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THE MAGAZINE FOR THE ELECTRONICS ACTIVIST!

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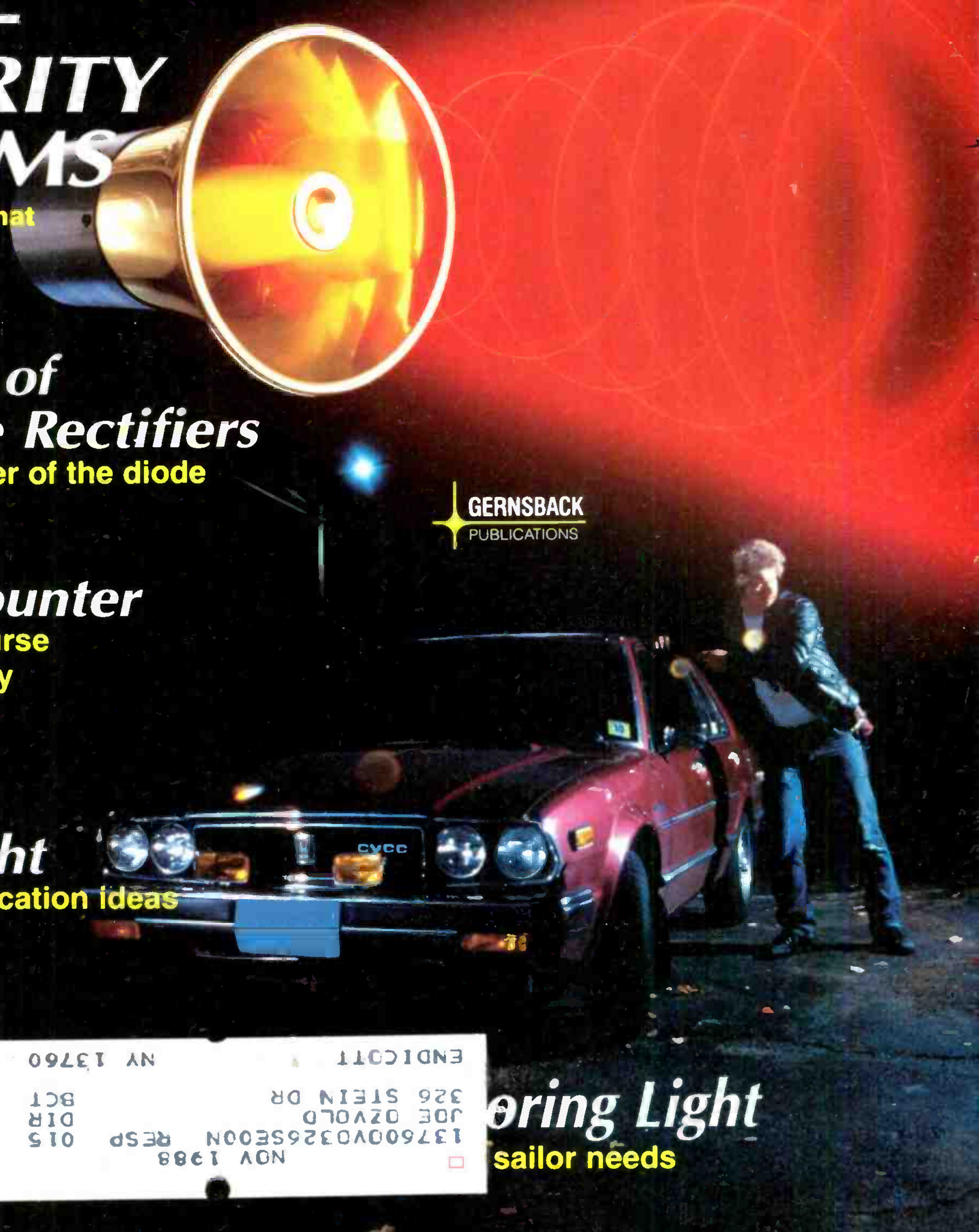

The ABC's of Solid-State Rectifiers

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GERNSBACK PUBLICATIONS

3-Digit Counter

A project and course on digital dexterity

Variable Strobe Light

Theory plus application ideas

3 New FactCards This Issue

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Hands-on Electronics® Volume 4, No. 2 February 1987

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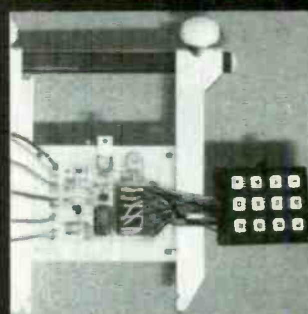

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Hands-on Electronics®

The Magazine for the Electronics Activist!

EDITORIAL PAGE

INCLUDING 12-PAGE GADGET

Volume 4, No. 2

February 1987

The Great PC-clone Contest!

"You and your staff are a great, creative group. In the last issue your 'Fred the Head' construction article was the best I've ever seen...."

Every day the postman drops off a sack of congratulatory comments from our readers, yet the truth of the matter is that it is our authors who are creative. And where do our authors come from? They are the readers of this magazine.

We need many more good articles of all types, and want to encourage our authors and readers to send articles to us for consideration. Of course, we pay for articles, but we want to sweeten the pot! So, the author of the best article purchased and published in the May through December, 1987 issues of **Hands-on Electronics** will receive a PC-clone computer of our choice as a bonus payment. Our staff members are excluded. (Sorry, guys.)

What does it take to write for **Hands-on Electronics**? You need an idea, theme, home-brew project, or news item to write about. Don't get too fancy. Clearly state what you want to write. When drawings are required, do them neatly and print clearly. Photographs are important to many stories—either take them yourself or obtain them from agencies and companies that provide them. (But please, no photos clipped from newspapers and magazines.) Black-and-white glossy prints are preferred.

Come up with a creative story idea, get the facts, put them on paper, and send it off to me. If your story idea is what we want, but something is lacking to make it an acceptable article, I will let you know what is needed. Remember, I'm rooting for you!

Thus, the PC-clone contest is now officially launched. My address is at the bottom of the page. I'll be waiting for your articles.

Julian Martin

Julian S. Martin, Editor

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Cover photography by Dan Muro

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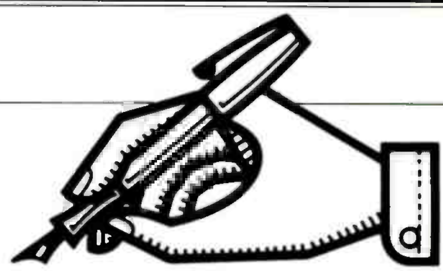
LETTER BOX



Strip Search

I found the article on Cauzin's Softstrip system (December 1986) fascinating. But there was one small problem. The alignment marks for the strip are missing from Fig. 1. That makes aligning the reader almost impossible, so you can't read the strips.

I said *almost* because, using the information in Fig. 2, it's possible to pencil in marks in the appropriate places on the page of the magazine. Mark an "X" $1\frac{1}{4}$" from the center of the strip, $\frac{3}{32}$" up from the top of the strip. That's the center of the circle. Then draw a vertical line near the bottom of the strip $1\frac{9}{32}$ from the center. Then you can align the reader and read the strips. I did it and it works.
J. H., Astoria, NY

You're right; we goofed. Our production people aren't computer people, and they didn't realize the importance of the alignment marks. But we're glad you found a fix.

New Bulletin Board!

A national electronic bulletin board system has been set up for writers, secretaries, educators and other users of word processing. The phone number is 516-294-9724, and no password is needed.

The Word Processing Users' Group (W/Pug)—an international group—set up the SCROLL Bulletin Board so that computer users who utilize their machines for writing will be able to "converse" with each other. This allows the uploading and downloading of documents for evaluation and review. The bulletin board, which was named after the newsletter (SCROLL) published by W/Pug, also invites users to download special programs developed for word processing. So burn up those phone lines and get processed!

What Goes Where?

I sent for two kits for the fence charger from the May and June issues of **Hands-on Electronics**. Everything has progressed well so far, but now that I'm ready to hook them up I find that the connections for the CD4001 chip do not conform with the schematic. The first six connections are okay, but after that everything goes askew. Which is right, the schematic or the circuit board?
C.R.K., Paradise, CA

The confusion that you've experienced is all too common to all who dare enter the mysterious world of electronics. First let me assure you that both the schematic and layout diagrams are electrically correct. That is, it doesn't really matter which gate within the chip is used to perform which function. So, for instance, if you use gate "b" to do the job of gate "a," and vice versa, no error will result.

