even after you have made your point so you have to stay alert and watch for the POINT and "WIN" lamp to come on.

The circuit is about as close as you can get to a special computer circuit without using an actual CPU and all the other specialized support components associated with a basic computer circuit. In reality, the game is a simple dedicated computer that has been hardware oriented. What that means



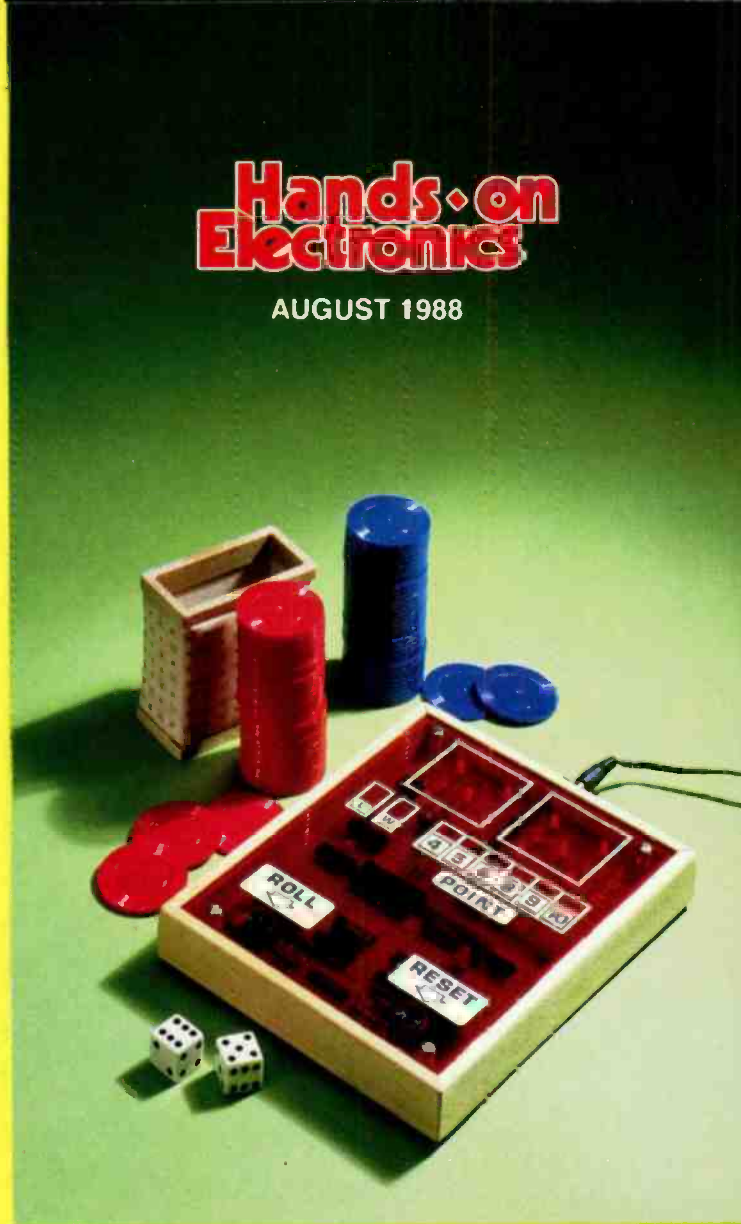
The casino dice game is shown here fully assembled in a wood-frame enclosure. The front panel is laid out in such a way that the boxes (representing the outline of the dice) are positioned just above dice spot LEDs; the "win-lose" boxes ("L" and "W") above LED15 and LED16, and the "point" boxes are over the POINT lamps.

DICE GAME

is that the circuit has been complicated by the use of a lot of standard chips instead of simplified with a computer circuit and program. It all depends on your own definition of simple and complicated.

A lot of comparisons can be made between this circuit and a computer circuit. It uses manually clocked logic instead of a pre-written EPROM program and high-speed clock. The clocking is done automatically by the player as he plays the game. Latches are used to hold data in memory, with the latches controlled by the clocked logic, rather than a CPU.

A variety of decoders are used to change the output from decade counters into a BCD code to illuminate the proper LED dice spots. In a computerized circuit, that would be done with a pre-programmed EPROM. The circuit is an example of what can be done using standard chips as opposed to a specialized computer circuit.



How It Works

A schematic diagram of Computerized Casino Craps is shown in Fig. 1. Although the circuit uses 18 chips, it is not overly complicated or hard to understand if it is taken one step at a time.

A new game is initiated by pushing the reset button, which causes a positive voltage to be applied to pin 15 of U8 (a 4017 decade counter/divider), causing outputs 1 to 9 to go low, while the zero output (pin 3) goes high. That high is applied to U7a at pin 15 (reset). The reset signal (from S2) is also applied to pin 7 of U7b and pin 3 of U7c, causing their outputs to go low. For now, we can say that when the reset button is pressed, all the outputs of U7 go low.

A hex Schmitt trigger, U1, is configured as two square-wave oscillators (U1a/U1b and U1f/U1e), whose frequencies, are determined by C3/R29 and C4/R36, respectively. The series/parallel combination of R34/D3 and R29 connected across U1a causes a positive voltage to be applied to pin 1, inhibiting the oscillator. The combination of R35/D8 connected to pin 13 of U1f performs the same function on the other oscillator.

The outputs of the oscillators (U1a/U1b and U1e/U1f) are fed to the clock input of the decade counters, U3 and U4, respectively. When ROLL (a single-pole, double-throw push-button) switch S1 is momentarily depressed, C2 charges to the supply rail and then slowly discharges through R37. That decaying voltage is applied to pin 5 of U1c and pin 9 U1d, forcing their outputs low, which reverse-biases D5 and D6. That allows C3 and C4 to discharge though U1a and U1f, respectively, enabling the two oscillators.

The oscillators continue to cycle, as the charge on C2 decays. When the charge on C2 reaches 50% of the supply voltage, the outputs of U1c and U1d abruptly go high, forward-biasing D5 and D6, stopping the oscillators. The use of two separate gates enhances the random-number factor because they shut off at different times (due to varying internal characteristics of the gate).

The outputs of U1c and U1d are applied to U2a (¼ of a 4081 2-input AND gate) causing its output to go high. That high is, in turn, fed to the set input of U7d (¼ of a 4043 quad, tri-state NOR R/S latch) at pin 12. The output of U7d is applied to the clock input of U8 at pin 14, causing it to advance one count.

When S1, ROLL—a single-pole, double-throw pushbutton switch—is depressed, a positive voltage is applied to pin 11 of U7d and to pin 5 of U1c and pin 9 of U1d, resetting U7d and stopping the oscillators. On the next roll, U7d again sets and U8 is advanced to count 2, at which time it is disabled until reset again by pressing S2.

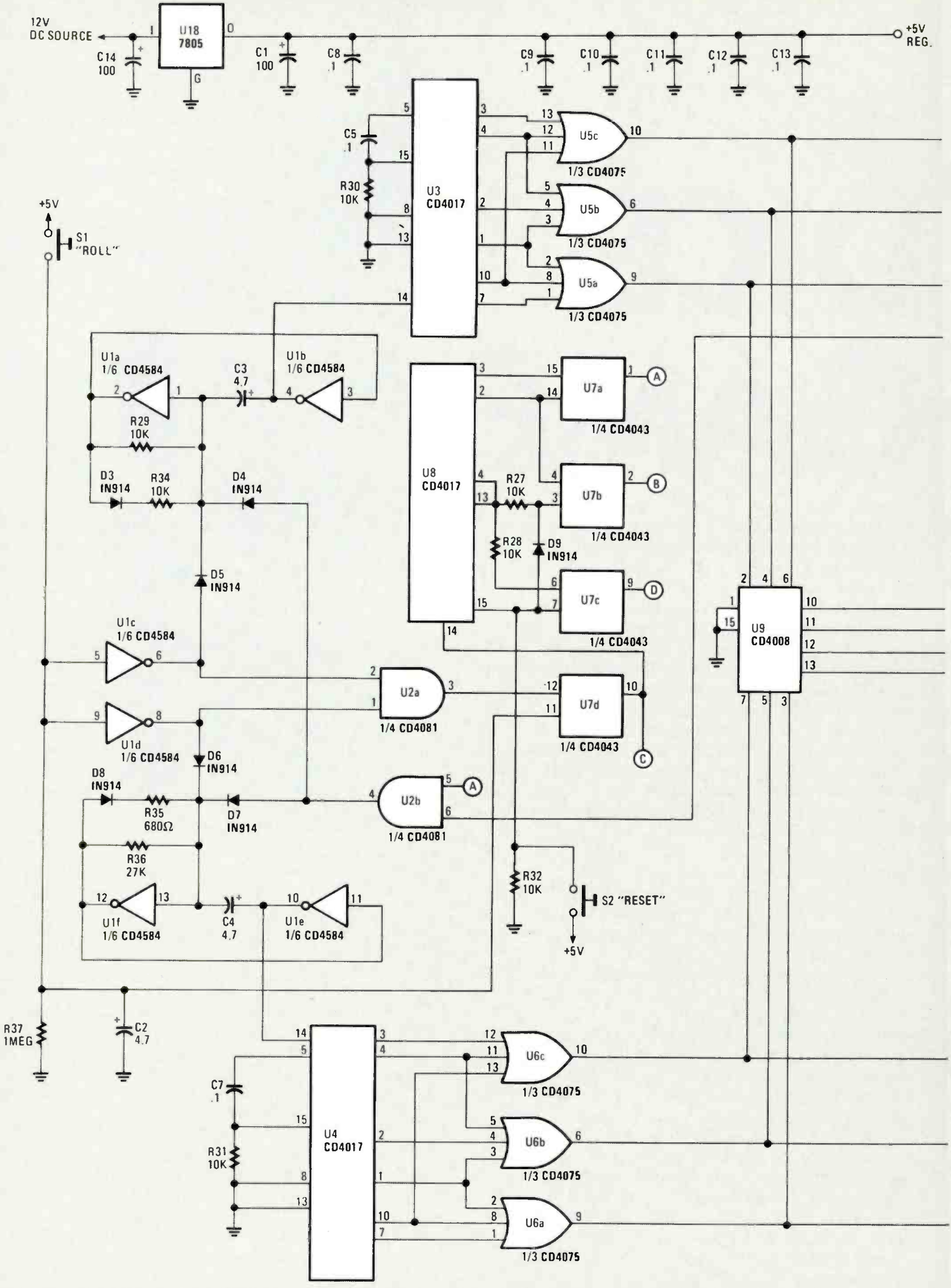
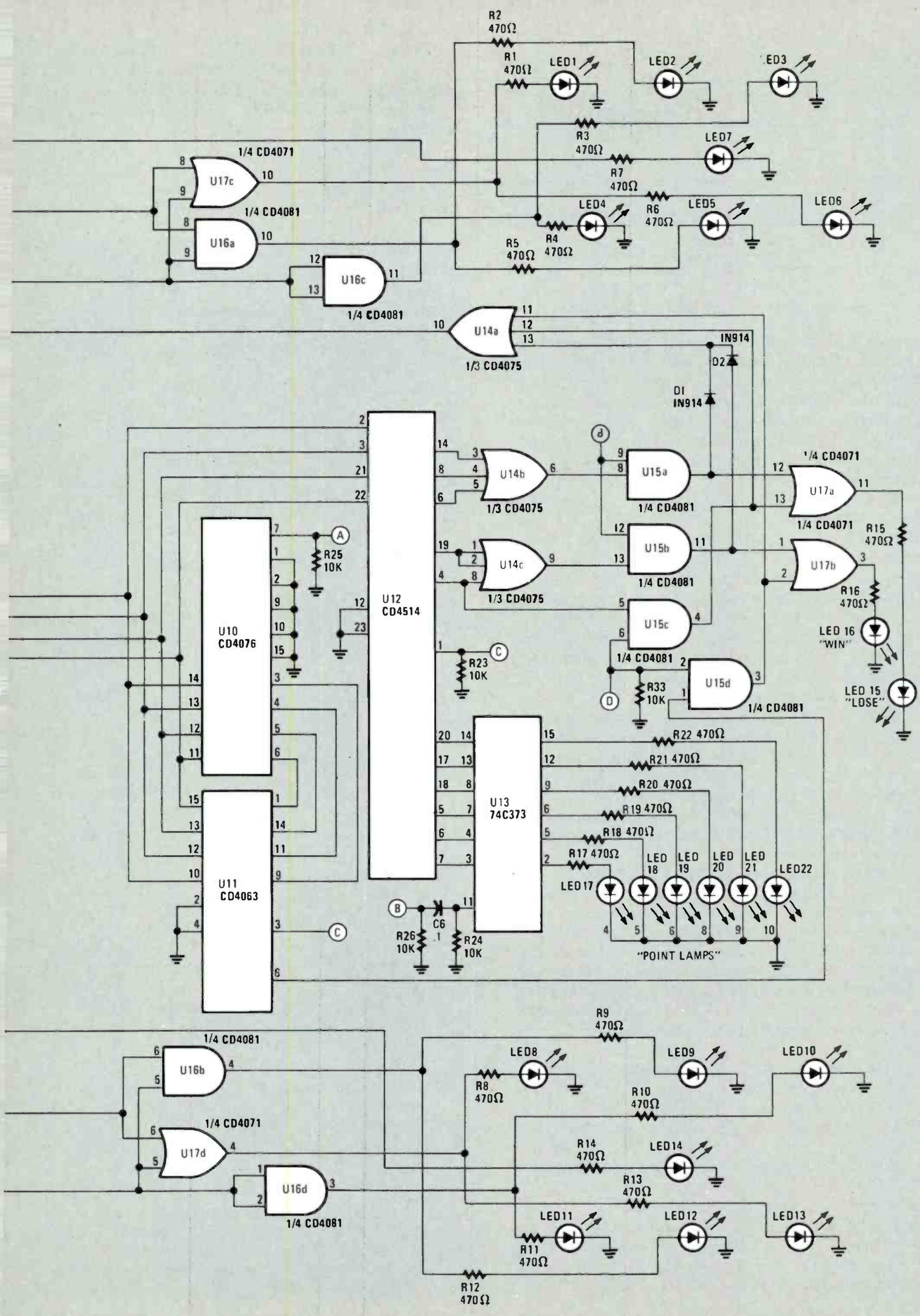


Fig. 1—A schematic diagram of our computerized dice game is shown here. A new game is initiated by pushing S2, resetting the circuit, causing outputs 1 to 9 to go low, while the zero output (pin 3) goes high. The hex Schmitt trigger, U1, is configured as two square-wave oscillators, the outputs of which are fed to the clock input of U3 and U4.



R2 470Ω
R1 470Ω
LED1
LED2
LED3
R3 470Ω
LED7
R7 470Ω
R6 470Ω
LED4
LED5
LED6
R5 470Ω
R4 470Ω
1/4 CD4071
U17c
1/4 CD4081
U16a
U16c
1/4 CD4081
U14a
1/3 CD4075
IN914
D2
D1
IN914
U12
CD4514
U14b
1/3 CD4075
U14c
1/3 CD4075
U15a
1/4 CD4081
U15b
1/4 CD4081
U15c
1/4 CD4081
U15d
1/4 CD4081
R33 10K
1/4 CD4071
U17a
1/4 CD4071
U17b
R15 470Ω
R16 470Ω
LED 16 "WIN"
LED 15 "LOSE"
U10
CD4076
R25 10K
R23 10K
U11
CD4063
U13
74C373
R22 470Ω
R21 470Ω
R20 470Ω
R19 470Ω
R18 470Ω
R17 470Ω
LED17
LED 18
LED 19
LED 20
LED 21
LED22
"POINT LAMPS"
C6 .1
R26 10K
R24 10K
1/4 CD4081
U16b
R9 470Ω
LED8
LED9
LED10
R8 470Ω
R10 470Ω
1/4 CD4071
U17d
R14 470Ω
LED14
R13 470Ω
U16d
1/4 CD4081
LED11
LED12
LED13
R11 470Ω
R12 470Ω

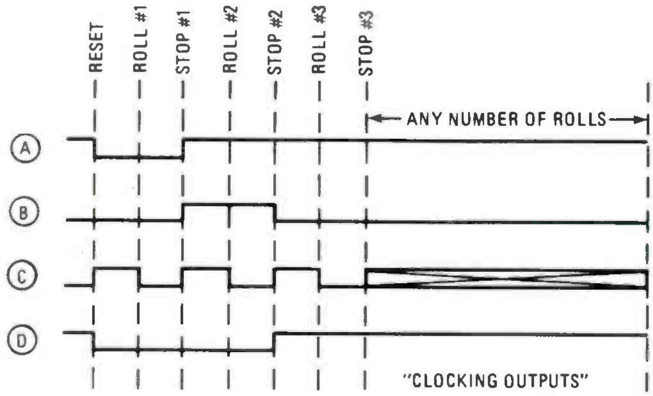


Fig. 2—Shown here are the various latch outputs of U7.

The two counts are fed into latches U7a, U7b, and U7c as the decoded output of U8. Recall that all of their outputs were initially set to zero at the start of the game. The outputs of those latches are used throughout the circuit to switch gates on and off as the game progresses. Figure 2 shows the various latch outputs of U7 for clarification, the operation of which becomes easier to understand as the circuits using those signals are analyzed.

More Counting

Integrated circuits U3 and U4 (4017 decade counter/dividers) were chosen over BCD counters because they can be programmed to read a repetitious count of 1 to 6 without a zero status. By using the outputs 0 to 5 and using output 6 to reset the counter, we have our one to six counter with no zero. The triple three-input OR gates, U5 and U6, decode and change the decade outputs of U3 and U4 to BCD outputs for the two dice-display circuits, consisting of LED1 to LED7 and LED8 to LED14, respectively.

The BCD outputs of U3 and U4 are fed to the A and B inputs of U9 (a 4008 four-bit full adder). Since we have no counts over 6 from either die, two inputs (pin 1 and pin 15 of U9) of the adder were grounded. The outputs of U9 is the BCD total count for both dies. That count is fed to U10 (a 4076 tri-state D-type flip-flop). Referring to Fig. 2, U10 is clocked once at the end of the first number input and puts the point number into memory.

After storing that number in memory, the number is isolated (within U10) from the changing numbers on the input of the latch. The number in memory is also applied to a set of inputs of the magnitude comparator, U11. If, on a succeeding roll, the identical BCD number is rolled (matching the number in memory), a positive output is produced at pin 6 of U11. During the dice roll, a control signal applied to pin 3 (the clock input at point C) inhibits U11. That keeps the comparator from picking up a number match while the dice are rolling.

Once the dice have stabilized, if the number in memory equals the number rolled, the output of U11 at pin 6 goes high. That high is applied to pin 1 of U15d (¼ 4081 quad two-input AND gate), which is toggled by the clocked logic *only* after the second number is displayed. Gate U15d keeps the circuit from displaying a "win" on the first roll. The output signal of U15d at pin 3 is used to turn on LED16, the "WIN" lamp when a match occurs after the first roll.

The various numbers rolled are also applied (in BCD) to the 4-bit latched/4-to-16 line decoder, U12, and are accepted by U12 only when a positive gate (from U7d) is applied to pin 1. That occurs at the end of each roll (see Fig. 2).

The S2, S3, and S12 outputs (at pins 10, 8, and 14), are fed to U14b at pins 3, 4, and 5, respectively. The S7 and S11 outputs of U12 at pins 4 and 19 (respectively) are fed to U14c. Those two outputs are fed to the "WIN" and LOSE lamps through AND gates U15a and U15b.

Referring to the waveforms of Fig. 2, it can be seen that those gates are turned off after the first roll. That action lets you win (if you roll 7 or 11) or lose (if you roll a 2, 3, 12,) on the first roll. One leg of gate U15c (pin 5) is tied to the pin 4

PARTS LIST
FOR THE COMPUTERIZED CASINO DICE GAME

SEMICONDUCTORS

D1–D9—1N914 (or equivalent) small signal diodes
LED1–LED22—Jumbo light-emitting diode (any color)
U1—CD4584 hex Schmitt-trigger inverting buffer, integrated circuit
U2, U15, U16—CD4081 quad AND gate, integrated circuit
U3, U4, U8—CD4017 decade counter/divider, integrated circuit
U5, U6, U14, U17—CD4071 quad OR gate, integrated circuit
U7—CD4043 quad R/S flip-flop, integrated circuit
U9—CD4008 4-bit full adder, integrated circuit
U10—CD4076 quad tri-state D-type flipflop, integrated circuit
U11—CD4063 4-bit magnitude comparator, integrated circuit
U12—CD4514 1 of 16 decoder, integrated circuit
U13—74C373 Octal latch, integrated circuit
U18—7805 5-volt, 1-A voltage regulator, integrated circuit

RESISTORS

(All resistors are ¼-watt units unless otherwise noted.)
R1–R22—470-ohm
R23–R33—10,000-ohm
R34, R35—680-ohm
R36—27,000-ohm
R37—1-Megohm

CAPACITORS

C1—100-µF, 16-WVDC electrolytic
C2–C4—4.7-µF, 16-WVDC electrolytic
C5–C13—0.1-µF, ceramic disc
C14—100-µF, 25-WVDC electrolytic

ADDITIONAL PARTS AND MATERIALS

Printed-circuit or perfboard materials, enclosure, IC sockets, Wall-type power supply (#DC1210), wire, solder, hardware, etc.

NOTE: All integrated circuits are available from Jameco Electronics, 1355 Shoreway Rd., Belmont, CA 94002, (415) 592-8097; Digi-Key Corp. PO Box 677, Thief River Falls, MN 56701, (800) 344-4539.

S1 and S2 (Panasonic #EVQ-PAR11K) are available from Digi-Key Corp. PO Box 677, Thief River Falls, MN 56701, (800) 344-4539.

12-volt wall-type power supply (#DC1210)—Jameco Electronics, 1355 Shoreway Rd., Belmont, CA 94002, (415) 592-8097.

Double-sided PC board with drilled and plated-through holes $22.50;Red plastic front panel, drilled and silk screened $10.00, plus $2.00 *each* shipping and handling—Electronic Enterprises, 3305, Pestana Way, Livermore, CA 94550.

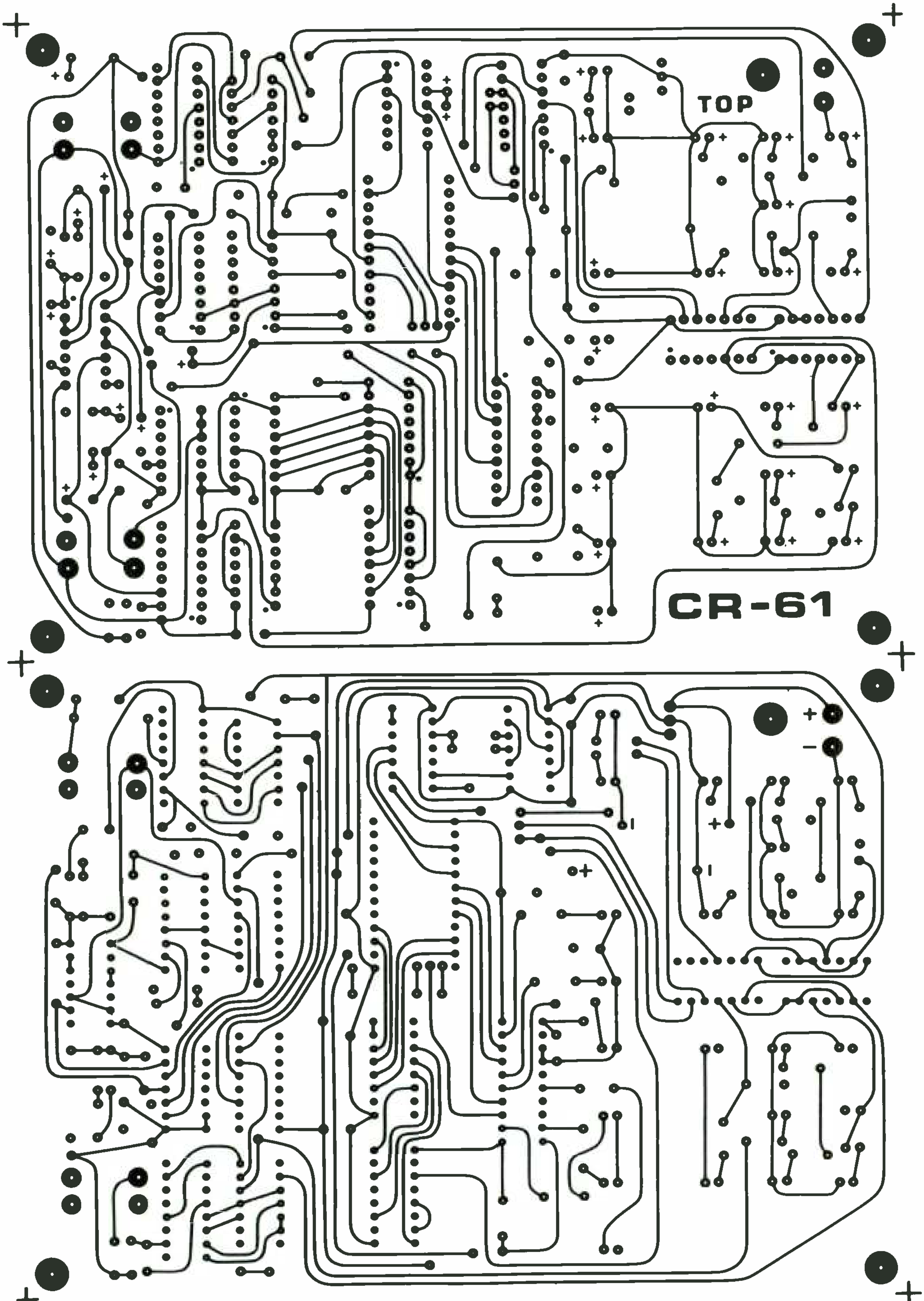


Fig. 3—The author's prototype was built on a double-sided, printed-circuit board—a supplier of which is given in the Parts List. The upper pattern shown here is the component side of the board, and the lower one is the copper side of the board.

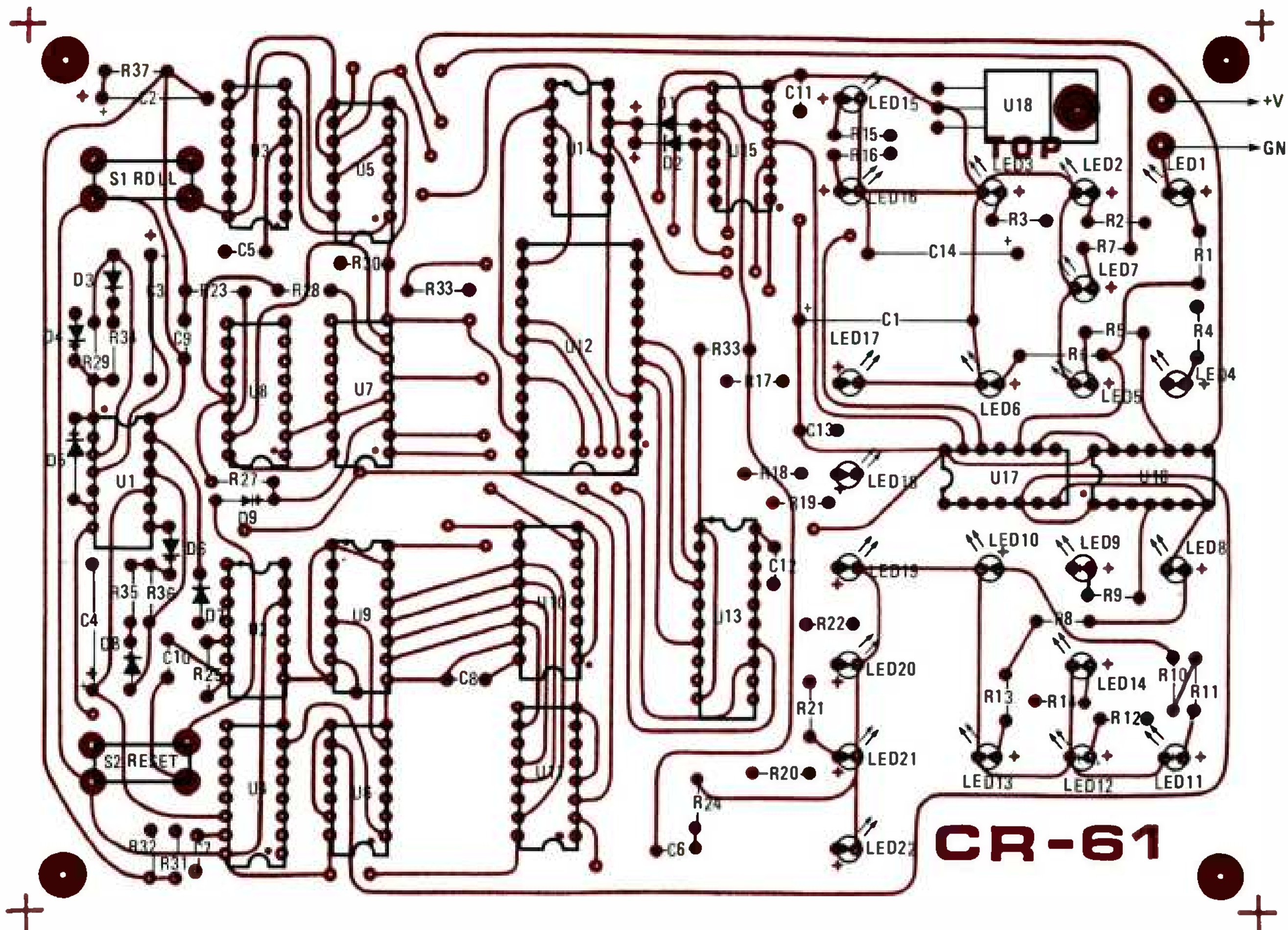


Fig. 4—Once you've obtained the board and collected all the parts shown in the Parts List, begin construction following this guide. Note: the CD4584 hex Schmitt trigger, U1, can be replaced by the MC14584 or the CD40106, should you have difficulty in obtaining the unit specified.

output of U12. As shown in Fig.2, the other input of U15c is enabled by the clock after the second roll. If seven is rolled after the first roll, LED15 comes on, indicating that you've lost.

The "point" numbers are also decoded by U12 and appear on the inputs of U13. A pulse from U7b (at the end of the first roll) latches the point number presented to U13. The "point" number is displayed on one of the LED's representing the point (4, 5, 6, 8, 9, or 10). The number is held in display until the game is reset and a new point is rolled.

Anytime a first roll win or loss is recorded, or craps is rolled, the output of U14a at pin 10 is fed to pin 6 of U2b. The other leg of U2b goes positive only after the first roll (refer to Fig. 2,) and stays positive until reset. The output of U2b feeds a positive signal through D4 and D7, disabling the oscillators. The dice can not be rolled again until the game is reset.

As pointed out earlier, be careful that you stop shooting when you make your point and the WIN lamp comes on, or you could lose even after making your point.

The outputs of U5 and U6 is converted by U16a/U16c/U17c and U17d/U16b/U16d (respectively) to a code that causes the proper LEDs to light when the output of the gate tied to its anode goes high.

The total current drain for the game is about 150-mA maximum with all spots lit on each dice. A 5-volt regulator, U18, is used to regulate the supply voltage from a plug-in wall-type power supply. Use at least a 500-mA supply. The source voltage is filtered by C14 prior to being input to U18 (a 7805 5-volt, 1-A regulator). The regulator output is filtered by C1 and *de-glitched* by bypass capacitors C5 through C13.

Putting It Together

The author built the prototype of Computerized Craps on a double-sided, printed-circuit board (see photos)—a supplier of which is given in the Parts List. But for those of you who like to roll your own, a foil pattern for the printed-circuit board is shown in Fig. 3 (the upper one being the component side of the board and the lower the foil side of the board). Once you've obtained the board and collected all the parts shown in the Parts List, begin construction.

Place and solder the components on the board, beginning with the passive components, guided by the part-placement diagram shown in Fig. 4. Note: The CD4584 hex Schmitt trigger, U1, can be replaced by the MC14584 or the CD40106 should you have difficulty in obtaining the unit specified.

Once the board is fully populated and you are satisfied that the circuit contains no defects, apply power and press S2 to reset the game. Then press S1 to "roll" the dice. The circuit cycles, LEDs flashing, finally coming to a stop at some random number, which is displayed by the dice. If the

(Continued on page 96)

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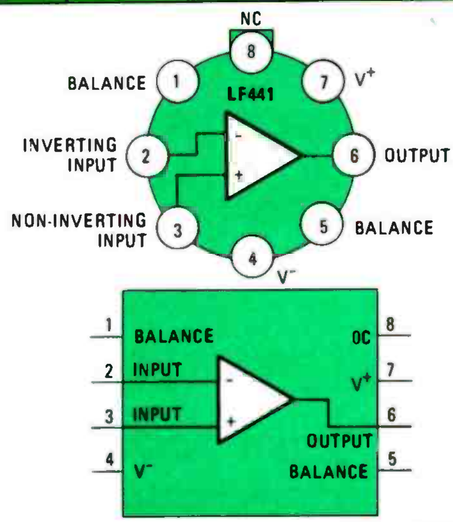
79 Hands-on Electronics FactCard — LF441: Low Power JFET Op-Amp



FEATURES

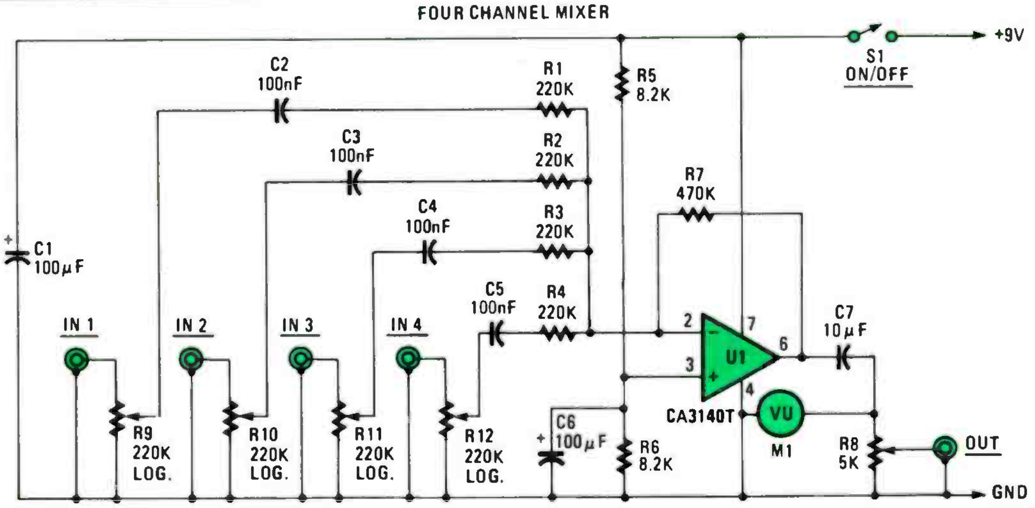
■ 1/10 supply current of a LM741	200 μA (max)
■ Low input bias current	50 pA (max)
■ Low input offset voltage	0.5 mV (max)
■ Low input offset voltage drift	10 μV/°C (max)
■ High gain bandwidth	1 MHz
■ High slew rate	1 V/μs
■ Low noise voltage for low power	35 nV/√Hz
■ Low input noise current	0.01 pA/√Hz
■ High input impedance	$10^{12}\Omega$
■ High gain $V_O = \pm 10V$, $R_L = 10k$	50k (min)

ABSOLUTE MAXIMUM RATINGS

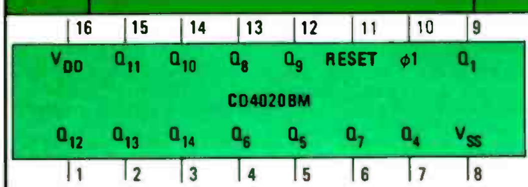
	LF441A	LF441
Supply Voltage	±22V	±18V
Differential Input Voltage	±38V	±30V
Input Voltage Range (Note 1)	±19V	±15V
Outut Short Circuit Duration	Continuous	Continuous
Power Dissipation	670 mW	500 mW
T_j max	150°C	115°C
θjA	150°C/W	160°C/W

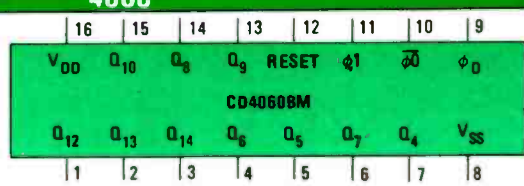
80 Hands-on Electronics FactCard — Op-Amp Circuits

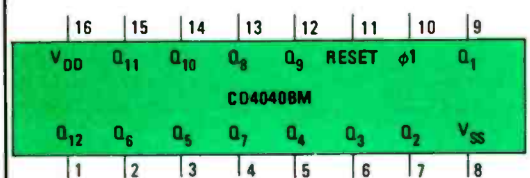
FOUR CHANNEL MIXER



81 Hands-on Electronics FactCard — 4020, 4040, 4060: Ripple Carry Binary Counter







FEATURES

■ Wide supply voltage range	1.0V to 15V
■ High noise immunity	$0.45V_{DD}$ (typ.)
■ Low power TTL compatibility	fan out of 2 driving 74L or 1 driving 74LS
■ Medium speed operation	8MHz typ. at $V_{DD} = 10V$
■ Schmitt trigger clock input	

ABSOLUTE MAXIMUM RATINGS

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

RECOMMENDED OPERATING CONDITIONS

V_{DD} Supply Voltage	+3V to +15V
V_{IN} Input Voltage	0V to V_{DD}
T_A Operating Temperature Range	
CD40XXBM	−55°C to +125°C
CD40XXBC	−40°C to +85°C

79 Hands-on Electronics FactCard — LF441: Low Power JFET Op-Amp

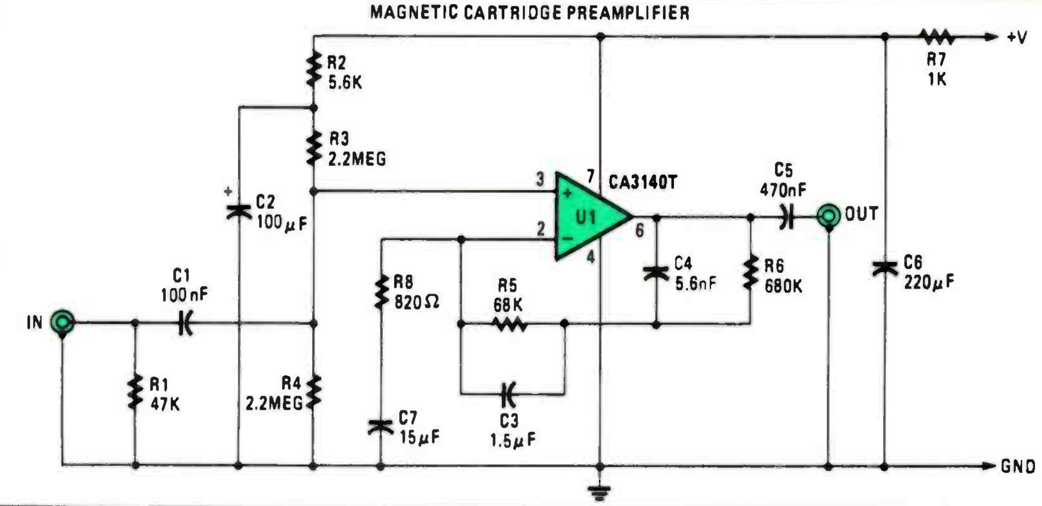
DC ELECTRICAL CHARACTERISTICS

Characteristic	Conditions	LF441A Typ	LF441 Typ	Units
Input Offset Voltage V_{OS}	$R_S = 10\ k\Omega$, $T_A = 25°C$	0.3	1	mV
	Over Temperature			mV
Average TC of Input Offset Voltage $\Delta V_{OS}/\Delta T$	$R_S = 10k\Omega$	7	10	μV/°C
Input Offset Current I_{OS}	$V_S = \pm 15V$			
	$T_j = 25°C$	5	5	pA
	$T_j = 70°C$			nA
	$T_j = 125°C$			nA
Input Bias Current I_B	$V_S = \pm 15V$			
	$T_j = 25°C$	10	10	pA
	$T_j = 70°C$			nA
	$T_j = 125°C$			nA

Characteristic	Conditions	LF441A Typ	LF441 Typ	Units
Large Signal Voltage Gain A_{VOL}	$V_S = \pm 15V$, $V_O = \pm 10V$, $R_L = 10\ K\Omega$, $T_A = 25°C$	100	100	V/mV
	Over Temperature			V/mV
Output Voltage Swing V_O	$V_S = \pm 15V$, $R_L = 10\ k\Omega$	±13	±13	V
Input Common-Mode Voltage Range V_{CM}		+18	+14	V
		−17	−12	V
Common-Mode Rejection Ratio CMRR	$R_S \leq 10\ k\Omega$	100	95	dB
Supply Voltage Rejection Ratio PSRR		100	90	dB

80 Hands-on Electronics FactCard — Op-Amp Circuits

MAGNETIC CARTRIDGE PREAMPLIFIER



81 Hands-on Electronics FactCard — 4020, 4040, 4060 - Ripple Carry Binary Counter

STATIC ELECTRICAL CHARACTERISTICS

CHARACTERISTIC	CONDITIONS V_O (V)	V_{IN} (V)	V_{DD} (V)	LIMITS at 25°C (Typ.)	UNITS
Quiescent Device Current, I_{DD} Max.	—	0,5	5	0.04	μA
	—	0,10	10	0.04	
	—	0,15	15	0.04	
	—	0,20	20	0.08	
Output Low (Sink) Current I_{OL} Min.	0.4	0,5	5	1	mA
	0.5	0,10	10	2.6	
	1.5	0,15	15	6.8	
Output High (Source) Current, I_{OH} Min.	4.6	0,5	5	−1	
	2.5	0,5	5	−3.2	
	9.5	0,10	10	−2.6	
	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)	LIMITS at 25°C (Typ.)	UNITS
Output Voltage: Low-Level, V_{OL} Max.	—	0,5	5	0	V
	—	0,10	10	0	
	—	0,15	15	0	
Output Voltage: High-Level, V_{OH} Min.	—	0,5	5	5	
	—	0,10	10	10	
	—	0,15	15	15	
Input Low Voltage, V_{IL} Max.	0.5,4.5	—	5	—	V
	1,9	—	10	—	
	1.5,13.5	—	15	—	
Input High Voltage, V_{IH} Min.	0.5,4.5	—	5	—	
	1,9	—	10	—	
	1.5,13.5	—	15	—	

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50 YEARS OF CAR ANTENNAS

With the recent changes in music reproduction, almost everyone today is into high-tech car audio. What most don't realize is that the car antenna has been changing all along, too

By Edward Janicki

THE EVOLUTION AND DEVELOPMENT OF THE AUTOmobile radio antenna is perhaps one of the most neglected success stories in the automotive industry. Born in the twilight of the last century, it evolved from a simple wire wrapped around a tree branch, to the modern antenna.