Bread for a Breadboard

Between **Radio-Electronics** and **Hands-on Electronics** I'm finding great projects that I'm dying to build, but I want to test the projects before I buy and assemble the parts. Bread-boarding seems the way to go, but I can't afford the powered ones on the market. Please help; my mind is hungry and my hands are anxious!

By the way, congrat's on a fine magazine.
C.M.M., Lake Station, IN.

I ran into exactly the same problem when I entered the field of electronics. By making several separate purchases of solderless breadboards (Radio Shack part # 276-170), and mounting them on a piece of plywood, I had the beginnings of an excellent circuit development station. To that I added several dual (±) power supplies based on the 7800 and 7900 series of three terminal regulators (available from the same source). Then as time went on, I found that I needed a waveform generator. Again I went to Radio Shack, this time for the XR2206 function generator chip. The chip is supplied by Radio Shack with applications notes. In fact, you need to go through the supplied data sheet and decide what waveform or functions you want and wire the circuit accordingly. Oh yes, an excellent article, Audio Function Generator, *based on that chip appeared in the November issue of this magazine. Other such single-chip function generator articles have appeared in previous issues. Well, that's all there is to it. Have Fun!*

Where're the Parts?

I wanted to buy a kit for the Musical Door Bell, but no parts supplier was listed in the parts list. I thought naming one was common practice for your authors. If you could steer me to one or tell me how I could get my hands on a circuit-board I would appreciate it.
N.B., Malverne, NY.

Let me assure you that it is not up to us to supply kits. Whenever a supplier is referenced in an article it is the author who has contracted someone to provide the materials, or (as is often the case) he will supply them himself.

I too am making the Musical Doorbell. The way that I handled things was to copy the PC layout from the page. Next, I went to a local stat house to have the layout transferred to acetate film. Then, using the photo-resist method of PC board preparation, I used the film to expose the board; dipped it into ferric-chloride etching solution, and a few minutes later, I had a PCB ready for drilling. There's another method for the transfer of the image to film—Lift-it film. Lift-it is a contact film that you can place on the page to transfer the printed image to clear acetate, so you can avoid a trip to a photostat house.

Counting the Moments

I want to build a frequency counter from the family of chips you featured in the May/June issue but can't find a board for mounting. Can you tell me where I can get a fairly complete set of parts; chip included?
B.F., Kalispell, MT.

The best source of a board for the frequency counter is from the manufacturer, Intersil. They'll supply an evaluation kit that contains most, if not all, the parts for the project. The kit is also available through mail order outfits, like Digi-Key—telephone 800/344-4539; ask for part number NT5011-ND—and others. From there it will be up to you to develop the kit into what you want.

Whoopsie Daisy

Murphy's law has claimed another victim. The Zener diode in the parts list for the Musical Doorbell featured in the November issue should not be a 50-volt unit (in fact, far from it). It should have

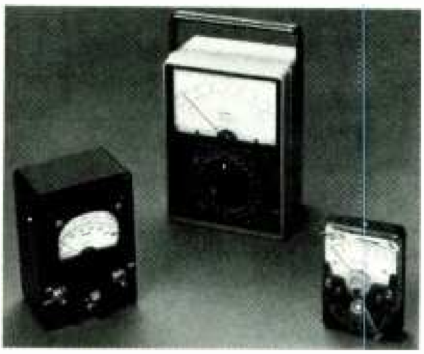
(Continued on page 107)

NEW PRODUCTS

Communications Testers

Three revised analog communications testers, Triplett's Model 310-TEL hand-size VOM, Model 60D drop-proof VOM, and Model 8455 line-tester, feature solid-state electronics and can withstand a wide temperature range for both operation and storage.

The Model 310-TEL hand-size VOM features a drop-resistant case, single enclosed range switch, polarity-reverse switch, and overload protection. Ranges are: 0-300 AC/DC volts in 4 ranges; 0-600 microamps DC 0-600 milliamps DC in 4 ranges; 0-20 megohm resistance in 4 ranges. Batteries, safety leads, screw-on insulated alligator clips, and instruction manual are included. The price is $90.00.



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The Model 60D VOM is a full 4-½" scale, diode overload protected, analog tester, that can withstand a 5-foot drop. The rugged case is *safety orange* with a molded handle and includes an easy-access sealed battery compartment. Ranges are: 0-600 AC/DC volts in 5 ranges; 0-60 microamps DC; 0-120 milliamps DC in 3 ranges; 0-10 Megohms in 5 ranges. Safety test leads, screw-on insulated alligator clips, batteries and instruction manual are included. The price is $180.00.

The Model 8455 is a compact, reliable, communications-industry standard that measures DC voltage and resistance for checking line shorts and opens, multiple ringers, and other test operations. A R/10 switch and a reverse switch facilitate line testing. Ranges are: 100 VDC at 100 ohms/volt; 0-2-megohm with 100,000-ohm at center scale—direct-reading or pushbutton actuated; 0-200,000-ohm full-scale with 10,000-ohms at center scale. The price is $100.00.

Literature is available from Triplett Corporation, a Penril Company, One Triplett Drive, Bluffton, OH 45817; tel. 800/ TRI-PLET, Extension 30; or 419/358-5015 within Ohio.

Mobile Scanner

Just about everyone needs a programmable scanner to keep on top of the action in the public-service bands. For volunteer firemen, paramedics, policemen, and individuals who live in rural areas—where only a handful of active frequencies are in use—a crystal scanner such as the Regency R806 may be all the scanner they need. The dedicated listener of fire, police, or other public-service actives may find the Regency R806 just as valuable in a big metro-center.

Ideal for home or mobile use, the scanner measures just 1½-in. H × 5⅕-in. W × 6⅞-in. D, so it is small enough to fit under the dash or even in the glove-box of the tiniest subcompact car.

Yet, despite its smal size, the scanner covers eight channels and six of the most popular bands, including VHF-Low (30-50 MHz), VHF-Amateur (144-148 MHz), VHF-High (148-174 MHz), UHF-Amateur (440-450 MHz), UHF (450-470 MHz), and UHF-T (470-512 MHz). A separate version of the scanner substitutes the Government Land Mobile Band (406-420 MHz) for UHF-T.

In addition to its full-frequency coverage, the scanner includes such sophisticated features as a programmable

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priority control, dual scan speeds (fast and slow), channel lockout, which skips channels not of current interest, and a scan/ manual control for scanning or manually stepping through channels.

All controls are located on the front panel, which includes LED channel indicators plus volume and squelch controls. A top-mounted speaker delivers a full 1.5 watts of audio.

The Regency R806 crystal mobile scanner comes with a mobile mounting bracket, AC power-cord, DC power-cord, and a telescoping antenna. Additional details are available from Regency scanner suppliers or by writing directly to Regency Electronics, Inc., 7707 Records Street, Indianapolis, IN 46226.

Gold-Tipped Dubbing Kit

Carter-Craft Gold Tip Stereo-To-Stereo Dubbing Cable Kit is part of the "Gold" line of audio/video accessories. It is used in dubbing from one stereo VCR to another stereo VCR. The dubbing cable (#60-355G) features gold electroplated connections that reduce signal loss and help reduce picture interference. Also featured are coded plugs for correct input/ output, strain reliefs, and six-foot cables.

For information about the complete line of Carter-Craft audio and video accessories, request illustrated, descriptive liter-

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ature by writing to Carter-Craft, Inc., 1916 11th Street, Rockford, IL 61101; tel. 815/397-3200

Digital Clamp-On Probe

The Universal DCP4 is a compact, clamp-on current probe that does one thing—and does it well! It measures AC current up to 400 amperes with reliability and digital precision.

The DCP1 has only two switches: Power ON/OFF and DATA HOLD. The DATA HOLD feature is an *electronic hold* that

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locks the last reading on the LCD display for those times when the user can't see the display while taking a reading. Automatic overload protection is built in.

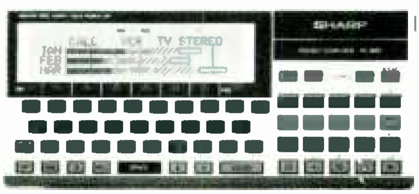
The current probe jaw is a new, compact tear-drop shape to make it easier to get into tight places. A standard 9-volt transistor-radio battery will last for about a year. When the battery is low a Lo Batt reminder will appear on the LCD display. The case is impact and shock proof, and a wrist strap is supplied to help the user hang on to the DCP1 on those jobs where a third hand would be helpful.

The DCP1 measures a compact 7¼-in. × 2⅛-in. × 1¼in.; weighs only 8 oz.; and comes complete with battery and instruction book. A carrying case is available as an option. The DCP1 has a suggested user price of $69.95. For more information, contact Universal Enterprises, Inc., 5500 SW Arctic Drive, Beaverton, OR 97005; tel. 503/644-8723.

Floppy-Based Handheld

The Sharp PC-1600 handheld computer features random-access floppy-disk storage. The PC-1600 has an optional 2½-in. micro-floppy disk drive with 128K mass storage, and also includes a fiberoptic interface. The PC-1600 is software-compatible with Sharp's PC-1500A, and with many peripherals fitting both units.

The unit's microprocessor is a *Z80A-like* proprietary Sharp design. The software compatibility with the PC-1500 is due to the fact that the ROM-resident BASIC interpreter and 60-pin I/O bus are



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the same in both models. The PC-1600's processor is about 2.5 times faster.

The PC-1600 features a four-line, 26-character display. The standard configuration includes 16K RAM, expandable to 80K. Also, in addition to the fiberoptics interface, the unit has an analog input and an RS-232C serial port.

The unit measures 3½-in. × 8-in. and weighs slightly less than a pound. The new model's floppy-disk storage makes it ideal for collecting data in a variety of decentralized (on the road or at home) settings.

Suggested retail price for the PC-1600 and options are as follows: PC-1600 pocket computer, $345.00; CE-1600F micro-floppy drive, $210.00; CE-1600P 4-color pen plotter/cassette interface, $315.00; and CE-1600M 32K RAM module, $155.00. For more information, contact Sharp Electronics Corporation, Systems Division, Sharp Plaza, Mahwah, N.J. 07430; tel. 201/529-8965. Sharp computer products are available at computer outlets across North America.

RS-232C to RS-422A Converter

The B&B RS-232C to RS-422A Converter (Model 422CON) answers the need for RS-422A interface compatibility. Using balanced differential signals, this new converter permits communication on cable lengths up to 4000 feet with bit rates up to 90K-bits-per-second. For those who use multi-drop systems, the B&B RS-232C Converter allows as many as ten receivers to be connected to a driver at once.

The Converter retails for only $49.95. It includes a male DB25P connector for RS-232C and female DB25S connector for RS-422A: RS-232 *transmit data* is

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converted to RS-422 and RS-422 *receive data* is converted to RS-232. No handshake lines are connected to the unit. The Converter requires 12 VDC at 100 mA. An optional power supply is available for only $14.95.

An alternate Reversed Converter (Model 422COR) is also available with a female DB25S connector for RS-232C interface and male DB25P for RS-422A. The retail price is $49.95.

B&B offers a complete line of RS-232

interface and monitoring equipment. All products are backed by a one-year warranty and money-back guarantee.

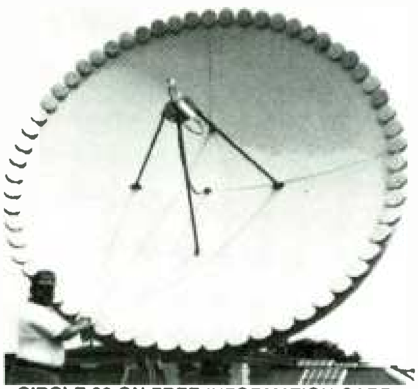
For a free, illustrated catalog of products and prices, as well as additional information about the RS-232C Converter, write to B&B Electronics Manufacturing Company, 1500P Boyce Memorial Drive, Ottawa, IL 61350; tel. 815/434-0846.

Reduce TVRO TI

A kit of absorber disks, model 5552, will reduce *terrestrial interference* (TI) as much as 10 dB when placed around the edge of TVRO antennas.

Available from Microwave Filter Company, the disks prevent TI, which is almost solely due to re-radiation of energy on the dish rim. This is usually enough to clear mild to medium interference, or bring severe wipeouts back to levels that can be filtered.

The absorber kit can also be applied to the edge of screens, erected to shield TVRO antennas, to reduce edge diffraction and expand the screen's dimensions.



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The kit is available for any size of dish. Each disk is approximately 6-in. in diameter and 1.25-in. thick. They are placed at intervals around the edge of the dish with two-way tape included in the kit. The disks are also weatherized to prevent moisture absorption.

The kit can be ordered by stating 5552-(dish size in feet). The price of the kit is determined by the number of disks needed. Delivery is three weeks. For more information contact Jim Carrick at Microwave Filter Company, Inc., 6743 Kinne St., East Syracuse, N.Y. 13057.

Business Card with a Brain

Your business card won't be a *dis-card*, thanks to C P Products, a California-based developer of business support systems and sales tools. They've combined space-age technology with down-to-earth good business sense, and devised a new improved method to convert almost any regular business card to an elegant, practical keepsake *that really counts*.

CIRCLE 57 ON FREE INFORMATION CARD

You supply your own business card (most standard-size cards can be converted). It's impregnated with clear plastic and bonded to the back of a wafer-thin, solar-powered, six-function (with memory) electronic calculator.

C P's *business card with a brain* is the perfect way for sales professionals to express their appreciation to special customers—or to impress select new prospects. It weighs less than an ounce and there are no batteries to wear out.

To order, simply provide C P Products with one business card for each card/calculator desired. (Please include two extra cards per order for formatting and sizing.) Pricing is as follows: $15.00/each (quantities of 1-9), $12.50/each (10-24) and $10.00/each (25 or more). Prices include delivery; California residents add 6½% sales tax. Send orders to C P Products, Box 431, San Pedro, CA 90733; tel. 213/514-8666.

Line-Cord Lock-Up

The Switch is a foolproof mechanism that can be installed on any television set, home computer, stereo, video recorder or other electric appliance. It *captures* the plug-end of the powercord from an appliance. The appliance is plugged-in inside The Switch's case and ingeniously locked up. When the powercord from The Switch is plugged into the wall outlet, power to the television or appliance is provided or prohibited with a turn of the special key mechanism. The control of power to the appliance is in the hands of the person who holds the key.

CIRCLE 85 ON FREE INFORMATION CARD

The Switch is made of high impact ABS plastic in a light oak color with woodgrain accents. The suggested selling price is $19.95. The Switch just might be the best investment a parent can make in their child's future. It gives parents control over electronic appliances. The Switch is currently available in North America in major retail outlets and mail-order catalogs, or direct from Positive Impact Marketing, 120 Richardson St., Grass Valley, CA 95945.

Compact Digital Multimeter

The Triplett Models 3350 and 3360 autoranging digital multimeters provide 19 ranges and 7 functions for industrial, commercial, or consumer electrical/electronic equipment testing. (Model 3360 provides 2 additional DC/AC current ranges.)

Both units have 3.5-digit LCD displays, auto polarity with diode test, and continuity check. DATA HOLD and RANGE HOLD features are included on the Model 3360.

CIRCLE 66 ON FREE INFORMATION CARD

Ranges include: 0-1000 VDC in 5 ranges; 0-750 VAC in 4 ranges; 0-10 amperes AC/DC current in 2 ranges for the Model 3350 (Model 3360; in 4 ranges); 0-20 meghom resistance in 6 ranges; 200-ohm continuity check; 2-V diode test.

These compact-size/light-weight (2.67-in. W × 5.67-in. H × 1-in. D; 1/2 lb.) testers are furnished with a tilt stand, safety test leads and jacks, three input jacks, two AA batteries, plus a comprehensive instruction manual.

Price of the Model 3350 is $64.50 and the Model 3360 with 2 additional ranges, plus DATA- and RANGE-HOLD features is $76.50.