In those pioneering days, the United States public was having a love affair with both the automobile and radio broadcasts, so it was no surprise that their marriage did not take long to arrive. Unfortunately, only a few of the technicians that experimented with car radios had any formal engineering degrees or training. Bold men who had been lured to radio while in their teens, they were basically tinkerers who developed their skills by the "cut and try" method. It is a tribute to their ingenuity that some of their achievements are being rediscovered today, proving that many "new" ideas are only as new as the people who conceive them.

The following reviews the evolution of the car antenna from the mid-1930's to the current day.

The Basics

The car-radio antenna and its lead-in cable are the only links between the shielded receiver and the radio broadcast station signals. Early on, it became apparent that the efficiency of the car-radio antenna did not depend on its length, and special attention had to be given to a multitude of critical factors, including impedance matching, stray capacity, wire shielding, and location on the vehicle.

At first, antennas were placed on the roof, such as a "clothesline" or "chicken wire," or on the fender or windows. Due to their impracticality, in time they were replaced by various types of under-car antennas, among them: the running-board dipole, metal plate, double and inverted "V," triangle, and the "Flexo-O-Strip." The last one was introduced by Delco Radio in 1935 and is shown in Fig. 1. Those types of undercar antennas disappeared due to their difficult installation and susceptibility to mud, snow, and flying stones.

An attempt was made by the Ford Motor Company in 1933 to use the spare-wheel carrier and the spare wheel as an antenna, but difficulties in insulating the wheel carrier from the rest of the car, led to an early demise of that system (see Fig. 2).

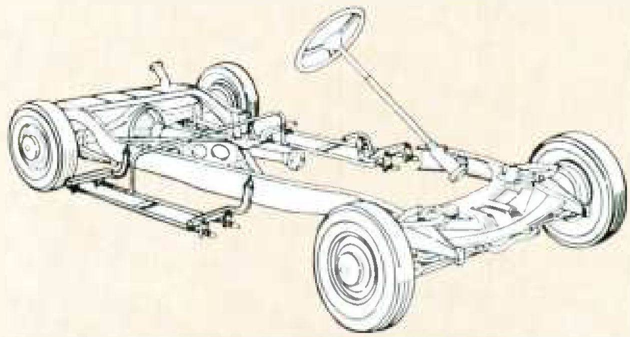


Fig. 1—Undercar antennas such as the one shown, disappeared due to their difficult installation and susceptibility to mud, snow, and flying stones.

It was obvious, well into the 1903s, that the ultimate car-antenna system had yet to be found. The lack of such a car-

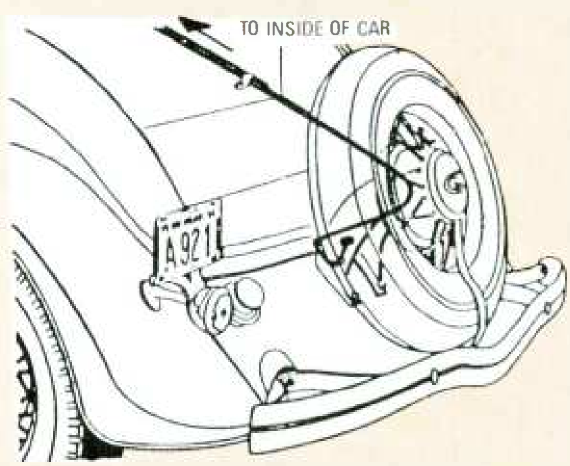


Fig. 2—The Ford Motor Company tried to use the spare wheel carrier and the spare wheel as an antenna, but difficulties in insulating the wheel carrier from the rest of the car, led to an early demise of that system.

antenna system presented a dual challenge, both to the engineer, who had to find a suitable solution to the all-steel top automobile, and to the antenna manufacturer, who wanted to make his system the industry standard.

Since it was a well-established fact that the received signal strength increased with the height of the antenna above the ground, the emphasis of antenna installation shifted back to the roof of the car.

Car-Top Antenna

Necessity being the mother of invention, a new device was introduced for the 1937 model year in the United States: the car-top antenna, ideally suited for Turret-Top automobiles. Consisting of a ⅜" copper tube running down the middle of the roof, no drilling was necessary to install it, and the car body was not marred in any way.

According to the June 1936 issue of *Radio Craft* magazine, "the antenna can be removed at any time, since it is fastened in place with rubber suction cups, which, when applied according to directions, will hold firmly and indefinitely. Rain and ice will not affect the operation of the antenna, and the capacity between antenna and car top is usually low."

The antenna was sold in kit form, containing all necessary materials such as the copper tubing itself, special suction cups, insulators, connectors, and shielded lead-in wire (see Fig. 3).

In reality, the car-top antenna was typically no more than a running-board dipole mounted on the roof (as in Fig. 4).

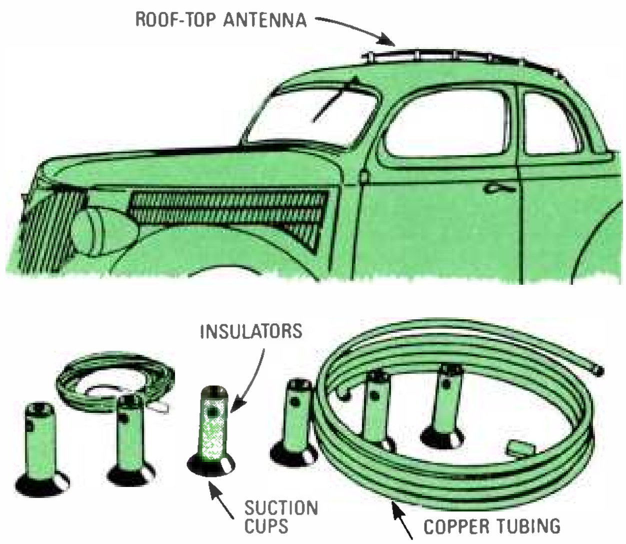


Fig. 3—Consisting of a copper tube running down the middle of the roof, no drilling was necessary to install the car-top antenna, and the car body was not at all marred.

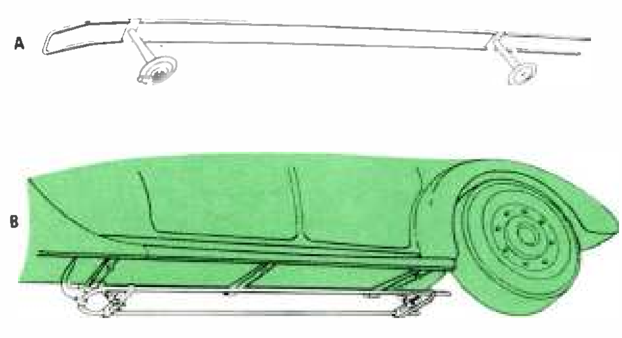


Fig. 4—The car-top antenna (A) was typically no more than a running-board dipole (B) mounted on the roof instead.

Manufactured in the United States by Snyder and Philco under the names "Topper" and "Hi-Way" respectively, and by Bosch in Germany (shown in Fig. 5), the car-top aerial was the forerunner of the rod antenna.

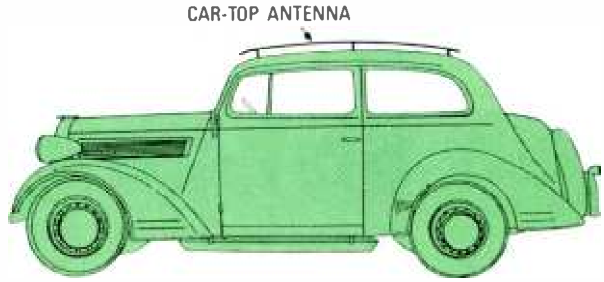


Fig. 5—Manufactured by Snyder and Philco under the names "Topper" and "Hi-Way," and by Bosch in Germany, the car-top aerial was the forerunner of the rod antenna.

Rod Antenna

The first mobile rod antenna on record was manufactured by Telefunken for the Phoenix Tire Co. bus in July 1926. With a length of 4 ft. and mounted on the roof of the bus, it was said to "offer sound up to eighty miles from a station—even further with headphones."

In 1934 Phillips offered in Europe an aerial reputed to be the first rod antenna "designed solely for car use." Across the Atlantic, however, Philco was merrily offering another "first" that same year: a telescopic rod antenna.

Whatever the case might be as to which company was the first to come up with a rod antenna, it was clear that by the end of the 1930's the rod antenna—also known as "whip," "buggy whip" or "fish-pole"—was rapidly becoming the workhorse of the car-radio industry.

Figure 6 shows a reproduction of part of a 1939 advertisement by Studebaker picturing a retractable cowl-mounted whip in its collapsed position (its full length reached 43" and was adjustable from the driver's seat), while Fig. 7 shows several European versions of that same year as advertised by Telefunken.

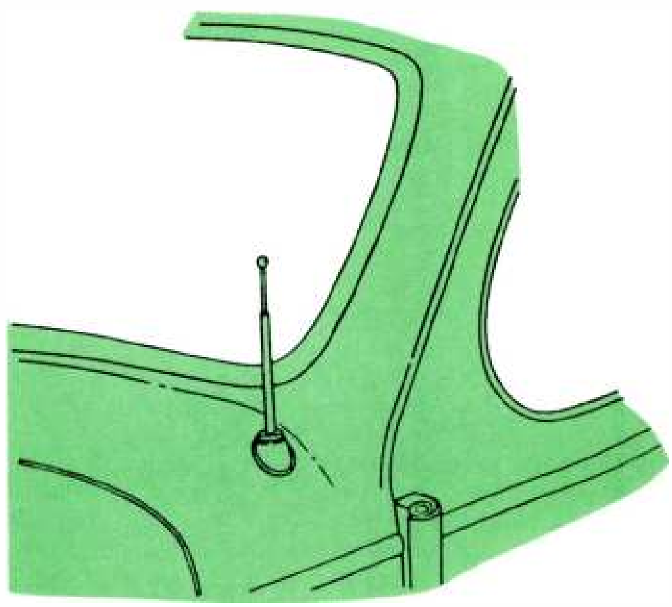


Fig. 6—Here's a reproduction of part of a 1939 advertisement by Studebaker, picturing a retractable, cowl-mounted whip in its collapsed position.

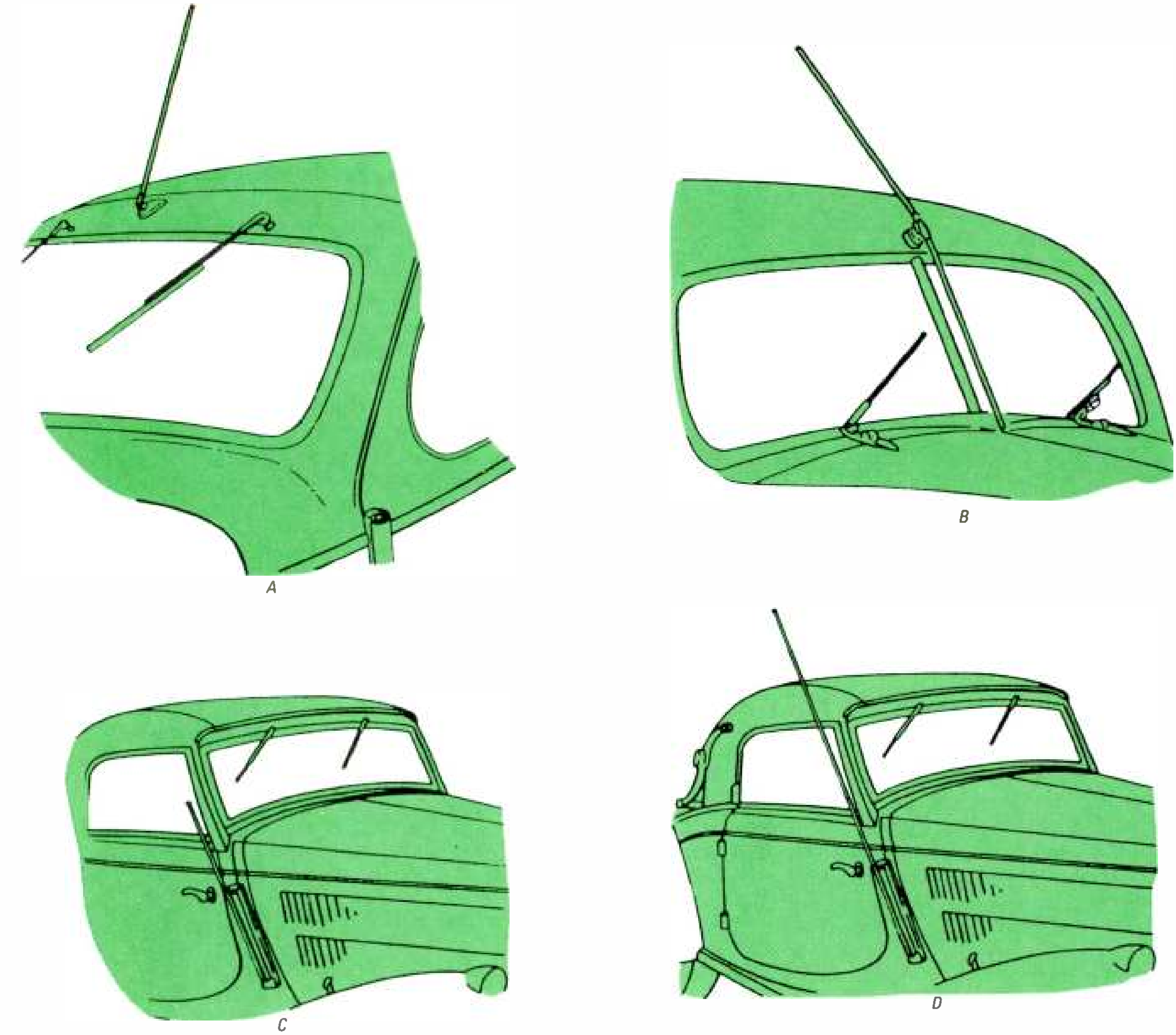


Fig. 7—Here we show three European versions of 1939 retractable antennas from Telefunken. The tiltable-rod (controled from inside) is shown in A, the flip antenna in B, while C and D show a three-section rod antenna in its collapsed and fully extended positions, respectively.

Jumping on the Wagon

Buick and Cadillac quickly joined the parade, and soon came up with vacuum-operated antennas as an option. Average lengths available varied from 25" to 96", the latter generally sold in three sections, and it was recommended that they should be coated with a thin layer of light oil to extend their useful life.

The most successful of the new rod antennas were the rotatable aerial mounted above the windshield and controlled from inside the car by a knob which could flip a spring loaded rod up or down (used by Buick and Ford in 1937 as shown in Fig. 8), and the side-cowl antenna that was supported on the side cowl by two stanchions.

Soon, most of the car manufacturers were equipping some or their models with the whip antenna. In 1940, Philco and Zenith supplied Ford with car radios that had the antenna rod coming straight through the roof and plugged into the top of the receiver, as in Fig. 9). By pushing up on a plastic sleeve, the telescopic rod could be operated from the front seat.

As claimed by a 1937 advertisement from Snyder, Inc., the rod antenna became available in "every conceivable style" (see the opening of this article). Antennas were mounted on the fender; at the rear of the car, mechanically attached to one end of the rear bumper; under hood mounts; on the front

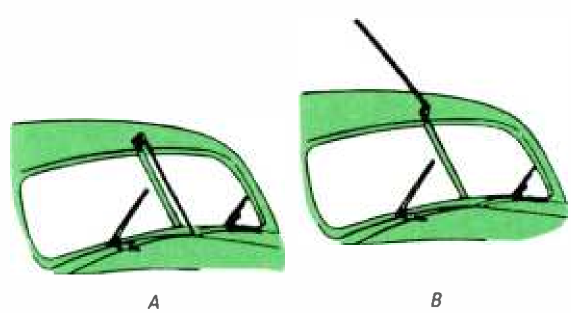


Fig. 8—Here is a rotatable aerial which was mounted above the windshield and controlled from inside the car by a knob which could flip a spring loaded rod down (A) or up (B).

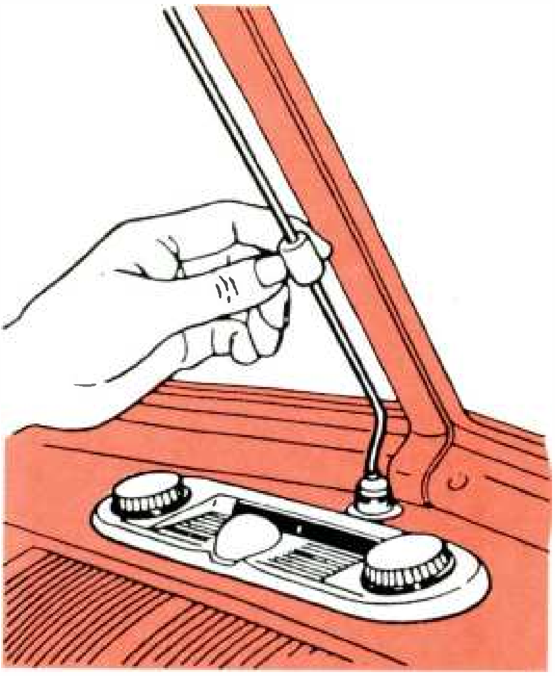


Fig. 9— In 1940, Philco and Zenith supplied Ford with car radios that had the antenna rod coming straight through the roof and plugged into the top of the receiver.

bumper, known as the "straight protector;" in front of the grille; even on the hinge pin of a car door.

Some rod-type antennas defy description, such as the Insuline "Vidi-Tenna" which looked—and was advertised—as a miniature television antenna. Or the 1937 "Clipper" by the Galvin Manufacturing Corporation, which was a combination of roof and rod antenna, and which was, according to the December 1937 issue of *Radio News*, "styled in the modern manner to match the stream-lined automobile" It's shown in Fig. 10.

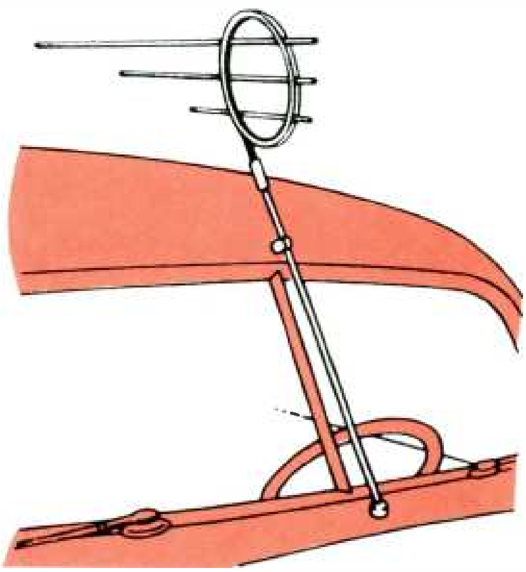


Fig. 10—This is the "Clipper" antenna which was a combination of roof and rod antenna, and was styled to match the steam-lined automobiles of the time.

In 1950, Insuline came up with the "Tenna-Beam," a 24", two-section, rod aerial with a pilot light built into the base to offer "additional antenna protection," with a "special light-transmitting jacket" that carried the light completely up the antenna shaft (Figure 11). In addition, the aerial had two red discs on the top that glowed brightly in the day-time.

Windshield Antenna

The rod antenna met the requirements of in-car reception quite successfully, but then, with the introduction of the windshield antenna in the 1969 Pontiac Grand Prix, the car-radio industry completed one of its many full circles.

Joseph M. Callahan, former engineering editor of *Automotive News*, reported in 1968 that "auto engineers have been trying to get rid of the outside radio antennas in cars for 40 years, but it remained for the innovation-minded engineers at Pontiac to successfully accomplish this on the 1969 Grand Prix. On this car, the antenna will consist of two pieces of wire thousandths of an inch in diameter that will be sandwiched between two layers of laminated glass in the windshield. The slightly-visible copper wire will run up the center of the windshield and across the top toward the A-pillars, forming a half-wave dipole."

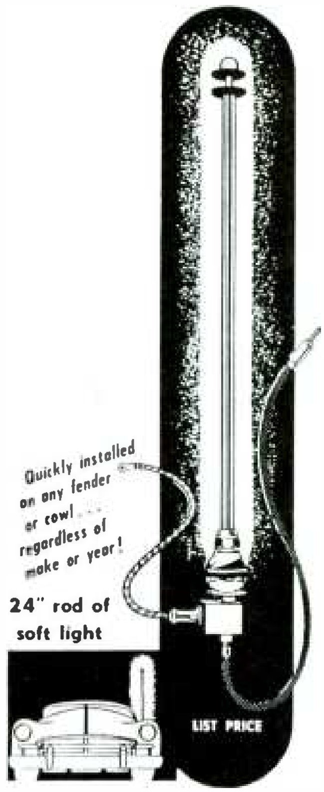


Fig. 11—In 1950, out came the "Tenna-Beam," a 24", two-section, rod aerial with a pilot light built into the base. The jacket carried light up the antenna shaft.

Besides its better reliability, the windshield antenna had two major advantages over the telescopic rod: it reduced the clutter outside the car and was always "extended" full-length for optimum radio reception. Its major disadvantage, as compared to a fully-extended 56" or 32" whip, was a 16 dB loss in AM sensitivity.

Making it Better

Ken Jensen, an electrical development engineer at General Motors, was credited with the idea of bringing the thin wires up the middle of the windshield which, by reducing stray capacitance, improved AM reception to some degree over the original proposal of running the wires up near the pillars.

While at first there was some concern that wires in the windshield would reduce visibility. Pontiac management bought the concept and the windshield antenna was introduced in production shortly afterwards.

Ford Motor Company followed suit with the introduction of the windshield antenna in the 1970 Thunderbird. While the antenna itself was, for all practical purposes, identical to the one used in the Grand Prix, Ford's approach to the AM sensitivity problem was not the same: there was to be little, if any, compromise in the overall performance of the radio system.

Since the Thunderbird windshield antenna had the identical 16 dB loss as compared to the 56" whip, the task was to improve the sensitivity of the radio by the same amount, if at all possible.

After many trials and tribulations—which included adding an extra buffer stage in the RF amplifier, higher impedance antenna and RF coils, and increased number of turns on the secondary coupling—the radio AM sensitivity, when used in conjunction with a windshield antenna, became essentially comparable to the original whip-antenna system.

Active Antennas

Experiments with "active" or "integrated" antennas began in the mid-1960s both in the United States and Europe, but active antennas did not become commercially available until the early 1970s.

The basic concept of the active antenna is quite simple. It is a well-known fact that, independent of the polarization of the broadcast signal, the car body distorts the electromagnetic field and creates vertical and horizontal components. The vehicle's body acts as the rod antenna ground plane, and effectively becomes part of the antenna system. The upper part of the vertical rod antenna, however, extends to an area of the electromagnetic field where it provides very little to the total received power. Since the rod antenna is not effective in its upper part, it would be ideal, for esthetic as well as practical reasons (garage doors, car washes), to shorten the overall length of a rod antenna.

Unfortunately, as the overall length of a rod antenna is directly proportional to the available signal to the receiver in the AM band, and should not be shortened too much to avoid impedance mismatches in the FM band, short, passive-rod antenna systems are not viable. A short-rod antenna associated with an amplifier overcomes that problem (see Fig. 12).

Several active-antenna systems are available today which are especially designed to produce a better signal-to-noise ratio than passive antennas such as the whip. Such active antennas have separate amplifiers for AM and FM, and despite their short length of about 16" (40 cm), they typically give higher outputs than 36" whips. Their main drawback is overload at high input levels.

Heated Backlite Antenna

A system which combines the advantages of windshield and active antennas is known as heated backlite antenna, or HBA for short. Designed by B.S.H. Electronics of Swinton, Manchester, England, this new vandal-proof antenna system went on sale on September 30, 1983, in Ford's Orion. It was the first high-volume production car in Europe with an antenna in its rear-window heating element, eliminating the need for a conventional rod antenna (see Fig. 13).

Basically, the HBA is a long-wire design capable of receiving a broad frequency spectrum. It consists of the back window heater elements suitably designed to allow connection to an amplifier module mounted in the car's rear vertical pillar. The module is in turn connected, via coaxial cable, to the RF stage of the radio receiver.

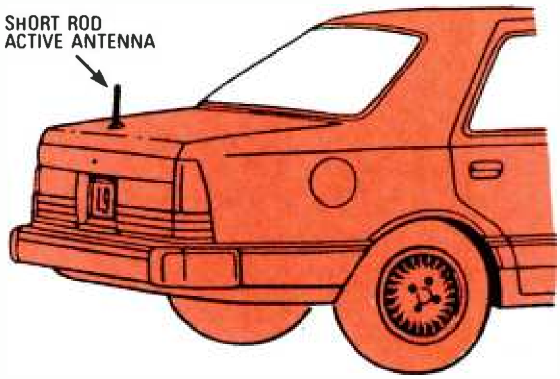


Fig. 12—As the overall length of a rod antenna is directly proportional to the AM signal they can provide to the receiver, and since an antenna should not be shortened too much lest impedance mismatches in the FM band creep up, short, passive-rod antenna systems are not viable. But active systems such as that shown here are very good.

Fig. 13—The HBA is a long-wire design capable of receiving a broad frequency range. It consists of the back-window heater elements designed to allow connection to an amplifier module mounted in a vertical pillar.

The back-window heater pattern has a specific design for its new dual purpose role, optimized for use as a radio receiving antenna. The main difference over current designs is the use of a single-ended, power, feed arrangement that is required to provide the shortest possible connection leads between the isolated assembly module (the "amplifier") and the heater busbars on the backlite glass. That is an essential condition for predictable antenna performance.

Besides improved styling, the performance of the HBA is comparable to the rod antenna. Its major disadvantage is the higher system cost as compared to the whip, which is more than compensated for by its consistent performance.

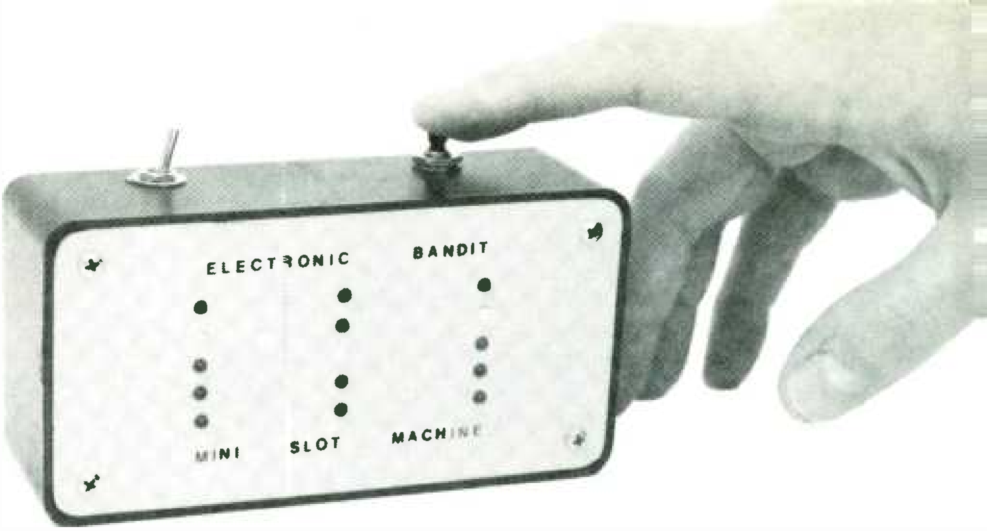
It Goes On

As should be clear by now, automobile antennas have been used in every conceivable place in the car.

Engineers were faced with a system in a constant state of change. Year to year they were forced to abandon relatively new antenna systems, made obsolete by dramatic vehicle-configuration changes and not by poor performance.

While few new systems appear to be available in the near future, there has been some serious developmental work on the slot antenna which will be mounted as a plastic insert in the roof of the vehicle. Initial performance data has been excellent. The system also has the potential to make the antenna an integral part of the vehicle construction and, once and for all, rid the automobile of its added appendage. ■

All the fun and excitement that Reno, Las Vegas, or Atlantic City have to offer without fore-going the comforts of home



BUILD THE *ELECTRONIC* BANDIT

By Daniel P. Ray

ANYONE WHO HAS EVER PLAYED A SLOT MACHINE, more affectionately known as a *one-armed bandit*, is familiar with the excitement of trying to hit that elusive "jackpot." Unfortunately, they also know how expensive it is to play, since the odds of winning aren't all that great.

But take heart! With a little electronic prestidigitation, you can put together the *Electronic Bandit*—an electronic slot machine that provides all the thrills of the real thing at a fraction of the cost.

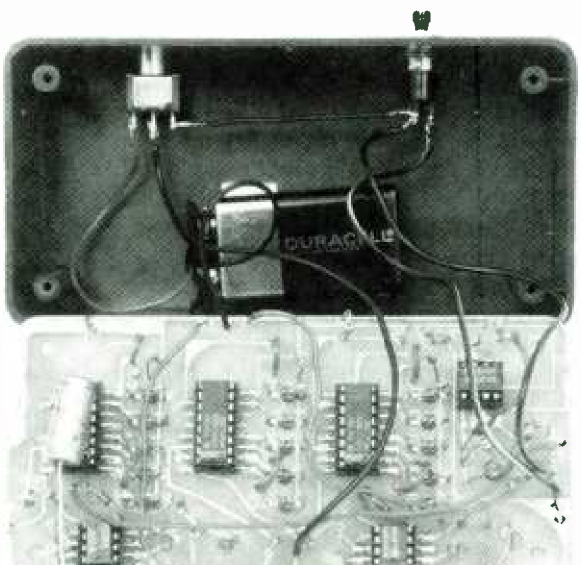
How It Works

Figure 1 shows the Electronic Bandit's schematic diagram. As shown, each of three vertical rows of LEDs is triggered by a similar circuit. In the first row, U1 (the first of three 555 oscillator/timers) is wired to create a stream of pulses, the frequency of which is determined by R1 and C1. Pressing S2 triggers the pulses, and at the same time causes C4 to charge through a voltage-divider network, consisting of resistors R3 and R4.

When S2 is released, U1 continues to oscillate (outputting a stream of pulses) until C4 has discharged through R4, pulling pin 4 of U1 low, thereby resetting the oscillator. The output of U1 is fed through R5 to the clock input of U2 (a 4017 decade counter/divider). The counter is wired to count until the last of five LEDs lights, at which time it recycles. The result is that when S2 is momentarily pressed, the LEDs glow in sequence, creating a "rolling" effect. Finally the rolling effect stops, leaving one random LED lit.

Resistor R6 keeps the input of U2 from floating after U1 stops sending pulses. That operation is the same for the other two rows of LEDs except that row two stops rolling after row one, and row three stops rolling after row two, because of the values of C4, C5, and C6. The three diodes D1, D2, and D3 are necessary to keep C4, C5, and C6 isolated from each other.

An interesting feature of the circuit is that the 4017B counter can be programmed to count to any number between two and ten, thereby allowing the builder to change the odds by adding or subtracting LEDs from each vertical row. (See Table 1 for details.) The circuit shown contains five LEDs per row and makes for a nice, compact, handheld project that's lots of fun to build and use.



The author's prototype of the Electronic Bandit is shown here, prior to being placed in its enclosure. Note the bending of the pins to allow surface mounting.

Assembly

The author's prototype of the Electronic Bandit (see photos) was built on a printed-circuit board and the whole thing was enclosed in a 5¹⁄₁₆ × 2⅝ × 1⅝-inch project box (Radio Shack part #270-233). But instead of drilling componenting-mounting holes in the printed-circuit board, the author chose to use the PC board as a cover, with the components surface mounted on the copper-trace side.

Once you've obtained all of the components, including the enclosure specified in the Parts List, the next thing to do is to cut a copper-clad PC board to fit in place of the cover. When that's done, the next task is to etch the circuit board. Figure 2 shows the PC-board etching pattern used by the author in the production of his prototype.

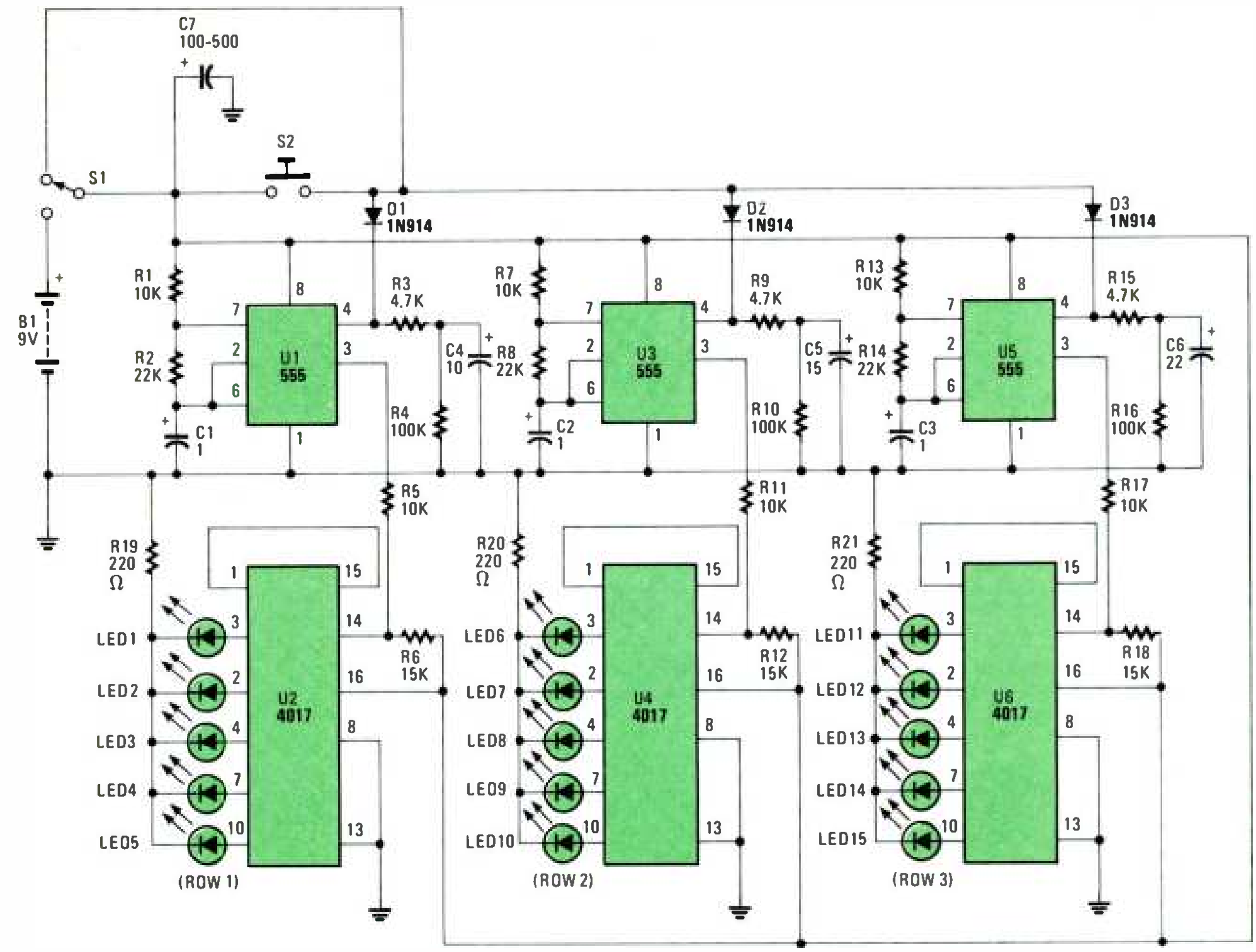


Fig. 1—Shown here is the Electronic Bandit's schematic diagram. As shown each of three vertical rows of LEDs is triggered by a similar circuit.

Fig. 2—Shown here is the PC-board etching pattern used by the author in the production of his prototype. The pattern may be lifted from the page, transferred to a copper-clad slug, and etched to reproduce the board.

That pattern may be lifted from the page (using the method with which you are most familiar), transferred to a copper-clad slug and etched to reproduce the board. Note: For those of you who are unfamiliar with duplicating PCBs, a simple method for the transfer of printed-circuit patterns to copper-clad slugs—entitled *One Shot PC Boards*, by Peter A. Lovelock—was presented in the December, 1987 issue of this publication.

After etching the board, drill the four mounting holes (see Fig. 2), the holes for the LEDs, and then round the corners for a perfect fit. Also drill two holes in one side of the enclosure for S1 and S2. The switches should be located about ½ to ⅝ of an inch from the bottom of the case, so that the switches won't interfere with the other components when the cover is in place.

The foils should be pre-tinned wherever a component will

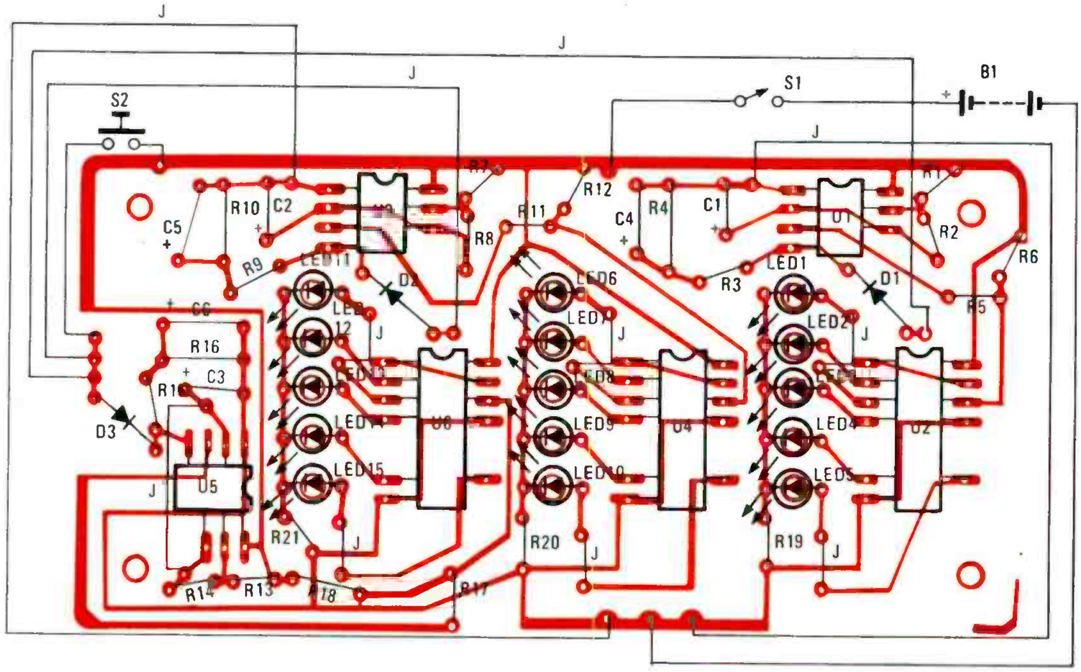


Fig. 3—The author's prototype of the Electronic Bandit was built on a printed-circuit board, with the components surface mounted on the copper-trace side. Shown here are the locations of the components.

PARTS LIST FOR THE ELECTRONIC BANDIT

SEMICONDUCTORS
D1–D3—1N914 small signal silicon diode
LED1–LED15—Jumbo light-emitting diode
U1, U3, U5—555 oscillator/timer, integrated circuit
U2, U4, U6—4017 decade counter/divider, integrated circuit

RESISTORS
(All resistors are ¼-watt, 5% units unless otherwise noted.)
R1, R5, R7, R11, R13, R17—10,000-ohm
R2, R8, R14—22,000-ohm
R3, R9, R15—4700-ohm
R4, R10, R16—100,000-ohm
R6, R12, R18—15,000-ohm
R19–R21—220-ohm

CAPACITORS
C1–C3—1-µF, 16-WVDC electrolytic
C4—10-µF, 16-WVDC electrolytic capacitor
C5—15-µF, 16-WVDC electrolytic
C6—22-µF, 16-WVDC electrolytic

ADDITIONAL PARTS AND MATERIALS
B1—9-volt transistor-radio battery
S1—Single-pole single-throw toggle switch
S2—Single-pole single-throw momentary-contact pushbutton switch
Printed circuit or perfboard materials, enclosure, IC sockets, battery and battery holder, wire, solder, hardware, etc.

be soldered. That makes mounting the components a whole lot easier when the time comes. The components need to be altered (leads bent to fit space) for surface mounting. Their leads should be pre-tinned also. (A complete description of the surface-mounting technique is given in an article by Herb Friedman called "SMT Darkroom Spotmeter" in **Hands-on Electronics**, January, 1988.)

It's best to solder the LEDs first, then the other components and then last of all the IC sockets. Use tweezers to hold the parts in place while soldering. The tweezers, aside from making the components easier to handle in those tight spaces, also acts as a heatsink, preventing component damage and scorched fingers during soldering. Make sure you observe the correct polarity when soldering the LEDs, capacitors, and diodes!

Since the two switches are not mounted on the board, you'll have to leave them hanging, along with the battery snap, until you are ready to put the cover of the bandit in place. Make the leads long enough so that you can mount the switches before you close up. With the components all soldered in place, connect a 9-volt battery, providing some means of holding it in the box. (I used two squares of double-sided foam tape in the prototype.) Mount the two switches, put the ICs in their sockets, then flip the board over and install the four mounting screws.

Flip the power switch and then press S2 momentarily. All three rows of LEDs should roll and then stop sequentially. Press S2 to play again. If there is any problem with the operation, it can likely be traced to one of the following: 1) incorrect polarity of component(s) and/or power supply 2) accidental solder bridge(s) on the circuit board 3) missing jumper wire(s) 4) faulty IC(s).