For a free demonstration, contact your Triplett distributor. Literature is available from Triplett Corporation, a Penril Company, One Triplett Drive, Bluffton, OH 45817; tel. 800/TRI-PLET, Extension 30; or 419-358-5015 within Ohio.

Train for the Fastest Growing Job Skill in America

Only NRI teaches you to service all computers as you build your own fully IBM-compatible microcomputer

With computers firmly established in offices—and more and more new applications being developed for every facet of business—the demand for trained computer service technicians surges forward. The Department of Labor estimates that computer service jobs will actually *double* in the next ten years—a faster growth rate than for any other occupation.

Total systems training

No computer stands alone... it's part of a total system. And if you want to learn to service and repair computers, you have to understand computer *systems.* Only NRI includes a powerful computer system as part of your training, centered around the new, fully IBM-compatible Sanyo 880 Series computer.

As part of your training, you'll build this highly rated, 16-bit IBM-compatible computer system. You'll assemble Sanyo's "intelligent" keyboard, install the power supply and disk drive and interface the high-resolution monitor. The 880 Computer has two operating speeds: Standard IBM speed of 4.77 MHz and a remarkable turbo speed of 8 MHz. It's confidence-building, real-world experience that includes training in programming, circuit design and peripheral maintenance.

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Even if you've never had any previous training in electronics, you can succeed with NRI training. You'll start with the basics, then rapidly build on them to master such concepts as digital logic, microprocessor design, and computer memory. You'll build and test advanced electronic circuits using the exclusive NRI Discovery Lab®, professional digital multimeter, and logic probe. Like your computer, they're all yours to keep as part of your training. You even get some of the most popular software, including WordStar, CalcStar, GW Basic and MS DOS.

Send for 100-page free catalog

Send the post-paid reply card today for NRI's 100-page, full-color catalog, with all the facts about at-home computer training. Read detailed descriptions of each lesson, each experiment you perform. See each piece of hands-on equipment you'll work with and keep. And check out NRI training in other high-tech fields such as Robotics, Data Communications, TV/Audio/Video Servicing, and more.

If the card has been used, write to NRI Schools, 3939 Wisconsin Ave., N.W., Washington, D.C. 20016.

NRI is the only technical school that trains you as you assemble a top-brand microcomputer. After building your own logic probe, you'll assemble the "intelligent" keyboard...

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

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switch-mode technology.

Drawing from research papers, conference reports, and his own experience, the author provides insight into hardware design, the use of pulse-width modulator IC's, the reliability of switch-mode supplies, and ways to improve reliability by using redundancy techniques.

Leading off with an introduction to switching regulators and power supplies, the book provides practical explanations of modeling, analysis, design, measurement of loop gain and phase, and computer-aided design. Actual examples of power supplies are given to show how hardware is designed. Then, using spacecraft power systems as models, Chetty shows how power systems are designed for a typical space satellite. The section devoted to the use of integrated circuits in switch-mode power supplies includes a review of available IC's.

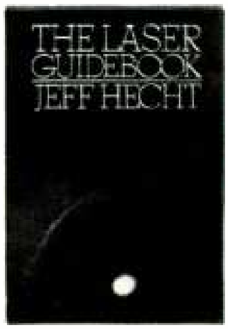
Designed as a tutorial on the practical aspects of switch-mode power supply design, this is a sourcebook that provides a sophisticated technical exploration of a fascinating new aspect of electronics technology.

The book has 192 pages, and costs $19.45 hardbound from TAB Inc., P.O. Box 40, Blue Ridge Summit, PA 17214; tel. 717/794-2191

The Laser Guide Book by Jeff Hecht

Presenting vital information on the functional characteristics of commercial lasers, *The Laser Guidebook* enables engineers and scientists to identify—easily and quickly—the type of laser that best meets the requirements of a particular system or application.

Comprehensive in scope and thoroughly practical in approach, the guidebook offers a helpful overview of the field that explains the basics of lasers and optics.



CIRCLE 74 ON FREE INFORMATION CARD

In introductory chapters, the author discusses such topics as the evolution of the laser concept, laser theory and principles, methods to enhance laser operation, and accessories that improve laser performance. The heart of the book, however, is devoted to individual laser types. In those chapters the text examines all the major and minor kinds of lasers that are commercially available, such as helium-neon, ion, carbon dioxide, chemical, copper vapor, excimer, far-infrared, dye, nitrogen, gallium arsenide, semiconductor diode, and neodymium.

The Laser Guidebook has 381 pages and sells for $49.50. Published by McGraw-Hill Book Company, 1221 Avenue of the Americas, New York, NY, 10020; it is available at better bookstores across North America. ■

By Byron G. Wels

WELS' THINK TANK

If you haven't found the circuit—look here!

IT'S NO SECRET THAT THE RESOURCES that we most frequently use are books. When a reader question arrives, the first thing we turn to are the books we depend on for the information and schematics to solve the problems. In most cases, the books do indeed provide us with the necessary answers. But occasionally, a search of all the volumes yields nothing, and we have to turn to other directions. Our secondary resource is the manufacturer's fact sheets and application notes. Both the books and application notes are made available to us, very generously, by the publishers and manufacturers. Certainly, that kindness makes our lives a good deal easier all around.

This month's schematics were used with the kind permission of Howard W. Sams & Co., 4300 West 62nd Street, P.O.Box 7092, Indianapolis, IN 46206. To order, call 1-800/428-SAMS. The books used were Electronic Telephone Projects, by Anthony J. Caristi, $10.95, and *The IC Timer Cookbook, Second Edition*, by Walter G. Jung, $17.95.

Low-Power Timer

"Can you help us?" asks T.P., of Provo, UT. "We've got a battery-operated circuit and need a low-power, monostable timer."

You're right, of course, about needing a low-power circuit. For many simple timing applications, the 555 oscillator makes an ideal timing circuit. But because it has a current drain of 3 mA at 5.0 volts in the standby state, it is not well suited for battery-powered applications. Figure 1 shows a simple timer circuit based on the the 555. For battery operation, one of its CMOS cousins, either the low-power TCL555 or 7555, can be dropped directly into the circuit, without having to modify the board. The CMOS versions will lower standby consumption considerably. The 7555 chip can be powered by as little as 2

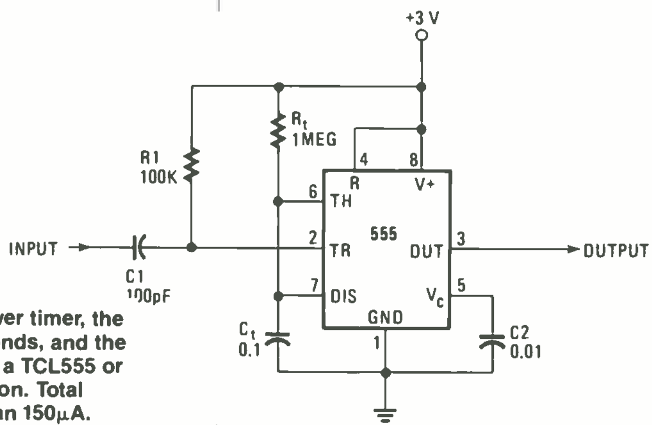


Fig. 1—In this low-power timer, the time is set for .11 seconds, and the timer chosen is either a TCL555 or 7555 for 3-volt operation. Total power drain is less than 150μA.

volts, and the TCL555 has a bottom limit of 2.7 volts.

Either the TCL555 or 7555 can operate in this 3-volt circuit using two 1.5 volt cells, with a standby drain of under 150 μA for the TCL555, while the 7555 generally will function at under 100 μA. Note that the timing resistor can dissipate appreciable power also, as it is connected across the line in the *standby* state. The timing resistor is 1 megohm to minimize standby current. If it were set at 100,000 ohms, the drain would be 30 μA, a fairly large percentage of the total power drain.

Cost-Conscious

"It's going to be back to the drawing boards for us if you can't come up with a way to add a 555 timer to our completely designed circuit and use only a minimum number of components. We omitted this from our new product and now must add it but within cost-effective guidelines." That's what P.T., of Covina, CA told us.

Okay, P.T., take a look at Fig. 2. This is the simplest circuit with the fewest

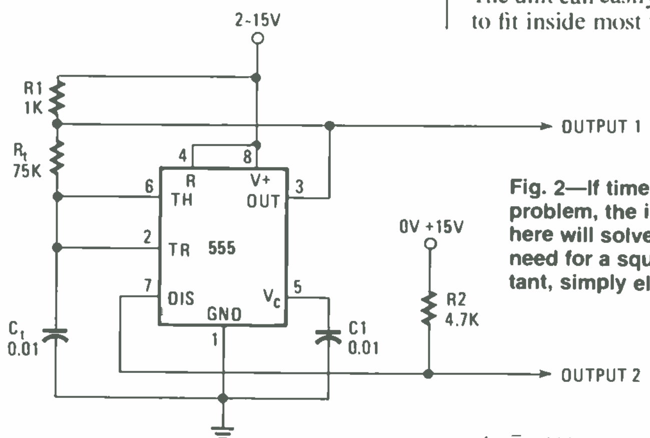


Fig. 2—If time asymetry becomes a problem, the improved circuit shown here will solve it. If that, or the need for a squarewave is not important, simply eliminate resistor Rt.

number of components we could find. Resistors R1 and R_t, along with capacitor C_t determine the output high time; while R_t and C_t determine the low time. Identical times can be generated if a single timing resistor is placed between the charging voltage and ground, with fixed upper and lower thresholds.

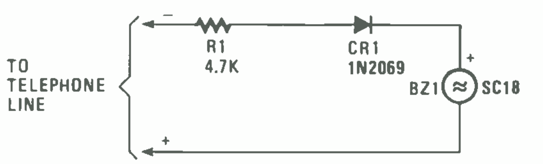
The timing resistor is an added pull-up resistor, which forces the voltage at pin 3 to rise to V+ in the high state. That removes the time-assymetry error, making the waveform square in shape. The time and frequency expressions then become more precise.

Peace and Quiet

"My telephone bell jingles and jangles my nerves. It makes my teeth itchy." That's what P.Y. (Reno, NV) tells us.

Have we got a simple solution for you P.Y.! Check out Fig. 3. By using a Mallory Sonalert module with this circuit, you can convert your raucous telephone bell into a very polite, soft-tone device. There are only three components, and the circuit is operated by the telephone's 90-volt, 20-Hz ring signal. R1 and D1 are added to the circuit to limit the current to the module, thereby protecting it against reverse-voltage. The diode acts also to present an open-circuit condition when not in use. That also makes the unit undetectable to the telephone lines when not in use.

Which Sonalert module? Type number SC18 offers a 3500 Hz, 70 db, soft tone. Type number SC628 has a 2900 Hz, 80-db, medium tone, and type number SC616N has a 2900 Hz, 95-db loud tone. The unit can easily be made small enough to fit inside most telephone housings.



TYPE NUMBER	FREQUENCY	SOUND LEVEL	LOUDNESS
SC18	3500 HERTZ	70dB	SOFT
SC628	2900 HERTZ	80dB	MEDIUM
SC616N	2900 HERTZ	95dB	LOUD

Fig. 3—A resistor, a diode and a Mallory Sonalert are all that are needed to take the jangle out of your telephone. Selecting the correct Sonalert module will determine the loudness of the tone. (See text.)

Of course, you'll probably also want to disconnect the bell from your phone, once you've got the unit operating. However, it's a simple matter to install a small toggle switch so that you can have the option of either the Sonalert signal, or the bell.

Unfortunately, we've run out of space once again. But as they say on TV, keep those cards and letters coming in folks! and we'll see you here again next month. Write to By Wels, **Hands-On Electronics** Magazine, 500-B Bi-County Blvd., Farmingdale, NY 11735. ■

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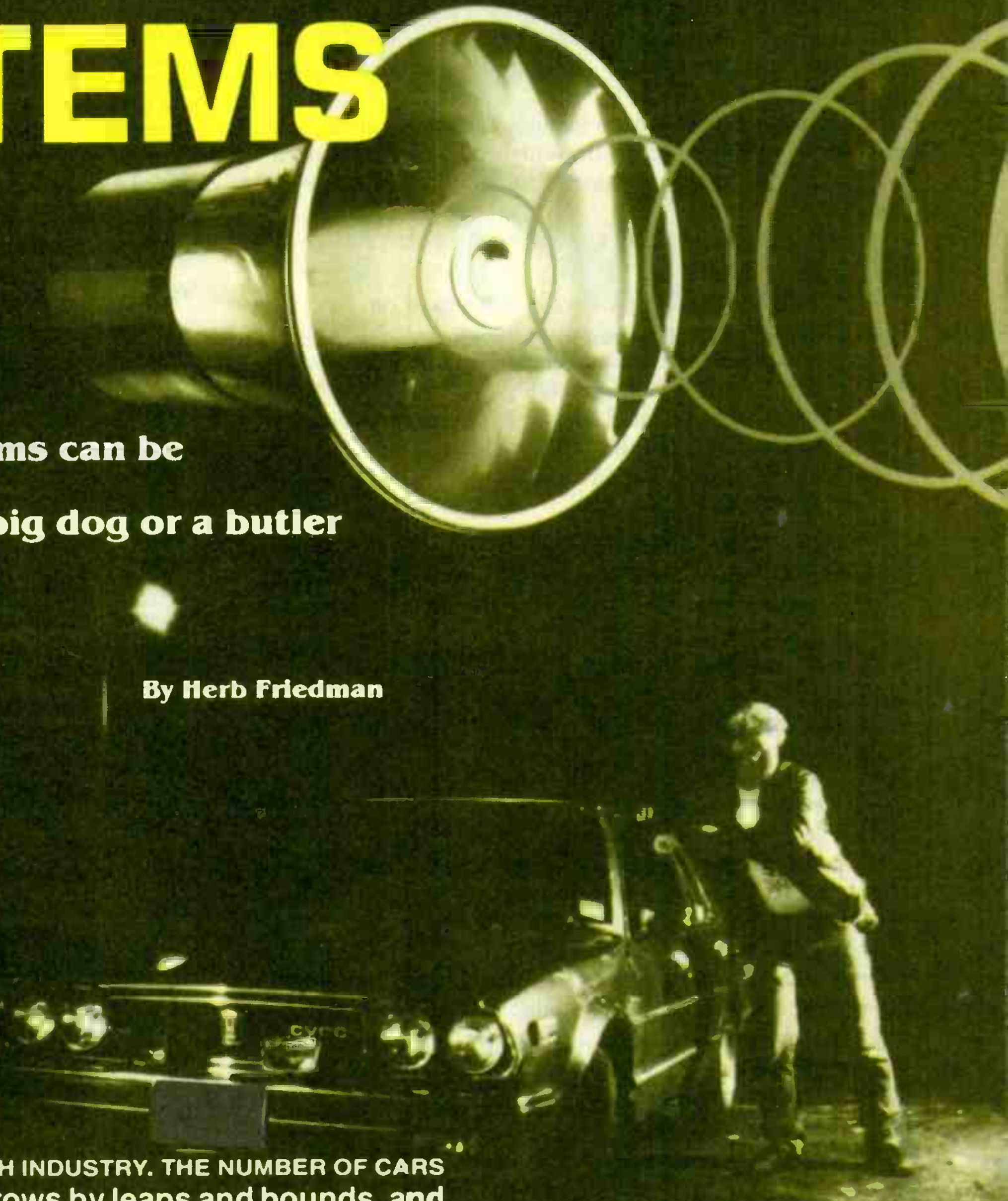
FEBRUARY, 1987

AUTO-SECURITY SYSTEMS



Auto-security systems can be better than a big dog or a butler

By Herb Friedman

AUTO THEFT IS A GROWTH INDUSTRY. THE NUMBER OF CARS stolen or stripped grows by leaps and bounds, and the police can do virtually nothing to stop it. Worse still, insurance almost never covers the replacement cost.

As many car owners discover too late, the first line of defense in protecting their car is an *aftermarket* security system; aftermarket meaning something installed after the car leaves the dealer—either by the owner or by an automotive shop.