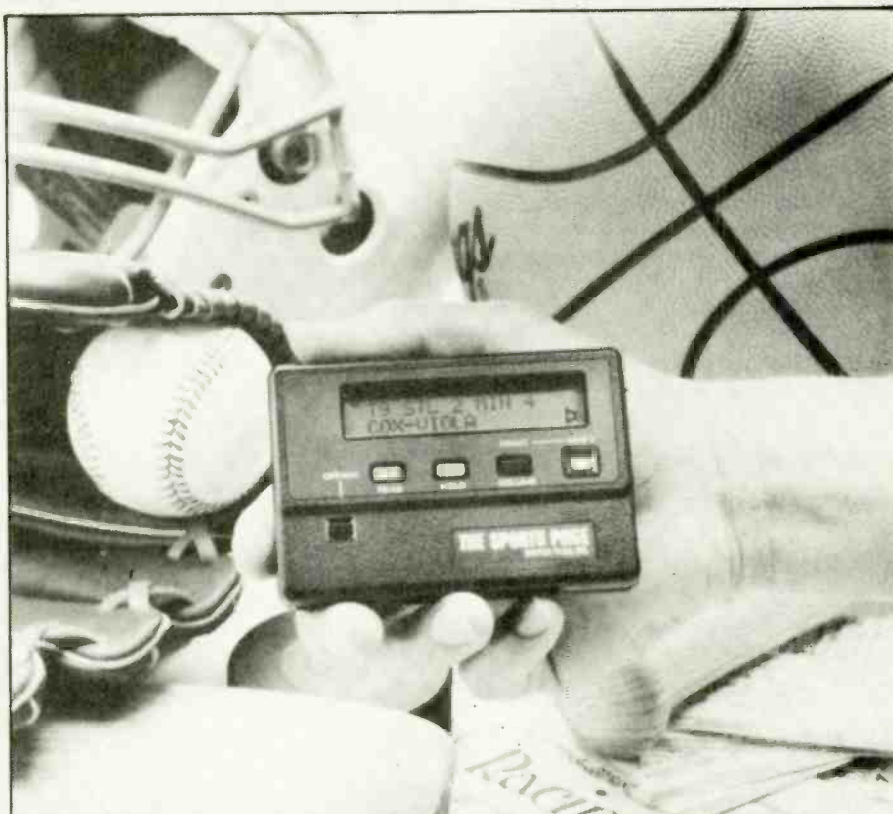
Playing It

In order to be a winner, you must end up with the same LED lit in each of the three rows, forming a horizontal row of lights. If you wish, the horizontal rows can be marked with different values to indicate different levels of winning. For example: Rows 1 and 5, 3 to 1 payoff; rows 2 and 4, 5 to 1 payoff, and row 3, 10 to 1 payoff

Even though there's no real monetary payoff, its still gratifying to know you've beaten the bandit at its own game. Try it...You'll like it! ■

GIZMO

AUGUST 1988 | ELECTRONICS FOR THE MIND & BODY | VOLUME 1, NUMBER 6



CIRCLE 50 ON FREE INFORMATION CARD

Bettor Living

THE SPORTS PAGE. Manufactured by: Beeper Plus, Inc., 3900 Paradise, Suite 110, Las Vegas, NV 89109. Price: $360 (plus monthly charge).

Sports mania is an obsession perhaps unlike any other. It's impossible to tell a non-believer why the latest update of an early-season baseball game being played on the other side of the continent is information of paramount importance to a sports fanatic.

Unless, of course, you tell them your interest is fiduciary.

The latest development in sports-information monitoring, *The Sports Page*, is offered by a company called *Beeper Plus*. It's a pocket-size beeper outfitted with a custom chip that acesses multiple channels of sports information simultaneously.

The Sports Page day starts off slowly with scratches from local racetracks, a run-down of major-league schedules, latest Las Vegas odds, injury reports, and even relevant weather conditions. Information is displayed on an easy-to-read 32-character dot-matrix screen. The screen offers the disclaimer that sports information supplied is for news purposes only, but the unit is obviously designed with the gambler in mind.

As the day progresses, information starts coming fast and furious. Race results, complete with starting times and payoffs (a must for bar-room bookmakers who want to protect themselves from past-posting) are on the beeper within 20 minutes. Running scores are tallied for games in progress (a particularly useful feature during the early rounds of the NCAA basketball playoffs.) Final scores are available on another channel.

Games in progress are updated every five minutes. After a recent New York Rangers hockey game, The Sports Page was flashing the results on the line even as we were leaving Madison Square Garden.

"The Sports Page is a major technological breakthrough," Beeper Plus maintains. "Increasingly people aren't going to have to go to the source to find answers they need. The source is going to have to come to them."

The unit is designed as the initial product in a line of information systems that the Las Vegas-based company plans to offer. Scores and results taken from three national sports newswires are collected in the company's computer then sent via satellite to local paging services around the country, which in turn feed information to customers via the pager, a modified four-ounce Motorola PMR 2000 alpha-numeric paging device. As a result, The Sports Page can do double duty as a standard paging beeper and as a receiver for Beeper Plus's sports-information service.

The unit has a 1,984 character memory, which means, "each unit can store as many as 80 games at a time." Turning it off, however, dumps the information stored in the unit.

The Sports Page works only in cities and locations with the necessary paging networks—Las Vegas, Southern California, Boston, Chicago, Dallas, Houston, New York, San Francisco, Miami, Atlantic City, and Michigan. Due to be serviced shortly are Atlanta, Baltimore/Washington D.C., Alabama, Denver, New Orleans, Cincinnati, Minneapolis/St. Paul, Memphis, and Hawaii.

On a ski trip to Vermont, a visit to Saratoga Springs, a business trip to Austin, or hundreds of other locations, the thing is useless. In locations with the service, coverage range varies from 30 to 150 miles.

Besides the initial cost of the pager and a recharging unit, Sports Page subscribers pay a service charge ranging from $45 to $75 per month, depending on location. The system's designers claim that charge makes The Sports Page a bargain compared to the cost of using one of the phone-in services that provide sports and race results. That's debatable, perhaps, but for the sports nut to whom money is no object, it's certainly a convenient and even compelling service.

A number of celebrities have picked up on Sports Page already—Jimmy the Greek, pop singer Rod Stewart, and New York Mets pitcher Rick Aguilera, who bought one of the units for his mother so she could keep up with his exploits.

The system is not without its drawbacks. The 20-minute wait for race results is too long if you've got a bet going. After making our customary payday office daily-double wager through New York's legal Off Track Betting service, we found out just how long 20 minutes can be. So even with The Sports Page, we quickly ran out of patience and still had to call the result line to find out if we had won (we didn't, a

(Continued on page 6)

CIRCLE 51 ON FREE INFORMATION CARD

The Bread Also Rises

BREAD BAKERY AUTOMATIC BREAD MAKER (SD-BT2P). Manufactured by: Panasonic Co., One Panasonic Way, Secaucus, NJ 07094. Price: $329.

Bread didn't become a widely ingested foodstuff in Japan until about 30 years ago. But the ancient occidental staple proved to be widely popular and today Japanese consumers buy the same variety of loaves as their counterparts in the west. As proof of its popularity, there's the ingenious automatic bread maker marketed in this country (after its successful introduction in Japan) as the *Bread Bakery*.

A little bigger than the proverbial breadbox, the device has received widespread publicity and provoked the predictable culinary controversy. One well-known food writer passed severe judgment on the *Panasonic* product, stating that the loaves it produces aren't worth the effort it takes to make them.

GIZMO, after using the Bread Bakery for a couple of weeks, has to wonder what effort the food journalist was referring to. As kitchen gadgets go, that item is the soul of simplicity. Ingredients are measured into a container, a few buttons are pushed, and, after a minimum of four hours, out comes the staff of life.

The container, measuring cup, and spoon are included with the Bread Bakery, so it's possible to make a loaf of bread with just the specified ingredients and the device itself. What the Bread Bakery does is the tedious work involved in bread-making: mixing and kneading the dough. That leaves only the measuring, waiting, and eating to its human operator.

Measuring 13 inches high, 14 inches wide and 9 inches deep, the Bread Bakery is a box with a hinged lid. At the right on the front is a control panel. Inside, on the left is what might be called the "baking chamber." It's a metal-lined compartment into which the unit's bread pan fits snugly.

On the floor of the compartment is a shaft that fits into the bread pan's bottom-mounted "kneading blade," a component that mixes and kneads the dough. Since neatness counts, the rig also includes a cord storage compartment (the directions say the unit should not be left plugged in when not in use) and inside the lid, a small compartment for storing the measuring cup and spoon.

The Bread Bakery's operating instructions include a recipe for "basic loaf bread." The specified ingredients, except for dry yeast, are measured into the bread pan and the pan is slipped into the baking compartment. The top is closed and latched, and the yeast is measured into a dispenser mounted on the lid above the baking chamber.

At that point the user goes to the control panel, setting it for BREAD (a second DOUGH setting is for recipes that the unit mixes and kneads but does not bake). The Bread Bakery offers two baking time options. Pushing a START button will bring forth a loaf of bread in four hours. Using the timer, the unit can be set to produce bread at any time within 13 hours of setting its timer. With the Panasonic Bread Bakery the user can time-shift the loaf.

The control panel includes stop and restart buttons, and its display shows what the machine is doing (KNEAD, REST, RISE and BAKE). Other signal lights indicate TIMER (the display counts down to the preset time), OPERATION and, COMPLETE. Eight electronic beeps signal the completion of a loaf. Clean-up is nearly as automatic as producing bread. The interior of the baking pan and its kneading blade should be wiped free of crumbs and the sides of the baking compartment should also be kept clean. In addition, there's a crumb tray, which fits at the bottom of the compartment, that can be removed and emptied.

The finished product is a bit smaller than a commercial loaf of bread, and resembles a cartoon representation of a loaf, taller than it is long. Anyone who has seen contemporary Japanese cartooning will recognize the style. The unit can also bake a smaller loaf using half the ingredient amounts specified in the basic loaf recipe.

A recipe book furnished with the Panasonic Bread Bakery presents what are essentially variations on the basic loaf theme, with further ingredients or the substitution of other liquids for the water specified in the original list. There are also recipes to be used with the DOUGH setting. Those are for bread shapes and styles that don't conform to the unit's dimensions, like rolls or doughnuts, or for ones that require further preparation.

We imagine that the near-foolproof bread factory for the home takes some of its cues from commercial baking equipment. As a consumer-market entry, it takes its inspirations from all those frozen, unbaked bread loaves sold in supermarkets, catering to the widespread hankering for bread that's warm from the oven.

Our first attempt at using the Bread Bakery was a total failure. In our eagerness, we didn't properly set the unit to BREAD instead of DOUGH. The loaf came out a white, unbaked slab of congealed flour and other ingredients. Which is why we say that the Bread Bakery only near foolproof. Once we followed directions to the letter, the loaves came out with factory-like precision. Which is probably why the Bread Bakery doesn't thrill food writers.

The phrase that best describes the unit's product is a "perfectly acceptable" loaf of bread. It's uniform in the same way as any commercially baked bread. On the other hand, the automatic loaf that's produced isn't likely to satisfy true bread believers. That is, the tribe of home bakers who would stone grind their own wheat (preferably from their own field) if it was feasible.

Attempting to time shift a loaf and then deciding that the selected completion time was too late (we were taking the loaf to a friend's home for taste testing), GIZMO discovered one variation that Panasonic doesn't mention. When we reset the Bread Bakery, it started again from the beginning, meaning the bread was kneaded twice. The result was a chewier, more dense loaf.

As for the taste test, nobody disliked the bread, and the diminutive loaf disappeared quickly. But nobody was passionate about it, either. But, almost everyone expressed interest in the Bread Bakery, and its cost. Price information brought a reaction that was as uniform as the device's output. A little arithmetic will indicate how many loafs of bread at what retail price equals the cost of the bread maker.

In general, this was a thoroughly enjoyable appliance to test. There was something altogether homey about hearing the unit kneading then resting, automatically working away in the GIZMO test kitchen. As the instructions assure users, "a clicking noise [actually more of a clunking] may be heard during operation, but this is not a malfunction." There was the added bonus of bread's delicious aroma faintly rising through the unit's steam vent during the actual baking.

As kitchen items go, this one has "Father's-Day gift" written all over it. Something about the combination of the mechanical and the automatic gives the Panasonic Bread Bakery a masculine character.

Whatever doubts we entertained about the utility of a midget bread factory for the kitchen were overcome by our enjoyment of a clever piece of gadgetry. The results obtained may not be the bread of our forefathers (and mothers), but it's also only slightly more trouble to bake than preparing a container of frozen orange juice. The Panasonic Bread Bakery may not produce the ultimate bread, but half a loaf (especially one prepared automatically) is better than none.

Micro Vision

LCD COLOR TELEVISION (TV-3000). Manufactured by: Casio, Inc., 570 Mt. Pleasant Ave., P.O. Box 7000, Dover, NJ 07801. Price: $399.95.

The average American family watches TV for about seven hours a day. Putting in a full shift in front of the 3.3 inch screen of the *Casio TV-3000* would not be doing your eyes any favors, but nobody claims this tiny set is designed for marathon family viewing. In fact, the six "AA" cell option on the TV's "four-way power system" gave us barely two hours viewing with the fluorescent backlight on. Interestingly, the manual claims 2.5 viewing hours with the backlight in use, 20 hours with it off, adding "the batteries supplied with your TV are test batteries which have a shorter life span than that noted above"(hmmm ...).

Rather it is for the solitary viewer who needs or wants to keep in touch with news,

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sports, or weather reports while away from the home or office, or a parent who wants to keep the kid quiet in the back seat on a long drive. En route, an optional vehicle cigarette lighter adaptor (CA-K90) takes the load off the dry cells.

The 93,720-pixel image has the resolution of a 3-D postcard. Vertical lines in the image can be sharp, but diagonals and horizontals are just slightly fuzzy. Color is good. Skin tones are easy to fine tune using the TINT and COLOR controls on the side of the unit.

One irritation was the transistor radio-like channel indicator. Until the viewer becomes familiar with the dial, he or she never knows for sure where a favorite station is. The scan-and-lock tuning itself, if not its display, is sharp and stable. The transistor-radio feel of the unit is carried through in the TV-3000's vinyl carrying case (supplied).

After a lifetime of watching conventional CRT screens, viewers may notice little discrepancies in the LCD image. Motion is more fluid, less abrupt on the LCD screen. But the main curiosity is the way the mouths of talking heads seem slightly out of sync with the sound. Programs appear to have been dubbed from another language. We began to wonder if the technology was delivering the standard 25-frames-per-second of CRTs, or slightly fewer to compensate for the slower response of the LCD pixels.

It's surprising how fast the viewer adjusts to the limitations of the tiny TV format. After a few minutes, the thin sound emerging from the TV-3000's 1⅞-inch speaker and the ghostly quality of the 3.3-inch image are forgotten and you're just there doing what you do best, watching the tube.

It's a measure of how far LCD television technology has come that it bears comparison with CRT sets, and not just the early versions of the dominant technology.

The illustration on the TV-3000's box pictures the unit with a football game on-screen, indicating that sports fans are indeed an intended market for the product. Football, basketball, soccer, or any other game that uses large-size balls looks fine. Baseball is not as satisfactory on the small screen. The ball disappears even during infield plays. We doubt sports fans will be as confident second-guessing first-base umpires from the evidence presented on the set's screen.

The UHF-VHF rod antenna pulled in most stations adequately. There is an external antenna jack and an optional adaptor (AS-35S) to enhance reception for viewers in weak-reception areas, and a mini-plug connector-equipped car antenna will make for better reception on the road. The instruction manual warns in boldface "You should never, however, attempt to watch television while operating a motor vehicle," and certainly never while you're talking on the cellular phone at the same time.

The four-way power-supply system includes, beside the car adaptor and batteries, an AC adaptor and rechargeable battery packs. With the unit drawing 5.5 watts, running on batteries cells is a sure short cut to bankruptcy.

Another way to save power is to operate with the LCD panel raised. That automatically shuts off the high-luminance fluorescent-material backlight, and allows the screen to be illuminated by reflected ambient light. The backlight is good for over 1500 hours before it has to be replaced.

LCD sets have definitely moved beyond the novelty stage. But what we've got now is a transistor radio with a video component. It will probably be no one's choice for a first set. The technology's payoff will come down the road, perhaps in telecommunications. Electronics firms don't expect to recoup development costs by satisfying upscale consumers who are unable to spend ten minutes out of doors without watching television.

CIRCLE 55 ON FREE INFOPMATION CARD

Silent Partner

TELESCREEN II CALL SCREENING DEVICE (87520). Distributed by: Executive Communications Systems, 2622 Quaker Ridge Pl., Ontario, CA 91761. Price: $225.

Now that electronic communication is universal and instantaneous, the problem is no longer connecting, but disconnecting. That is our impression, anyway, when we survey the myriad of telephone accessories and add-ons designed to insulate the called party from unwanted callers. Answering machines, to take the most common example, nearly always are advertised as including "call screening" capability. Or, to take an uncommon example, there's the *Telescreen II Call Screening Device*.

That device might be an "intelligence community"spin-off, a budget-minded adaptation of some platinum-priced spy tool. What the Telescreen II is designed to accomplish is putting telephone access to its user on a "need to know" basis. Incidental to that function, it also serves as an electronic telephone index, capable of storing 40 ten-digit numbers.

Beyond its function, the "microcomputer telephone filter device with incoming call display"(that's the full moniker that appears on the device) would make a great prop in a sci-fi movie. Its potential, however, is a great deal more practical.

Encoding numbers is done on the unit's numerical keypad, with three additional buttons (used in conjunction with the pound sign) used in entering the numerical data. Each telephone number is assigned a memo number (telephone numbers one through 40). So apart from screening functions, the user can call up a memorized telephone number by using the single- or double-digit memo number.

In use, the unit allows the telephone to which it is connected to accept only calls from numbers entered into the Telescreen II's memory. Callers, in addition to the user's number, must dial an additional four digits to ring through.

The Telescreen II is programmed to accept the final four digits of any of the numbers in its memory as an access code. But that's merely a convention, as the call can come from any phone, as long as the caller knows to punch in the four-digit code, presumably from his or her telephone number.

On the Telescreen end of the call, the unit delays the phone's ring, and then displays the encoded telephone number as the instrument rings. Among other presumed advantages, that allows the Telescreen-shielded user to answer the call knowing who's on the other end.

Calling a Telescreen-equipped phone involves dialing the number, hearing two rings and then quickly dialing the four-digit access code. In GIZMO's brief use of the device, there were several possible outcomes to that sequence. When we attempted to call using an outmoded rotary instrument, ring-through was hit and miss. Sometimes we made it and sometimes not. "Line drop" is the communications industry nomenclature for the most frequent result using the rotary phone. With more modern equipment, contact was unfailingly made.

However, when we turned on the answering half of our phone/answering machine unit, callers did not receive the outgoing message and were instead disconnected. The circuitry in those units apparently defeats the Telescreen II's programming. A telephone-answering device of the non-combo variety supposedly can be used in tandem with the unit.

Clearly, the Telescreen II is not a telephone add-on designed to sweep the mass market (though we wouldn't be surprised if it eventually shows up on one of the cable-TV shopping channels). Instead, it is a rather specific electronic tool for a variety of individual situations. At first, beyond escaping telephone solicitors or maybe bill collectors, the unit might not appear to have many applications.

But consumer imagination being what it is, uses probably abound, legitimate and otherwise. As a way of controlling incoming calls during a specific time period (say during two hours a day a firm devotes to sales reports), the Telescreen could prove useful. As an organizer of incoming calls (with a common code shared by various persons), the unit's LCD display could be used to organize or classify incoming calls for the Telescreen user.

If there's anything more irritating than an electronic product that doesn't work, it's one that seems to work randomly. That callers using rotary-dial phones might not be able to get through to a Telescreen-equipped number seems a limitation to its use. The user of the screening device might select who can call, but wouldn't seem to have much control over what kind of telephone is used by the caller. Security and privacy buffs, however, might find that device to be exactly what they've always wanted. We still think it will eventually turn up on the movie screen as a prop or on the TV screen as a sale item.

CIRCLE 53 ON FREE INFORMATION CARD

CIRCLE 54 ON FREE INFORMATION CARD

Three-D Showdown

NINTENDO ENTERTAINMENT SYSTEM. Manufactured by: Nintendo of America, Inc., P.O. Box 957, Redmond, WA 98052. Price: $99.95. RAD RACER GAME PAK. Manufactured by: Nintendo. Price: $39.95. SEGA SUPER SYSTEM. Manufactured by: Sega Division of Tonka Corp., 6000 Clearwater Dr., Minnetonka, MN 55343. Price: $149. MISSILE DEFENSE 3-D. Manufactured by: Sega. Price: $39.95.

Video games, business reporters and the industry keep telling us, are back. After a spectacular rise and an equally breathtaking fall, the video-game industry has picked itself up and tended to its wounds, and the result is that once again the sales curve is heading upward instead of over the cliff.

Video games hit a peak in 1982-1983, racking up total sales, according to figures supplied by Nintendo of America, Inc., of three billion dollars. By 1985-1986, dollar-sales figures plummeted to $100 million. For 1988, the company, which claims 70 percent of the current market, projects industry-wide sales of $1.9 billion.

Frankly, we missed the video-game mania the first time around. Sure, we were aware of it, but having spent our teen years fascinated by pinball machines, we weren't part of the age group that made video games, in both arcades and at home, their generation's own. This time around, what has caught our attention is the tantalizing phrase "3-D."

Having also grown up in the era of 3-D movies, the idea that video games today have moved that special effect into the home intrigued us. So we set out to test two of the mostly widely publicized 3-D-capable systems. At this point, GIZMO should offer a few disclaimers, given that there are entire magazines devoted to video gaming and that among cartridge partisans, emotions and loyalties are only slightly less extreme than among supporters of major-league sports teams.

Ours was not a comprehensive test in that we didn't play the games non-stop for hours, or in any particularly competitive situations. Instead, we were interested in finding out just how three-dimensional the 3-D video-game experience is.

Very and not much are our respective judgments of the Sega and Nintendo 3-D games, Missile Defense 3-D and Rad Racer. The Sega game has the edge if only by virtue of greater emphasis on three-dimensionalty as a selling point.

In setting up the game systems, we were pleased by one change in the home-video-game technology. Both systems feature automatic RF switches for linking control decks to a TV. Previously, the players had to manually make the shift between TV and game. Now it's done automatically. A small refinement, but it beats turning on the television only to be confronted by the roar of video static, then jumping up to reset the RF switch for television viewing.

Both systems also feature point-and-shoot game guns, Nintendo's Zapper and the Sega Light Phaser. Those add-on accessories allow player interaction with the TV screen and all the aggression satisfaction inherent in a weapons approach to game playing. But only the Sega Missile Defense 3-D cartridge makes us of that accessory in 3-D play. Nintendo Rad Racer, with its road race motif, uses the system's game control pad.

What Sega also has are LCD 3-D glasses, described as "sleek, black wrap-around frames [with] liquid crystal shutters...synchronized in precision timing with the image generated by the 3-D game cartridge." Those appear to be the same sort of rig with which Toshiba outfits its 3-D video camcorder, shown at last January's Consumer Electronics Show.

Actually, the 3-D specs are kind of sleek and not at all uncomfortable to wear, even for extended periods. They're connected to the Sega game console with a wired adapter that fits into the unit's game-card slot.

With glasses in place and our finger wrapped around the trigger of the Light Phaser, we found the three-dimensionality of Missile Defense quite satisfactory. We even found ourselves, once deep into the game, ducking and dodging the missiles heading our way.

Looked at without adaptive eyewear, the screen image projected by Missile Defense appears to pulsate and shudder. Using the same optical principal as the one behind one of the 19th Century's favorite home-entertainment devices, the stereopticon, the Sega glasses "shutters" merge the layered, pulsating image for the viewer. The result is 3-D that's as convincing as any experienced by Vincent Price fans in movie houses throughout the world 25 or so years ago.

Nintendo's version of 3-D suffers in comparison. It uses the traditional low-cost red/blue viewer specs. The instruction booklet for Rad Racer includes a warning that theater of yore never gave their audiences. Nintendo cautions on use of the 3-D peepers, "please limit continuous play to approximately 15 minutes" and "during 3-D play, if you feel your eyes are becoming tired, discontinue play..." Which kind of takes the pleasure out of fond childhood memories of 3-D double features.

In two dimensions, Rad Racer is a heart-pounding, instant-reflex collection of twists and turns over eight different terrains. But its 3-D effects are weak. We've seen 3-D postcards of cut flowers with more animation.

Instead of the image extending toward the player, Nintendo's system gives the background of the screen image a certain dimensionality. It's logical in that the player is driving towards the screen's horizon line, behind the wheel of the Rad Racer. So attention should be focused on the distance as represented on the screen. As logic, it's fine, but as illusion it falls fatally short.

Nintendo deserves recognition for not going the expensive accessory equipment route. Sold separately, Sega's super-duper LCD 3-D specs go for as much as $59.95. The device is delicate enough that instructions include "care and cautionary" directions. Avoid pokes, scrapes, and scratches on the inside of the glasses as well as contact with direct sunlight, high temperatures, or water. Which are also some of the ordinary hazards of childhood play.

Better the kid-vid player should get a free set of cardboard glasses with each 3-D Nintendo game. Still, in our brief examination, Sega is king of the 3-D hill. A decision backed up by a very select group of testers.

A young woman we know is a very active babysitter. She tells us that among her charges, Sega appears to be the overwhelming favorite of video-game players. In a group of 15 tots she and co-workers regularly supervise, there are four video-game owners, only one of whom has a Nintendo system. The kids themselves, between 6 and 9 years old, overwhelmingly prefer the Sega mix of lights, action, and image.

Not scientific, of course, but the sampling points up a possible difference between video-game fans past and present. The first time around, teens and pre-teens were the fans. But today's video-game enthusiast, unless we misjudge, is likely to be younger still. Partly a reflection of the move from arcade to home playing, but also a basic part of kid culture.

Those 3-D horror films of the 1950s started out with a high-school age audience, but by the end of the cycle were depending on a younger crop of moviegoers. The playthings may be electronic, but toys still get handed down to younger brothers and sisters.

Bettor Living

(Continued from page 2)

fact that the beeper device confirmed 15 minutes later).

The system goes down from time to time, as systems do. In that situation, there's little recourse except to get out the roll of quarters and head for the nearest pay phone.

It's important to keep The Sports Page charged up. We didn't tend to that chore, and eventually the unit stopped functioning. At which point, according to a Beeper Plus representative, the pager was due for another 12-hour charge-up in its stand.

The day will come when every bookmaker and serious punter within range of the service will have The Sports Page. Currently Beeper Plus will only say that somewhere between 4,000 and 10,000 units have been sold. In years past, a service like this would have raised eyebrows in a number of circles, including law-enforcement agencies.

But with many states in the lottery business, legal gambling enclaves on both coasts, and sports fanaticism a widespread and thoroughly documented phenomenon, The Sports Page is just another accessory for better (and bettor) living through electronics. From our exposure to the device, we'd say the odds for its exceptance by the public, and hence its success, are fairly good.

*GIZMO is published by Gernsback Publications, Inc. 500-B Bi-County Blvd., Farmingdale, NY 11735. Contributors to this issue of GIZMO are: George Arthur, senior writer; Ross Skoggard; and John Swenson. Copyright 1988 by Gernsback Publications, Inc. All rights reserved. Printed in the U.S.A.

Gizmo/Bytes

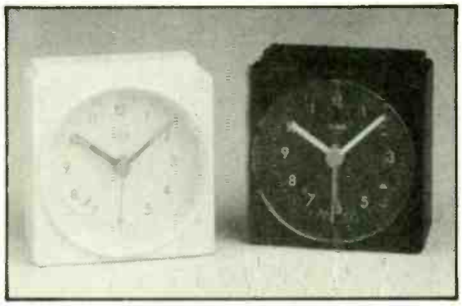
Panasonic Electronic Typewriter

Thinking about upgrading your home or school typewriter with an eye on eventually going the PC route? A model that could help you do both is the *RK-T37 Electronic Typewriter from Panasonic* (One Panasonic Way, Secaucus, NJ 07094). With the addition of a computer interface adaptor (available from Panasonic), the RK-T37 can function as a printer for most personal computers. On its own, the typewriter features a 63,000-word correction function, Accu-Spell Plus, which can even "be directed to suggest a list of correctly-spelled alternate words." There's also an 8,000-character text memory, including word-wrap and word-search functions, and optional RAM-memory cards that are interchangeable and useful for storing additional information. An auto-column function makes it easy to set up lists and charts, while the RK-T37 correction system, "Quick-Erase," offers single-touch erasure of entire words. Price: $479.95.
CIRCLE 56 ON FREE INFORMATION CARD


Electronic Typewriter

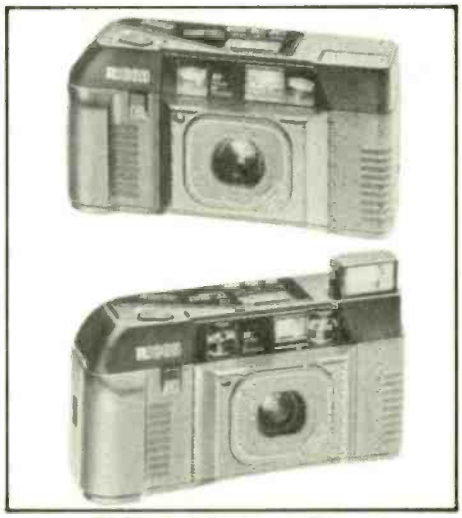
Braun Battery Alarm Clock

Wasn't it Henry Ford who supposedly said his cars were available in "any color the buyer wanted, as long as it's black?" That marketing philosophy appears to have been reversed by *Braun, Inc.* (66 Broadway, Rt. 1, Lynnfield, MA 01940). In its entire line of travel timepieces, there's only one *Battery Alarm Clock* (AB 1) offered in black, or white. A compact 2.5-inches square, the AB 1 features luminous hands and a square, easy-to-read face. The quartz mechanism, "very quiet for uninterrupted sleep," draws power from a single "AA" battery. Maybe best of all, in black or white the AB 1 is available at a price just about anyone going on a trip could afford. Price: $10.
CIRCLE 57 ON FREE INFORMATION CARD


Portable Alarm Clock

Ricoh Bi-Focal Auto-Focus Camera

The electronization of picture taking continues. The *Ricoh Corp. Camera Division* (5 Dedrick Pl., W. Caldwell, NJ 07006) is calling its new TF-500 *Bi-Focal Auto-Focus Camera* "the smallest and lighest bi-focal 35mm camera currently available." The compact camera features a 23-step auto-focusing system and one-frame-per-second film transport. Its shutter-speed range, one full second to 1/500 a second, is said to exceed the capacity of comparable cameras. A DX coding system "automatically provides the correct inputs" for the TF-500's metering and monitoring functions. Other features include a "highly readable" information display, an automatically activated built-in flash, and a total weight of 11.3 oz. An optional 105mm "tele-attachment" extends the versatility of the camera. Price: $300.
CIRCLE 58 ON FREE INFORMATION CARD


Bi-Focal Auto-Focus Camera

Message Stopper

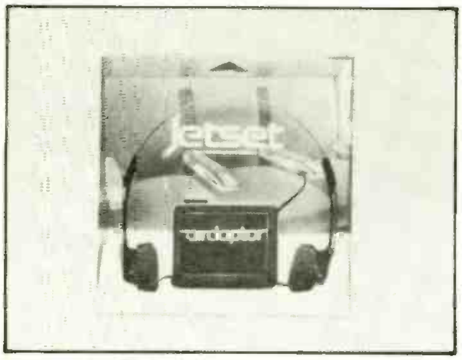
Here's a simple device that does double duty. Called the *Message Stopper* and available from *Synchronics Catalog* (*Hanover, PA 17333-0042*), it plugs into a phone jack and is equipped with jacks for the telephone and answering machine. In place, it turns off the answering machine when the phone's receiver is picked up and also assures that nobody on an extension line can listen in on a conversation. Price: $14.95.
CIRCLE 59 ON FREE INFORMATION CARD

Wordfinder Dictionary/Thesaurus

Whatever one thinks of his opinions, most everyone knows that commentator William F. Buckley's loquaciousness is fueled by a gargantuan vocabulary. Which makes his enthusiasm for the *Wordfinder Dictionary/Thesaurus* all that more intriguing. The handheld unit features a 100,000-word spelling lexicon, with a 220,000-synonym thesaurus that columnist Buckley dubs "a bloody miracle." Based on programs developed for the IBM PC and the Macintosh computers, the Wordfinder is manufactured by *Selectronics, Inc.* (701 Decatur Ave. N., Suite 204, Minneapolis, MN 55427), and features an alphabetic keyboard used with "spell" and "synonym" keys to bring up the desired word on a 20-character LCD screen. Spelling is verified or alternative spellings of phonetically similar words are offered. The synonym key brings up alternative words of that mean the same as the one entered by the user. Price: $99.50.
CIRCLE 60 ON FREE INFORMATION CARD

Wordfinder Dictionary/Thesaurus

Gizmo/Bytes



In-Flight Headphone System

Jetset Stereo Headphone System

We've always thought that some air travelers probably forego in-flight entertainment because of the notorious discomfort of standard-issue airline headsets. The same idea apparently occurred to someone at *Executive Travelware* (P.O. Box 59387, Chicago, IL 60659). Its *Jetset Stereo Headphone System* includes lightweight stereo headphones of the home-audio variety with an adaptor that allows them to be plugged into a standard airliner-seat audio jack. Since airline system sound is merely piped in (and not amplified electrical signals), the patented "Airdapter module" pickup features a pair of sensitive condenser microphones and acoustic "correction baffles." With power from two "AAA" batteries, the Jetset system microphones "convert the piped sounds to stereo electronic signals," that are, in turn, amplified by a "high-quality hi-fi stereo amplifier" and then "reconverted to sound by the stereo headphones." Now if Executive Travelware could only do something about the music and movies selected for in-flight use, flyers could enjoy first-class entertainment in the air. The Jetset can be purchased direct at an "introductory" discount. Price: $19.95 (plus $3 shipping).

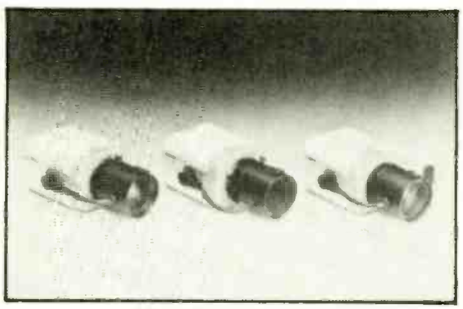
CIRCLE 61 ON FREE INFORMATION CARD

Children's Humidifier

Soundesign Child-Friendly Ultrasonic Humidifier

Here's a practical addition to the growing category of electronics designed for kids—the 1866 *Ultrasonic Humidifier* from *Soundesign Corp.* (Harborside Financial Center, 400 Plaza Two, Jersey City, NJ 07311). The unit features a dome-shaped water tank that's also a swimming pond for a family of white-plastic ducks. There's a built-in night light and a "melody button" that activates a "soothing lullaby" for up to an hour. In its humidifier functions, the 1866 uses a 360 degree rotating nozzle, mist-intensity control, a medication/deodorizer chamber, a 12-setting humidity-level control, and an automatic switch that turns the unit off when the water tank empties. One-and-one-half gallons of water can last 36 hours at a 70 percent humidity level or, at its highest setting, the entire amount can be vaporized in as little as 15 hours. Price: $79.95.

CIRCLE 62 ON FREE INFORMATION CARD

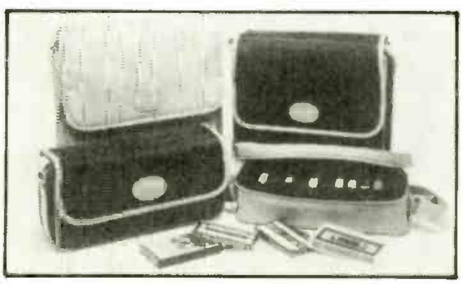


Mini Video Camera

Canon Mini TV Camera

It's finally dawned on someone that all those miniature TVs out there are going to require midget cameras in order to capture the tiny images received by the personal-size sets. Just kidding, but there is a new *Mini TV Camera* trio from *Canon U.S.A., Inc.* (One Canon Plaza, Lake Success, NY 11042). The Ci-20, Ci-20M, and Ci-20R are, respectively, color, black-and-white, and infrared video cameras that weigh a mere 13.8 oz. and measure a space-saving 2¹³⁄₁₆ inches by 2⁵⁄₁₆ inches by 3⁹⁄₁₆ inches. The company proudly claims the series "brings video monitoring to a new level of performance for home, commercial, and institutional security systems." The Ci-20R infrared unit can record images in total darkness and provides 500 lines of horizontal resolution. The color Ci-20 delivers 320 lines of horizontal resolution and has a low-light capacity of 20 Lux, while the monochrome Ci-20M features 500 lines of horizontal resolution and a low-light capacity of five Lux. Price (Ci-20, Ci-20R, Ci-20M): $1995, $1595, $1465.

CIRCLE 63 ON FREE INFORMATION CARD



Audio Cassette Organizer

Coastar Audio-Cassette Organizer

Still hauling your audio tapes around in cardboard boxes and shopping bags? If so, *Coast Manufacturing Co.* (118 Pearl St., Mt. Vernon, NY 10050) would like you to know about its *Coastar Classic Flap-Front Audio Cassette Organizer* (CA-12, CA-24). Besides being flap-fronted, the carry case uses "Stay-Loc" cushion, "a unique and patented feature that cradles audio cassettes in a secure and protected environment," and its exterior is doubled-coated with "DuraHyde." Flaps are secured by zipper and Velcro. One tote bag, three trademarked features, for either a dozen or two-dozen audio cassettes. Price: $29.95, $39.95.

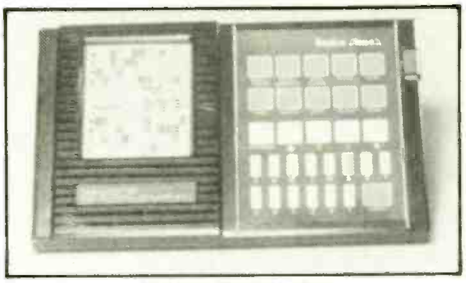
CIRCLE 64 ON FREE INFORMATION CARD

Gizmo/Bytes

Radio Shack Bridge Companion

We don't know much about the venerable card favorite, contract bridge, but we're not surprised to discover that it takes a microcomputer to play it electronically. The *Bridge Companion* (60-2202) from *Radio Shack* (500 One Tandy Center, Fort Worth, TX 76102) displays the player's hand and the dummy's, and can recall "tricks made, contract of current game, and scores anytime." It also doesn't eat sandwiches or require a fresh deck of cards for each session, which is money-saving in the long run. Price: $59.95.

CIRCLE 65 ON FREE INFORMATION CARD



Bridge Companion

Panasonic Multi-Band Radio

Novice multi-band receiver users in years past were often frustrated in trying to tune their unit to a clear signal, but with advances in technology, the current generation of units makes tuning as easy as flipping through the dials on a television set. The new RF-B40 *Multi-Band Radio* from *Panasonic Co.* (One Panasonic Way, Secaucus, NJ 07094) combines a "microcomputer-controlled PLL quartz synthesized receiver with a double-superhetereodyne system" for "outstanding sensitivity, stability, and selection." For further tuning ease, the RF-B40 features a five-way tuning system, including 27-station preset, direct-access frequency selection, and auto-scan. The unit operates on four "AA" batteries. Price: $199.95.

CIRCLE 66 ON FREE INFORMATION CARD

Multi-Band Receiver

Casio Pacer Watch

Walking seems to be coming into its own as a serious form of physical fitness. On the accessories front, *Casio, Inc.* (570 Mt. Pleasant Ave., P.O. Box 7000, Dover, NJ 07801) has introduced a *Pacer Watch* (J52W) that measures the distance walked by length of stride and strides per minute. Other functions include calendar, alarm, countdown timer, and the usual wristwatch data. For those of us with gills, it's also water resistant to a depth of 50 meters. Price: $34.95.

CIRCLE 67 ON FREE INFORMATION CARD

Pacer Watch

America's Achievements in Space Video Cassettes

With the explosion in VCR ownership of the past decade, mass merchandisers have been hard pressed to keep up with software demand. Which has lead to some interesting, if unexpected video releases, like the ten-cassette *America's Achievements in Space* series offered by *The Easton Press* (47 Richards Ave., P.O. Box 5705, Norwalk, CT 06857) via direct mail. The programs make use of National Aeronautics and Space Administration film footage of space probes dating back to 1961. Each 90-minute cassette is introduced by former U.S. astronaut James Lovell, and features a "mission summary" with information on the mission's objective, spacecraft, and astronauts. The entire series is sold book-club style. Price: $29.95 (per cassette).

CIRCLE 68 ON FREE INFORMATION CARD

Precor Semi-Recumbent Stationary Cycle

One of the more innovative developments in bicyle design in recent years is the so-called recumbent bike. Among other advantages, its partisans say the configuration distributes weight more evenly across the back. The fitness equipment firm *Precor, Inc.* (20001 N. Creek Pkwy., P.O. Box 3004, Bothell, WA 98401-30004) has adapted its advantages in its 815E *Semi-Recumbent Stationary Cycle*. An LCD display-module updates time, distance, and pedal-RPM information every five seconds, and a patented ergometer computes the calories burned in an exercise session. An anatomically designed foam set increases air circulation and Precor invites users to "read a book throughout your workout if you wish." The company also explains that since "legs are closer to the same level as your heart, your workout blood pressure is lower than when pedaling on a standard upright cycle." Price: $429.

CIRCLE 69 ON FREE INFORMATION CARD

Semi-Recumbent Exercise Cycle

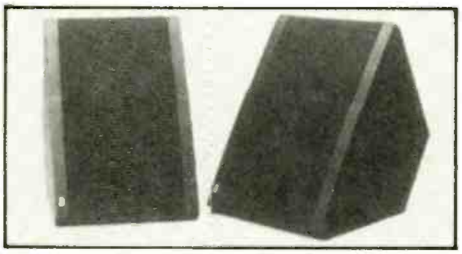
Gizmo/Bytes


Compact 35mm Cameras

Konica Compact 35mm Camera

In years past, 35mm cameras were aimed at the professional or highly committed amateur photographers. But the market has changed, as indicated by a new line of *35mm Compact Cameras* from *Konica U.S.A., Inc.* (440 Sylvan Ave., Englewood Cliffs, NJ 07632). Packaged for mass merchandise display, those cameras are "focus free" and feature built-in flash and easy film loading, plus individual models come in "designer colors" and have names like "Tomato," "Jump,"and "Pop 10." Fun cameras in a 35mm format, a free roll of Konica color film is included with each unit. Price: $78.95.

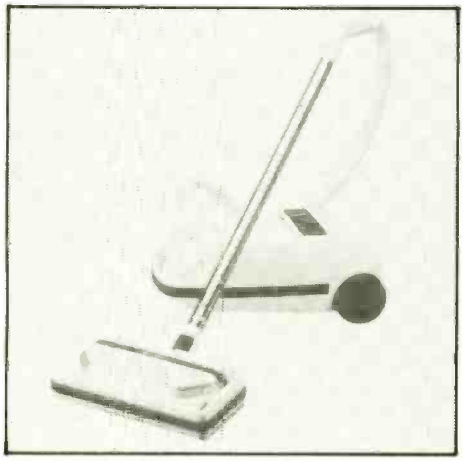
CIRCLE 70 ON FREE INFORMATION CARD


Party Partner Speakers

AR Party Partner Speaker

Party animals, party favors, party politics, now from *Teledyne Acoustic Research* (330 Turnpike St., Canton, MA 02021) there's a *Party Partner Speaker*. Described as the "larger sibling" of AR's popular "Rock Partner" model, the stage monitor-style speaker offers 100 watts of power, while "floor placement boosts the already deep bass to reproduce great party music." The bookshelf/floor-standing acoustic suspension two-way loudspeaker measures 25⅝ inches by 14 inches by 15⅜ inches and weighs 30 lbs. The cabinet is finished in black-vinyl veneer. Price: $225.