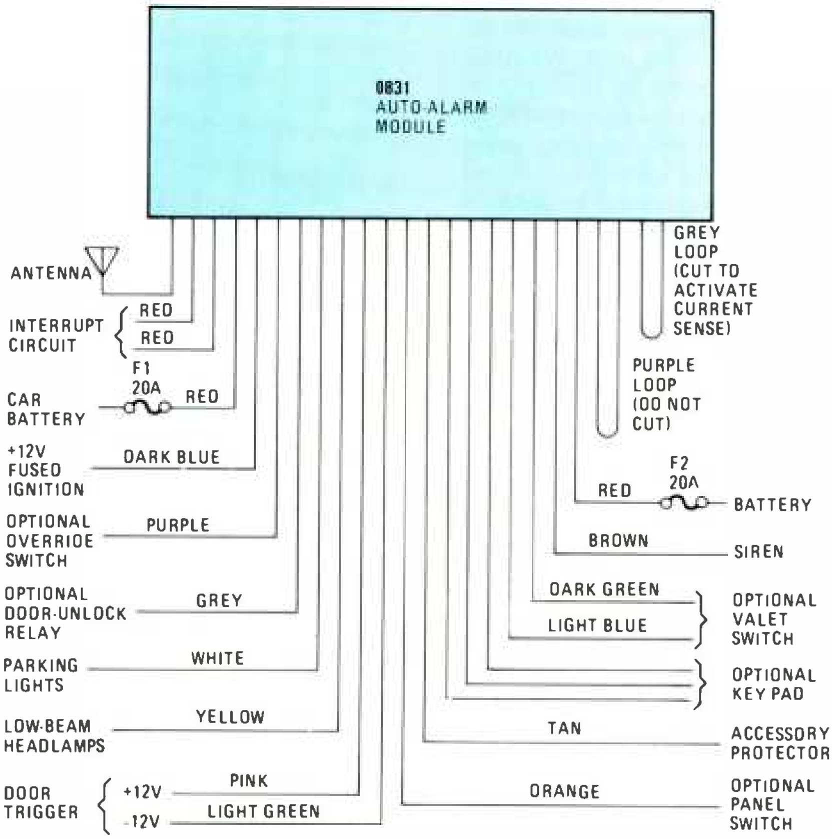


Fig. 1—Just about any feature is possible in a computerized vehicle-security system such as the *Thug Bug* is the basic alarm module which has accessories such as a keypad and valet switch. The antenna is used for receiving remote-control signals from a key-fob transmitter which disarms the alarm.

Digital Protection

Although conventional hard wire and electronic current-sensing alarms provide considerable protection—particularly because any of the high-tech sensors such as glass breakage and movement detectors are easily connected—it's possible to offer a lot more protection if the alarm device uses digital circuits or a microprocessor. Not that the digitized extra protection is necessarily better, it's just easier to install certain kinds of high-tech sensors if they're needed.

For example, one of the computerized systems provides for extensive expansion—sensor inputs are pre-wired so the user can upgrade the system by simply connecting new sensors. The entire electronics system is encapsulated in a module that also contains a radio receiver for remote-control of the system, or at the very least, remote door and trunk entry.

Although the the most basic auto-alarms need only a noisemaker, a latching relay, and a few switches, the control box of a computerized alarm system usually has a printed-circuit board jam-packed with transistors, integrated circuits, and a microprocessor.

Alternately, for those who can't afford to blow the next mortgage payment for a super-security system, there are models that provide the basic protection, allowing for customized expansion of functions at a later date.

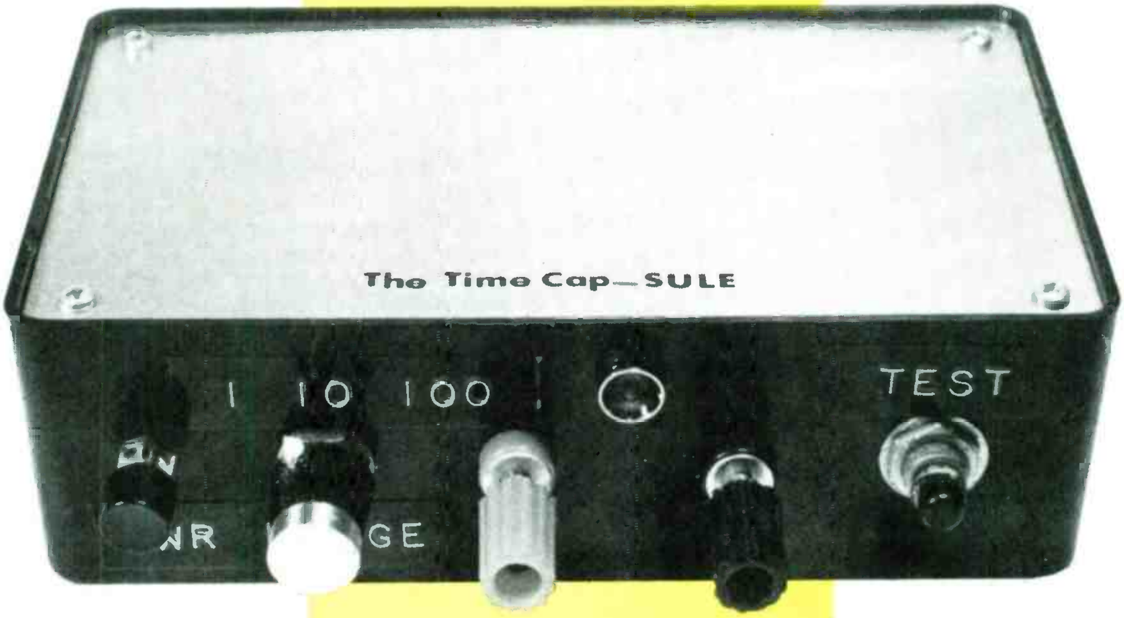
Figure 1, the wiring diagram for a *Thug Bug*—one of the super high-tech security systems—gives a good idea of just about all the major features that are possible. Bear in mind as we discuss the various options that the alarm is passively armed about 30-seconds after the ignition is turned off and the last door has been closed, giving the driver and passengers time to get out of the vehicle.

First, note the antenna. The system has a built in 49-MHz receiver that responds to digital codes radiated by a key-fob transmitter. On that particular model, the user can pop the doors or trunk open when hurrying through a dark parking lot. Next, there is the *interrupt circuit*, which disables the starter unless the system is turned off. The *door unlock relay* is used to open the doors by remote control. The *pulsed +12V output* flashes the parking lights and headlamps to call attention to your vehicle. After all, it's hard to tell which car in a lot of several hundred is sounding an alarm—flashing lamps are great, particularly if the system has the *optional panic switch*—hit the switch and no one is going to hang around your car.

A pair of loops provide for a current sensing circuit and

(Continued on page 102)

THE TIME CAPSUL—
UNMASK THOSE PHANTOM CAPACITORS



If your junk-box over-floweth, you most likely don't know the value of many of your capacitors. Well, now you can easily sort the large values.

By Frank I. Gilpin

☐WHETHER YOUR JUNK-BOX IS THAT, OR IS A COLLECTION OF neatly labeled boxes or jars containing clearly-identified parts, you can still put the Time CapSUL to good use on your workbench. This is not the Jules Verne model. The name is a point-stretching acronym meaning, "Timing Capacitance for Sorting Unidentified Large Capacitors".

There are many commercially-made capacitor checkers and some which can be built by the experimenter, but none so accurate, simple, or as much fun to use as the Time CapSUL. You can come up with this precision instrument in less than two evenings, and probably under $20. It will test 1 to 10,000 microfarads with great accuracy and, if you wish, keep any family musician on the beat.

How's it Work?

The Time CapSUL is composed of two simple building-block circuits. The first (see Fig. 1) is a timing circuit using the familiar 555 IC operated as an astable oscillator (U1). Its cycling is determined by capacitor C4 and timing resistors R6, R7, and R8. When the voltage across C4 reaches about two thirds of V_{CC}, it discharges rapidly through R6 and pin 7 of U1 until it reaches one third of V_{CC} before the cycle repeats. The frequency rate of the cycle can be varied by adjusting R8. The output pulse at pin three drives a small speaker through coupling capacitor C5. Since much of the circuitry for that section is contained in the IC itself, the unit's timing will be little affected by changes in the supply voltage.