CIRCLE 71 ON FREE INFORMATION CARD


Canister Vacuum Cleaner

Sharp Powerhead Canister Vacuum Cleaner

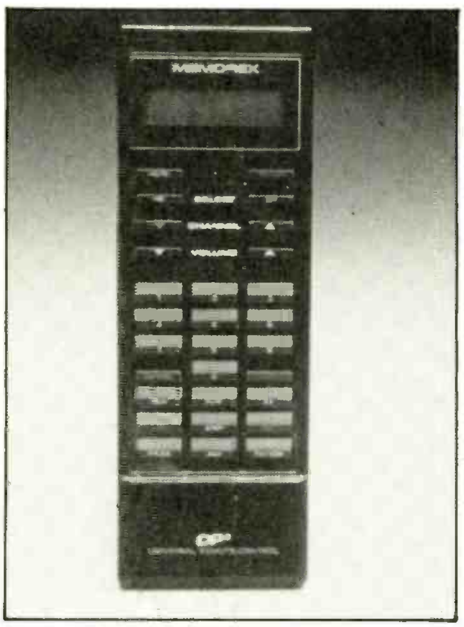
If there's such a thing as the cutting edge of home vacuum-cleaner technology, the new *Powerhead Canister Vacuum Cleaner* (EC-8530) is undoubtedly on it. From *Sharp Electronics* (Sharp Plaza, Mahwah, NJ 07430), the futuristic unit features a 1,000-watt motor, triple micron filter system, automatic power control, electronic dust indicator, and a "V"-shaped agitator brush. The electronics of the cleaner "regulate suction power" and "automatically sense when the EC-8530 dust bag is full," alerting users to replace it with a new one. So when's the remote control model being introduced? Price: $339.95.

CIRCLE 72 ON FREE INFORMATION CARD

Three-Phase Pulsating Ionizer

According to its distributor, the *Three-Phase Pulsating Ionizer* uses the same technology as the computer industry in creating dust-free conditions in computer-assembly rooms. The 1.5-lb. unit can clean the air of smoke, dust, and pollen in any area up to 250 square feet. *Hammacher Schlemmer* (147 E. 57th St., New York, NY 10022) says the unit's "high" setting uses a steady, continuous stream of negative ions, forcing pollutants to quickly settle out of the air to ensure maximum cleaning of highly polluted areas. Power is supplied via a standard household outlet. Price: $134.50.

CIRCLE 73 ON FREE INFORMATION CARD



Universal Remote Control

Memorex Universal Remote Control

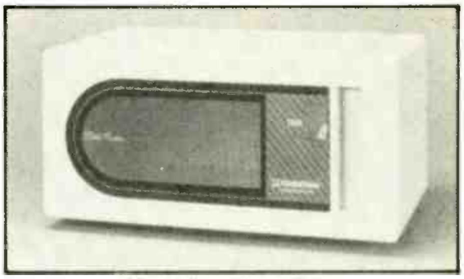
With the number of all-in-one remote controllers now on the market, we're surprised there isn't a magazine devoted to them (yet). *Memtek Products* (P.O. Box 58118, Santa Clara, CA 95052-8118) has joined the marketing fray with its CP-8 *Universal Remote Controller*, a unit that can direct operation for up to eight separate audio and video components. Once the 24-key unit has learned the commands of the single-component controllers it's designed to replace, the user can input a sequence of commands to "achieve a desired combination of equipment operating conditions." Five timers make it possible to "activate any command sequences for daily or weekly automatic function" at any selected time for up to two weeks. Its "non-volatile memory" allows the user to change the CP-8's four "AA" alkaline batteries without losing the unit's programming. Memorex says, "the unit can't be used to replace infrared remote controls using frequency-variation commands and it's not compatible with ultrasonic remote systems." Finally, there are some functions available on individual control units that can't be taught to the CP-8, including "memory scanning features, favorite channel selection, and alternative channel selection." Price: $119.99.

CIRCLE 74 ON FREE INFORMATION CARD

Goldstar Mini-Microwave Oven

People are eating light and watching personal-size TVs, so why not offer a down-sized microwave oven for heating those light meals while watching a tiny tube? *Goldstar Electronics International, Inc.* (1050 Wall St. W., Lyndhurst, NJ 07071) says its *Little Cooker Mini-Microwave Oven* (ER-3010) is "perfect for small kitchens, dens, and dorm rooms." Features include a 15-minute timer with automatic shut-off, single-step power control, and a "stirrer-fan cooking system." The unit offers "400 watts of cooking power." Price: $99.95.

CIRCLE 75 ON FREE INFORMATION CARD

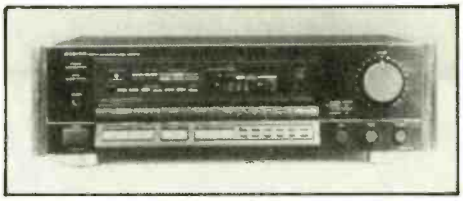


Mini-Microwave Oven

Onkyo Audio/Video Receiver

The *Onkyo Corp.* (200 Williams Dr., Ramsey, NJ 07446) has come up with a particularly consumer-friendly feature for its full-featured *A/V Surround Sound Receiver* (TX-SV7). The manufacturer says that the receiver makes it possible to "obtain state-of-the-art audio and video quality without replacing existing video equipment." Onkyo says the TX-SV7 includes built-in Dolby Surround sound capacity and a four-speaker system through which TV, cable box, or VCR audio output can be routed, "allowing stereo TV or VCR reception." The unit is sold with Onkyo's deluxe universal programmable remote control, the RC-AV7M. Price: $1050.

CIRCLE 76 ON FREE INFORMATION CARD

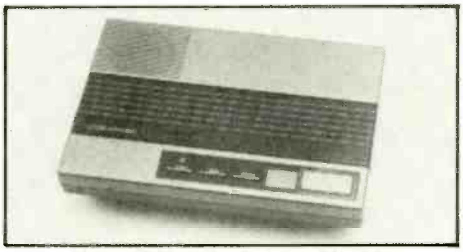


Audio/Video Receiver

Code-A-Phone Home/Office Answering Machine

Something like 100-million Americans work mostly at home today. That figure comes from the *Code-A-Phone Corp.* (16261 S.E. 130th, Clackamas, OR 97015), which describes itself as "striving to answer the telephones" of those professional homebodies. The instrument designed to do that is a *Home/Office Answering Machine* (5530) with business-model features like digital call- and message-counters, an answer-only function, 60-minute recording capacity, and a battery of 15 beeperless remote commands. A function called "announcement break-through" allows the unit to skip over the outgoing message. There's a toll-saver, remote message backspace, and "a high-tech metallic bronze finish with contrasting gold and red accent stripes." Price: $149.95.

CIRCLE 77 ON FREE INFORMATION CARD

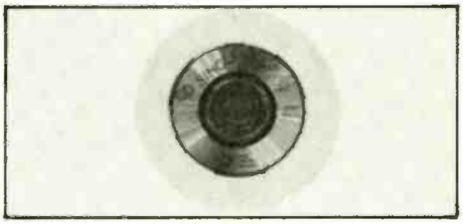


Home/Office Answering Machine

Sony 3-Inch CD Adaptor

Although new CD players from *Sony Corp. of America* (9 W. 57th St., New York, NY 10019) are designed to play the new CD "single" 3-inch format, the audio equipment manufacturer has no intention of leaving buyers of previous CD players in the lurch. The company has developed a *CD "Single" adaptor*, a simple clip-on device "manufactured to the same precision as CDs themselves." Price: $2.99.

CIRCLE 78 ON FREE INFORMATION CARD



CD-Single Adaptor

Pioneer CD Player

Been searching for a home-CD unit with true 18-bit D/A converters? Look no further as *Pioneer Electronics (USA), Inc.* (2265 E. 220th St., P.O. Box 1720, Long Beach, CA 90801-1720) is claiming its new *CD Player* (PD-91) as the first in the world with that feature. Those 18 bits, along with an "eight-times oversampling digital filter" produce "waveform resolution accuracy 16 times greater than other 16-bit players on the market." We imagine the player sounds pretty good, too. Pioneer's "Accu-Focus System" is part of the PD-91's arsenal, "resolving tiny phase differences among the four signals output from the photo detector." Access time for any music selection on a disk is cut to a razor-sharp 0.5 second, and beyond that, the PD-91 features the usual range of compact-disc features: 24-selection random access, three search modes, digital fader, auto program edit and "music-window" random play. Price: $1300.

CIRCLE 79 ON FREE INFORMATION CARD

Compact Disc Player

Sima Camlight 2 Video Light

The current generation of camcorders may have remarkable individual low-light capabilities, but *Sima Products Corp.* (4001 W. Devon Ave., Chicago, IL 60646) still thinks home-video enthusiasts will be interested in its *Camlight 2*, a 100-watt quartz-halogen light that the company calls "the smallest, lightest weight video light in its class." The Camlight 2, sold with a power pack, weighs seven oz. and is a mere 3.5-inches long. The light can be mounted on a camcorder or set on a surface for use as a side or back light. Price: $159.95.

CIRCLE 80 ON FREE INFORMATION CARD

Video Camlight

Reader Request: *PULSE CODE MODULATION*

You asked for it and here it is: everything you wanted to know about pulse-code modulation!

By Rodney A. Kreuter

IN ELECTRONICS TODAY THERE SEEM TO BE MORE WAYS OF representing information than there are op-amps. In addition to the traditional methods of modulation, such as AM, FM, and on-off keying, the revolution in digital electronics has brought about many different ways of representing information using simple pulse techniques. Some of these have been around longer than you might think, but the popularity of digital electronics has made it easier to use them than in the past, and it seems that many different systems are taking advantage of different pulse-code techniques. Take compact discs for example. Traditional records used a form of AM. The louder the music the broader the groove. Today a 16-bit code (plus some bits for error checking) are used to represent the amplitude of a sound.

Now we will explore the topic in greater depth. You will find Fig. 1 helpful in understanding the distinctions in the main methods of pulse modulation. Refer to it as you read each topic.

Pulse-Width Modulation

On-off keying has probably been around the longest of the traditional techniques, and I'll bet many of you never stopped to think that it is simply a *P*ulse-*W*idth *M*odulation (PWM) technique. One modulation system that uses it is a lot better known as Morse code. In Morse code "elements" (dits and dahs, dots and dashes, shorts and longs) are represented by pulses of two different widths. Letters and numbers are composed of groups of elements.

Another system that has used PWM for a long time is the radio-controlled model. In that system, the position of a

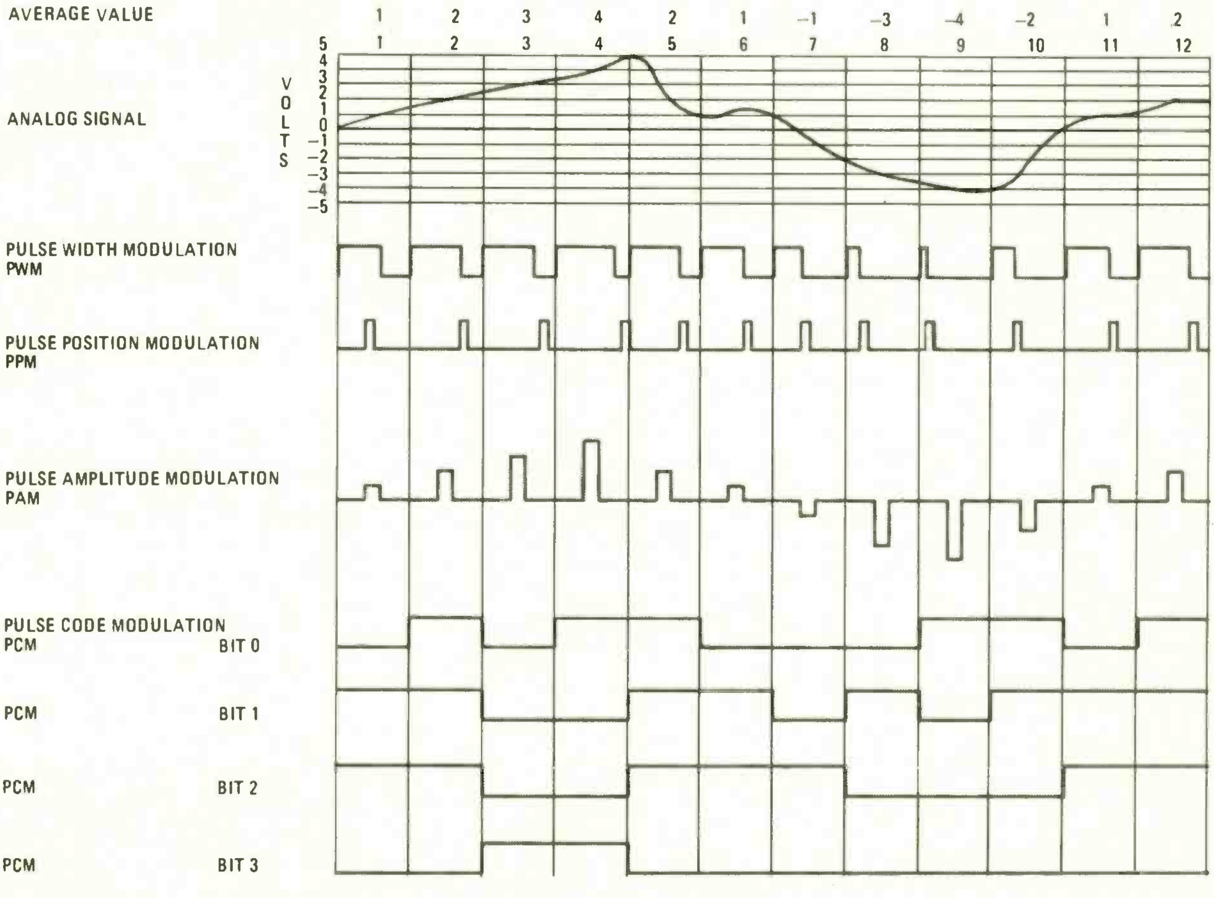


Fig. 1—Here an analog signal is digitized by the four methods described. The signal is divided into 12 time slots sometimes called "frames" or "cells." Each cell is further divided into 50 periods of time which I will call "units." The average value is the average voltage of the analog signal during a particular cell.

servo is represented by the width of a pulse. Many people think of that as "digital" radio control, but in truth it's more analog than it is digital. Here's why: The transmitter sends out a pulse which is proportional to the position of a control stick or lever. If the stick is all the way down, for example, the transmitter will send out a 1 millisecond pulse. If it is all the way up it sends out a 2 millisecond pulse. For any position between the two extremes the transmitter will send out a pulse proportional to the position of the stick. Hence the term "proportional" control. Notice, however, that the number of discreet positions and the number of pulse widths are not limited to any number of positions. In a true digital system only 32 positions, for example, would be allowed. Because the number of positions are not limited, I've always considered this system more analog than digital.

In digital electronics today pulse-width modulation is probably interpreted more strictly than in the examples above. Basically, every pulse begins at a very definite time interval. Information is represented by varying the width of the pulse. Some people refer to this as "duty-cycle modulation" since the frequency of the pulses are constant but the ratio of "on" to "off" is varied by the signal.

Taking a look at Fig. 1 and use table 1 as a reference for conversion. Notice that in PWM each pulse begins at the start of a cell. The amount of time (units) that the signal stays high is proportional to the average voltage of the modulating signal during that cell.

TABLE 1—PULSE-WIDTH CONVERSION

Average Voltage	Pulse Width (in units)
5	50
4	45
3	40
2	35
1	30
0	25
−1	20
−2	15
−3	10
−4	5
−5	—

Uses for PWM

By now, you're probably wondering why anyone would want to use PWM. Three examples come to mind: First the Class-D audio amplifier. In class "D" audio amplifiers, the output transistors are switched on and off using a pulse-width modulation technique. That keeps the power dissipation of the transistors low and results in a high-power amplifier than runs fairly cool. Since the speaker cannot respond to the fast rise and fall times of the signal, it "smooths" out the pulses and can reproduce the audio with amazing accuracy.

Second, there are motor-speed controls. A motor's speed is proportional to the average voltage applied to it, but it's torque is proportional to the peak voltage. By applying pulses of voltage to it, the speed can be varied while keeping the torque high.

Last, switching power supplies make use of pulse-width modulation. Newer "switching" power supplies regulate the voltage delivered to a load by varying the width of their output. An output filter capacitor acts much like the speaker in the example above, and a much smaller, lighter, and cooler power supply results.

Pulse-Amplitude Modulation

*P*ulse-*A*mplitude *M*odulation or PAM is a technique in which information is represented by the amplitude of pulses, although I don't know whether to call it analog or digital. I haven't seen it used for many years, but it does have one interesting application. It can be used to multiplex (or mux) many signals on to a single data path.

In PAM the analog signal is sampled at regular intervals. Each time a sample is taken, a pulse is sent out with an amplitude equal to the analog signal. At the other end, the pulse is put through a low pass filter and the original analog signal is recovered. The sample time interval can be divided into as many intervals as required and many signals can be sent down the same path. Of course, some method of sorting the samples according to there "time slots" is necessary at the other end.

To sum up, PAM simply samples the signal in the middle of the cell and outputs the average value. Looking at Fig. 1, note that another signal could be placed (muxed) in between the samples and more than one signal could be sent via the same transmission line. At the receiving end, the signal is sent through a low pass filter and the signal is recovered.

Pulse-Position Modulation

*P*ulse-*P*osition *M*odulation or PPM is almost the opposite of PWM. Remember that in PWM the pulses occurred at regular intervals. In PPM they don't. Instead PPM sends out pulses which all have the same width, but their position represents the analog information. For example, imagine that each pulse has a "zero" position. That is the position that they would be in if an analog voltage of zero volts would be represented. Assume that any voltage greater than zero volts moves the pulse forward in time and any voltage less than zero (a negative voltage) moves it backward in time, with respect to the zero position. In that manner, an analog voltage is represented by a shift of position.

A common use of PPM is to control the time at which a Triac "fires" and thus the brightness of a light bulb. For example, suppose that the zero position of the pulse is at 359 degrees into the 60 Hertz sinewave. When the Triac fires, it will only conduct for 1 degree because the current will fall to zero at 360 degrees. The lamp will be very, very dim. Now lets modulate the position of the firing pulse. As the analog voltage increases imagine that the firing angle moves (or modulates) toward zero degrees. As the firing pulse moves further and further back along the sinewave, the lamp becomes brighter and brighter because the Triac conducts for a longer period of time.

You'll notice from Fig. 1, in PPM the pulses are all the same width, but they do not begin at the beginning of a frame. Instead they are "held off" depending on the average value of the signal. Use Table 2 to convert the voltage to approximate position, and back again.

Pulse-Code Modulation

Yet another type of pulse modulation is *P*ulse-*C*ode *M*odulation or PCM. Years ago PCM was a general term for all types of pulse modulation techniques. Today it usually means one specific type. No wonder it's confusing. PCM today refers to a group of 1's and 0's which are used to represent information. The most common example is the Analog to Digital converter or A/D.

A/D's convert an analog voltage to a digital "word" which

(Continued on page 96)

ELECTROLUMINESCENT GLOW STRIPS

Phosphor displays are interesting and can produce interesting effects. This lighted display background may just be the thing you need for your next project.

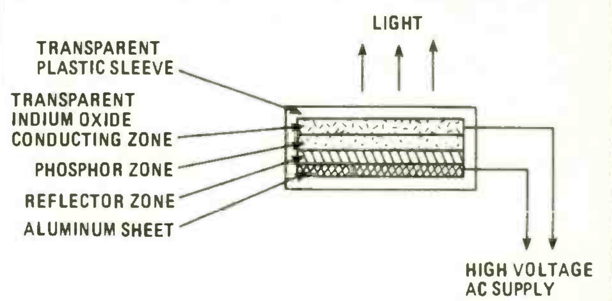


Fig. 1—The display is really a sandwich of substrates in a plastic case. The phosphor is the part that glows, however.

By Stan Czarnik

IN THE PRESENCE OF A SUITABLE ELECTRIC CURRENT, certain chemical solids will radiate light. That is the principle on which the light-emitting diode (LED) is based. The LED has become a very popular electronic component. A much less-familiar example of such an effect goes under the name of electroluminescence.

Most LEDs are built around single crystal III-V compounds, such as gallium arsenide, and require fairly high levels of direct current and low levels of voltage. Most electroluminescent devices involve microcrystalline powder phosphors based on II-VI compounds, like zinc sulfide, and require fairly low levels of current and high levels of voltage, alternating or direct depending on construction.

Electroluminescent Design

Most LEDs produce a single, concentrated, point of illumination. Most electroluminescent components are made to produce a relatively soft, diffuse, surface of light. That makes the electroluminescent panel especially appropriate for display, decoration, and unusual lighting effects. With a little imagination, you are sure to find many interesting applications for them in your next project.

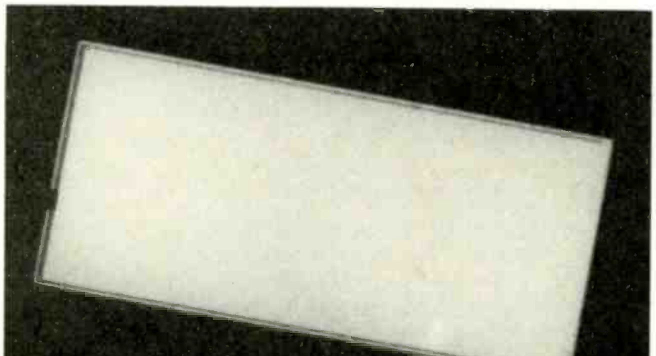
The typical electroluminescent plastic panel consists of four internal layers. First, there is the electroluminescent phosphor itself. That is usually purified zinc sulfide activated with copper. The phosphor is embedded in a dielectric medium and sandwiched between two flat, parallel electrodes. One of those is made of transparent indium oxide. The other, opaque electrode is usually thin aluminum foil. In many AC panels, a reflective layer of barium titanate is placed between the phosphor and the aluminum. That serves to reduce electrical breakdown and direct most of the light created within the panel through the transparent electrode. Finally, leads are attached to the electrodes, and the entire cell is enclosed in a clear plastic sleeve (see Fig. 1).

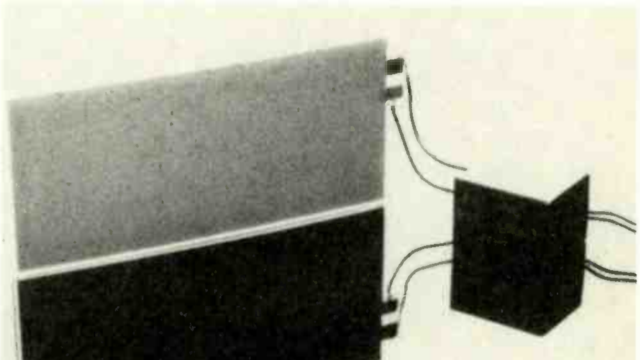
Note how similar that is to the structure of a simple capacitor, i.e., a dielectric between two conductive plates. In fact, when electroluminescent panels first became commercially available around 1950, they were known as *luminous capacitors* and *condensor lamps*.

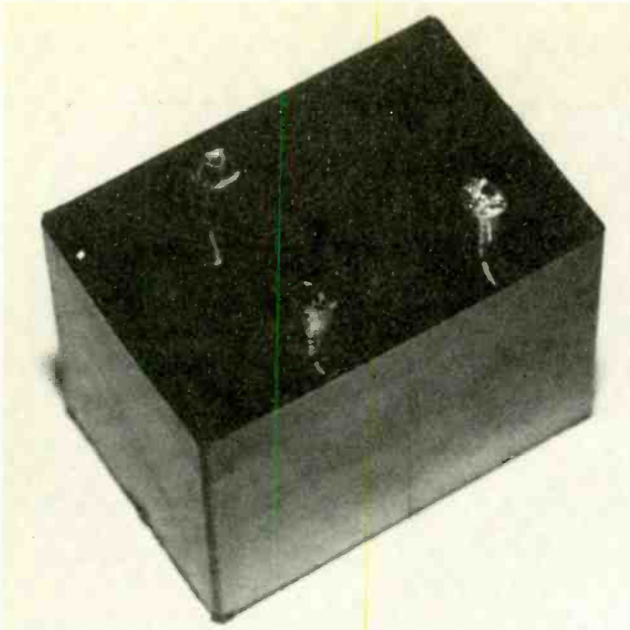
The Glow Strip

A small electroluminescent plastic glow strip, including a high-voltage power inverter, is currently available from the All-Electronics Corporation, 15004 Oxnard Street, Van Nuys, California 91411. It's easy to operate, attractive, inexpensive, and a lot of fun besides. One glow strip (catalog number GS-400) will cost you $6.50 (two for $12.00) plus $3.00 for shipping and handling. The minimum order is $10.00.

When your glow strip arrives, examine it carefully, with a magnifying lens perhaps, near the edge and near the two wire


An electroluminescent panel made with zinc sulfide emits a cool, gentle, green glow. It can be used as a background for any display, provided you can give it the voltage it requires.


Here's an electroluminescent glow strip and voltage inverter from All-Electronics Corporation. Be careful with the inverter when connected to the battery, as the output is high voltage.



This is the voltage inverter. Small pieces of metal tubing have been placed over wire terminals to improve their visibility. Be sure that all connections are insulated.

leads especially. You will find that the construction corresponds to the description given above.

The Voltage Inverter

Now look at the small, shiny, black plastic box. That is the voltage inverter, the purpose of which is to change 6 volts DC to about 140 volts AC at 400 Hz. Turn the inverter upside-down. You will see a total of three very short wire terminals forming a right angle. Place the 90 degree corner of the angle to your lower left. The terminal situated directly to the right is the low-voltage positive DC input. The terminal up and to the left is high-voltage AC output. The wire in the middle, at the corner of the angle, is common. The positions of those terminals are illustrated in Figure 2.

You can run the voltage inverter with an electronic power supply or a battery. A cool, gentle, green glow from the glow strip was obtained with a 6-volt Eveready Lighting Battery (No. 510S). Smaller batteries will work too, but not quite as well. Experiment with the type of power source and voltage until you get the effect you desire.

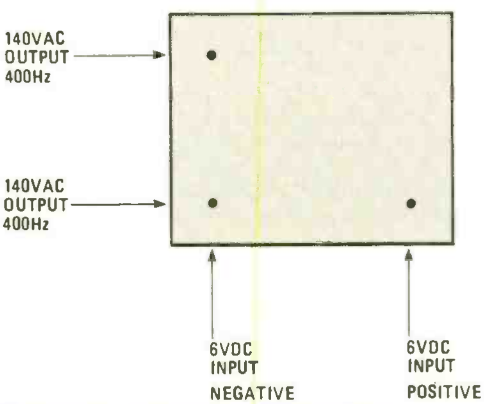
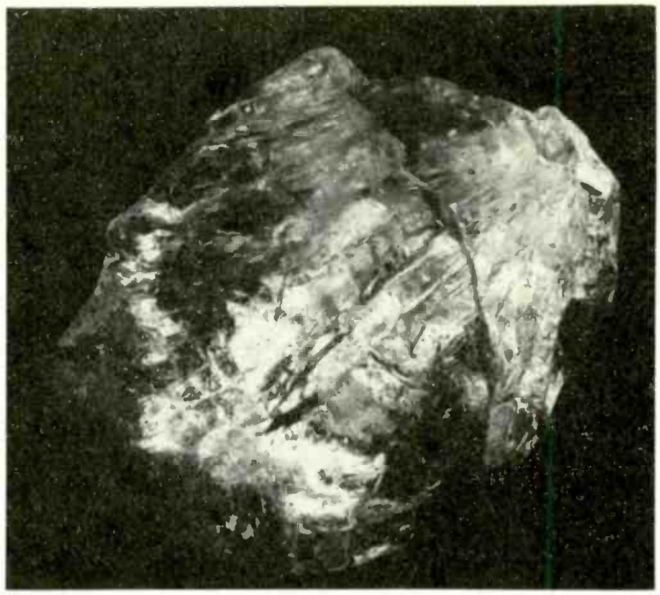


Fig. 2—This diagram will allow you to identify the terminals on the voltage inverter. Check the connection for proper battery polarity. The inverter can be used in a number of interesting projects, including high-voltage generators.



This unusual effect was obtained by placing a glow strip under a large lump of rough glass. You will enjoy coming up with interesting uses of your own for the glow strip.

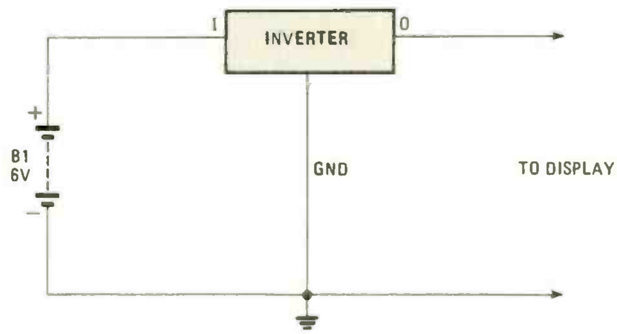


Fig. 3—Wiring up the inverter and the strip will perhaps make this the easiest project you've ever built. You need not stick with using a six-volt battery, but don't go lower.

There yet are other ways of energizing an electroluminescent specimen. In one interesting experiment, G. Destriau, working back in the 1930s, found that, instead of an alternating voltage, it was possible to produce light by rotating an electroluminescent sample in a constant electric field. That changes the direction of the electric field relative to the axes of the phosphor crystals. The faster the rotation of the sample, the brighter the electroluminescence that is produced by the glow strip becomes.

Precautions

Electroluminescent devices seem to work best at or near room temperature. And like all electronic components, they should be kept away from heat to avoid possible damage. As the ambient temperature rises, electroluminescent efficiency begins to fall, as the increasing rate of atomic vibration within the phosphor crystal takes up more and more of the input energy.

Also, do not be deceived by the small size of the voltage inverter. It can deliver a fairly strong shock, so please be careful.

For further information on electroluminescence, see chapters 8 and 17 of M. A. Mardens' *Lamps and Lighting* (London, Edward Arnold, 1983). ■

Using Comparators to Detect and Measure

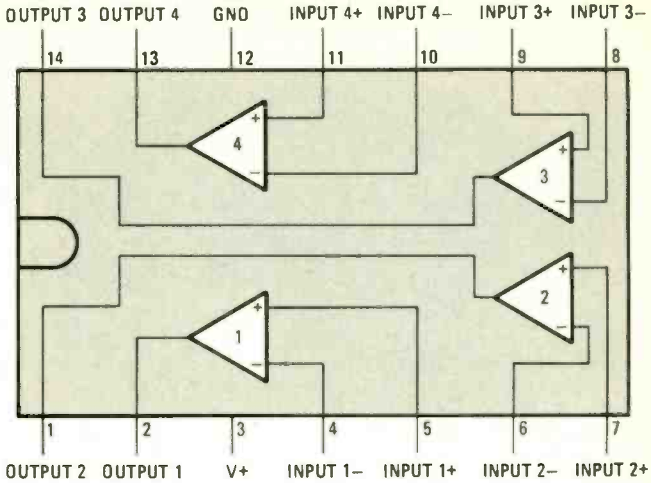


Fig. 1—The LM339 contains four independent comparators and can operate from single or dual-voltage power supplies.

Discover how to use op-amps to monitor real-world conditions

By Jan Axelson

Comparator circuit chips offer the experimenter some of the easiest op-amp circuits with which to experiment. Unlike other op-amps, whose outputs vary linearly with their inputs, the outputs of comparators switch between just two voltage levels, depending on the relative voltages at their inputs. You could compare a comparator to a toggle switch. When the toggle, or lever, is raised slowly (in a linear fashion) it will suddenly snap to the on position—there's no in-between! Likewise, as the toggle is lowered, the inner switch mechanism flips to the off position. The comparison stops here, because comparator circuits are much more flexible than ordinary toggle switches.

The one-of-two-state characteristic makes comparators ideal for voltage monitoring in test or alarm circuits. Any condition, such as temperature or light, that can be sensed as a voltage can be monitored with a comparator. Besides using comparators in simple voltage-detecting circuits, you can use a pair of comparators to detect whether an input falls within a range of voltages; or use a series of comparators to control a bar-graph display, for a good-looking and more precise indication of signal levels.

The circuits that follow are interesting and typical examples of comparators in action, and can be used to guide you in choosing and using comparators to fit your own circuit-crafting needs.

Whats Special About Comparators?

Although some op-amps are specifically designated comparators, in many cases a general-purpose op-amp can also serve the same purpose. The dominant limitation is that op-amps often include phase and frequency compensation for better closed-loop stability. Since comparator circuits operate open-loop (without negative feedback), they don't need this compensation and respond faster without it.

Most of the examples in this article use the low-cost and readily available LM339, which contains four independent comparators on one chip. Figure 1 shows the LM339 chip's pin out. Conveniently, the chip can be powered from a single supply of from 2- to 36-volts DC or from dual supplies (±1- to ±18-volts DC). Supply-current requirements are less than one milliampere, low enough to allow battery-powered operation.

Comparator Basics

Figure 2 shows a basic comparator circuit using the LM339. The voltage to be sensed (V_{in}) is connected to the + input (pin 5), and the reference, or trip-point, voltage (V_{ref}) is at the – input (pin 4). The comparator's operation is straightforward: When V_{in} is greater than V_{ref}, V_{out} (at pin 2) goes high, and when V_{in} is less than V_{ref}, V_{out} goes low. Figure 3 illustrates the comparator's response (V_{out}) to a changing input (V_{in}) compared to a fixed voltage (V_{ref}).

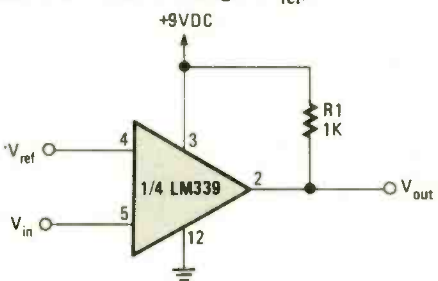


Fig. 2—In this basic comparator circuit, V_{out} goes high when V_{in} is greater than V_{ref}. On the other hand, the output voltage (V_{out}) goes low when V_{in} is less than V_{ref}. The reference voltage determines the comparator's toggle point.

For inverting operation (that is having the V_{out} high and then go low when the V_{ref} goes from low to high) V_{ref} and V_{in} are swapped at the comparator's pin connections in Fig. 2. The reference connects to the + input, and V_{in} connects to the – input. Now V_{out} of the comparator will go high when V_{in} is less than V_{ref}.

A light-emitting diode (LED) provides a simple indicator of a comparator's output state. The circuits in Fig. 4 show several ways of interfacing an LED to a comparator's output.

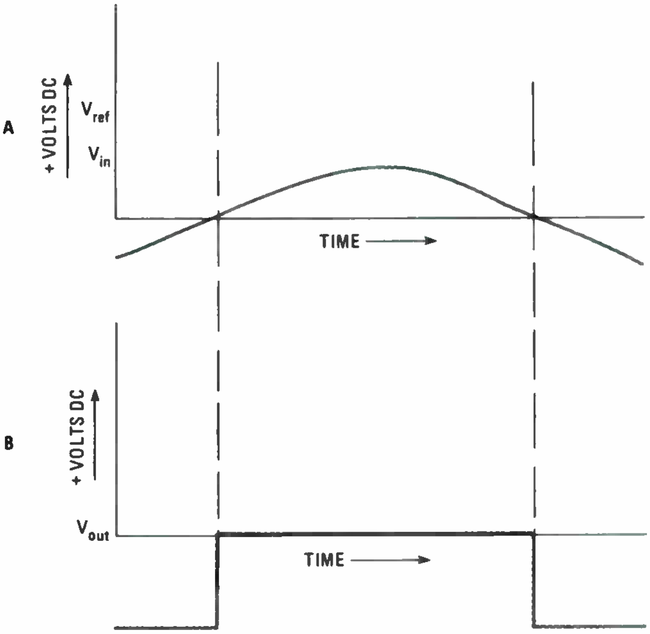


Fig. 3—The charted relationship between the comparator's input and output voltages is shown here. The upper graph (A) shows inputs to the comparator's + and – circuits diagrammed in Fig. 2. The lower graph (B) shows the circuit's output response.

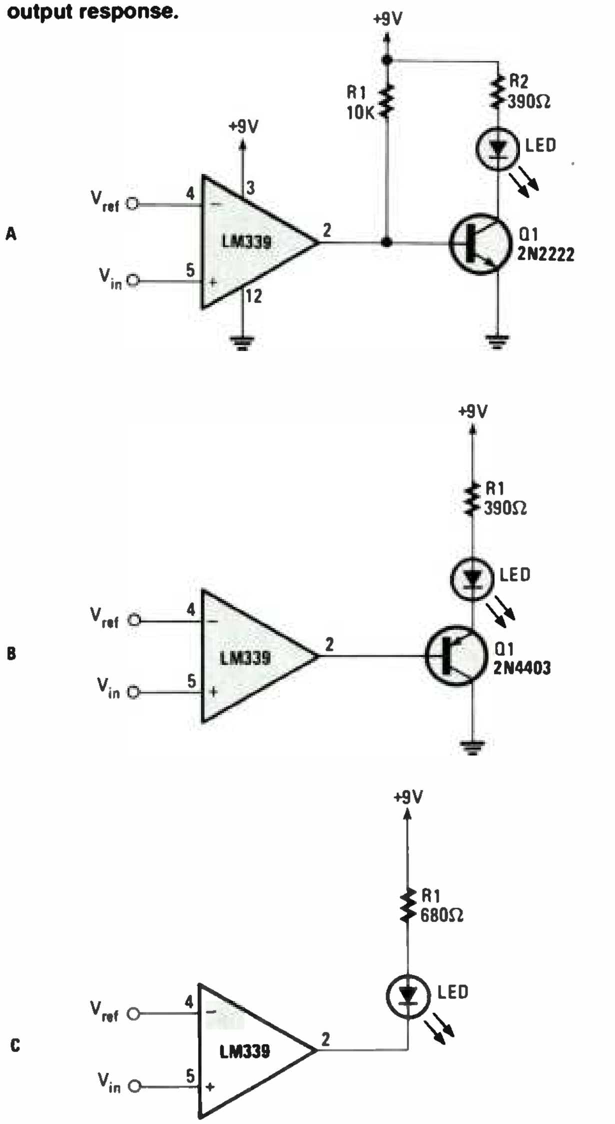


Fig. 4—Here are three ways of using a light-emitting diode (LED) to indicate the electrical output state of a comparator.

In Fig. 4A, when V_{in} is greater than V_{ref}, pin 2 goes high, transistor Q1 turns on through pull-up resistor R1, and the collector current through Q1 lights the LED. When V_{in} is less than V_{ref}, pin 2 is low and Q1 is cut off, turning the LED off. Resistor R2 limits the current through the LED.

The circuit in Fig. 4B is similar to Fig. 4A, but this time the comparator controls a PNP transistor. When pin 2 goes low, Q1 turns on and lights the LED, giving the opposite effect of the NPN circuit in Fig. 4A.

Figure 4C shows yet another option for connecting an LED. Typical current-sink capability of the LM339 is 16 milliamperes. This is enough current to light a high-efficiency LED directly, without using a drive transistor.

The circuits in Fig. 4 are shown using one of the four identical comparators in the LM339. In these and the circuits that follow, inputs and outputs to unused comparators on the chip should be tied to ground. Power supplies are not shown, but should be connected at pins 3 and 12 as shown in Fig. 2.

Achieving Snap-Action

The circuits shown so far all have limitations. If V_{in} has noise riding on it, the output may chatter high and low as V_{in} approaches V_{ref}. And a slowly changing input may permit the output to oscillate as V_{in} nears the trip voltage. Adding a little positive feedback can take care of both of those problems.

Figure 5 shows a temperature-monitoring circuit with positive feedback added through resistor R6. The trip voltage is set with potentiometer R4. The sensed voltage is taken from a voltage divider containing a thermistor (temperature-dependent resistor) and resistor R2. As the temperature of thermistor R1 increases, its resistance decreases because it has a negative temperature coefficient. The resulting drop in the network's (R1/R2) resistance increases the current through R2, raising the voltage at pin 4 of the LM339.

Here's how the positive feedback works. When the output at pin 2 is high, a small part of the output voltage feeds back through R6 to pin 5. This raises the voltage at pin 5 slightly higher than the level set at R4. When rising temperatures cause pin 4 to go higher than pin 5, pin 2 goes low, buzzer BZ1 is energized, and the voltage at pin 5 drops, this time to a level slightly lower than that at R4.

The buzzer remains on until the temperature falls enough so that pin 4 is less than pin 5 again. Because the *turn-on* trip voltage is higher than the *turn-off* voltage, the buzzer snaps on decisively at the desired temperature and remains on until the temperature drops.

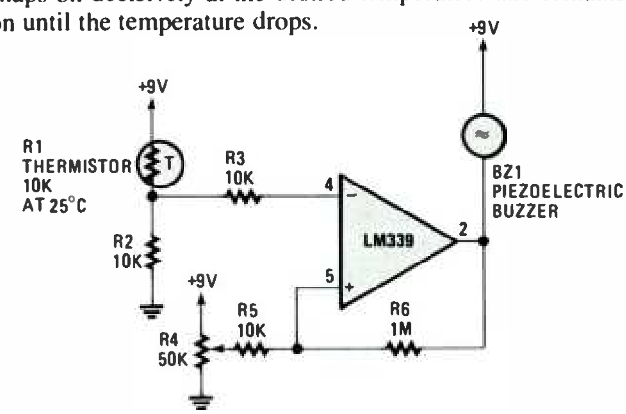


Fig. 5—The piezoelectric buzzer sounds at and above a temperature selected by R4. Positive feedback through R6 ensures that the buzzer snaps on decisively at the trip voltage.

How Much Feedback?

The feedback resistor (R6 in Fig. 5) is usually chosen to be much larger than the input resistor (R5). Its precise value isn't critical, but the smaller it is, the greater will be the difference between the turn-on and turn-off trip voltages.

Although you can calculate the effects of the feedback mathematically, for basic alarm circuits like this, it's often just as easy to set the trip point by experimentation. Simply bring R1 to the desired alarm temperature and adjust R4 so the buzzer just turns on. As shown, the difference between the trip points in Fig. 5 is around one millivolt.

Positive feedback is also useful in relay-control circuits. Figure 6 shows a light-sensing circuit that controls a relay. The light sensor, R2, is a cadmium-sulfide photoresistor whose resistance decreases as the light hitting it increases. When an increase in light level causes pin 5 to be greater than pin 4, pin 2 goes high and turns on Q1, activating relay K1. Resistor R6 makes sure that K1 turns on and stays on until the light level has fallen a certain amount (determined by the value of R6).

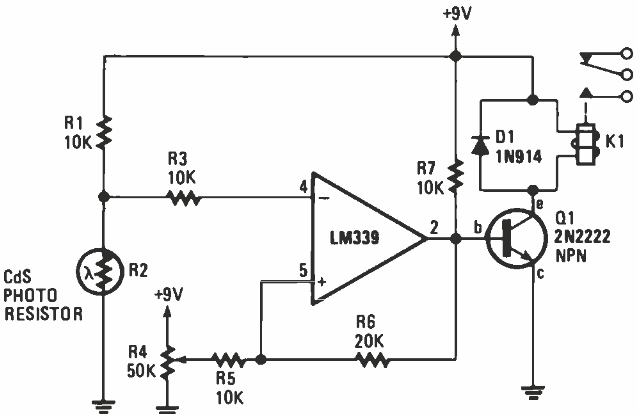


Fig. 6—Photoresistor R2 senses the light level. At the light-intensity level set by R4, the relay solenoid is energized.

Monitoring Large Voltages

An important characteristic of comparator devices is their common-mode input-voltage rating. That is the maximum voltage difference allowed between the + and – inputs of the device for proper operation. Many comparators, including the LM339, can handle input differences nearly as large as the difference between their + and – supply pins.

If you need to monitor voltages larger than the input rating allows, a voltage divider can be used to input a smaller, proportional part of the total voltage. Or, a single-ended comparator like the one shown in Fig. 7 can be used. Here both V_{in} and V_{ref} connect through resistors R2 and R3 to the + input of the comparator, and the – input is grounded through R1. In the single-ended configuration, V_{ref} is in proportion, but not equal to, the trip voltage of V_{in}.

If R2 is selected to be much larger than R3, the voltage at pin 5 will remain well within the common-mode input rating, even with very large input voltages. For instance, in Fig. 7, if V_{ref} is set at –1 volt, the trip voltage at V_{in} is 100 volts!

One important limitation to the single-ended configuration is that V_{ref} must be of opposite polarity from the trip voltage. In the circuit shown in Fig. 7, V_{ref} is always negative, so the trip voltage will always be positive. Germanium diode D1 protects the comparator by limiting negative-voltage inputs to –0.3 volt.

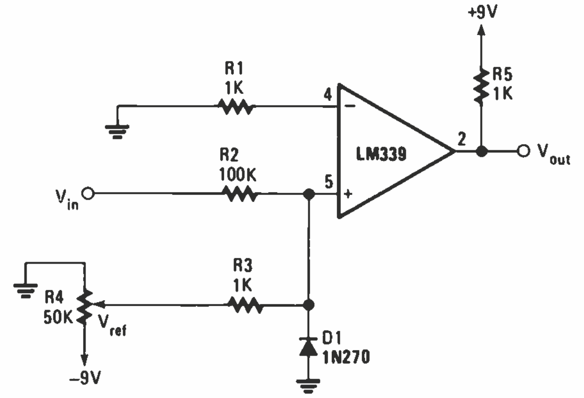


Fig. 7—Use the single-ended comparator circuit to measure voltages that would exceed the comparator's input-voltage rating.

Creating a Window

What if you want to determine if a voltage falls between an upper and a lower limit? A window detector is the answer, and the LM339, with its multiple comparators and open-collector outputs, is ideal for that use. In Fig. 8, the thermistor/resistor voltage divider of R4 and R5 connects to the – input of one comparator and the + input of another.

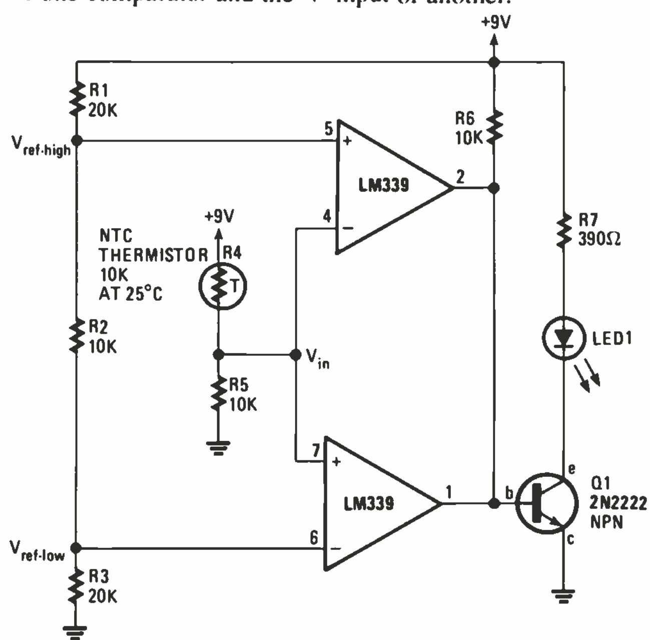


Fig. 8—This window detector circuit lets the experimenter know when the detected temperature is within a pre-selected range.

The trip points for the comparators are taken from another voltage divider made up of R1, R2, and R3. Because the outputs of the LM339 have open, or uncommitted, collectors, they can be connected together as shown, and a low output on either one will pull their combined output low.

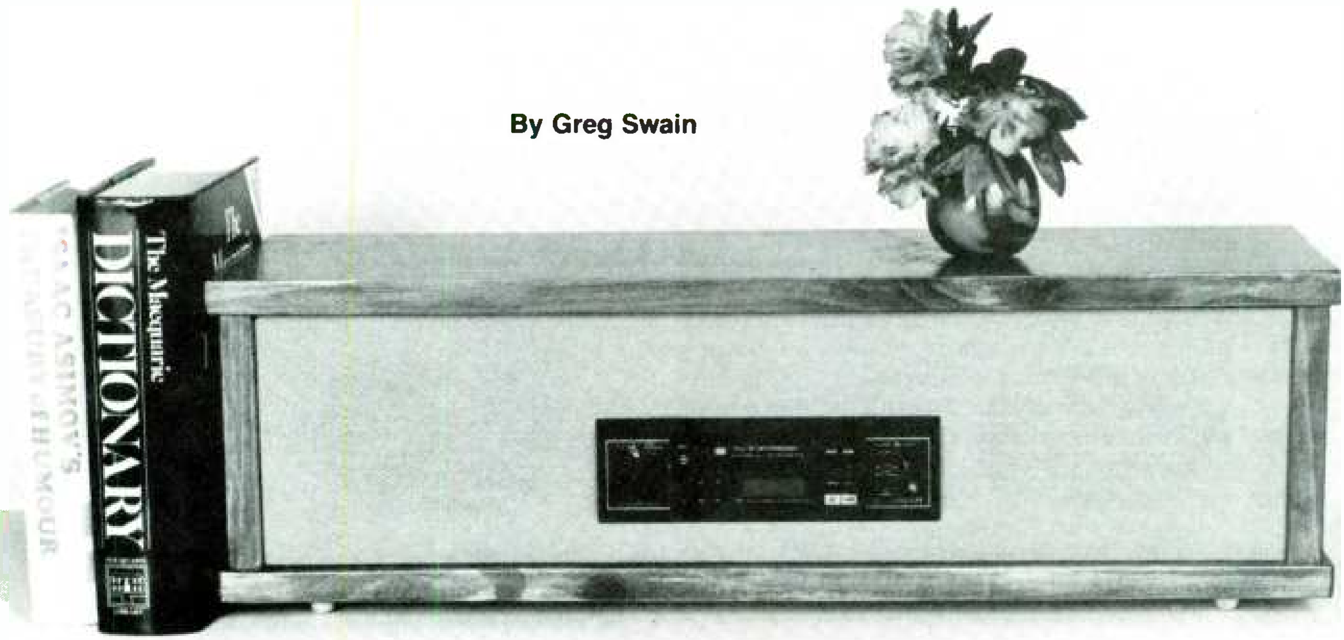
So when V_{in} falls between $V_{ref\text{-}high}$ and $V_{ref\text{-}low}$, the outputs of both comparators go high and turn on LED1. But if V_{in} is greater than $V_{ref\text{-}high}$ or less than $V_{ref\text{-}low}$, the output goes low and LED1 is off. The LED is on only when the temperature is within the window set by resistor network R1, R2, and R3.

Figure 9 is similar, but different—it's an *out-of-window* detector. The output of the bottom comparator goes high when the temperature is too high, lighting LED2 (red), and

(Continued on page 103)

CAR STEREO IN YOUR HOME*

By Greg Swain



Adapt that orphaned car radio-cassette player for in-home use

THOSE OLD VACUUM-TUBE SETS SURE HAD A PRETTY good sound—much better than what you'd get from transistor radios. When was the last time that you heard that sort of statement? But don't dismiss it as mere nostalgia. Those old tube sets really did have the edge over the familiar "tranny" (transistor radio), at least in terms of sound quality.

The reasons are not hard to find. Compared to modern transistor radios, those old vacuum-tube sets boasted greater power output, better bandwidth (*i.e.*, they reproduced a wider range of audio frequencies), better AGC, and lower overall noise levels. They also usually had a decent loudspeaker to reproduce the sound.

Take a look in the back of one of those old tube radios and you'll invariably notice a big speaker, often 6 or 8-inches in diameter. What's more, because the chassis was quite large, the cabinet was also quite substantial and could provide a fair amount of baffling for the speaker.

The signal-handling capabilities of vacuum tube sets was better too. They could comfortably handle very-high input signals—the stuff that makes the audio output of many of today's solid-state stereo systems sound like someone's frying an egg—without overload or cross-modulation, and had much better automatic-gain control (AGC) circuits to cope with the wide range of signal-strength variations.

These days, bandwidths are much narrower, the baffling is woeful, and the miniature speakers used sound dreadful. Add to that the overload and distortion problems inherent in lower-power, audio-output stages and it's not hard to see why modern table radios don't measure up to the vacuum-tube sets of yesteryear.

The fact is, you can no longer buy a decent table-type radio. All you can get is *boom-box* style radio/cassette players, which can be quite expensive; or cheaper clock/radios, which can sound really *brutal*. But there is an alternative: adapt a car radio to run off the 117-volt mains for in-home use.

Car Radio Conversion

This is such a ripper of an idea that you'll wonder why it hasn't been done before. (It has—you've simply slept past the first *go-round*.) As will be shown, converting a car radio to run off the mains is quick and easy to do. What's more, you can spend as much or as little as you like.

What are the advantages of car radio conversions? First, car radios offer much better station-pulling power and sound quality than virtually any currently available domestic AM/FM radio, regardless of price. Because they are designed for mobile use, car radios have much better sensitivity selectivity, and better bandwidth.

Second, car radios incorporate desirable extra features not usually found on domestic radios. Many have pushbutton station selection, which is a great convenience feature, while upmarket models feature synthesized tuning, digital frequency-display and memory storage of favorite stations.

*This story first appeared in *Silicon Chip*, Nov. 1987; reprinted with permission.

They often also have a built-in cassette player, bass and treble controls, and a power output of several watts per channel or more. Finally, car radios are very rugged and are well shielded, thereby reducing interference. A car radio can form the basis for a very good sound system. All you have to do is add a mains power supply, two speakers, and a suitable cabinet.

Choosing Your Radio

The old adage that *you get what you pay for* holds true here. You can either take the low-cost route with a no-frills $25 radio, or you can buy something with a cassette player and a few other "bells and whistles."

As a matter of interest, we took a quick flick through a couple catalogs. Each offered a complete AM/FM-stereo radio-cassette player for around $79.95, but you can also buy fully synthesized models with electronic tuning and AM stereo with prices starting in the $350 range. Radio Shack carries a wide range of models, with features and prices to suit every budget. Of particular interest is a new synthesized model that sells for just $250. They also have a $400 model with a "logic-controlled" cassette deck, Dolby B-C noise reduction and 15-watts per channel of output power.

Of course, you don't have to buy. You may already have a surplus car radio stashed away in the garage or under the workbench. If so, then the price is right, and it's the ideal candidate for conversion to mains power.

If you don't already have a radio, but want to save money, try a local auto wrecker. They often have car radios available for a few bucks; but make sure that the model you choose is still in working order. A radio that's been pulled from a wreck may have been damaged in some way.

We decided to go "whole hog" and convert a Pioneer KE433AM AM/FM radio-cassette player with synthesized tuning, 18-station memory, AM stereo, and 4-watts per channel power output. It is an excellent radio, although unfortunately no longer part of the Pioneer lineup.

The Power Supply

Figure 1 shows the power supply circuit that we'll use in our conversion. As you can see, the circuit is very simple. A transformer with a 15-volt secondary feeds a conventional full-wave bridge rectifier, consisting of diodes D1–D4. The output of the bridge is then filtered by a 4700-µF electrolytic capacitor to give a smoothed DC voltage of about 20 volts.

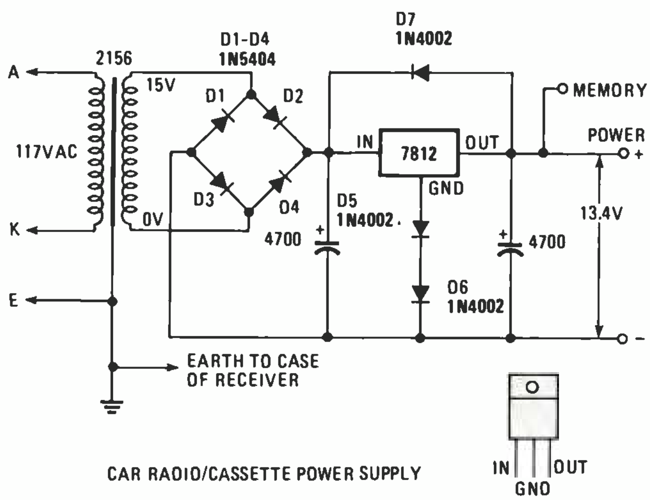
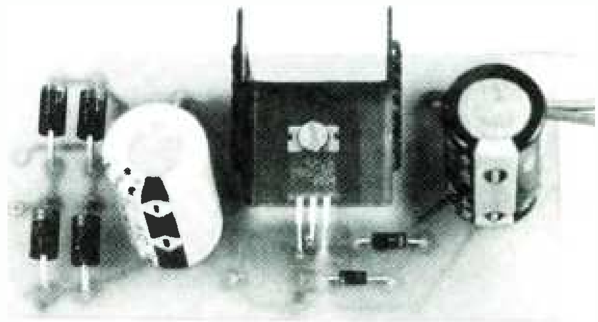


Fig. 1—The conversion of the car radio for home use requires little more than providing a suitable power supply, like that shown here. T1, a 15-volt stepdown transformer, feeds a full-wave bridge rectifier, consisting of diodes D1–D4, with its 20-volt output filtered by a C2, and regulated by U1. The ground connection of the regulator is jacked up by about 1.4 volts by diodes D5 and D6, to deliver a 13.4-volt output.

Voltage regulation is provided by a 3-terminal 12-volt regulator (the 7812). In this case, however, the ground connection of the regulator is jacked up by about 1.4 volts by series-connected diodes D5 and D6. As a result, the supply delivers a 13.4-volt output to the radio.

The inclusion of D5 and D6 may be seen as "gilding the lily" somewhat. After all, the radio will work quite happily at 12 volts, so why bother? Our reasons are that the diodes are cheap (about 10 cents each) and the extra 1.4-volts improves the available power output from the built-in audio amplifiers of the car radio and also improves its RF (radio frequency) sensitivity.



Shown here is the power supply board prior to installation in the system cabinet. Note the orientation and installation of the U1, the three-terminal regulator. U1 is mounted facing up (flat side down) with its leads bent at right angles, and secured to a heat sink.

Diodes D5 and D6 also reduce the power dissipation in the 7812 by lowering the voltage between the IN and OUT terminals.

A second 4700-µF electrolytic capacitor filters the output from the 7812 and provides high short-term current capability when required. Diode D7 is included as a safety measure and protects the output of the 7812 against connection to external voltages (e.g., charged capacitors).

Strictly speaking, D7 is not required here as the supply will be permanently connected to the radio. We've included it for those readers who want to build the supply as a free-standing unit for use in other applications.

It is necessary to fit a small heatsink to the 7812 regulator to obtain the required current rating, because the 7812 includes internal thermal overload protection. Our supply delivers about 1 ampere on a continuous basis and 1.5 A on a short-term basis, which should be enough for just about any car radio, even high-powered units.

PCB Assembly

Figure 2 shows the printed-circuit board, foil pattern for the power supply used in the conversion of our car radio for home use. If you lack the expertise needed to reproduce that board, or simply prefer to use perfboard (for whatever reason), feel free to go that route. Once the board is etched (assuming PC board construction), and you've obtained all the parts, you are ready to begin the assembly process.

Using Fig. 3 as a guide, begin installing the printed-circuit mounted components. All the parts, except for the power

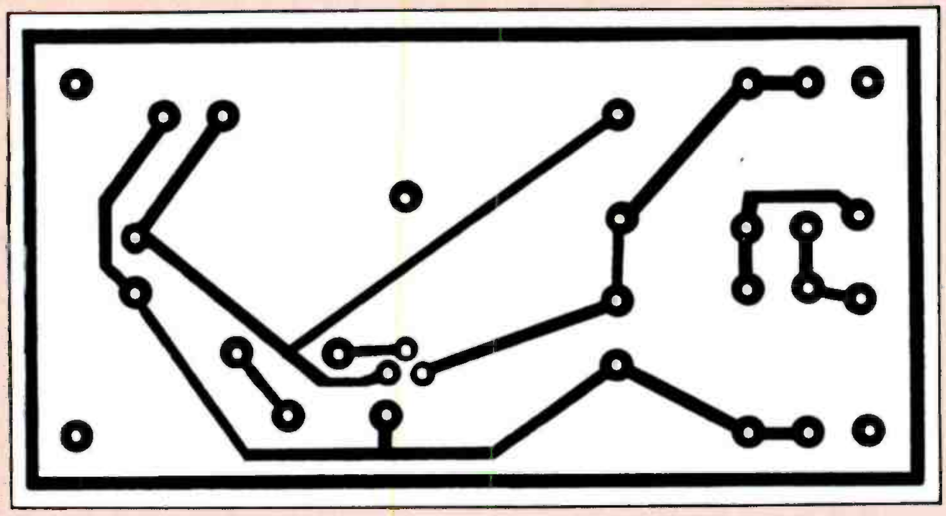


Fig. 2—The printed circuit board for the In-Home Car Radio power supply is shown here for those who prefer the convenience of PCB construction. However, if all you have on hand is perfboard material feel free to use it.

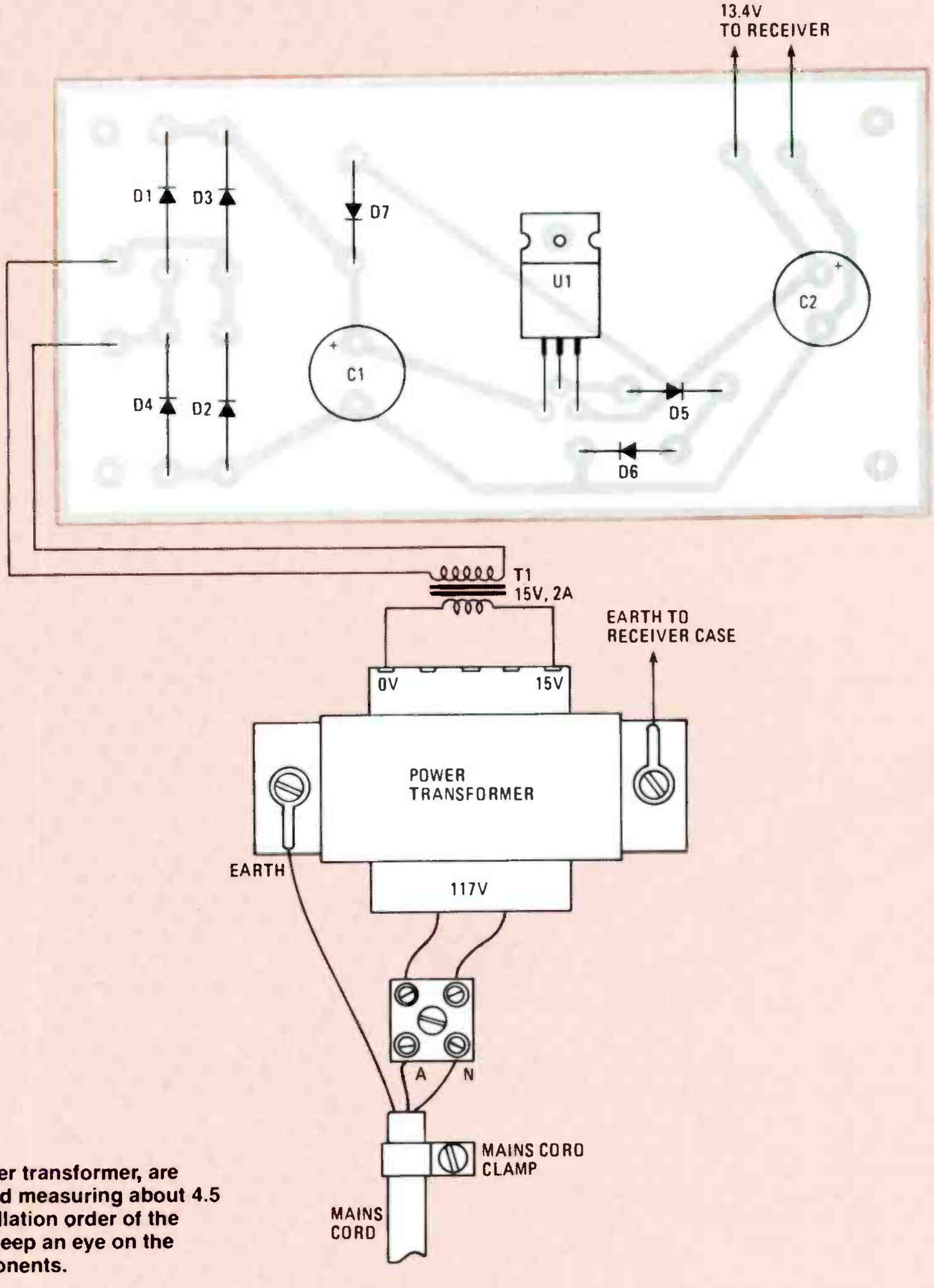


Fig. 3—All the parts, except for the power transformer, are mounted on a small printed-circuit board measuring about 4.5 by 2.5 inches, as shown here. The installation order of the parts is strictly a matter of choice, but keep an eye on the orientation of the semiconductor components.

transformer, are mounted on a small printed-circuit board measuring about 4.5 by 2.5 inches. The parts can be mounted in any order, but be sure to install the diodes with the right orientation. Note that the 1N5404 rectifier diodes (D1–D4, which are rated at 3-A) are specified in the bridge rectifier. That's because a high surge-current rating is required (by virtue of the 4700µF/25-WVDC capacitor).

The two 4700-µF capacitor, C1 and C2, must be oriented correctly. Note that C1, which is adjacent to diodes D1–D4 (the bridge rectifier), must be rated at 25 WVDC. The other capacitor (C2) on the regulator output can have a minimum voltage rating of 16 WVDC. Don't use a 16-WVDC capacitor at the output of the rectifier—its voltage rating will be inadequate.

Finally, install the 3-terminal regulator (U1) by bending its leads at right angles so that they fit into the holes in the board. The regulator can then be bolted to the PCB, separated from the board surface by its heatsink (as shown in the photos).

The Cabinet

One of the best things about this project is that you can build your own cabinet. We made our cabinet from dressed radiata pine, which is relatively cheap and much easier to work than particleboard. Rather than go for tricky miter joints, we elected to use butt joints because they are much easier to make. Figure 4 shows the dimensions of our cabinet. Cut the timer to the dimensions shown, then bevel the edges using a plane or sanding block. The panels can then be sanded to a smooth finish, ready for assembly.

The baffle (front panel) board is secured using cleats, which must be recessed in from the front edge according to the thickness of the baffle and either glued or screwed in position. Once the cleats have been installed, the cabinet is ready for the final assembly.

It's up to you how you secure the various panels. We simply glued them in position using a woodworking glue. Four large C-clamps were used to hold the cabinet together while the glue was drying. After that, the cabinet was given a coat of walnut stain and three coats of satin silk timber finish.

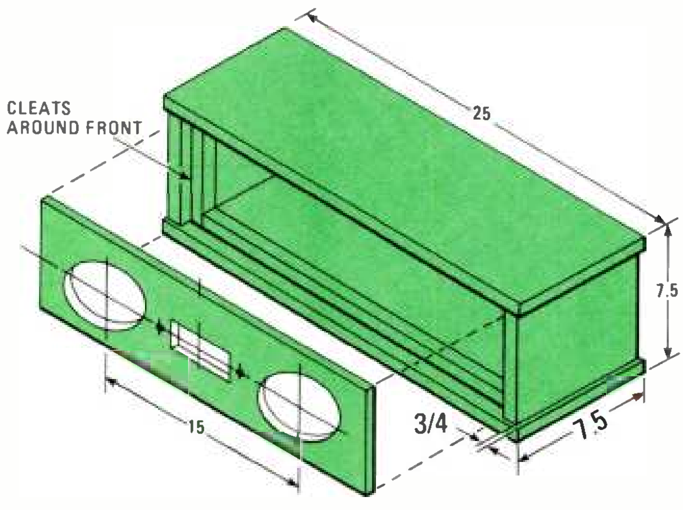


Fig. 4—Shown here are the dimensions of our cabinet. Cut the timer to the dimensions shown, and bevel the edges using a plane or sanding block. The panels can then be sanded to a smooth finish, and assembled. The baffle board is secured using cleats, which must be mounted recessed from the front edge according to the thickness of the baffle and either glued or screwed into position.

PARTS LIST FOR THE IN-HOME CAR STEREO

C1—4700-µF, 25-WVDC electrolytic capacitor
C2—4700-µF, 16-WVDC electrolytic capacitor
D1–D4—1N5404 3-A, 400-PIV rectifier diode
D5–D7—1N4002 1-A, 100-PIV rectifier diode
T1—117-volt primary, 15-volt secondary, stepdown power transformer

ADDITIONAL PARTS AND MATERIALS

Car radio (see text), speakers, grill cloth, printed-circuit or perfboard materials, 2-way mains terminal block, 3-conductor line cord, mains strain-relief (clamp or chassis mount), enclosure, banana plug, heatsink, hook-up wire, solder lugs, solder, hardware, etc.

Incidentally, if you are using radiata pine for the cabinet, be very careful in handling the timber. Because it is soft, it is easily marked; grubby finger marks can be a problem as well. Be careful also not to get excess glue on what will be the visible surfaces of the cabinet. If all traces of glue are not thoroughly removed they will show up as white spots when the stain is applied.

It doesn't particularly matter what you use for the rear panel. We used a piece of perforated Masonite we had on hand. The baffle board can be made from scrap timber since it will later be covered by speaker-grill cloth. It should be at least ½-inch thick to provide the necessary degree of rigidity.

Before mounting the baffle board, it will be necessary to make cutouts to suit your loudspeakers and radio. The baffle can then be covered with a suitable fabric. We recommend the use of either an acrylic scrim* material (looks like hessian*) or a stretch fabric. The fabric should be pulled tight over the baffle and stapled in place.

The radio and speakers can now be mounted and the baffle fastened to the cleats using screws installed from inside of the cabinet (see Fig. 4).

We suggest the use of standard oval car radio speakers, which can be either 6 × 4 inches or 7 × 5 inches, which have good sensitivity and will work quite well without any fancy baffling in the form of sealed or bass-reflex cabinetry. **Do not** use high-quality speakers—they are usually far less sensitive and require properly-sealed or bass-reflex cabinets if they are to provide a decent audio output.

Hooking Up the Radio

Connecting the radio to the speakers, the power supply, and an antenna is a fairly easy task. Usually, it will be possible to identify the various leads from the manual, or from a chart pasted to the top or bottom of the radio. If you don't know what the leads are, you'll have to do some detective work.

Figure 5 shows the hookup for radios with built-in front/back fader controls. Such configurations are normally used with four loudspeakers. Connect the front and back outputs together as shown. If your radio is a higher powered unit with bridging outputs, connect the speakers as shown in Fig. 5B.

For radios that do not have fader controls, the power amplifier outputs are connected directly to the loudspeakers. Note that power switch S1 can be regarded as optional. If your car radio has a built-in digital clock or station memory, the switch should be omitted and the radio turned on and off using its own power switch.

The power transformer should be mounted in the cabinet with the mains terminals facing inward. Before doing that, however, solder two short lengths of mains-rated cable to the 117-volt AC terminals, and sleeve the terminals with plastic tubing. The transformer can then be screwed to the side of the cabinet using self-tapping screws. Install an Earth (ground) solder lug under one of the mounting screws. That solder lug should be secured with a lock washer, to ensure a positive connection.

The primary leads from the transformer are connected to a two-way mains terminal block. That should be screwed to one of the front-panel cleats. Make sure that the mains cord is securely clamped and terminate the active (brown) and neutral (blue) leads as shown in Fig. 3. The Earth wire (green/yellow) is soldered to the solder lug secured by one of the transformer mounting screws.

The idea to keep in mind when doing the mains wiring is to make sure that it is not possible for anyone to come into contact with exposed active wiring, even if their hands are probing where they shouldn't be.

Note: The metal case of the radio must be connected to mains ground. That means that you must have a wire running from the radio case to the transformer mounting foot, as shown in the wiring diagram. If that wire is omitted, the radio will be completely unusable on the AM band, due to a very loud rectifier buzz. Also note that the mains wiring and power supply should be mounted as far away as possible from the antenna socket of the radio to minimize mains interference.

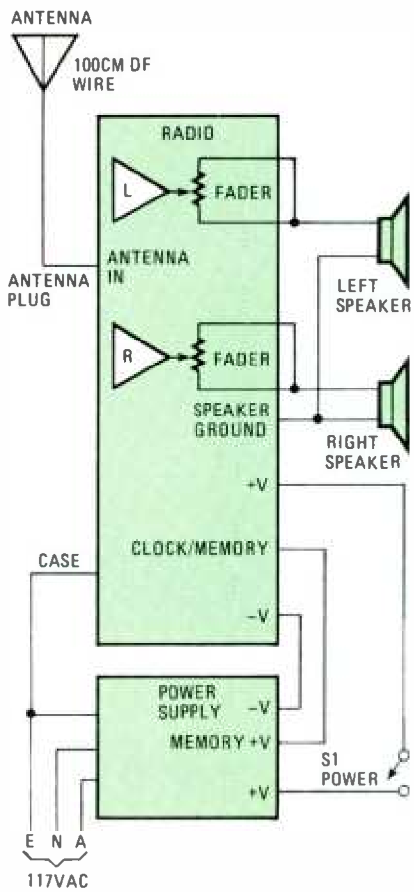
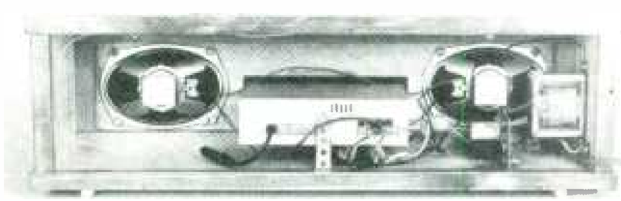


Fig. 6—Shown here are the final connections that must be made to put the In-Home Car Radio into operation. Remember, S1 (the power switch) should be used *only* in the units that need it. If the radio that you choose has a digital clock, or station memory, incorporated into its design, use the units own power switch, as switching the radio off via S1 would also turn off the clock.



The car radio, power-supply board, and twin speakers are shown here mounted in its home-made enclosure. Note the location of the power transformer (right). The power transformer should be mounted in the cabinet with the mains terminals facing inward.

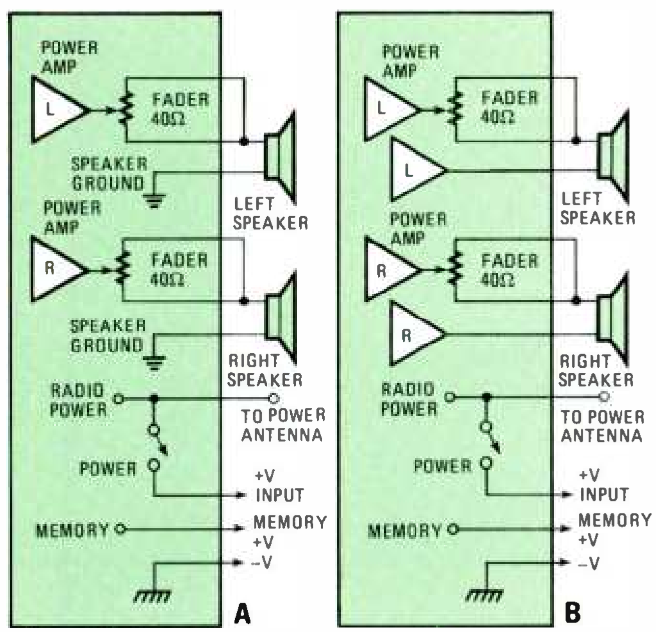


Fig. 5—Shown here are hookups for radios with front/back fader controls (normally used with four peakers). Connect the front and back outputs together as indicated: Shown in "A" are the output connections for the typical car radio; while "B" shows how to connect the output of higher-powered units with bridged outputs.

The next step is to assemble and install a simple antenna. Cut a 3-foot length of stranded hookup wire and solder it to a standard banana plug. The antenna can then be plugged into the radio.

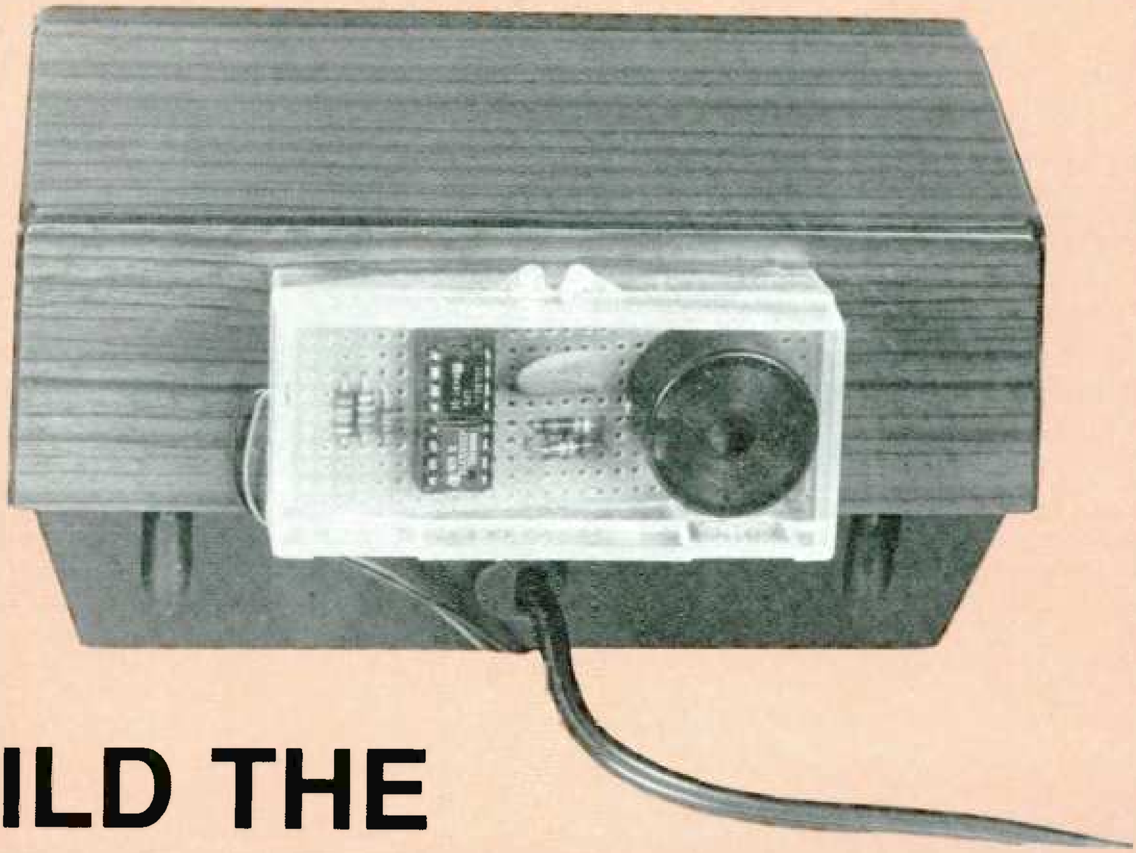
On the prototype, the antenna was stapled to the inside of the cabinet. But usually it will be better to simply drape the cable out the back, but away from the mains cord.

Finally, interconnect the various sub-assemblies in the manner indicated in Fig. 6. Once done and you are satisfied with the integrity of your work, prepare for the big moment. Disconnect all the in-line fuses to the radio, so that no power can be applied to it. Apply mains power and check that the DC voltage from the power supply is close to 13.4 volts. A voltage within 0.5-volts of 13.4-volts can be considered OK.

If that checks out power down, reconnect the in-line fuses, and reapply power. Now turn the radio on with its own on/off switch. There should be a soft thump from the speakers and you should be able to tune stations in the normal way.

If your radio is manually tuned, it will be necessary to peak the antenna trimmer for the best AM reception. That adjustment is normally be found next to the antenna jack, although it can also be situated on the front of the case behind the dress panel. To make the adjustment, tune in a weak station near 1400 kHz, then peak the trimmer for maximum volume.

The final step is to fit the rear panel. That's it—your new table radio is now ready for use. ■



BUILD THE LOW-BATTERY ALARM

Free yourself from dead-battery hassles with a circuit that monitors the voltage of your back-up batteries and tells you when they start to run down before its too late

By Jan Axelson

IN THEORY, BATTERY BACK-UP IS GREAT. WHEN AC POWER fails, battery power kicks in and keeps your equipment running as if nothing had happened. With clocks and timers, that means that you don't have to tediously step through the hours and minutes to reset the correct time when power is restored.

But the system isn't foolproof. Because batteries have a limited shelf-life, you have to remember to check them periodically. Otherwise, chances are that when power goes out, the batteries will be dead and you'll end up without your back-up power anyway.

Our Solution

A low-battery indicator light can help to warn you of failing batteries, but an audible alarm is harder to miss. The circuit presented here gives just such a warning. It continuously monitors battery voltage and turns on a warning buzzer when the voltage has dropped to 5 volts.

The circuit receives its power from the battery or batteries being monitored, so no complicated modifications to the original equipment are required. By selecting different resistors, you can change the trip voltage to suit your needs.

The circuit can be used with any clock, timer, or other device that's battery powered or has battery back-up, using batteries of 3 to 16 volts. Circuit design is made easy due to an IC designed specifically for voltage monitoring—the Intersil 8211 programmable voltage detector. While monitoring, the low-battery alarm draws well under 100 microamperes and so has little effect on battery life. In alarm mode, the 8211 provides current to operate a 555 timer. And the timer in turn activates a piezoelectric warning buzzer. Let's now look at the circuit in more detail.

Circuit Details

The schematic diagram for the circuit is shown in Fig. 1. The battery voltage is monitored by U1, which contains its own internal voltage reference of 1.15 volts. A voltage divider made up of R1, R2, and R3 determines when U1's output at pin 4 turns on and off.

When the voltage at pin 3 of U1 falls to about 1 volt, pin 4 turns on and provides current to operate U2. The resistor values are chosen so that this happens when the battery voltage is 5 volts.

The hysteresis connection at pin 2 causes pin 4 of U1 to remain on unless the battery voltage rises to 5.5 volts (when fresh batteries are inserted and pin 3 rises to at least 1.15 volts). That 0.5-volt hysteresis, or difference between the "on" and "off" voltages, guarantees that the output will snap

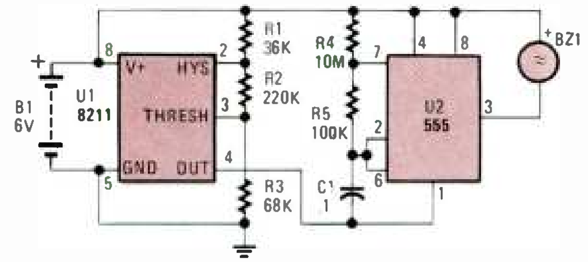


Fig. 1—Battery voltage is monitored by U1. When the voltage drops to below the threshold value, U2 begins to oscillate, turning on buzzer BZ1.

on and remain on in spite of small variations in the battery voltage.

Note that the circuit as shown in Fig. 1 is powered by a 6-volt battery (obtained by using four 1.5-volt cells). If you wish you can substitute a 9-volt battery.

Buzzer Control

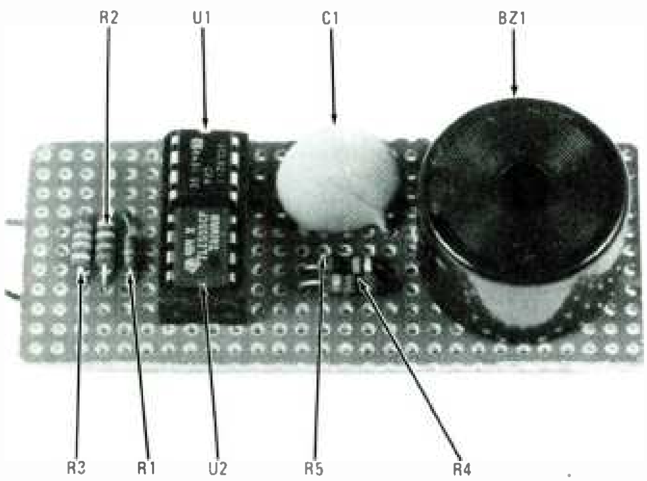
To conserve power (and your hearing) the buzzer gives short warning beeps instead of sounding continuously. The buzzer is controlled by U2, a CMOS low-power version of the 555 timer.

When turned on by U1, pin 3 of U2 oscillates high for about .7 second followed by a .01-second low. The frequency and duty cycle of the oscillations are set by R4, R5, and C1.

Each time pin 3 of U2 goes low, the voltage across the buzzer causes it to turn on briefly. The timer continues to oscillate and turn the buzzer on and off until the battery voltage has dropped to about 2 volts. Normally, that won't happen for several days, giving you plenty of time to notice the alarm and take action.

Customizing the Circuit

You can adapt the circuit to sound an alarm at any voltage level from 3 volts on up to 16 volts. All you need to do is calculate the correct values for R1, R2, and R3. Table 1 gives resistor values to use for monitoring other voltages. One caution: Because the maximum supply voltage rating for U2 is 18 volts, the batteries being monitored should not exceed that voltage.



Parts layout isn't critical for the low-battery alarm circuit. Both 8-pin ICs can be mounted on a single 16-pin socket, and either use wire wrap or point-to-point soldering.

TABLE 1—RESISTOR VALUES

Trip Point volts	R1 kilohms	R2 kilohms	R3 kilohms
15	13	300	24
14	13	300	27
13	15	300	27
12	16	300	30
11	18	270	33
10	18	270	36
9	20	270	39
8	24	270	47
7	27	270	51
6	30	240	56
5	36	220	68
4	43	200	82
3	56	160	110

To custom-design your own battery monitor, choose a trip point—the voltage at which you want the alarm to sound—and the amount of hysteresis desired. Plug those values into this equation.

$$R3 = 333{,}000 \times 1.15/(TP + HYS)$$

Using the resistor values calculated, solve these equations:

$$R2 = R3 \times (TP-1.25)/1.15$$
$$R1 = 333{,}000-R3-R2$$

When you've computed the ideal values for R1, R2, and R3, select actual values as close as possible, using available components.