Incidentally, the unit will deliver from about 40 to more than 220 beats-per-minute using the parts values shown in the schematic. That makes it a great candidate for a musician's metronome if you replace the miniature trimmer potentiometer R8 with a large, panel-mounted potentiometer. Use a stopwatch or sweep second hand to calibrate the panel according to the beats-per-minute table shown. Don't forget to carefully mark the 60 bpm spot on the dial so that the unit can still be used as a capacitor checker. The size or impedance of the speaker used is irrelevant, so pick one that best fits the case selected for the project.

The second section of the unit is also built around a 555 timer chip (U2) used in a monostable configuration (see Fig.

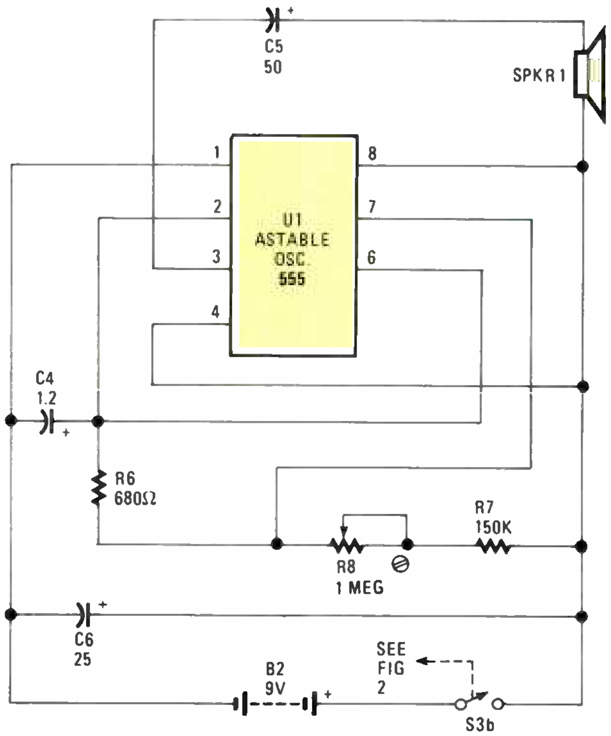


Fig. 1—Astable operation means that the 555 will trigger itself into operation after a specified low time and remain high for another specified time, and the cycle begins again. This output is feed to the speaker.

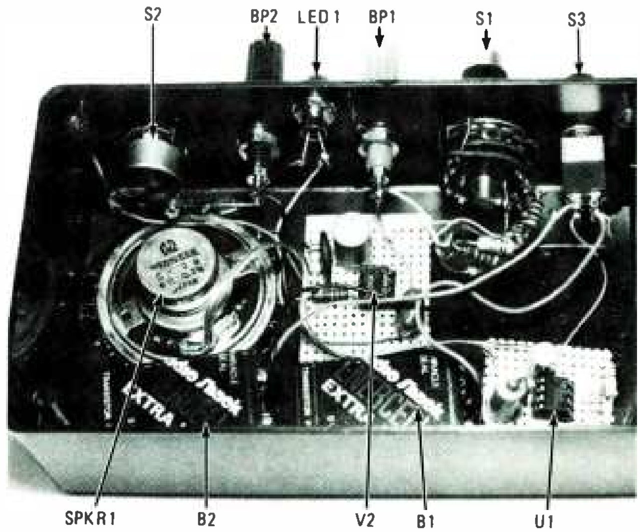
2). That section, however, uses the pulse at pin 3 of U2 to light an LED (LED1) through current-limiting resistor R2. The length of the output pulse equals the timing capacitance multiplied by the timing resistance. The timing resistance between pins 7 and 8 in that section is provided by switch-selected fixed resistors instead of a variable resistor. The capacitor under test becomes part of the timing circuit and determines the on-time of LED1. Range switch S1 will give you 1 µF-per-second at setting A, 10 µF-per-second at B, and 100 µF-per second at C.

So few parts are needed, that the original unit was wired on a perf board instead of the more time-consuming and expensive printed-circuit board. You may use any technique you prefer. The layout is not overly critical, but keep the leads between the chips and other components as short as possible. It is also a good idea to use sockets for U1 and U2 to eliminate any possibility of heat damage during soldering. The timing section and the LED-indicator section are independent of each other and have no direct connections. They do share the same power switch, but use separate sections of it. If you cannot find the correct values for R3, R4, and R5, use two or more resistors in series to total the values required.

The only calibration necessary is to adjust R8 with the power on until, measured against a stopwatch or sweep

TABLE 1—DIAL CALIBRATION

Beats Per Minute	Tempo
40-60	Largo
60-66	Larghetto
66-76	Adagio
76-108	Andante
108-120	Moderato
120-168	Allegro
168-200	Presto
200-208	Prestissimo



All switches, the LED, and multi-way binding posts mount on the utility-box front panel as shown. The speaker is epoxy-glued over a hole in the box. The perf board with the LED driver section is next to the speaker, and the speaker-driving IC section is to the far right. R3, R4, and R5 mount directly on range switch S1. The batteries and circuit boards are held securely in place with cabinet-sized foam rubber squeezed when the box cover is screwed down.

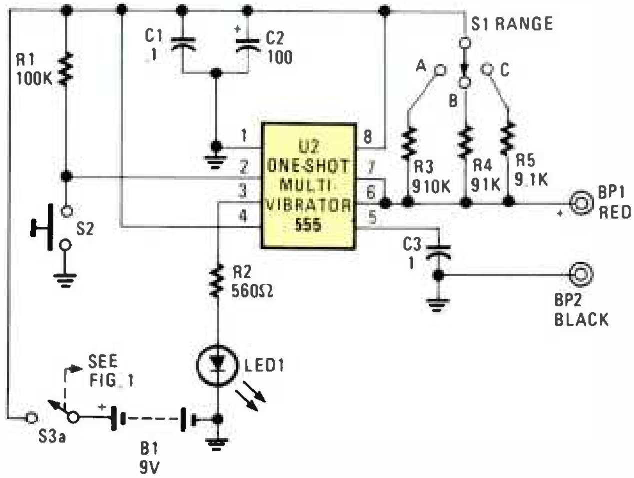


Fig. 2—Monostable operation allows the 555 to be triggered by input (a logic low) pulse, of any duration no matter how short, and it will output a high for a period of time determined by its resistor-capacitor network.

second hand, the speaker clicks at 60 beats-per-minute exactly. Get this as close as possible.

In the author's prototype, solid hookup wire was used to make the connections between the two perf boards and the panel-mounted components S1, S2, S3, J1, J2, and LED1. Flexible, stranded wire was used for the battery connectors. The small speaker, salvaged from an old pocket radio, was epoxy glued over a hole cut through the bottom of the enclosure. An enclosure-sized piece of two-inch-thick foam rubber was used under the cover to keep circuit boards and batteries firmly in place after the cover was screwed down.

Power-Up

To operate the assembled unit, turn on the power, set the range switch to the highest range (× 100) and connect the

(Continued on page 98)

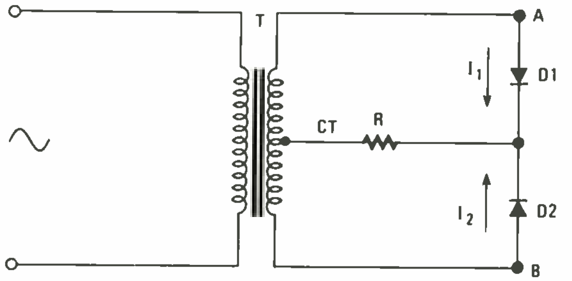


Fig. 6—Fullwave rectification can be achieved with only two diodes; however that requires the use of a center-tapped transformer. They are plentiful, but are more expensive.

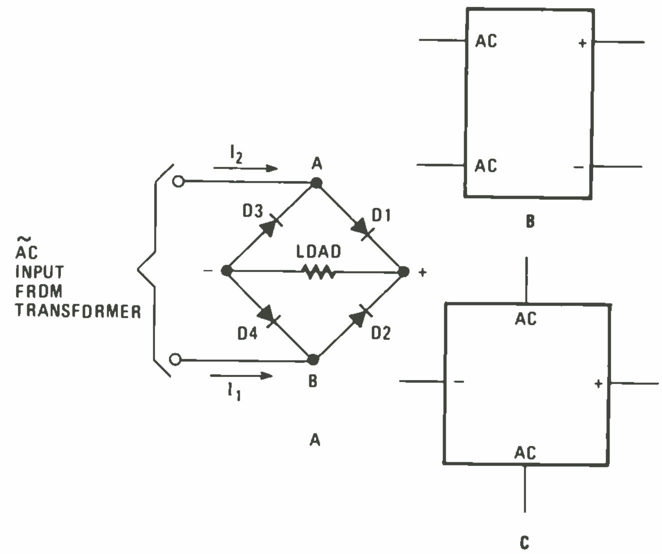


Fig. 8—The bridge rectifier requires no center-tapped transformer to fully rectify AC current. Also, two diodes operate at once, thus keeping the diode temperature down, as well as halving the necessary peak inverse voltage rating. Rectifier packages are varied enough to give the designer great freedom in deciding component layout.