If you have another application in mind, or if you just like to know the why and how behind the numbers, here is an example to help you design with the 8211: If TP=5 and HYS=.5, then:

$$R3 = 69{,}600$$
$$R2 = 227{,}000$$
$$R1 = 36{,}300$$

Which are ideal values. Some actual values, using available resistors to suit the application would be:

$$R3 = 68{,}000$$
$$R2 = 220{,}000$$
$$R1 = 36{,}000$$

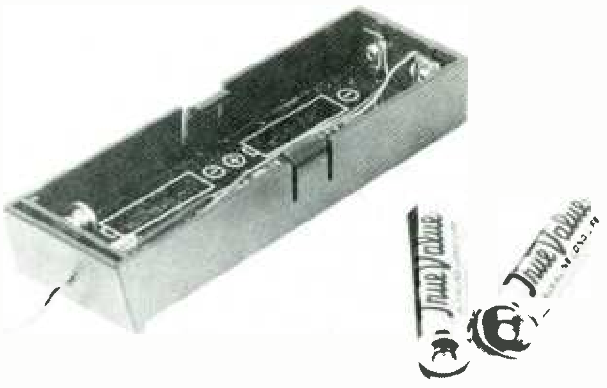
Construction

You can easily assemble the circuit on a small piece of perfboard just 3 square inches in area. Or, if you wish, the circuit can be built on a printed circuit board of your own design. Regardless of which construction technique you use, the layout of the circuit is not critical.

For the enclosure, use a small plastic case at least 1 inch deep and cut the circuit board to fit it. A plastic box that has been recycled from another use will do fine—most enclosures sold for hobbyists' projects are larger than needed to accomodate the circuit.

Sockets for the two ICs are recommended. To save space and cost, both ICs can be mounted end-to-end on one 16-pin IC socket as shown in the photo.

To build the circuit, mount the resistors, capacitor, IC socket, and buzzer on the board. Then use Fig. 1 as a guide to wire the circuit, using point-to-point soldering or wire wrapping. Be sure to orient the buzzer correctly—its two legs are marked "+" and "–" and connect them to the rest of the circuit as shown in Fig. 1.



Two wires are soldered to the battery contacts to connect the batteries to the alarm circuit. The pack is snapped back into place and the wires connected to the alarm.

If the equipment you'll be monitoring is AC-powered, unplug it and remove the back-up batteries. If you'll be using a device with battery power only, also remove the batteries from it. The next step is to locate the metal contacts the battery or batteries plug into or push against within the equipment that's to be monitored. The alarm circuit will be wired to those battery connections.

Connecting the Alarm

The alarm-circuit enclosure mounts on the outside of the equipment case, as shown in the lead photo. Two wires connect the alarm circuit to the batteries, so you'll need to drill two small holes for running the wires from the batteries to the alarm circuit. Holes that are 1/16 inch in diameter are large enough if you use small-diameter wire, such as 28-gauge, to make the connections.

Carefully drill one hole in the instrument case, in a spot that will provide access to the battery compartment. If the batteries are held in a plastic drawer that slides into the case, the outside wall of the battery drawer is the place to drill the hole. The accompanying photo (see above) shows that type of installation.

Drill a similar hole in the Low-Battery Alarm circuit's case. Decide where on the instrument case you wish to mount the alarm, then choose a hole location that offers convenient routing for the battery wires.

Cut two lengths of insulated hookup wire and strip ½ inch of insulation from one end of each. Solder a wire to each of the battery connectors in the equipment. After soldering, tie a strain-relief knot in the wires several inches from the soldered ends. Then push the free ends of the wires through the hole in the battery compartment and into the hole in the alarm-circuit case.

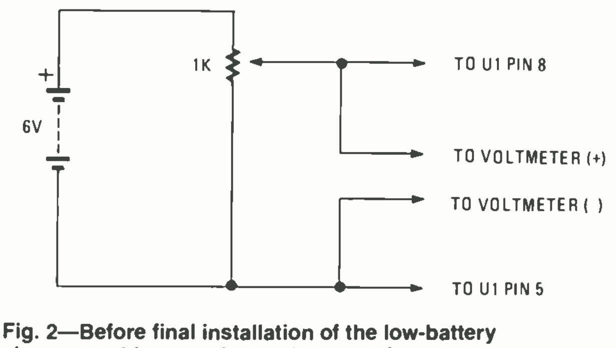


Fig. 2—Before final installation of the low-battery alarm, use this setup to test its operation.

PARTS LIST FOR THE LOW-BATTERY ALARM

SEMICONDUCTORS

U1—8211 programmable voltage-level detector integrated circuit
U2—XRL555 or TLC555 CMOS timer integrated circuit

RESISTORS

(All resistors are 1/4-watt, 5% units.)
R1—36,000-ohm
R2—220,000-ohm
R3—68,000-ohm
R4—10 megohm
R5—100,000-ohm

ADDITIONAL PARTS AND MATERIALS

C1—0.1-µF ceramic disc capacitor
BZ1—piezoelectric buzzer (Radio Shack #273-065 or equivalent)

Small case, perfboard, IC socket (optional), wire, solder, etc.

All components except BZ1 available from Jameco Electronics, 1355 Shoreway Road, Belmont, CA 94002.

Insert the two ICs in the socket. Be sure to orient them correctly, and for U2 observe the usual precautions for handling CMOS devices.

Circuit Check-Out

Don't solder the hookup wires to the alarm circuit before you test the circuit's operation. To do that you'll need a 1000-ohm potentiometer, test leads, and a voltmeter.

Check over your work carefully. Then refer to Fig. 2 for the test setup. Use test leads to connect the potentiometer across the battery or batteries being monitored. Connect the wiper of the potentiometer to pin 8 of U1 in the battery alarm, and connect the – battery terminal to pin 5 of U1. Set your meter to measure volts and clip the meter leads to pin 8 and pin 5 of U1 as shown.

You should now be able to turn the buzzer off and on by adjusting the wiper of the pot. When the voltage at pin 8 of U1 falls below 5 volts, the buzzer should begin to sound. Raise the voltage to 5.5 volts and the alarm should turn off.

If you're not getting results, monitor the voltage at pin 3 of U1 as you adjust the potentiometer to verify that pin 3 drops to 1 volt. Check to see that pin 4 of U1 is pulled low at this point. If that much checks out, inspect your wiring at U2 for correctness and solid connections.

Final Installation

When all looks okay, you're ready to connect the batteries directly to the alarm circuit. Measure the length needed for the two hookup wires, being sure to leave enough slack in the wires so the batteries can be removed when necessary. Cut the wires to size, strip ¼ inch of insulation from the ends, and tie another strain-relief knot in the wires inside the alarm-circuit case.

Then with the batteries disconnected, solder the + wire in the battery case to pin 8 of U1, and solder the – wire to pin 5 of U1. Use glue or double-sided tape to mount the alarm circuit case on the equipment case. And finally, insert the back-up batteries.

You can now free yourself from dead-battery worries. When your batteries begin to run down, the low-battery-alarm circuit will be sure to let you know. ■

BUILD THE ELECTRONIC "BUG" SWATTER

Route out RF interferance, evesdropping, and more with a handheld RF detector

By Charles D. Rakes

IS IT SAFE? HAS YOUR LUCK SUDDENLY gone sour? Is your competition always one jump ahead? Could it be that someone is listening in on your private conversations? Is there an electronic bug hidden in your home or office? Does paranoia touch you at every turn? Is some elusive equipment noise interfering with your favorite radio program?

If the answer to one or more of those perplexing questions is yes, then it might be to your advantage to take a closer look at the *Electronic Bug Swatter*—an RF sniffer, which we jocularly refer to as Mr. McSniff. Mr. McSniff can sniff out minuscule RF signals from just about any source including radiation from a hidden bug to the garbage that *cometh* from our microwave ovens.

By adjusting the Bug Swatter's antenna length and sensitivity control, signals as small as a few milliwatts up to *antenna meltdown* can be detected and their locations pinpointed. RF radiation with frequencies as low as 10 kHz to wiggles as fast as 1 GHz can be picked up by the Bug Swatter.

If you decide to take the challenge and build the Bug Swatter, for no other reason than to ferret out RF interference, it could prove to be the most valuable little gadget in your electronic detectives bag of tricks.

Modus Operandi

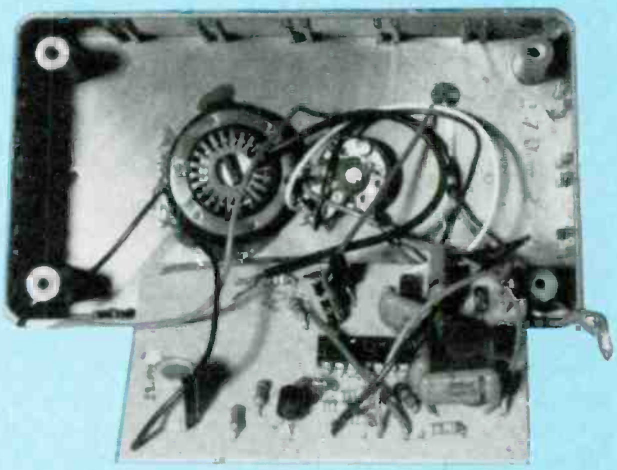
Figure 1 shows a schematic diagram of the Bug Swatter. Its front end is designed to pass a broad band of RF signals to a sensitive germanium diode detector, D1. RF energy induced into the pull-up antenna is coupled to the detector diode through C1. The two RF chokes (L1 and L2) are connected in series to extend the maximum detectable frequency range. L1 (a 10-µH choke) offers circuit isolation for the higher frequencies, and L2 (a 2.2-mH choke) accommodates the lower frequencies.

When an RF signal is detected, D1 produces a negative voltage, which is fed through the two chokes to the high end of the gain control, R18. The detected output is tapped off at the wiper and fed to the negative input of U1a (pin 2) through R17. The op-amp's gain is set near its maximum value by R5 (a 5-megohm resistor), which is connected in U1a's feedback loop. With no RF present at the antenna, the output of U1a (pin 1) is near ground potential, and LED1 and LED2 are dark. But as soon as a signal is detected, the op-amp's output goes positive, lighting one or both of the LED's.

LED2 lights first for low-level RF signals; LED1 comes on as the signal increases in strength. By aiming the antenna and adjusting the gain control (R18), while watching the two LED indicators, the RF source can be located in short order.

The remaining three op-amps add the *coup de maitre* to the detector's output circuit, by supplying an audible tone that varies in frequency in step with the strength of the detected RF signal.

Op-amps U1b and U1c, along with their associated components, comprise a voltage-controlled oscillator (VCO) that operates in the low audio-frequency range. When a very weak signal is detected, the oscillator responds with a low-frequency growl that increases to a more pleasant tone of several hundred Hertz as the RF signal increases in level. Op-amp U1d adds isolation between the oscillator circuit and the speaker's driver transistor, Q2.



The Bug Swatter's printed-circuit board is shown here fully populated just prior to being tucked away in its enclosure. Remember to keep the leads from the board to the off-board components as short as possible to prevent the leads from picking up stray signals, and giving false indications.

By Marc Saxon

SAXON ON SCANNERS

"Betcha" don't see scanners like this everyday

YOU DON'T SEE TOO MANY HAND-held scanners that are sophisticated enough to cover all the way up to the 800 MHz band (where the cellular telephones live). A recent release, carrying the label *AR800* does. This "do-hicky" tackles the 800-MHz band, as well as a hefty swathe of other frequencies "ta boot."

The complete frequency range of the AR800 is 30 to 50 MHz, 118 to 136 MHz, 140 to 174 MHz, 436 to 174 MHz, 436 to 512 MHz and 830 to 950 MHz. That provides 20-channel coverage of police, fire, business, industrial, maritime, land/air transportation, and emergency services as well as all of those new services on 800 MHz.

Twenty front-panel keys allow the user to operate the unit with ease, and a side-lighted LCD display keeps you informed of what's happening in respect to channels and frequencies, scan delay and channel lockouts, etc. The unit also provides scan/search capabilities.

The scanner carries a price tag of $259, and includes rechargeable batteries, a battery charger, carrying loop, rubberized antenna with a BNC-type connector and ruggedized case. It weighs only 19 ounces, and measures about two by five inches, so it can easily be dropped into an average size coat pocket.

More information on the AR800 can be obtained from Ace Communications, Monitor Division, 10707 East 106th Street, Indianapolis, IN 46256.

Can of Peas

Several recent letters have mentioned that some scanner instruction books make casual reference to the fact that there may be ordinances in effect that regulate the use of scanners in vehicles, but they never go on to explain further. The hope was that such ordinances would have been spelled out in detail.

The reason for the vagueness is that the topic is a real can of peas that is a rough one to open. That's mainly because there are several hundred local, county, and state regulations in all. No matter where you're located, a hundred miles away the regulations are probably different. What's worse, some regulations seem to conflict with others established for the same locality, and some ordinances are simply too vague to allow them to be pinned down to one exact meaning.

One state has an ordinance that says that a scanner can't be *installed* in a vehicle, but doesn't define what they mean by "installed." One guess was that if a handheld scanner was lying on the front seat and being powered from a plug in the vehicle's cigarette lighter, then it was installed. However, if the same set was powered by its own internal batteries then the scanner wasn't installed in the vehicle, it was simply being transported therein. That was the guess of someone we asked at the state's motor vehicle bureau—but it was pure speculation on their part.

The AR800 handheld scanner covers the 800-MHz band (where the cellular telephones live), as well as a hefty swath of other frequencies (30 to 50 MHz, 118 to 136 MHz, 140 to 174 MHz, 436 to 174 MHz, 436 to 512 MHz and 830 to 950 MHz), providing 20-channel coverage of police, fire, business, industrial, maritime, land/air transportation, and emergency services.

Another ordinance notes that you can have a scanner in your vehicle only if a special authorization permit is obtained. Unfortunately, no state, county, or local agency questioned had the foggiest notion as to what that permit was called or the name of the agency that issued same.

Still another state takes the vague approach by stating that nobody except licensed hams can have a mobile receiver that is capable of receiving frequencies used by police agencies. They fail to explain why licensed hams would have more reason to wish to monitor police transmissions than anybody else. And, since many police agencies operating on limited-access highways are equipped for CB channels 9 and 19, the way the ordinance is worded, it could be interpreted as making mobile CBs illegal.

Therefore, those manufacturers who offer only a brief mention to such matters are doing about all they can under the circumstances. They put the user on notice that such restrictive ordinances do exist so that users might pursue the matter further on their own. The user will then presumably have to sort out and interpret the patchwork quilt of vague and often conflicting laws, and then try to find out the extent that they are actually being enforced.

Many police officers confess that it's rare that someone actually gets hassled about a mobile scanner, unless it's suspected of having been used in connection with a felony.

Let's hear from our readers with questions, suggestions, photos, listening tips, etc. Write to us at: "Marc Saxon," *Saxon on Scanners*, **Hands-on Electronics**, 500-B Bi-County Boulevard, Farmingdale, NY 11735. ■

E-Z MATH

THE MATH OF CAPACITORS

By Louis E. Frenzel

You can't design with capacitors unless you know exactly what they are capable of in mathematical terms. Here's the chance to learn what you need before you'll need it

THE CAPACITOR IS SUCH A COMMON ELECTRONIC COMponent that its importance is usually understated. Further, its function is pretty well understood. It stores electrical energy in the form of an electric field created by a charge of opposite polarities on plates across an insulator. The charging and discharging of a capacitor produces many useful effects. Capacitors are commonly used in timing, sequencing and delay operations. Capacitors are also widely used as filters and phase shifters. Capacitors offer an opposition to current flow called *capacitive reactance*. And when combined with inductors, capacitors produce that invaluable phenomenon known as resonance.

In this installment, we take an in-depth look at capacitor operation and application by way of the math that defines and describes it.

Capacitor Review

Capacitors are pretty well known to most of you, so I won't belabor you with the obvious. But just for openers, here's a quickie overview of capacitor operation. It should refresh your memory about basic capacitor operation and characteristics.

First, a capacitor is nothing more than two conductors separated by an insulator. The two conductors are usually called plates, while the insulator is referred to as the dielectric. A simple capacitor is illustrated in Fig. 1. The dielectric can be any insulator, but common ones are ceramic, mica, paper, and various plastics such as polystyrene. Air or free space is also a common dielectric. The symbol used to represent capacitors in schematic diagrams is also shown in Fig. 1.

When a capacitor is connected to a voltage source, it becomes charged. That is, one plate takes on a negative charge and the other a positive charge.

Figure 2 shows what happens when a battery is connected to a capacitor. The positive terminal of the battery pulls many electrons from plate A. The negative terminal of the battery deposits extra electrons on plate B. The capacitor is then said to be charged.

The dielectric prevents electrons from flowing between plates A and B. The capacitor blocks the flow of direct current.

With the capacitor charged, the positive and negative charges on the plates attract one another across the dielectric. Remember, opposite charges attract, like charges repel. That attraction sets up an electric force field between the plates. If the battery were removed, the charge would remain due to the mutual attraction. The capacitor stores electrical energy in the form of an electric field.

Now if we short the plates of the charged capacitor as in Fig. 3, the electrons on plate B will rush through the short to neutralize the positive charge. That sudden momentary rush of current discharges the capacitor.

The charge on the capacitor is measured in Coulombs. A coulomb is a quantity of electrons. One coulomb is 6.28×10^{18} electrons. That is a big bunch of electrons. If that number of excess electrons appears on one plate to make it negative, then an exactly equal number of electrons will be removed from the other plate to make it positive.

Knowing the charge in coulombs (Q) and the voltage (V) that produces it, gives us a way to state the size or *capaci-*

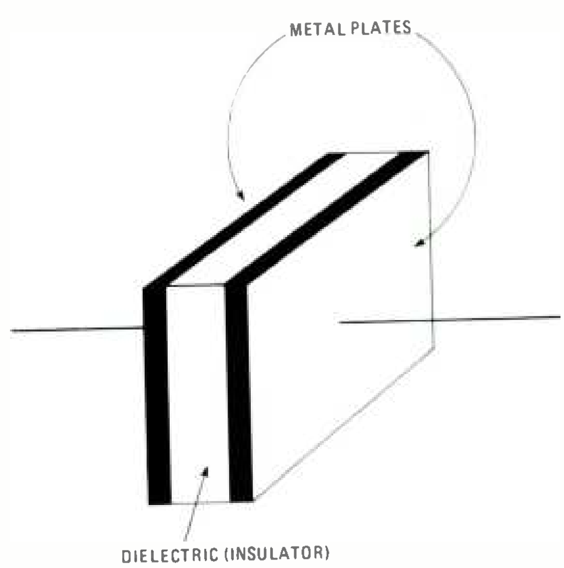


Fig. 1—This is a standard parallel-plate capacitor. Many capacitors, such as axial and radial types, do not have flat plates, but operate on the same principles.

The capacitor will keep on charging until the full 12 volts appears across it. It takes about five time constants for the full charge to be reached. In the example above, it will take $5 \times .47 = 2.35$ seconds for the capacitor to fully charge to approximately 12 volts.

The curve in Fig. 6 shows the voltage on the capacitor with respect to time. The one and five time-constant points are identified there.

Actually it would be nice to know the exact voltage on the capacitor at any given time during the charging process. If we knew the mathematical equation representing the curve in

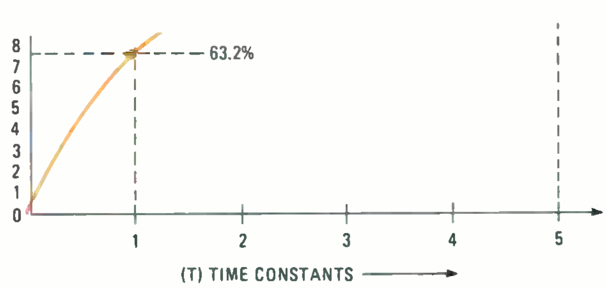


Fig. 6—The capacitor charges quickly at first, but then the build up of further charge takes longer and longer.

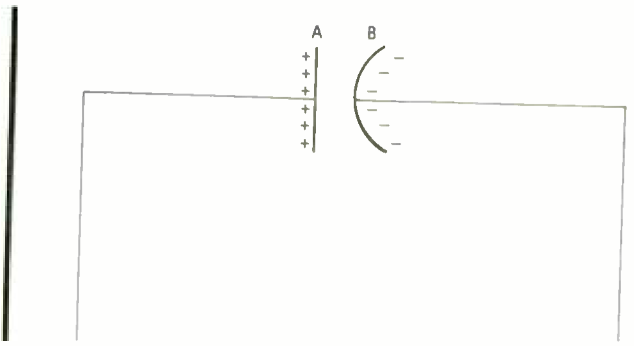


TABLE 1—FARAD UNIT CONVERSIONS

TO CONVERT	INTO	THEN
F	μF	$\times 10^6$
F	pF	$\times 10^{12}$
μF	F	$\times 10^{-6}$
μF	pF	$\times 10^6$
pF	F	$\times 10^{-12}$
pF	μF	$\times 10^{-6}$

$$v = 12(1-.12)$$

Now, subtract .12 from 1 to get .88. Finally, multiply the source voltage by the above value to get the capacitor voltage:

$$v = 12(.88) = 10.56 \text{ volts}$$

Now, that wasn't too hard, was it?

Refer back to Fig. 5. Assume we allowed the capacitor to fully charge to 12 volts. Now, we throw the switch to the B position. The capacitor will discharge through the resistor. The voltage across the capacitor will decline until it is eventually zero. It takes one time constant (T = RC) for the capacitor to discharge to a voltage of 36.8% of the initial applied voltage. Using the same values as earlier, we can say that in .47 seconds, the capacitor voltage drops to $12 \times .368 = 4.4$ volts. It takes about 5 time constants or 2.35 seconds for the capacitor to fully discharge.

The discharge curve, therefore, looks like that in Fig. 7. Its equation is:

$$v = V_i e^{-t/RC}$$

Here, V_i is the initial voltage on the capacitor. Assume we let the capacitor charge to the full 12 volts. Then we flipped the switch to the B position. What is the voltage after 1.5 seconds? In the formula, t = 1.5 second.

$$V = 12e^{-1.5/.47}$$

First, compute the exponent, or:

$$1.5/.47 = 3.19$$

Make it negative, then press INV and e^x. You should get .0411. Now the equation looks like this:

$$v = 12(.0411)$$

Making the final multiplication gives you the voltage on the capacitor after 15 seconds or about .49 volts.

Exercise Problems

Try your hand at this now: Assume a capacitor of 220pF, a resistor of 680 ohms, and a supply voltage of 5 volts.

1. What is the voltage on the capacitor after 2 time constants?

2. How long does it take for the capacitor to fully charge (or discharge)?

3. If the capacitor is fully charged, what is its voltage after 200 nS?

Rearranging

A lot of times you want to know what the time (t) is at a stated charge or discharge voltage (v). That is easy to find, but you have to rearrange the above equations to solve for t in terms of v. I won't bore you with the messy translation here, but if you're so inclined, feel free to take a swipe at the algebra yourself. Otherwise, just use the equations below.

$$\text{Charge: } t = -RC\ln(1-v/V_s)$$
$$\text{Discharge: } t = -RC\ln(v/V_i)$$

So, let's work on a couple of problems. Look back at Fig. 6. How much time does it take for the capacitor to charge to let's say 6 volts?

$$t = -RC\ln(1-v/V_s)$$

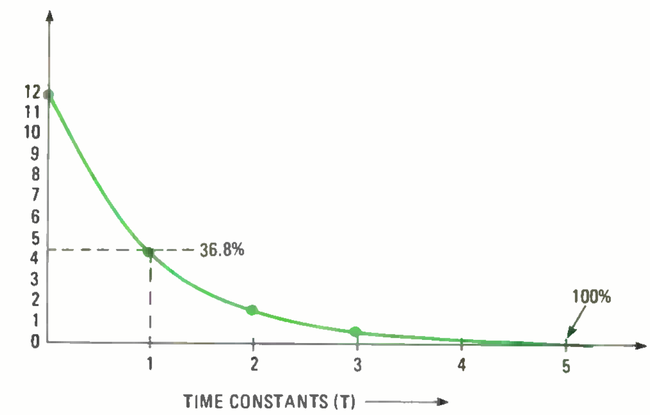


Fig. 7—A capacitor discharges in a fashion similar to the way it charges, quickly at first, but slowly as time continues. Its pace continues to slow as time goes on.

RC is our time constant T which we previously computed as .47. The instantaneous voltage is 6 volts. The supply voltage V_s is 12 volts. So:

$$t = -.47\ln(1-6/12)$$
$$t = -.47\ln(.5)$$

To find the natural log of .5 on your calculator, just key in .5, then press the LN key. You should get −0.693. Multiplying this by .47 gives:

$$t = -.47(-.693)$$
$$t = .326 \text{ seconds}$$

So after .326 seconds of charging, the voltage will be 6 volts.

Finding the discharge time is just as easy. Assume a full charge of 12 volts. How long does it take the capacitor voltage to drop to 3 volts?

$$t = -RC\ln(v/V_i)$$
$$t = -.47\ln(3/12)$$
$$t = -.47\ln(.25)$$
$$t = -.47(-1.39)$$
$$t = .65 \text{ seconds}$$

Exercise Problem

By now you have probably mastered that, but just to be sure, check yourself on this problem.

4. How long does it take a .01μF capacitor to charge through a 10K ohm resistor to 10 volts if the supply voltage is 15 volts?

RC Pulse Shaping

One common application of RC networks is pulse shaping. A pulse is a voltage (or current) that switches rapidly between two levels as shown in Fig. 8. At A, the pulse switches between zero and +10 volts. At B, the pulse switches between −0.5 and −12 volts. In Fig. 8C, the two levels are +5 and −5 volts. The pulses at A and B are DC, the one in C is AC. When the pulse on and off times are equal, we call it a square wave.

It is frequently necessary or desirable to change the shape of the pulse. One example is to create narrower pulses at the points where the pulse switches on or off. Such a circuit for doing that is shown in Fig. 9. It is called a differentiator circuit. It is nothing more than a simple series RC network.

The capacitor will charge or discharge when a pulse is applied to it.

The exact operation of the circuit really depends upon two key factors, the RC time constant and the on time of the pulse. The on time of the pulse or the pulse duration is shown in Fig. 8. It is less than the period of pulse. Let's examine the operation of the circuit in Fig. 9 in detail.

First assume that the capacitor is initially uncharged. The input pulse is like that shown in Fig. 8A and is in its zero-volt state. Let's further assume that the pulse period is 4 mS. That makes the pulse period one half this, or 2 mS.

We can now compute the time constant of the RC circuit.

$$T = RC = 10 \times 10^3 \times .02 \times 10^{-6}$$
$$T = .2 \times 10^{-3} \text{ sec or } 200\ \mu S$$

The capacitor will charge to 63.2% of the applied voltage, or 6.32 volts in 200 μS. Five time constants is:

$$5 \times 200 = 1000\ \mu S = 1 \text{ mS}$$

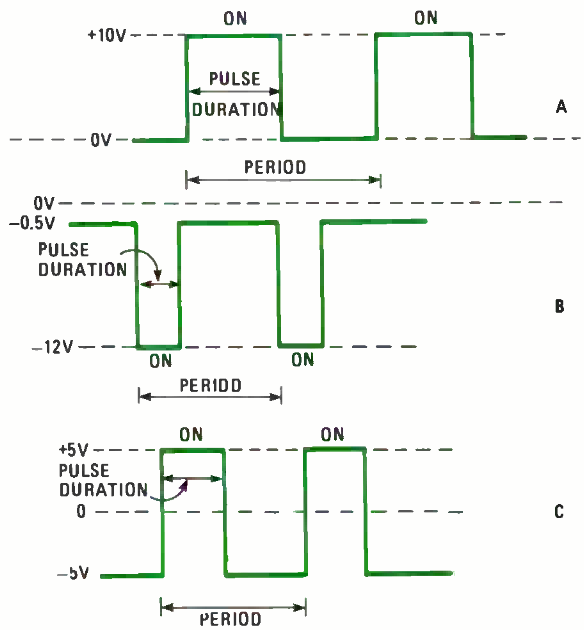


Fig. 8—Among the types of voltage pulses are positive logic (A) where "on" is represented by a positive voltage; negative logic (B), where "on" is represented by a negative voltage; and bipolar (C), where "on" is signified by a positive voltage, and "off" by a negative voltage.

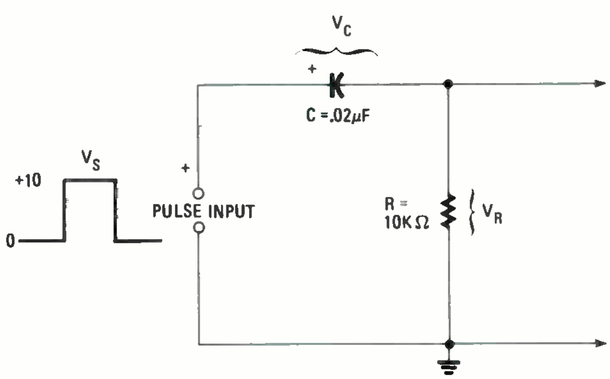


Fig. 9—A differentiator output can swing negative during discharge if the input is truly shorted at zero volts.

As you can see, the capacitor will fully charge to 10 volts in 1 mS.

Now, if the pulse switches on, the input voltage is suddenly +10 volts. The capacitor doesn't respond immediately. In fact, it acts just like a short circuit initially. The result is that we see the full +10 volts across the output resistor. However, this changes and then the capacitor begins to charge. The voltage across the capacitor begins to increase just as you saw in Fig. 6. But, if you look back at Fig. 9, you will see that in the differentiator circuit the output is taken from across the resistor, not across the capacitor.

To understand what the resistor voltage looks like, we need to review some basic concepts. First, remember Kirchoff's voltage law that says that the sum of the voltage drops in a series circuit equals the source voltage. In Fig. 9, the capacitor voltage (V_C) plus the resistor voltage (V_R) must equal the supply voltage (V_S).

$$V_S = V_C + V_R$$

The resistor or output voltage then is:

$$V_R = V_S - V_C$$

As you can see, as the capacitor voltage increases, the resistor voltage decreases. As the capacitor voltage reaches full charge, the resistor voltage will be zero.

Another way to look at this is to observe the polarities of the voltages involved in Fig. 9. The pulse polarity and the capacitor voltage polarity are series opposing. The capacitor, because it stores a charge, acts like a DC source as well. The source and capacitor voltages add algebraically to produce the composite voltage that appears across the resistor. Since the polarities are opposite, the algebraic addition becomes a subtraction. Therefore, the resistor voltage is the difference between the source and capacitor voltages. That's what the formula told us earlier. Anyway, as the capacitor charges, the total voltage applied to the resistor decreases.

Figure 10 shows what's happening. As you can see, the output rises steeply to +10 volts as the pulse switches on, then rapidly decreases as the capacitor charges. The capacitor is fully charged in 1 mS or one half the pulse width. The resulting output voltage is a narrow positive-going pulse.

Now, the input pulse switches from +10 to zero volts. A

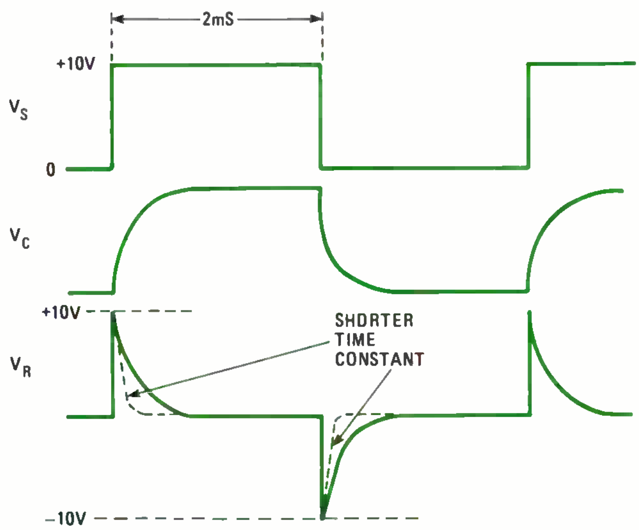


Fig. 10—Notice the voltage swing during discharge. That is due to the change in the current direction upon shorting.

zero pulse-generator output is equivalent to a short across the generator input. Referring back to Fig. 9, you can see that that effectively places the voltage directly across the resistor. The positive plate of the capacitor is brought to ground so the output goes negative with respect to ground. Since we let the capacitor charge fully to + 10 volts, the output conversely goes to –10 volts.

The capacitor then begins to discharge through the resistor. The discharge curve looks just like that shown earlier in Fig. 7. In one time constant, the output voltage drops to 36.8% of the initial capacitor voltage or .368 × –10 = –3.68 volts. After 5 time constants or 1 mS, the capacitor fully discharges to zero. You can see the effect in Fig. 10. As you can see, the differentiator produces narrow positive and negative pulses at the switching points of the input pulse. The width of those pulses depends upon the time constant. If the time constant is very short compared to the input pulse width, the capacitor charges and discharges, fast creating very-narrow output pulses. See Fig. 10.

On the other hand, if the time constant is long compared to the pulse duration of the input pulse, then the capacitor may not fully charge or discharge before the input pulse switches. That condition is illustrated in Fig. 11. Assume that the time constant is long compared to the pulse width. During the input pulse, the capacitor charges up to +6 volts. The resistor voltage will drop from + 10 to + 4 volts as the figure shows. Then, the input switches to zero. The capacitor is connected across the output resistor as described before. But it only has 6 volts on it so the output switches to –6 volts. Then the capacitor discharges through the resistor to about –2.4 volts before the input pulse switches again.

With the pulse on again, the + 10 input adds to the –2.4 volts on the capacitor giving a 10–2.4 = 7.6 volt output pulse. The capacitor begins to charge to this value and again the output decreases.

With larger time constants, the capacitor never fully charges or discharges during the input pulse. As a result, the output is not what you could really call pulses. It is instead more of a distorted square wave. If you make the time constant very long compared to the pulse duration, the capacitor will charge very little and the output will be very nearly the same as the input as Fig. 11 shows.

To create short, narrow pulses as desired, the differentiator must have a very short time constant compared to the pulse duration. If we call the pulse duration t_d and the time constant T, then for a good differentiator:

$$T \ll t_d$$

or

$$t_d \gg T$$

where ≫means much greater than and ≪means much less than. For a good differentiator, the pulse width ought to be at least ten times the time constant.

Now, let's look at an integrator circuit. It too is a simple series RC circuit except the output is taken from across the capacitor. See Fig. 12.

Let's again assume the input pulses of Fig. 8A. When the input switches from 0 to + 10 volts, the capacitor acts initially as a short so the output is zero. But then, the capacitor begins to charge toward + 10 volts. The output rises with the shape you saw back in Fig. 6. If the pulse duration is long enough, the capacitor will fully charge before the pulse switches back

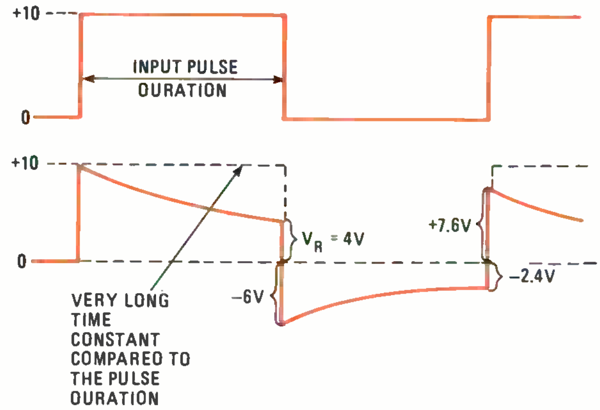


Fig. 11—Pulse distortion is easily created in a differentiator with a long time constant. Notice how the voltage does not stabilize, but drifts all over the place.

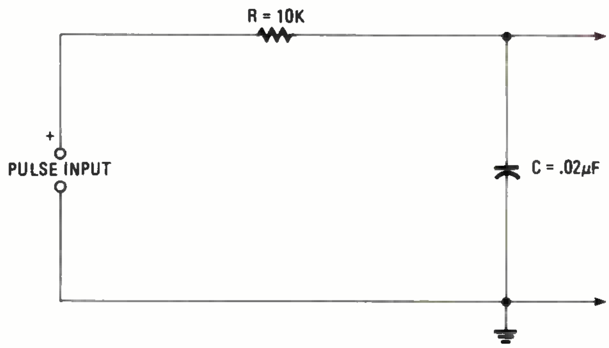


Fig. 12—An integrator setup is similar to that of a differentiator, except the output is taken off the capacitor. Its action is therefore the opposite of a differentiator.

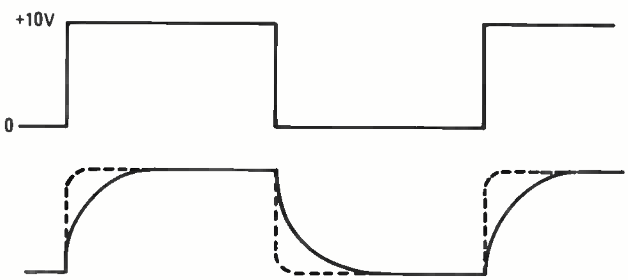


Fig. 13—The output of an integrator is a distortion of the input pulse. As you make the time constant shorter in comparison to the pulse duration, the output will begin to resemble the input more and more closely.

to zero. In other words, the time constant is short compared to the pulse duration.

When the input pulse switches back to zero, the generator acts as a short. Therefore, the capacitor will begin to discharge. If the time constant is short, the capacitor will fully discharge before the pulse changes positive again.

Using the RC and pulse-duration values given earlier, the input and output waveforms will be as shown in Fig. 13. That is not a particularly useful waveform. It is just a distorted form of the input pulse. Making the time constant even shorter will cause the capacitor to charge and discharge more quickly so that the output looks very much like the input as shown by the dashed lines in Fig. 13.

(Continued on page 106)

By Herb Friedman

FRIEDMAN ON COMPUTERS

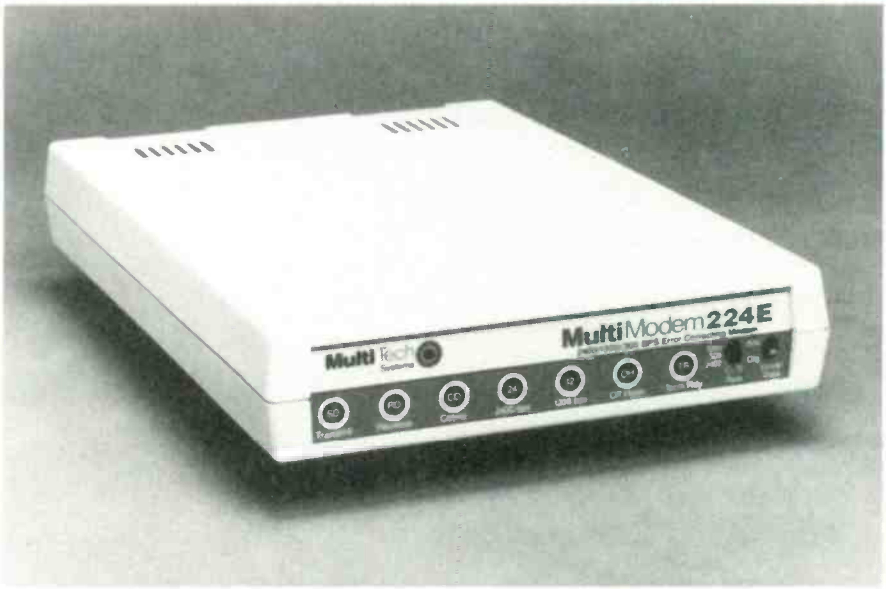
Class 5 modems can exchange up to twice the data in half the time

TIME!...PARTICULARLY WHERE IT concerns personal computing, is logarithmic. Each new item of hardware and software takes less time to develop, debug, and get into common use than its predecessors. Particularly where it concerns modemized communications, there is little time lost between the thought and the application.

I must have plugged along for some 15 years with a modem that ran at 110 baud, which was as fast as anyone needed because most of us used a TTY (teletypewriter) for mainframe and personal computer I/O; and 110 words-per-minute, which is what 110 baud works out to be, was as fast as the TTY could operate.

But then we got the electronic terminals and TTYs that could operate at 300 wpm; and it seems that almost overnight most computerists were converting to 300-baud modems so that they could apply the full potential of the new TTYs and on-line matrix printing.

I don't think I used a 300-baud modem for more than a couple of years before the on-line information services were pushing 1200-baud operation, because personal computers could store information for later transmission and retrieval; it was no longer necessary to print in step with the data-transmission rate.



Class 5 modems don't look much different than the usual full-feature modem. You almost have to read the fine print to discover that model *224E* from MultiTech Systems features error correction, speed correction for fixed-speed computer ports, and data compression.

Not Fast Enough

But even 1200 baud wasn't fast enough for business use, and about a year or so ago 2400 baud really caught fire as the preferred modem speed for asymmetrical communications on conventional subscriber telephone lines—what is called the *switched network*.

With telephone costs skyrocketing because of what is euphemistically termed "telephone deregulation," heavy users of modem communications pushed the capability of the conventional dial-up telephone system to its limit. But just as a marathon runner has "the wall" at which endurance runs out, so, too, does the switched network have a wall.

For conventional two-wire subscriber lines, it's 2400 baud; which for all practical purposes means a maximum of 2400 bps (bits per second). (While there has been some success on the switched network with higher baud rates, it usually means half-duplex operation, and/or synchronous modems—which tend to get very expensive, and are not all that reliable. The higher baud-rate modems usually have automatic fallback to a slower baud rate when the going gets rough.)

Now one of the facts of life is that if you can't blow up a wall, you can only get past it by going over, under, or around the sides. In the case of the 2400 baud "wall," depending how you look at it, we either tunnel under, or get a boost and go over in order to exceed the 2400 bps (bit per second) limitation.

The way it's done is with something called the *Class 5 Protocol*, which is based on Microcom, Inc.'s *Microcom Network Protocol* (almost always shortened to simply MNP).

Software to Hardware

Unlike a conventional modem that depends on the communications software to provide error correction, a Class 5 modem contains both error-correction and data-compression firmware (meaning built-in software). You probably all understand error correction, whereby the originate and answer computers or modems software-handshake each block of data. If the handshakes don't match, the originating station keeps repeating the block until it receives a handshake that indicates data has been received properly.

Data compression is something different. Basically, the originating modem strips out unneeded bits of data. It samples repeated characters, and when three more appear in succession, it compresses the three characters into enough data so that the three can be

(Continued on page 95)

By Don Jensen

JENSEN ON DX'ING

Guiana...Guinea—Not sound-alikes, but similar enough to cause confusion

GUIANA—ACTUALLY THERE ARE three of them—is in South America, while Guinea—all three of them—is in Africa. Add *New* Guinea, half a world away, and it complicates the situation still more. SWLs, of course, because of their tuning interests are more attuned to such geographical trivia than non-shortwave types.

But its more than a "name game" that we're playing here. Among the Guiana–Guinea countries are some interesting listening targets for shortwave DXers. Take the Guiana trio, for instance, located high on the "shoulder" of South America, tucked in there on the Atlantic coast between Venezuela and Brazil.

There is French Guiana, technically a part of France; Surinam, an independent nation formerly called Dutch Guiana; and Guyana, a post-independence spelling for the former colony, British Guiana.

Easily, the easiest to hear of the Guianas is French Guiana, thanks to a high-powered shortwave-relay transmitter facility operated by *Radio France International* (RFI). When you listen to RFI's English programming at, say, 0330 UTC, on 6055 or 9800 kHz, the strong signals you here are coming from 500-kilowatt transmitters at Montsinery, in French Guiana.

The other shortwave outlet in that French territory is *Radiodifusion Francaise d'Outre-Mer* Guyana, or simply RFO, which broadcasts from the city of Gayenne. That station's transmitter outputs a mere 4 kilowatts, so it is not an easy catch, but try 3385 kHz during the very-early morning hours, say 0900 UTC or so.

The other Guianas are iffy propositions. Surinam's *Radio Apintie*, in the capital of Parimaribo, sometimes shows up, mornings or evenings, on 5005 kHz, but that frequency is often a noisy one. Further, there are questions about whether the station's operations are all that regular. And the *Guyana Broadcasting Corporation's* shortwave station at Georgetown, Guyana, on 5950 kHz isn't reported by listeners too often, either.

This exotic scene of an Indian temple, Qubt Minar, is from a QSL card sent by All India Radio (AIR) in Delhi.

For Guinea, we have to leap the Atlantic. On the west-African mainland is the Republic of Guinea. Its government-operated shortwave voice, at Conakry, is *Radiodiffusion National's Voix de la Revolution*. Look for it at about 0600 UTC on 4900 kHz, and at other times on 7125, 9650, or 15,310 kHz. Given that country's colonial heritage, it isn't surprising that much of the programming is in French.

On the other hand, the linguistic background of the Democratic Republic of Equatorial Guinea is Spanish. It's a curious country, consisting of the mainland portion, formerly Spanish Guinea, and the offshore island that was earlier known as Fernando Po.

Radio Nacional de Guinea Ecuatorial has a mainland station at the city of Bata, operating on 5000 kHz. It is heard in North America with not too much difficulty, either at sign-on shortly after 0500 UTC, or at around 2100 UTC.

Even easier to log is the station's international service at Malabo, which is in English, around 2100 UTC; the broadcasts consist mostly of recorded religious programs by several U.S.-radio preachers. The frequency is 9553 kHz.

Portugal also controled part of African Guinea during its colonial days, but Guinea-Bissau has been independent for several decades now. In the past, *Radiodifusao Nacional* operated on shortwave in the 60-meter band, but that station has been inactive for quite some time.

New Guinea, naturally, is an entirely different bit of business. It is the largest island in the world, located north of Australia. The island is split, these days, between the nation of Papua New Guinea and the Indonesian territory of Irian Jaya.

Papua New Guinea has a series of shortwave transmitters throughout its farflung territory, most of which can, under favorable conditions, be heard in many parts of the U.S. and Canada. But for starters, the most commonly heard seems to be the NBC station—which stands for *National Broadcasting Commission* of Papua New Guinea—at Port Moresby, on 4890 kHz. Try to listen for that one at between about 1000 and 1400 UTC, or at about dawn where you live.

Finally, Indonesia's national network, *Radio Republik Indonesia* has several shortwave stations in Irian Jayas,

*CREDITS: Robert Ross, Ont; Richard Edkman, CA; Cedric Marshall, Ont.; Gordon Edwards, OH; Richard Lemke, Alberta, Canada; Steve Wallace, CA; Michael Bryant, GA; North American SW Association, 45 Wildflower Rd., Levittown, PA 19057; Ontario DX Association, Box 161 Station A, Willowdale, Ontario, Canada M2N 5S8 which is the western half of New Guinea. At the right time of year—September and October are good times to try—and under favorable conditions, the RRI outlets at Jayapura (on 5045 kHz) and at Fakfak (on 4789 kHz) can occasionally be heard.

So with Guiana and Guinea, in their various versions, and New Guinea, you've got some interesting DX hunting ahead of you.

Feedback

Questions, comments on SW programming heard, and commennts on what you've liked and what you haven't liked in this column are always welcome. Drop me a line in care of the address that appears at the beginning of the Down the Dial section, elsewhere in this column.

Dan Ritter of Allentown, PA is one of our readers who recently wrote. Dan asks: "Do you have a a circuit for a beat-frequency oscillator (BFO) that I can hook up to a portable receiver? Then I could listen to the many CW (code) and SSB (single sideband) signals that my receiver can pick up."

Hey, Dan, I have a pact with other **Hands-on Electronics** authors: I don't "do" construction projects and they don't deal with shortwave topics. Seriously, though, I have doubts as to whether the results of any such project would be worth the effort. In the long run, you'd be more successful in tuning CW and single-sideband signals (particularly the latter) with a receiver designed to easily receive SSB. That includes some not-too-costly models.

But, if you do want to play about with SSB, you might try this old trick—sometimes called the Poor Man's BFO—that dates back to the early days of single-sideband radio: Take a small AM radio, place it near your shortwave receiver. Turn it on but keep the volume as low as you can. No guarantees, but sometimes the RF radiated by the AM radio will mix with the SSB or CW signal and make those transmissions intelligible.

Usually, the focus in this column is on SW **roadcast**—i.e., music, entertainment, news, and other programs for general audiences. But there are other transmissions on shortwave, including the non-program "utilities" such as VOLMET—aircraft weather transmissions for international flights.

Robert J. McNulty, Raritan, NJ, mentions a couple of his VOLMET catches. "I had reception of Shannon Airport, Ireland on 3414 kHz at 0410 UTC with strong signal and no radio interference. Also I had the RAF VOLMET on 4723.6 kHz at 0422 UTC with a weak signal. It was difficult to stabilize with some drift."

R.J. uses a Panasonic RF-B600 receiver and I can't resist adding his final P.S.: "Great column! Read it each month!"

Down the Dial

Well once again we've reached the spot where each month we feature your reports about what's being heard on the shortwave bands. Send your loggings to *Jensen on DXing*, **Hands-on Electronics**, 500-B Bi-County Blvd., Farmingdale, NY 11735. Also any questions about stations heard or other SWLing subjects are welcome; I'll try to answer them in a future column.

ABBREVIATIONS

AIR	All India Radio
AM	amplitude modulation (modulated)
BFO	beat-frequency oscillator
CKFX	C is prefix for Canadian SW station call signs (CKWX, CKVP, CFRB, CFCX, etc.)
CW	continuous wave
DX	long distance (over 1000 miles)
DX'er	listener to long-distance shortwave broadcasts
kHz	kilohertz (1000 hertz)
NBC	National Broadcasting Commission
QSL	verification reply from broadcaster
RAF	Royal Air Force
RF	radio frequency
RFI	Radio France International
RFO	Radiodifusion Francaise d'Outre-Mer
RRI	Radio Republik Indonesia
SSB	single-sideband
SW	shortwave
SWL(s)	shortwave listener(s)
US	United States
UTC/GMT	Universal Time Code/ Greenwich Mean Time
WHRI	World Harvest Radio International

Canada—6030 kHz. *CFVP* in Calgary, Alberta is perhaps the toughest of the private Canadian SW station to log. But some DXers in the "Great White North" have heard it around 2100 UTC, identifying itself as *AM 106*, after the medium-wave outlet on 1060 kHz that it relays.

Galapagos Islands—4810 kHz. Six-hundred miles off the coast of Ecuador, is that land of exotic flora and fauna, which challenged and inspired Charles Darwin in the 19th Century. Today that lovely island is home to the shortwave station, *La Voz de Galapagos*, also announcing as *Radiodifusora de Galapagos*. That station, which broadcasts in Spanish, often can be heard until its sign-off, at about 0200 UTC.

Greece—9395 kHz. If you liked the music in "Zorba the Greek," chances are you'll enjoy tuning in to the *Voice of Greece*, which can be found on that frequency. Try looking at about 0130 UTC.

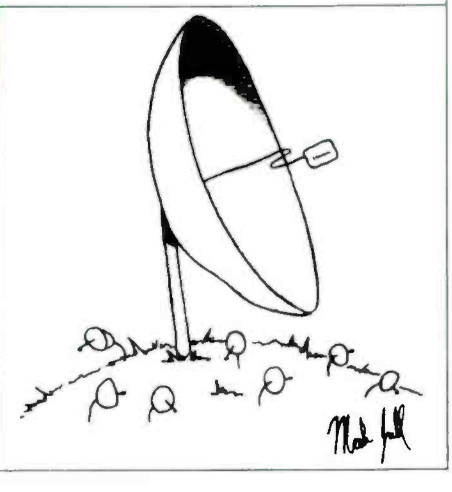
Guatemala—3380 kHz. Like listening to Central-American music such as Marimba rhythms? Try tuning *Radio Chortis* during the evening hours. The station signs off the air just prior to 0300 UTC.

Nicaragua—6100 kHz. What is the Sandinistas government in that country saying about US policy? You can find out by tuning in Managua's official station, the *Voice of Nicaragua*, in English, at 0300 UTC.

North Africa—12,005 kHz. One of the lesser-known and seldom-heard North African stations is *Tunisia RTVT*, which has been reported with Arabic programming, but European music at around 0730 UTC.

South Korea—9570 kHz. With the summer Olympics nearly upon us, a good spot to watch for shortwave coverage of the competition is *Radio Korea*, in Seoul. English-language programming can be hard between 1400 and 1500 UTC.

United States—17,830 kHz. WHRI, *World Harvest Radio*, transmitting from Indiana, is one of the new batch of shortwave broadcasters with religious programming that have gone on the air in the last several years. If you are interested in the station, you can tune it in at 2100 UTC. ■



By Marc Ellis

ELLIS ON ANTIQUE RADIO

Restoring A Zenith Shutter-Dial Set

JUDGING FROM THE VOLUME OF reader mail received, the columns dealing with the Echophone *EC1* restoration project (concluded in the November, 1987 issue of **Hands-On Electronics**) were among the most popular, to date, in the Ellis On Antique Radio series. So, never being shy about capitalizing on a good idea, I'm going to kick off a new restoration project this month.

But first, a word to all the people who wrote me in response to the two columns on the *Crosley 50* (January and February 1988): Even though I devoted the last two columns to catching up on the mail backlog, I wasn't able to get to the Crosley letters. Be patient, though! I'm saving your very interesting stories, questions, and comments for a column that will appear in the near future.

Zenith's Tricky 3-Band Dial

Some years ago, I happened to be driving through a rural area of Missouri on business. Passing a likely looking antique store and having a little time to spare, I stopped to check the old-radio scene. The young lady who waited on me showed me a Zenith BC/SW console with a very interesting looking round, black dial. It had been for sale, she said. But, now that she and her husband had made an accidental discovery about the dial mechanism, they were going to keep the set.

In response to my raised eyebrows, the girl reached out and turned the bandswitch. As she did so, I was amazed to see the dial calibrations change almost instantly from broadcast band, through two different shortwave bands, and back to broadcast band again. I couldn't figure out what was happening until I tried the operation myself. Rotating the bandswitch a little more slowly, I watched a pair of semi-circular dial segments carrying one set of calibrations flip out of the way, to be replaced immediately by a pair carrying another set.

The Zenith 7S232 as received from the dealer. The set is 16-inches wide, and almost two feet high; the charred area around the speaker is a result of a furnace explosion.

I left the shop with mixed feelings. While I was really taken with the beautiful and ingenious dial mechanism, I was almost happy that the radio wasn't for sale. Even though our home isn't exactly small, we don't have a whole lot of space available for console storage.

Bad Luck/Good Luck!

A few months later, I happened to be visiting an antique-radio dealer of my acquaintance—an old gentlemen who bought and sold the sets as a retirement hobby. I described the dial of the Zenith console and asked if he had ever come across one. "Oh yes," he said, "that's called a shutter dial, and Zenith made quite a few models using them."

"Were they all consoles?" I asked.

In reply, he led me over to a Zenith table model the size of a small juke box. It was easily the tallest non-console radio I had ever seen. And, though the mechanism was jammed, it obviously had a shutter dial just like the one I'd seen in the antique store. "How much?" I immediately queried. But it wasn't for sale because the dealer wanted to work on it himself! Disappointed, I began to wonder if I'd ever come across a shutter-dial set with an owner who'd be willing to part with it.

A few weeks later, though, I received a phone call from the dealer. It seemed that, not long after my visit, something had gone wrong with the gas furnace at his home. The result was a small, but violent, explosion that damaged several of his old sets. The table-model shutter-dial radio I'd admired was among them—but was still restorable. He was moving to a new location and wanted to reduce his stock. If I was still interested, he'd give me a good deal on the radio. Needless to say, I lost no time in getting out there to pick up my new acquisition.

Human nature being what it is, I didn't do much with the set after getting it safely under my wing. There were too many problems to be solved, and the time never seemed right to begin on them. But the radio's many problems and high interest value should make it an ideal restoration project for this column. So let's get started!

Introducing the Model 7S232

Though the photos don't suggest it, the *Zenith Model 7S232* has to be one of the largest table-model sets ever made. The cabinet is about 16-inches wide, and stands almost two-feet high. Its

Here's the shutter-dial assembly that makes the radio so interesting. You may be able to see the edges of the jammed shutters in the recessed inner circle.

91 Hands-on Electronics FactCard — LF444A: Quad Low-Power Op-Amp

DC ELECTRICAL CHARACTERISTICS

Characteristic	Conditions	LF444A Typ	LF444 Typ	Units
Input Offset Voltage V_{OS}	$R_S = 10\ k\Omega$ $T_A = 25°C$	2	3	mV
	$0° \le T_A \le 70°C$			mV
Average TC of Input Offset Voltage $\Delta V_{OS}/\Delta T$	$R_S = 10k\Omega$	10	10	$\mu V/°C$
Input Offset Current I_{OS}	$V_S = \pm 15V$			
	$T_j = 25°C$	5	5	pA
	$T_j = 70°C$			nA
	$T_j = 125°C$			nA
Input Bias Current I_B	$V_S = \pm 15V$			
	$T_j = 25°C$	10	10	pA
	$T_j = 70°C$			nA
	$T_j = 125°C$			nA

Characteristic	Conditions	LF444A Typ	LF444 Typ	Units
Input Resistance R_{IN}	$T_j = 25°C$	10^{12}	10^{12}	Ω
Large Signal Voltage Gain A_{VOL}	$V_S = \pm 15V$, $V_O = \pm 10V$, $R_L = 10\ K\Omega$, $T_A = 25°C$	100	100	V/mV
	Over Temperature			V/mV
Output Voltage Swing	$V_S = \pm 15V$, $R_L = 10\ k\Omega$	± 13	± 13	V
Input Common-Mode Voltage Range		+18	+14	V
		−17	−12	V
CMRR	$R_S \le 10\ k\Omega$	100	95	dB
Supply Voltage Rejection Ratio		100	90	dB
Supply Current		0.6	0.8	mA

92 Hands-on Electronics FactCard — LF351: Wide Bandwidth JFET Input Operational Amplifier

DC ELECTRICAL CHARACTERISTICS

PARAMETER	CONDITIONS	TYP	UNITS
Input Offset Voltage V_{OS}	$R_S = 10k\Omega$ $T_A = 25°C$ Over Temperature	5	mV mV
Average TC of Input Offset Voltage $(\Delta V_{OS}/\Delta T)$	$R_S = 10k\Omega$	10	$\mu V/°C$
Input Offset Current (I_{OS})	$T_j = 25°C$, $T_j \le 70°C$	25	pA nA
Input Bias Current (I_B)	$T_j = 25°C$, $T_j \le 70°C$	50	pA nA
Input Resistance R_{IN}	$T_j = 25°C$	10^{12}	Ω
Large Signal Voltage Gain A_{VOL}	$V_S = \pm 15V$, $T_A = 25°C$ $V_O = \pm 10V$, $R_L = 2k\Omega$	100	V/mV
	Over Temperature		V/mV
Output Voltage Swing V_O	$V_S = \pm 15V$, $R_L = 10k\Omega$	± 13.5	V
Input Common-Mode Voltage Range	$V_S = \pm 15V$	+15 −12	V V

PARAMETER	CONDITIONS	TYP	UNITS
Common-Mode Rejection Ratio CMRR	$R_S \le 10k\Omega$	100	dB
Supply Voltage Rejection Ratio PSRR		100	dB
Supply Current I_S		1.8	mA

AC ELECTRICAL CHARACTERISTICS

PARAMETER	CONDITIONS	TYP	UNITS
Slew Rate SR	$V_S = \pm 15V$, $T_A = 25°C$	13	$V/\mu s$
Gain Bandwidth Product GBW	$V_S = \pm 15V$, $T_A = 25°C$	4	MHz
Equivalent Input Noise Voltage e_n	$T_A = 25°C$, $R_S = 100\Omega$, $f = 1000Hz$	16	$nV/\sqrt{Hz}$
Equivalent Input Noise Current i_n	$T_j = 25°C$, $f = 1000\ Hz$	0.01	$pA/\sqrt{Hz}$

93 Hands-on Electronics FactCard — ICL7129: 4½ Digit A/D Converter

ELECTRICAL CHARACTERISTICS

Characteristics	Conditions	TYP	UNIT
Zero Input Reading	$V_{IN} = 0.0V$ 200mV Scale	0000	Reading
Zero Reading Drift	$V_{IN} = 0V$ $0°C < T_A < +70°C$	+0.5	$\mu V/°C$
Ratiometric Reading	$V_{IN} = V_{REF} =$ 1000mV RANGE = 2V	9999	Reading
Range Change Accuracy	$V_{IN} = 0.10000V$ on Low Range + $V_{IN} = 1.0000V$ on High Range	1.0000	Ratio
Rollover Error	$-V_{IN} = +V_{IN} =$ 199mV	0.5	Counts
Linearity Error	200mV Scale	0.5	Counts
Input CMRR	$V_{CM} = 1.0V$, $V_{IN} = 0V$ 200mV Scale	110	db
Input CMVR	$V_{IN} = 0V$ 200mV Scale		V
Noise	$V_{IN} = 0V$ 200mV Scale	7.0	μV

Characteristics	Conditions	TYP	UNIT
Input Leakage Current	$V_{IN} = 0V$, Pin 32, 33	1	pA
Scale Factor Tempco	$V_{IN} = 199mV$ $0°C < T_A < +70°C$ External $V_{REF} = 0$ ppm/°C	2	ppm/°C
COMMON Voltage	V^+ to Pin 28	3.2	V
COMMON Sink Current	ΔCommon = +0.1V	0.6	mA
COMMON Source current	ΔCommon = −0.1V	12	μA
DGND Voltage	V^+ to Pin 36 V^+ to $V^- = 9V$	5.3	V
DGND Sink Current	ΔDGND = +0.5V	1.2	μA
Supply Voltage Range	V^+ to V^-	9	V
Supply Current Excluding COMMON Current	V^+ to $V^- = 9V$	1.0	mA
Clock Frequency		120	kHz

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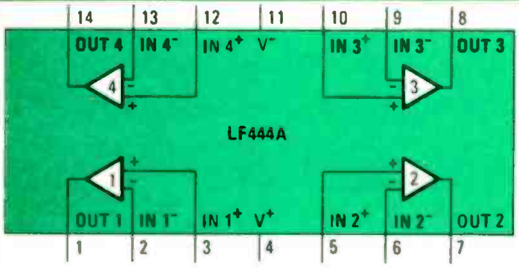
Hands-on Electronics.

91 Hands-on Electronics FactCard — LF444A: Quad Low-Power Op-Amp



GENERAL DESCRIPTION

The LF444 quad low power operational amplifier provide many of the same AC characteristics as the industry standard LM148 while greatly improving the DC characteristics of the LM148. The amplifier has the same bandwidth, slew rate, and gain (10 kΩ load) as the LM148 and only draws one tenth the supply current of the LM148. In addition the well matched high voltage JFET input devices of the LF444 reduce the input bias and offset currents by a factor of 10,000 over the LM148. The LF444 also has a very low equivalent input noise voltage for a low power amplifier.

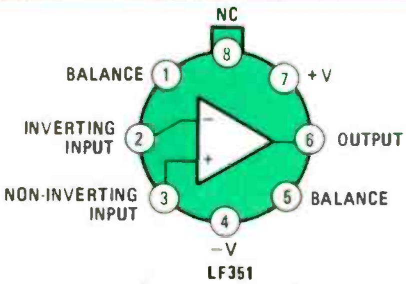
FEATURES

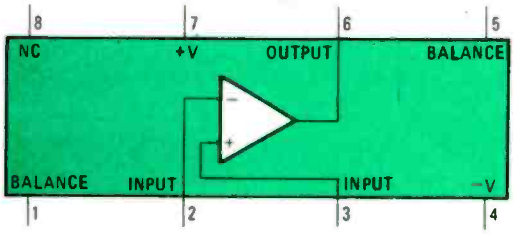
■ 1/10 supply current of a LM148	200 μA/Amplifier (max)
■ Low input bias current	50 pA (max)
■ High gain bandwidth	1 MHz
■ High slew rate	1 V/μs
■ Low noise voltage for low power	35 nV/$\sqrt{Hz}$
■ Low input noise current	0.01 pA/$\sqrt{Hz}$
■ High input impedance	10^{12}Ω
■ High gain $V_O = \pm 10V$, $R_L = 10k$	50k (min)

ABSOLUTE MAXIMUM RATINGS

	LF444A	LF444
Supply Voltage	±22V	±18V
Differential Input Voltage	±38V	±30V
Input Voltage Range	±19V	±15V
Output Short Circuit Duration	Continuous	Continuous
Power Dissipation	900 mW	500 mW
T_j max	150°C	115°C
θjA	100°C/W	150°C/W
Storage Temperature Range	−65°C≤T_A≤150°C	−65°C≤T_A≤150°C

92 Hands-on Electronics FactCard — LF351: Wide Bandwidth JFET Input Operational Amplifier





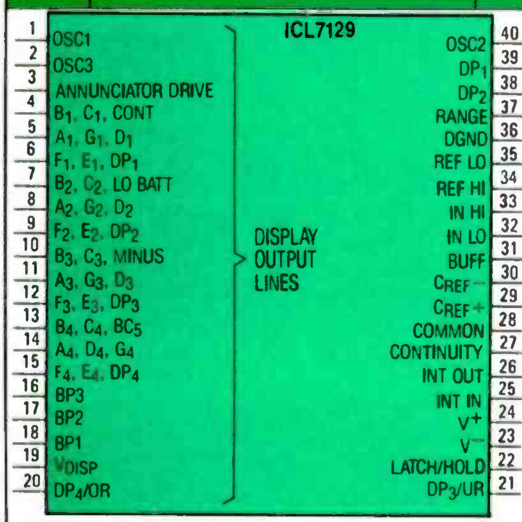
FEATURES

■ Internally trimmed offset voltage	10mV
■ Low input bias current	50pA
■ Low input noise voltage	16nV/$\sqrt{Hz}$
■ Low input noise current	0.01pA/$\sqrt{Hz}$
■ Wide gain bandwidth	4MHz
■ High slew rate	13V/μs
■ Low supply current	1.8mA
■ High input impedance	10^{12}Ω
■ Low total harmonic distortion $A_V = 10$, $R_L = 10k$, $V_o = 20Vp\text{-}p$, BW = 20Hz-20kHz	<0.02%
■ Low 1/f noise corner	50 Hz
■ Fast setting time to 0.01%	2μs

ABSOLUTE MAXIMUM RATINGS

Supply Voltage	±18V
Power Dissipation	500mW
Operating Temperature Range	0°C to +70°C
$T_{J(MAX)}$	115°C
Differential Input Voltage	±30V
Input Voltage Range	±15V
Output Short Circuit Duration	Continuous
Storage Temperature Range	−65°C to +150°C
Lead Temperature (Soldering, 10 seconds)	300°C

93 Hands-on Electronics FactCard — ICL7129: 4½ Digit A/D Converter



FEATURES

- ±19,999 count A/D converter accurate to ± 1 count
- 10μV resolution on 200mV scale
- 110dB CMRR
- Direct LCD display drive
- True differential input and reference
- Low power consumption
- Decimal point drive outputs
- Overrange and underrange outputs
- Low battery detection and indication
- 10:1 range change input

ABSOLUTE MAXIMUM RATINGS

Supply Voltages (V^+ to V^-)	15V
Reference Voltage (REF HI or REF LO)	V^+ to V^-
Input Voltage (Note 1) (IN HI or IN LO)	V^+ to V^-
V_{DISP}	V^+ to DGND −0.3V
Digital Input Pins 1, 2, 19, 20, 21, 22, 27, 37, 38, 39, 40	DGND to V^+
Power Dissipation — CERDIP package	1000mW
Power Dissipation — Plastic package	800mW
Operating Temperature	0°C to + 70°C
Storage Temperature	−65°C to + 160°C
Lead Soldering Temperature	300°C

seven-tube circuit includes a 6A8 oscillator-mixer, a 6K7 IF amplifier, a 6H6 diode detector, a 6F5 first audio amplifier, and a 6F6 audio output. The rectifier tube is a 5Y4, and a 6T5 is used as a "magic-eye" tuning indicator. I'd estimate that its date of manufacture is about 1938.

The radio includes three bands: broadcast, shortwave, and police. Since the shutters are stuck right now, I can't give you the frequency ranges covered by the shortwave and police bands. But I'll report on that in a future column.

At first glance, it looks as if the cabinet contains a lot of wasted space—perhaps the set was made unnecessarily large to look *extra-imposing*. And while there's no doubt that Zenith was going for an imposing look when they designed the 7S232, there is actually very little extra vertical space in the radio. First of all, the set's chassis is unusually deep to accommodate a large, below-deck, tuning flywheel. Stack the large tuning-dial assembly on top of that, cap the whole works with an eight-inch dynamic speaker, and you've used up most of two feet.

Zenith obviously intended for the dial assembly to be the focal point of the radio, sparing no pains to make it beautiful, smooth-operating, and convenient to use. I've already told you how the shutters work. The dial-drive mechanism itself is also worthy of mention. It contains a vernier-drive setup that resembles a clock mechanism. Turning the tuning knob moves a long pointer, somewhat like a sweep second hand, around the outer—or vernier—scale of the dial.

Continuing the clock analogy, the scale is divided into 60 second-like intervals. As the long pointer sweeps around that scale, a shorter, inner pointer moves, somewhat like a minute hand, at a much-slower rate. That "hand" points to the actual frequency-

A view of the chassis looking towards the rear of the dial assembly. The horizontal cylindrical unit at the top is the magic-eye tuning indicator.

calibration marks on the shutters. A heavy flywheel mounted on the tuning shaft makes operation of the tuning knob unusually smooth and positive.

The settings of the set's three other controls (volume, tone, and bandswitch) are displayed around the periphery of the tuning dial. Each has a numbered or lettered circular scale that turns as the control is rotated. And each scale is arranged so that a segment of it is visible through a crescent-shaped window. All the lettering is beautifully done in white on a jet-black background, and the total effect is very impressive indeed.

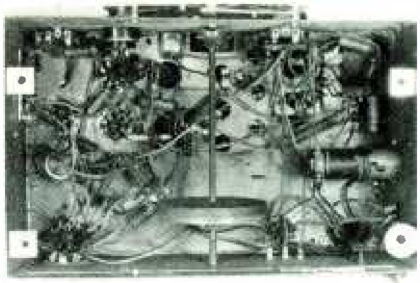
Taking Stock

If you look at the photo of the set in its cabinet, you'll notice that the grille cloth directly in front of the speaker is charred and torn. That was caused by the furnace explosion, which shot through the cabinet at that point, ripping the speaker cone right out. I'll need to locate an appropriate replacement cloth, but the speaker problem was solved some years ago: I had it reconed by an expert not long after I bought the set.

Knobs are going to be a problem. The large main-tuning knob was still on the set, as was one of the three smaller control knobs (although the latter has a broken flange). The other two control knobs are missing. Those are ornate wood knobs bearing the Zenith logo, and will be difficult to replace. The dial glass is also missing—possibly a victim of the explosion. Maybe a clock parts supplier will have one that fits.

Instead of using easy-to-replace dial cord, the set requires a special drive belt. The original is brittle and broken, but could be used as a model for some type of expedient replacement. The set's original owner presented me with a replacement that he fabricated from nylon-monofilament fishing line. He assured me that it would fit perfectly because he had made several just like it for similar models. We'll see!

All tubes in the set tested good, which is certainly a plus. However, a few of the original "G"-style (tall-glass) tubes have been replaced with their "GT" (short-glass) or metal equivalents. In one case, the top of a cylindrical tube shield had to be pinched-in to give the grid lead enough clearance to extend down to the much shorter replacement tube. In another case, where no tube shield was used,



There are lots of wide-open spaces under the chassis. Note the tuning flywheel (lower center) and the long, light-colored resistor (to left of center) with some of its paint burned off. The burned condition may indicate a short.

the grid lead looks absurdly long on the shorter replacement. If I can find them, I'd like to reinstall "G" types for a more authentic look.

Thus far, the only test I've made on the electronics of the set is my standard pre-start-up procedure. With the rectifier tube removed, I plugged in the set and turned it on. That allowed me to check the on-off switch and power transformer without applying B+ voltage to the radio. The switch functioned normally, the tubes and pilots lit up, and an AC voltmeter across the transformer's high-voltage secondary indicated a normal reading. So far, so good.

I did note, though, that the paint on one of the set's carbon resistors was partially burned off and that there seemed to be a deposit of soot on the chassis surface directly above the resistor. That evidence of overheating will not be ignored, because it could be symptomatic of a short-circuit condition that will have to be corrected before power is applied to the radio.

To complete our overview of the radio's more obvious problems, let's talk about the cabinet. The cabinet itself is very sound, but the finish is almost completely gone; it's down to the bare wood in most areas. That may be due to the explosion and/or storage conditions over the years.

What concerns me is the complete lack of grain in the exposed wood. It suggests that the cabinet originally had grain that was created using photographic procedures (very common in sets of this era), which disappeared along with the finish. That can't be restored, of course, and I'll have to content myself with a careful stripping, staining, and refinishing of the wood surface as it now exists.

When next we meet, we'll probe more deeply into the 7S232. ■

By Joseph J. Carr, K4IPV

CARR ON HAM RADIO

Resurrecting the old fashioned dipole: the low-cost alternative to a tri-band beam?

☐LOOKING AROUND MY NEIGHborhood might lead one to conclude that half the amateur operators in "4-land" live here. On every block there is at least one 40- to 60-foot tower topped with a multi-element tri-band beam antenna or quad. Given that such antennas are expensive, and the mortgage company eats a considerable portion of my budget every month, I am noticeably jealous, of course. But are those beams really necessary?

To ask a few of the top DXers you would think so, but amateur operations do not depend on having such an antenna. Some years ago I knew an amateur who hailed from Brooklyn, and then moved to downtown Washington, DC. In both places, he lived in an apartment building. His antenna was a dipole excited by the 30-watt output of a Heathkit DX-20 transmitter.

With that little rig and "impossible" antenna he worked 40-meter DXCC from both Brooklyn and Washington...which proves that it is the operator not the equipment that makes the critical difference. (A good mechanic never blames his or her tools.) Sure, the little guy has to work a little harder, but still can get good results...and become a lot better operator in the bargain than his "blowtorch" buddy.

Recently I resurrected the old-fashioned half-wavelength dipole to supplement my four-band trap vertical. Too few amateurs have proper respect for the dipole, and that's a shame for it really works. The dipole (when done right) is a good performing antenna, and it's dirt cheap...which makes the cost/benefit ratio tremendous.

The word *dipole* means "two pole." The basic configuration is shown in Fig. 1. Two quarter-wavelength sections form the half-wavelength radiator. The transmission line is typically 75-ohm coaxial cable (which we'll discuss later), and is applied to the center point between the two elements. The coax inner conductor is connected to one radiator, and the shield is connected to the other radiator.

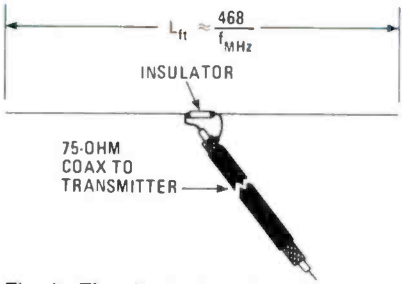


Fig. 1—The *dipole* (meaning "two pole") consist of two quarter-wavelength sections to form the half-wavelength radiator. The transmission line is typically 75-ohm coaxial cable, which is applied to the center point between the two elements. The coax inner conductor is connected to one radiator, and the shield is connected to the other radiator.

According to best practice, the ideal dipole should be installed several wavelengths above ground, and several wavelengths from any conducting object. In the real world, however, that's seldom attainable except (possibly) in the upper HF bands (*i.e.*, 21-MHz and up). At lower frequencies, the ideal is seldom achievable. Consider the 40-meter band dipole, for example. Half a wavelength is around 66-feet, so a full wavelength is 132-feet. *Several wavelengths* is usually taken to mean five wavelengths, so the ideal 40-meter antenna would be 660-feet off the ground, or 105-feet higher than the Washington Monument!

Obviously, a lot of good working dipoles are floating around the atmosphere at anything that approaches the correct (ideal) altitude.

Fortunately, the ideal need not be achieved in order to make a good working dipole. If the dipole is only a half wavelength above ground semi-ideal performance is approximated...not the best, but darn good. A 10-meter, 13-meter, or 15-meter dipole can easily meet the *half-wavelength high* criteria. A 15-meter dipole need only be 22-feet off the deck to meet that criteria.

But even at less than a half-wavelength high, the dipole performs well, but with some qualifications. For several years my 40-meter dipole (with which I worked a lot of DX) was only 15-feet off the ground at the porch end and 26-feet off the ground at the tree end; when a friend managed to climb a couple of trees for fat ol' K4IPV and install a 40-meter dipole at the 40-foot level, I was in hog heaven. I bet that most amateur-radio dipoles are installed in a situation (less than ideal) such as illustrated in Fig. 2: one end attached to the house (or in my case a porch) and the other end attached to a tree or another building.

There are two effects of installing a dipole at less than optimum height. First, the pattern is changed. The standard dipole pattern (ideal) is shown in Fig. 3A. The "figure-8" pattern shows that the dipole is bidirectional, and as such, places the vast majority of the energy in the two main lobes. At non-ideal heights, the ideal pattern degenerates into one with a lot of sidelobes (see Fig. 3B). But for practical purposes that's rarely a problem, and indeed if there are points where you'd like to make contact in several directions, then it may actually be a benefit.

The other defect of less than ideal dipoles is that the feedpoint impedance is not the ideal 72-ohms. The actual impedance can vary from about 40 to almost 140 ohms depending upon the antenna's height above ground. If the impedance causes a VSWR, it will be (at most) 72/40 = 1.8:1 in one direction or 140:72 = 1.9:1 in the other. That VSWR is almost not worth correcting, but if necessary, a coaxial "Q-section" or other method can be used to overcome the VSWR.

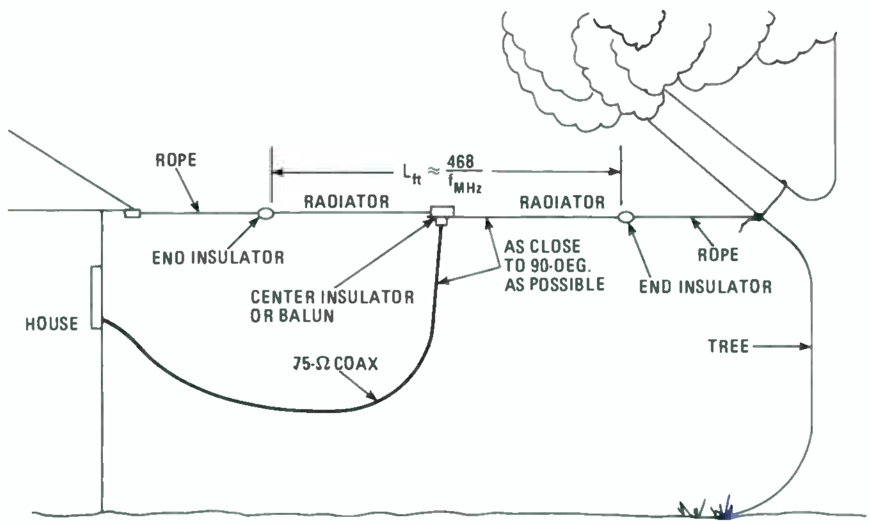


Fig. 2—It is a safe bet to say that most amateur-radio dipoles are installed under circumstances that are less than ideal, as illustrated here, with one end of the radiator attached to the house and the other end attached to a tree or another building.

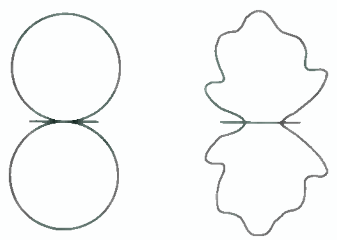


Fig. 3—There are two effects of installing a dipole at less than optimum height. First, the pattern is changed. The ideal pattern of the dipole in "A" shows the vast majority of the energy to be located in the two main lobes. At less than ideal heights, that pattern degenerates into one with a lot of sidelobes, as shown in "B."

Dipole Length

In free space, the length of a half-wavelength radiator is found from: L = 492/f, where "L" is the length in feet, and "f" is frequency in megahertz. But close to the Earth's surface (not several wavelengths above it), a "ground effect" takes over and reduces the required length by a few percent. The best formula to use is L = 468/f. That length is the overall length of both radiators together—the individual elements are exactly half that length.

But even that is a "first cut" attempt, for there are several factors that affect length. Make the length a few inches longer than that, and initially don't solder the outer insulators. Install the antenna at its regular height, and measure the VSWR at several frequencies until the frequency of minimum VSWR is found. If it is lower than the design frequency, then the antenna is too long; if the frequency is higher than the design frequency then it's too short.

Adjust the length (both elements equally) to compensate and re-measure. When the minimum VSWR is found at a frequency close to the design frequency, then you've made it. Tin both ends. According to the "standard wisdom" about dipoles, the following rules apply:

- Make the dipole as high off the ground as possible.
- Have the feedline go off at an angle of as close to 90-degrees as possible.
- Connect the center conductor of the coax to the end away from the house.

The validity of the latter is open to some doubt in my mind, especially if a 1:1 balun transformer is used at the feed point between the antenna and the transmission line. Balun manufacturers assert that the transformer balances the current in the two halves, and thereby reduces undesirable radiation from the transmission line.

Warning!: Under *no circumstances* install a dipole across a power line! Every year at least one amateur or SWL is killed by tossing a wire for an antenna across the power line in order to get clearance. Some people think that because the line is insulated, it is safe—well, it just ain't so. Insulation gets old, or can be damaged. It can easily cut through when the antenna wire contacts it...and that can electrocute you. ■

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By Charles D. Rakes

CIRCUIT CIRCUS

Get your shopping list ready for this month's supermarket of electronics circuits

☐GET READY FOR A WORKOUT, CAUSE this month the *Circus* is going to run an electronic marathon to see just how many "user friendly" circuits can be crammed into the allotted space.

Capacitance Checker

The circuit, in Fig. 1, came about at a time when I couldn't locate my old Eico capacitor checker to test the leakage of a tattered electrolytic capacitor that was needed for a project under construction. Granted that this simple capacitor tester won't give you a digital readout, but with a little practice you can tell a good deal about what's tied to its input, and in the process learn a little more about capacitors in general.

The capacitor tester, using the component values shown, can indicate a leakage resistance of 100 megohms, and more. That's a bunch of ohms. But a number of good-quality Tantalum capacitors, most all non-electrolytic, and a number of good-quality electrolytic capacitors test well above that leakage resistance value.

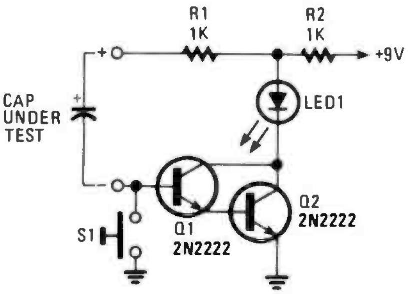


Fig. 1—The capacitance checker, using the component values shown, can indicate a leakage resistance of 100 megohms, and more. When checking electrolytic capacitors be sure to get the polarity right or the unit is sure to leak like a sieve.

PARTS LIST FOR THE CAPACITANCE CHECKER

- LED1—Jumbo light-emitting diode
- Q1, Q2—2N2222 general-purpose NPN silicon transistor
- R1, R2—1000-ohm ½-watt, 5% resistor
- S1—Normally-open, single-pole, single-throw pushbutton switch
- Printed circuit or perfboard materials, enclosure, IC sockets, battery, wire, solder, hardware, etc.

When checking electrolytic capacitors be sure to get the polarity right or the unit is sure to leak like a sieve. Most electrolytic capacitors take a long time to charge unless S1 is pressed for a few seconds, speeding up the charging process.

As soon as a good capacitor is charged, the leakage current should be very low or almost non-existent, and the LED should remain dark. After a long period of time, depending on the size and quality of the capacitor, the LED may begin to glow dimly as a small charging current flows to replace the capacitor's voltage loss due to the slight internal leakage current and Q1's minute base current.

A good 1-microfarad non-electrolytic capacitor connected to the tester causes the LED to light and remain on for about one minute as the capacitor charges. A 0.1-microfarad unit takes about 6 seconds, and a .01-microfarad unit takes about 1 second to charge. If the LED does not go out after a sufficient charging time, it's a good indication that an internal leakage resistance is lurking somewhere between the capacitor's leads. So, not only does our simple checker test for internal leakage resistance, but also gives a clue to the capacitance value. If you are only interested in checking for leakage resistance press S1 to speed up the testing procedure.

Simple Voltmeter

The circuit in Fig. 2 is almost too simple to share. But it's so darn handy to use that I couldn't resist. No matter how you connect the circuit to a voltage source, the meter always reads up scale. Diodes D1-D4 can be any good-quality

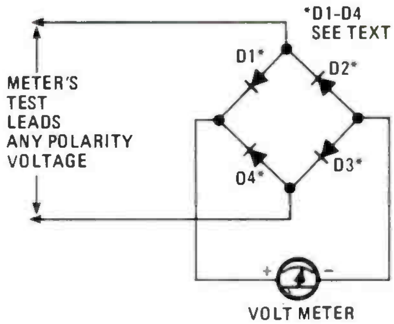


Fig. 2—Any voltage applied to this voltmeter circuit is fed to the meter, with the correct polarity. For instance, assume that a DC source is fed across the input to the circuit, and that the upper terminal is positive with respect to the lower terminal. The positive potential at the cathode of D2 reverse biases that diode so that it does not conduct. At the same time that positive potential is applied to the anode of D1, forward biasing that unit and causing it to conduct. While that action is going on at the upper terminal, a similar (but opposite) event is taking place at the lower terminal.

PARTS LIST FOR THE SIMPLE VOLTMETER

- D1–D4—Silicon rectifier diode (see text)
- M1—Voltmeter
- Perfboard materials, enclosure, wire, solder, hardware, etc.

silicon diode with a voltage rating that's greater than the full-scale voltage range of the meter used. Don't forget to add about 1.2-volts to the meter reading on the low voltage ranges, to compensate for the forward-voltage drop of the diodes when conducting.

The circuit's operation is simple. Any voltage applied to the circuit is fed to the meter, with the correct polarity. Let's assume that a DC source is fed across the input to the circuit, and that the upper terminal is positive with respect to the lower terminal. The positive potential at the cathode of D2 reverse biases that diode so that it does not conduct. At the same time that positive potential is applied to the anode of D1, forward biasing that unit and causing it to conduct.

While that action is going on at the upper terminal, a similar (but opposite) event is taking place at the negative terminal. A negative on the lower terminal reverse biases D4 so there is no current flow through that unit. At the same time D3 is forward biased, placing a low on the negative terminal of the meter, which indicates the voltage level.

By analyzing the current flow with the input polarity reversed, you'll discover that while the input polarity has reversed itself, the potentials on the meter have not. It's obvious that the circuit won't tell you the polarity of the applied voltage, but it does give its magnitude.

Utility Audio Amplifier

The next circuit to roar down the pike is the utility audio amplifier shown in Fig. 3. The basic amplifier offers a voltage gain of about 200 with a .4-watt output. If you chose to build that handy bench amplifier, it will never sit idle for long. It's just too convenient to use in testing a new project or troubleshooting a piece of equipment.

The utility amplifier is designed around the popular LM386 low-voltage audio power amplifier, which can be ordered from a number of mail order houses, or purchased from a local electronic parts house. The amplifier circuit can be built on a small section of perfboard and housed in a plastic or metal cabinet that's large enough to accommodate a 3- or 4-inch speaker and a battery.

Use an IC socket for U1 and keep all interconnecting component leads as short as possible. As in most amplifier circuits, a sloppy wiring job can turn a prince of a project into a croaking frog.

PARTS LIST FOR THE UTILITY AUDIO AMPLIFIER

C1, C2, C7—0.1-µF, 100-WVDC Mylar capacitor
C3, C5, C6—100-µF, 16-WVDC electrolytic capacitor
C4—10-µF, 16-WVDC, 16-WVDC electrolytic capacitor
J1—Headphone jack
R1—1000-ohm ½-watt, 5% resistor
R2—10,000-ohm, potentiometer
R3—10-ohm ½-watt, 5% resistor
SPKR1—4 ohm speaker, 3- to-4-inch diameter
U1—LM386 low-voltage audio power amplifier
Perfboard materials, IC socket, 9-volt battery, wire, solder, hardware, etc.

Utility Amp Add-ons

The usefulness of the utility audio amp can be expanded by building the three input circuits shown in Fig. 4. The simple two-component circuit in Fig. 4A turns the amplifier into an RF AM detector. Most any RF with AM modulation riding along can be demodulated and heard on the amplifier's speaker. The circuit in Fig. 4B turns the amplifier into an emergency BC AM receiver that should pickup at least one local radio station. Throw ten feet of wire out the window and connect it to the top of L1 and screw the coil's slug in or out for the strongest signal.

Figure 4C is nothing more than a hand-wound inductive pickup coil that can be used to seek out inductive transmitted interference, including 60 and 120 Hz. Also the coil can serve as an inductive telephone pickup or as a receiver to pickup inductive transmitted audio.

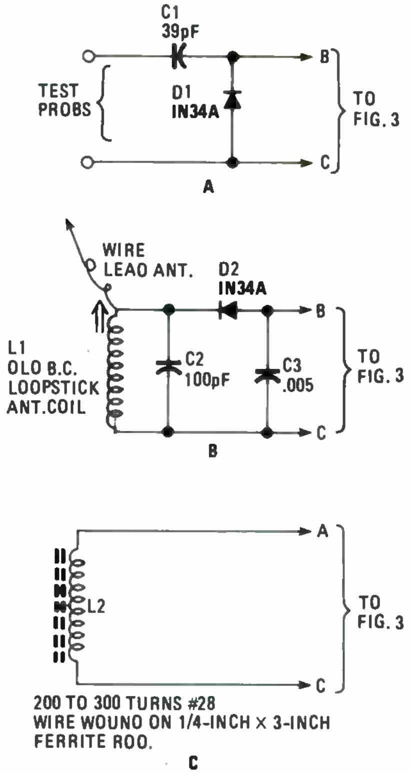


Fig. 4—By adding one of these subcircuits to the utility amp, you can make that somewhat hum-drum circuit perform some really useful tasks. The circuit add-on in A turns the amplifier into an RF AM detector; B turns the amplifier into an emergency BC AM receiver, and C is nothing more than a hand wound inductive pickup coil that can be used in conjunction with the utility amplifier to seek out inductive transmitted interference, or serve as an inductive telephone pickup.

PARTS LIST FOR THE UTILITY AMP ADD-ONS

C1—39-pF ceramic disc capacitor
C2—100-pF ceramic disc capacitor
C3—0.005-pF Mylar capacitor
D1, D2—1N34A general-purpose germanium diode
L1—See text
L2—200–300 turns #28 wire on ¼-inch × 3-inch ferrite rod
Printed circuit or perfboard materials, enclosure, IC sockets, wire, solder, hardware, etc.

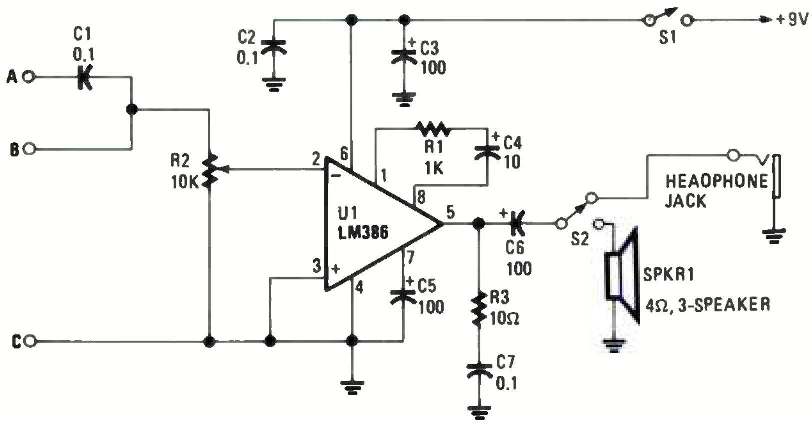


Fig. 3—Designed around the popular LM386 low-voltage audio power amplifier, this utility audio amplifier can save loads of time when building or troubleshooting some pet project or prized electronic instrument.

Current Limiter

If Murphy lurks in your workshop and shows up periodically to destroy your special semiconductor devices in the safest of experiments, then the circuit in Fig. 5 might just send Murphy a message and save the day. That single-transistor circuit places an electronic lid on the maximum current that can pass through it. By placing the current limiting circuit in series with your delicate

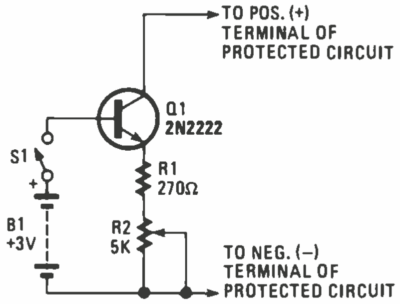


Fig. 5—The current limiter is adjustable from about 0.5 to 8 mA and can be used with circuits having supplies ranging up to 30-volts. If a more bullish circuit is required, replace the 2N2222 with a 2N3055 and R1 with a 10-ohm, 1-watt resistor and R2 with a 500-ohm, 2-watt potentiometer. That allows a maximum current of about 200 milliamps, and a minimum of 5 mA

PARTS LIST FOR THE CURRENT LIMITER

B1—9-volt transistor battery
Q1—2N2222 general-purpose NPN silicon transistor
R1—270-ohm ½-watt, 5% resistor
R2—5,000-ohm potentiometer
S1—Single-pole single-throw switch
Printed circuit or perfboard materials, enclosure, IC sockets, battery, wire, solder, hardware, etc.

project and its power source (DC only), you can keep the smoke from getting in your eyes, and Murphy at bay.

The circuit's current-limiting range is adjustable from about 0.5 to 8 milliamps and can be used with circuits having supplies ranging up to 30-volts. If a more bullish circuit is required, replace the 2N2222 with a 2N3055 and R1 with a 10-ohm, 1-watt resistor and R2 with a 500-ohm, 2-watt potentiometer. That allows a maximum current of about 200 milliamps, and a minimum of 5 milliamps.

When setting up the circuit, connect the current limiter in series with a current meter and connect that combination across the power source that's to be used. Adjust R1 for the maximum current that you want to pass through your circuit. OK get in there and give Murphy a kick for me.

Transistor Checker

The circuit in Fig. 6 is for those of us that never throw out any three-legged device no matter how "used" it might appear. If you have doubts about a number of your junkbox transistors, then build this simple go/no-go tester and at least separate the good ones from the bad. The circuit gives a good indication as to value of most NPN and PNP low-power silicon and older germanium-type transistors.

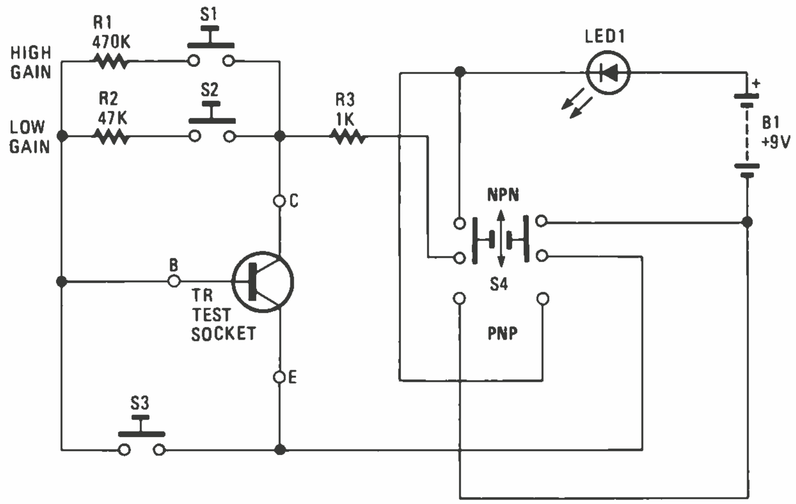


Fig. 6—The transistor checker gives a good indication as to value of most NPN and PNP low-power silicon and older germanium transistors.

PARTS LIST FOR THE TRANSISTOR TESTER

B1—9-volt battery
LED1—Jumbo light-emitting diode
R1—470-ohm ½-watt, 5% resistor
R2—47,000-ohm ½-watt, 5% resistor
R3—1000-ohm ½-watt, 5% resistor
S1-S3—Normally-open SPST pushbutton switch
S4—Double-pole, double-throw switch
Perfboard materials, enclosure, transistor socket, wire, solder, hardware, etc.

LED1 indicates the relative condition of the transistor under test. With the "suspect" in the test socket (TR) and the PNP/NPN switch, S4, in the correct position, the LED should remain dark. If it glows, it's usually an indication that the transistor is suffering from an internal short, or at the very least, that there is high leakage between its emitter and collector.

If LED1 is dark, press S1 and a medium to a high-gain transistor will cause the LED to light at full brilliance. A dim glow indicates a lower gain figure. Press S2 and the LED should glow at full brilliance. If not, it could mean that the device is a very-low gain transistor or that it's past retirement age.

Another useful check to perform, primarily with the older germanium type transistors, is the base-to-collector leakage-current test. By closing S3 the diode junction between the transistor's base and collector is placed in series with R3, LED1, and the battery. If the device has high leakage, the LED glows. If it glows a little more than "dim," it's a good indication that the transistor is defective.

PARTS LIST FOR THE DIODE SWITCHING CIRCUITS

FIG. 7
C1, C2—0.27-μF, 100-WVDC Mylar capacitor
D1—1N914 small-signal silicon diode
R1, R2—10,000-ohm ½-watt, 5% resistor
S1—See text

FIG. 8
C1-C3—0.27-μF, 100-WVDC Mylar capacitor
D1, D2—1N914 small-signal silicon diode
R1-R3—10,000-ohm ½-watt, 5% resistor
S1, S2—See text

FIG. 9
C1-C3—0.27-μF, 100-WVDC Mylar capacitor
D1, D2—1N914 small-signal silicon diode
R1-R3—10,000-ohm ½-watt, 5% resistor

Printed circuit or perfboard materials, enclosure, IC sockets, battery, wire, solder, hardware, etc.

Diode Switching Circuits

Diodes are useful for more duties than just changing AC to DC. The circuit in Fig. 7 uses a silicon diode to switch audio from point "A" to point "B" by applying a positive voltage to the bias circuit. The switching bias voltage can come from a mechanical switch or any logic output.

The switching circuit in Fig. 8 steers a single audio signal to a choice of two outputs. When a positive voltage is applied to the anode of either diode, through R2 or R3, its internal resistance goes from near infinity as an open switch, to a low of a few ohms when closed. If both switches are closed the audio will be switched to both outputs A and B.

The diode-switching circuit in Fig. 9 uses a positive voltage to switch input "B" to the output circuit and a negative voltage to switch input "A" to the output. All three of the diode switching circuits can handle audio levels up to 2-volts peak-to-peak, and operate with a bias voltage of 9 to 16.

Looks like we have just about filled our cup for this month. In closing, I wish you all good circuitry until the next time we meet. ■

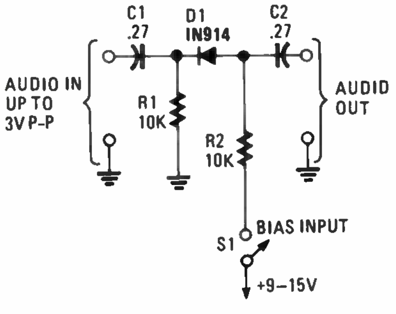


Fig. 7—This circuit uses a silicon diode to switch audio from point "A" to point "B" by applying a positive voltage to the bias circuit. The switching voltage can come from a mechanical switch or logic output.

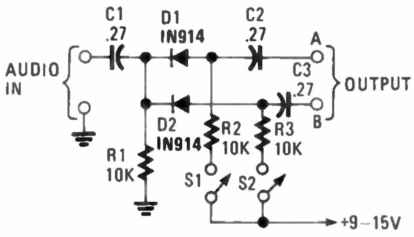


Fig. 8—The switching circuit shown here steers a single audio signal to a choice of two outputs. When a positive voltage is applied to the anode of either diode, through R2 or R3, its internal resistance goes from near infinity as an open switch, to a low of a few ohms when closed. If both switches are closed the audio is fed to both outputs A and B.

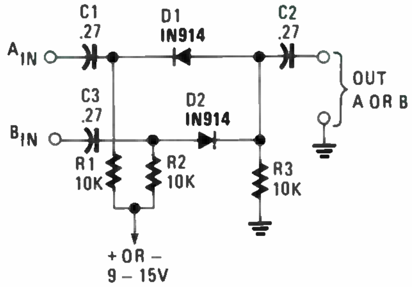


Fig. 9—This diode-controlled switching circuit uses a positive voltage to switch input "B" to the output circuit and a negative voltage to switch input "A" to the output.

FRIEDMAN ON COMPUTERS

(Continued on page 85)

reformed at the receiving modem. It also maintains dynamic tabulation of repeated characters—*dynamic* meaning continuous updating. In the compression process, any unneeded data, such as a character start bit, for instance, is stripped off.

Under the best of circumstances, which usually means text files, compression can provide up to double the throughput. In practical terms, it means that a 2400-baud modem can send information at the rate of 4800 baud, although an 80–85% increase is more typical. Also, compression has little effect on highly random data, such as executable files and pre-compressed data. And assuming the best of circumstances, if your computer is feeding the modem at only 2400 baud, compression or no compression, the maximum data-exchange rate that is possible is 2400 baud.

To get the maximum possible throughput, it's necessary to feed a Class 5 modem as fast as it can transmit data. That is done, as shown in Fig. 1, by providing memory within the modem, and then by outputting from the computer to the modem at a much higher baud rate, such as 9600 baud. The computer fills the modem's memory, which uses data-flow control (handshaking) to stop the flow of data from the computer when the memory is full.

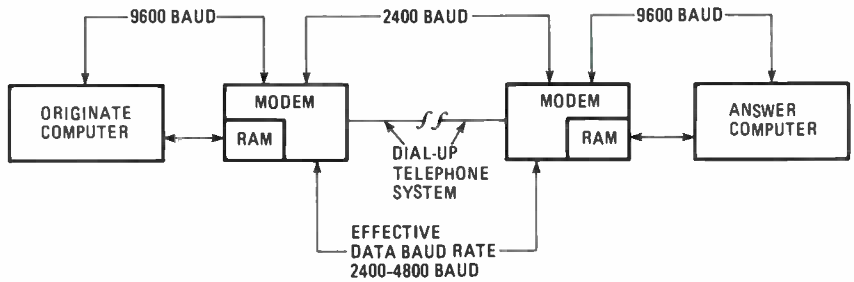


Fig. 1—In order for data compression to provide an effective baud rate higher than the actual baud rate of the modem, the data flow from the computer to the modem must be at least equal to twice the modem's baud rate. By *de facto* convention, 9600 baud is becoming the "standard" computer output rate when data compression is involved.

The modem then transmits compressed data. As the memory empties, the handshake is released so that the computer can again output data to the modem's memory.

Since the computer feeds data at an even faster rate than the compressed data can exit the modem, the modem has no wait-state unless the receiving modem signals by the error-correction handshake that it needs a retransmission of the last block of data. Although data compression requires that the computer output into the modem only at twice the modem's baud rate, by convention we generally output from the computer to the modem at rate of 9600 baud.

As shown in Fig. 1, the receiving answer modem can also output to the computer at 9600 baud, although it does not result in throughput beyond the maximum effective baud rate, which is 4800 bps. The reason we receive (answer) at 9600 baud is because a conventional serial port must transmit and receive at the same rate, so if we're transmitting at 9600 baud we must receive at 9600 baud.

Of course, data compression techniques can be applied to virtually any modem. If, for example, you are using 9600 baud on a dedicated 4-wire telephone circuit, data compression can provide an effective throughput of up 19,200 baud.

Who knows how fast next year's effective modem rate will be? After all, it seems like it was only yesterday when many *gurus* claimed that 1200 baud was the "ultimate limit" for the dial-up telephone system. ■

PULSE-CODE MODULATION

(Continued from page 59)

represents it's amplitude at some specific point in time. For example, an 8-bit A/D puts out an 8-bit word from 0 to 255. In that manner an analog voltage from say 0 to 2.55 volts can be represented by a number. One volt would be 100.

For our example use table 3 to convert the signal to code. In Fig. 1 a four-bit A/D converter is represented by bits 0–3. Each voltage is assigned a four bit code. In that manner, any voltage from –5 to 10 volts can be represented with a least significant bit (LSB) of 1 volt. Although some people may have some problem with zero volts being represented by the code 0101 (5), any coding system that you wish to use is okay. The only restriction is that the same code must be used to decode the waveform.

Going Further

This is by no means a comprehensive list of all of the pulse codes in use today, but it does hit upon the basics, and I hope sheds some light on why some of these techniques are used. If you would like to explore these techniques in more depth, try one of the following:

Signetics Application Notes AN170—NE555 and NE556 applications. The applications notes describes how the ever-popular 555 timer can be used to build a pulse-width modulator and a pulse-position modulator.

The Art of Electronics, by Horowitz and Hill, published by Cambridge Press.

Basic explanation of PAM, PWM, PPM, and PCM.

Understanding Data Communications, by George E. Friend, John L. Fike, H. Charles Baker, and John C. Bellamy, Howard W. Sams and Company publisher. This book is carried by Radio Shack and is part of the Texas Instruments series of books. It covers almost all forms of radio frequency modulation, including pulse-code modulation. ■

TABLE 2—PPM CONVERSION CHART

Average Voltage	Pulse Position (in units)
5	—
4	45-50
3	40-45
2	35-40
1	30-35
0	25-30
−1	20-25
−2	15-20
−3	10-15
−4	5-10
−5	0- 5

TABLE 3—VOLTAGE AS PCM CODE

Average Voltage	PCM Code	
	Binary	Decimal
5	1010	10
4	1001	9
3	1000	8
2	0111	7
1	0110	6
0	0101	5
−1	0100	4
−2	0011	3
−3	0010	2
−4	0001	1
−5	0000	0

CASINO DICE GAME

(Continued from page 36)

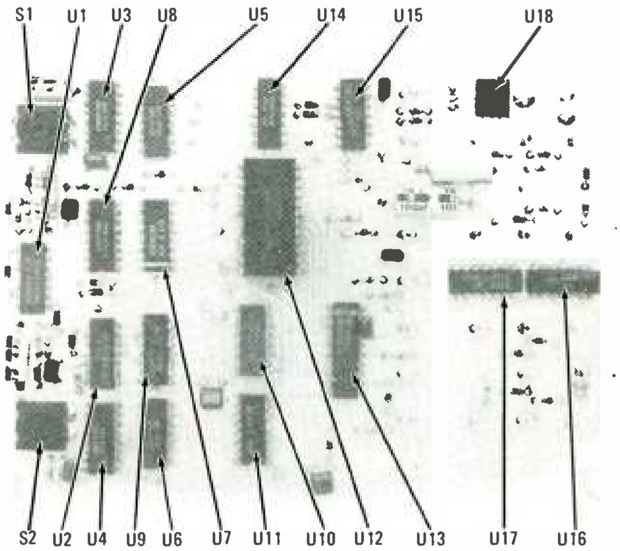
number (on the first roll) that's display on the dice is 7 or 11, check that WIN lamp LED16 is on. If the two dice total 2, 3, or 12, LED15 should turn on (you've lost). Roll several more times to check the circuit's operation. Remember it is necessary to reset the circuit after each win or loss for the circuit to work correctly.

If you "throw" any other number (4, 5, 6, 8, 9, and 10) that number becomes your "point." Check that the total of lighted LEDs of the two dice equals the number indicated by the lighted LED on the POINT line.

The finishing touch is to permanently mount the project in an enclosure behind a piece of red transparent plastic (bezel). The dice spots, point number, and WIN or LOSE lamps are visible below the surface of the panel. When assembling the unit, mount the LEDs after the panel is in place, and mount them high enough to touch the bottom of the front panel before soldering them in place. In the author's prototype, four ⅜" long 4-40 threaded standoffs were used between the PC board and face plate.

The face plate is cut larger than the PC board so that it can be mounted easily into a case of your choice. The front panel of Computerized Craps (which is available from the supplier given in the Parts List) is shown in the photo that appears on the first page of this article.

When you finish assembling the project game, you can really make an in-depth study of the odds. You can also spice up your next party with an appeal that can not be resisted by any "high roller." If you like to gamble, you could even lose some money while you are having a lot of fun. Of course, you can still have fun and win, too. The game takes care of the menial task of keeping track of the point and settles a lot of arguments before they start. As it was mentioned earlier, the only thing missing is the noise of the dice. ■



Shown here is the dice game's fully-populated printed-circuit board. Note the positioning of the components, particularly the 3-terminal regulator. Once soldered to the board, the regulator is bent back and secured to the board with a screw.

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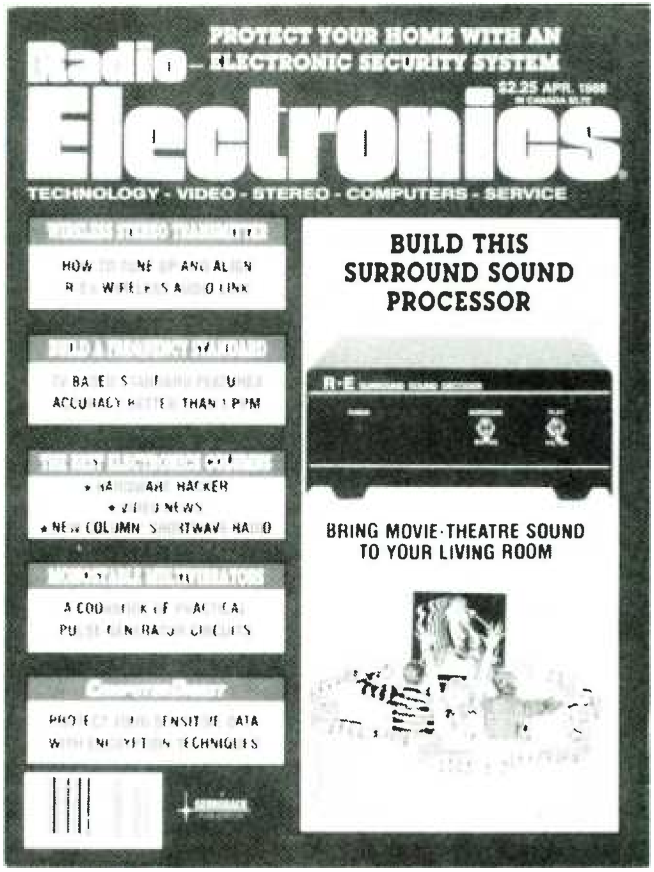

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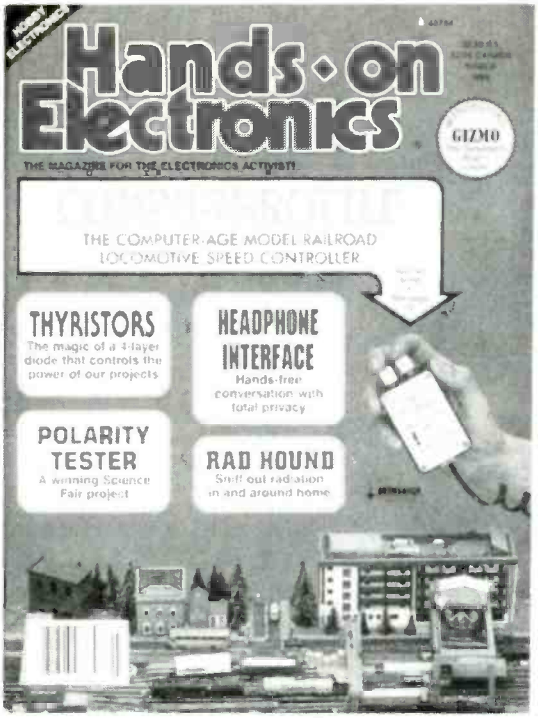

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(Continued from page 29)

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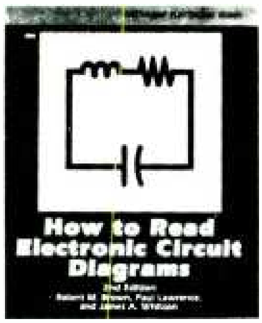
For every hobbyist, student, or experimenter who wants to learn how to recognize electronic schematic symbols, understand how the components those symbols represent work, and accurately read schematic diagrams of electronic circuits—here is the ideal book.

The authors begin with a look at some common electronic components and their schematic symbols. Then, some simple electronic circuits are introduced, along with a variety of more specialized electronic components, such as transducers and indicating devices. More complicated solid-state devices like transistors, diodes, and integrated circuits are then explained, and vacuum tubes are covered.



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Through this self-teaching guide, readers will become proficient at reading block diagrams, exploded views, mechanical construction diagrams, and, finally, actual electronic schematic diagrams. All information is given gradually and painlessly, with new concepts building logically upon those explained before. As the material evolves into more complicated schematics, readers will find themselves easily identifying relays, fuses, resistors, and circuit breakers from the full-sized schematic diagrams pictured in the book.

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Radio Electronics' State of Solid State By the Editors of Radio Electronics

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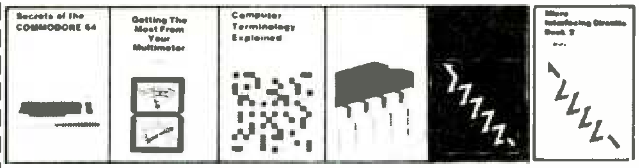

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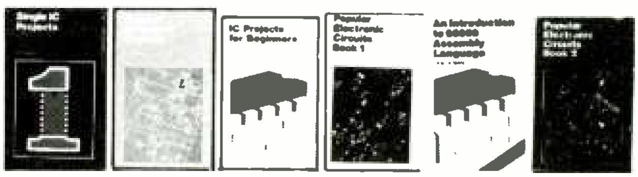

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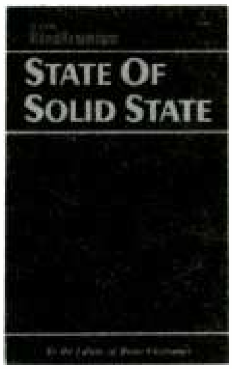

CIRCLE 98 ON FREE INFORMATION CARD

Using Comparators to Detect and Measure

(Continued from page 64)

the output of the top comparator goes high and lights LED1 (green) when the temperature is too low. In that circuit, when the temperature falls within the window, both light-emitting diodes are off.

Bar-graph Display

The final example (Fig. 10) is a light meter with bar-graph output. Circuit design is made easy by using an LM3915 bar-graph-driver IC, which contains a series of 10 comparators. The – input of each comparator connects to the buffered input voltage, and the + inputs connect along a nine-resistor voltage-divider network.

To use the LM3915, you need only add a sensing circuit and connect the comparator outputs to a bar-graph display or succession of 10 light-emitting diodes.

In Fig. 10, the input at pin 5 of U1 is taken from a voltage divider made up of R1 (a cadmium-sulfide photoresistor) and R2. Each comparator inside U1 compares the buffered input voltage to its reference and turns its light-emitting diode on or off, as appropriate. The number of light-emitting diodes lit thus varies with the light level at R1.

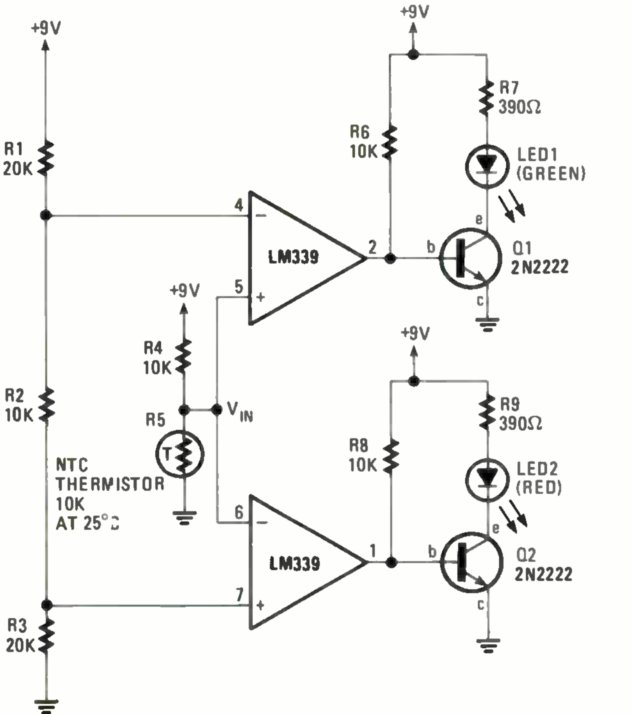

Fig. 9—This out-of-window comparator detector warns the experimenter of too high, as well as too low, temperatures levels.

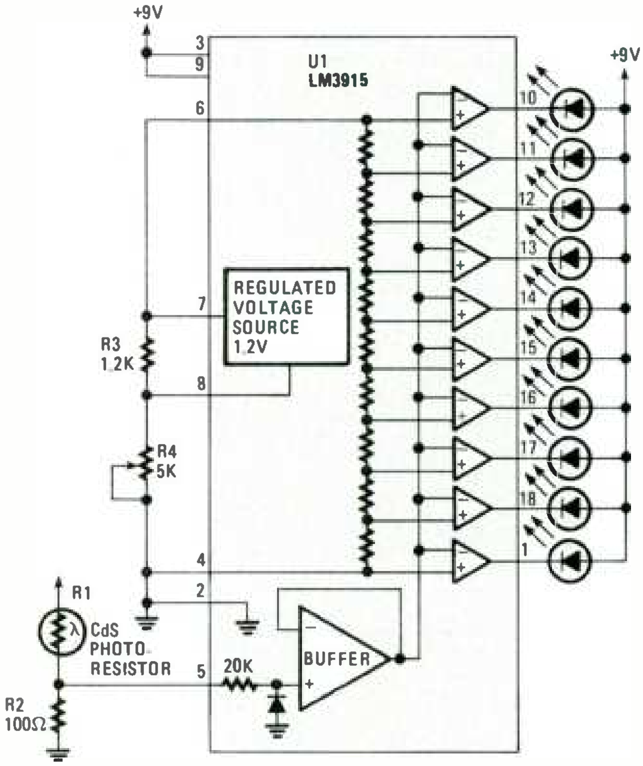

Fig. 10—The number of LEDs progressively lit in the bar-graph display varies with the light level sensed by photoresistor R1.

Resistor R3 sets the current in each of the light-emitting diodes at 10 milliamperes, and potentiometer R4 selects the full-scale (all light-emitting diodes on) input voltage between 1.2 and 7 volts.

Leaving pin 9 of U1 unconnected will change the display from a bar graph to a single-dot display. In that mode, only one LED is lit at a time (which saves on battery power!) and the position of the LED indicates the signal level and thus the light intensity.

Now It's Your Turn

Comparators are circuit building-blocks that are both easy to use and adaptable to many circuit situations. With the collection of circuits presented in this article, you should be able to begin to adapt the circuits provide here and design your own comparator circuits to meet specialized voltage-detecting needs. ■

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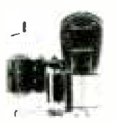

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BUY BONDS

E-Z MATH

(Continued from page 84)

To be really useful, the integrator time constant must be very long compared to the input pulse on and off times. With that relationship, the capacitor will never fully charge or discharge before the pulse switches states. The result is shown in Fig. 14. Assume the same +10 volt, 2 mS wide pulse as before. But assume a time constant of 20 mS. During the 2 mS input pulse, the capacitor will charge up to:

$$V = V_S(1-e^{-t/RC})$$
$$V = 10(1-e^{-2/20})$$
$$V = 10(1-e^{-.1})$$
$$V = 10(1-.905) = 10(.095)$$
$$V = .95 \text{ V.}$$

When the input pulse shuts off, the capacitor will discharge toward zero and will be about +.86 volts before the input pulse goes positive.

Examine the resulting waveform in Fig. 14. The output amplitude is very low because the pulse switches so quickly that the capacitor never really has enough time to charge to a higher value. But look at the shape of the output waveform. It is a triangular shaped wave with nearly linear (straight line) rises and falls of voltage. While the capacitor charge and discharge curves are certainly not linear, we are only looking at a very short portion of those curves. Over such a short duration, the curve is nearly linear so the output is a respectable triangular wave although its output amplitude is severely limited. As you can see, the integrator converted our input square wave into a triangular wave.

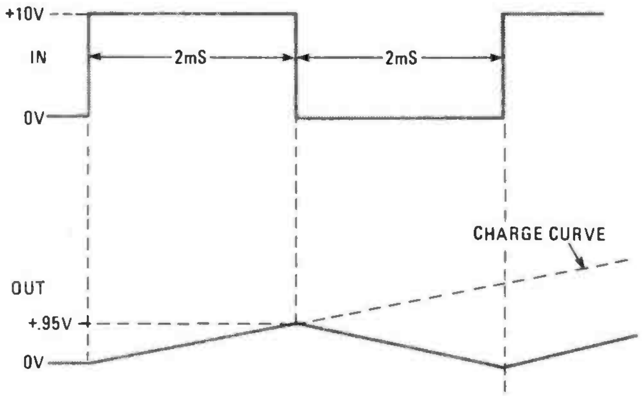


Fig. 14—An RC integrator circuit has an output whose value is directly proportional to the area under the curve formed by the input signal's waveform. As you move left on the top curve (the input) the area under the curve increases steadily for 2 mS. Thus the output increases steadily.

The key to the integrator's usefulness is in making its time constant very long compared to the input pulse duration. For best results, the time constant should be ten or more times the pulse duration. Or:

$$T > 10t_d$$

Practice Problems

It's time to review the key points in this section with some exercises.

5. The duration of the on/off times of a square wave is 150nS. What should the time constant of a differentiator be? If R is 470 ohms, what value of capacitor should be used?

6. The duration of the on/off pulses is 3 μS. What is the minimum time constant of an RC integrator? Given C = .001 μF, what is R?

Answers

1. The time constant (T = RC) is about 150 nS. So t is two time constants of 300 nS. RC is 150 nS so the exponent is just

$t/RC = 300/150 = 2.$

The equation is:

$v = 5(1-e^{-2}) = 4.3$ volts.

2. It takes five time constants to fully charge or discharge or about

$5 \times 150 = 750$ nS.

3. If the capacitor is fully charged to 5 volts, the equation is

$v = 5e^{-200/150}$
$= 5e^{-1.33} = 5(.26) = 1.3$ volts.

4. $T = RC = (10 \times 10^3)(.01 \times 10^{-6})$
$= 1 \times 10^{-4}$ second $= 100\ \mu S$
$t = -1 \times 10^{-4} \ln(1-10/15)$
$t = -1 \times 10^{-4} \ln(1-.66)$
$t = -1 \times 10^{-4} \ln(.34)$
$t = -1 \times 10^{-4}(-1.08) = 1.08 \times 10^{-4} = 108\mu S$

5. For a differentiator, the time constant (T) should be less than one tenth the pulse duration, or

$150/10 = 15$ nS maximum.

Since T = RC, then C = T/R. If R is 470, then

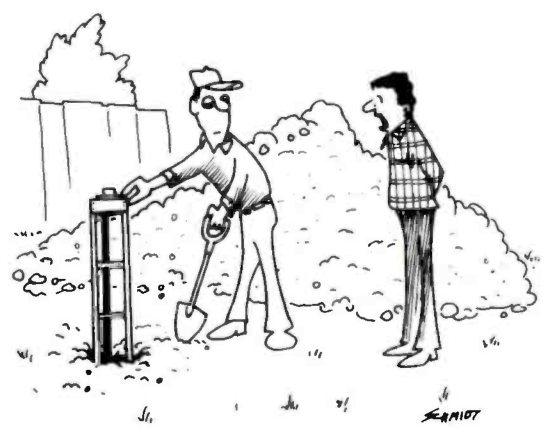
$C = 15 \times 10^{-9}/470$
$= .032 \times 10^{-9}$
$= 32 \times 10^{-12} = 32$ pF.

6. In an integrator, the time constant (T) should be ten or more times the pulse duration or, in this example,

$10 \times 3 = 30\mu S$

or greater. If $C = .001\mu F$, then:

$R = T/C$
$= 30 \times 10^{-6}/.001 \times 10^{-6}$.
$= 30K$ ohms. ■



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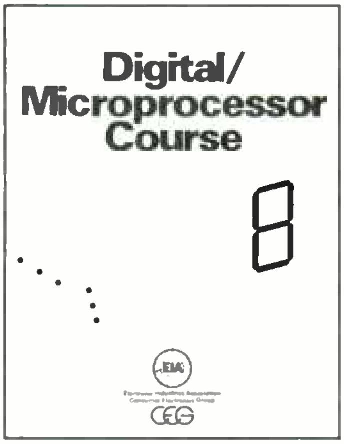

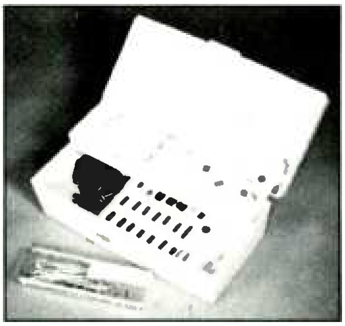

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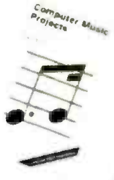

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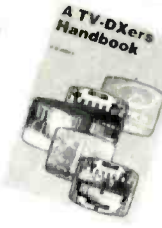

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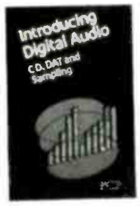

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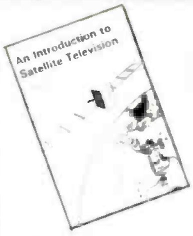

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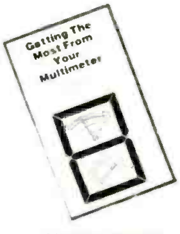

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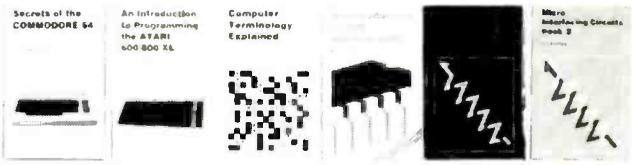

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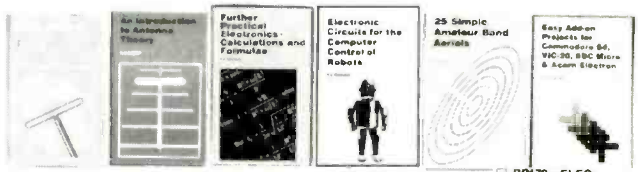

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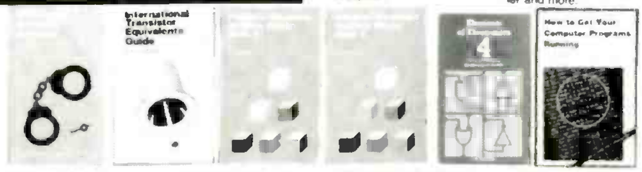

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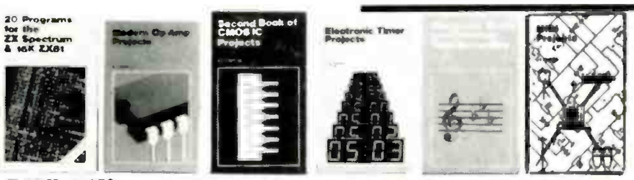

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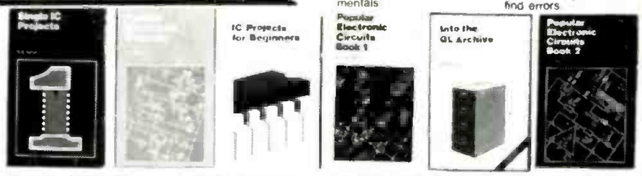

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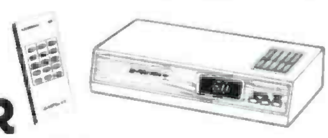

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