Let's follow the circuit through one complete AC cycle—times T_1 through T_3 in Fig. 7. On the first half-cycle (T_1-T_2), point A is positive, so D1 is forward-biased and conducts current; D2 is reverse-biased and does not conduct. Current I_1 flows from point A, through D1, into the load R and back to the transformer at the CT. During the next half-cycle (T_2-T_3), current I_2 flows from point B, through D1 into load R, and back to the transformer at the CT. Now notice what happened: I_1 and I_2 are currents, generated on alternate half-cycles, and they flow through R in the same direction. Thus, we have unidirectional current through load R flowing on both halves of the AC sinewave. The waveform resulting from that is called fullwave rectified pulsating DC.

We can eliminate the center-tapped secondary requirement by using the fullwave bridge rectifier circuit of Fig. 8A. That circuit requires twice as many rectifier diodes, but allows us to use a simpler transformer. The operation, however, is similar. On one half-cycle, point A is positive and point B is negative. Electron current I_1 flows from the transformer at point B, through D4, load R, rectifier diode D1 and back to the transformer at point A. During the next half-cycle, point A is negative and point B is positive. In that case, electron current I_2 flows from point A, through rectifier diode D3, load R (in the same direction as I_1!), rectifier diode D2, and back to the transformer at point B.

In some cases you might want to build a bridge rectifier using four discrete diodes (D1-D4). In most modern equipment, however, a bridge stack is used. A bridge stack is a bridge rectifier built into a single package with four leads coming out. Figures 8B and 8C show the two alternate symbols for bridge-rectifier stacks.

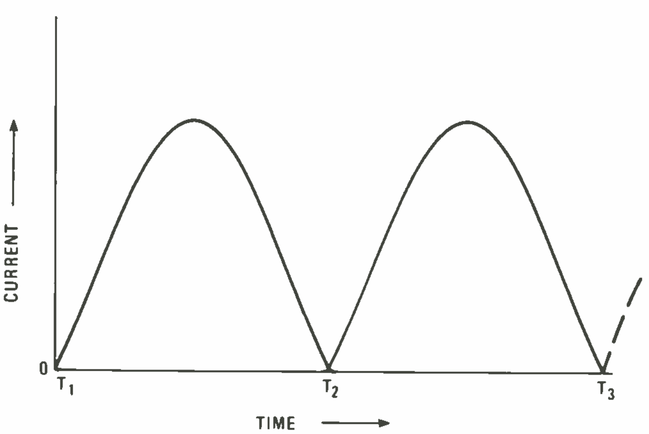


Fig. 7—Using fullwave rectifiers not only provides more power, more stable current, and are easier to filter than their halfwave counterparts, they can also be used to avoid problems that leakage current can produce.

Figure 9 shows a rectifier stack coupled to a center-tapped transformer to make a pair of halfwave rectified DC power supplies. The CT is the common (or ground), while the bridge positive terminal supplies the positive voltage and the negative terminal supplies the negative voltage.

A pulsating DC waveform is almost as useless for electronic circuits as AC input. However, we can filter the pulsating DC output to form nearly pure DC. Although the subject of filtering is beyond the scope of this article, we must consider at least the simplest form of power-supply filter in order to correctly select a rectifier for any given application. Figure 10 shows a simple power supply with a brute-force filter capacitor (C) shunting the load to filter the pulsating DC into nearly pure DC.

Selecting Rectifier Diodes

The two parameters that you will most often use to specify

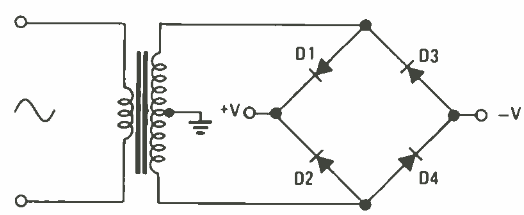


Fig. 9—A single bridge can be used to create a dual supply when used with a CT transformer. This design, however, creates two halfwave rectified wave forms, not fullwave.

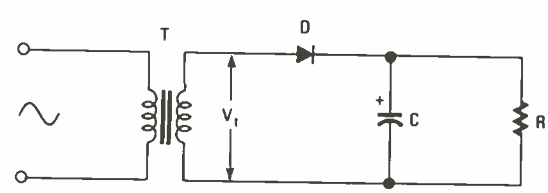


Fig. 10—Proper diode selection depends just as much on the filtering method used as anything else. The diode here must have a PIV rating equal to at least twice the peak transformer voltage, because of the capacitor.

power-supply diodes are the forward-current and peak-inverse voltage. Get those right, and in almost all cases the rectifier will work long and hard for you.

The forward-current rating of the rectifier diode must be at least equal to the maximum current load that the power supply must deliver. That's common sense, but in the real world a safety margin is necessary to account for tolerances in the diodes and variations of the real load (as opposed to the calculated load). It is also true that making the rating of the rectifier diode larger than the load current will greatly improve reliability. A good rule of thumb is to select a rectifier diode with a forward-current rating of 1.5 to 2 times the assumed load current—or more if you can get it. Although selecting a rectifier diode with a much larger forward current (e.g. 100 amperes for a 1-ampere circuit) is wasteful, and likely to make the rectifier diode behave improperly, it is generally the tendency. Use of the 1.5 to 2 times rule should result in a reasonable margin of safety.

The peak inverse voltage (PIV) rating can be a little more complicated. In unfiltered, purely resistive, circuits the PIV rating need only be greater than the maximum peak applied AC voltage (1.414 times the RMS voltage). If a 20-percent safety margin is desired, then make it 1.7 times RMS voltage ($120\% \times 1.414 \times V_{rms}$).

Most rectifiers are used in filtered circuits like that in Fig. 10, which makes the problem different. Figure 11 shows the simple capacitor filtered circuit laid out to better illustrate the circuit action. Assume that the circuit has functioned long enough to charge C close to the peak voltage with the polarity shown. When V_t is positive, the transformer voltage and capacitor voltage are about equal, making the voltage across

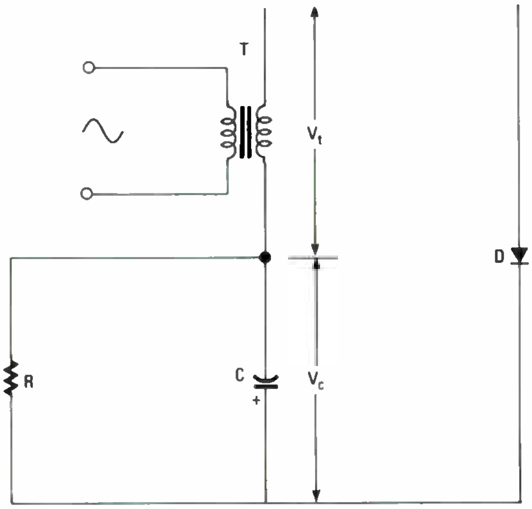


Fig. 11—When V_t goes to its negative maximum, C will still have much of its charge, and D will be exposed to an inverse voltage equal to twice the transformer rating.

D nearly zero. But when V_t goes negative, the transformer and capacitor place almost twice the peak voltage across the diode, (which is almost 2.82 times the RMS value). Therefore, the absolute minimum PIV rating for the rectifier diode in that circuit should be 2.82 times the applied RMS voltage. If you prefer a 20-percent safety margin (a good idea), then make the rectifier diode PIV rating 3.4 times the RMS voltage.

In most cases, especially for the low-voltage power supplies needed by most hobbyists, we can get away with simply using the diodes as shown in the circuits above. In Fig. 12,

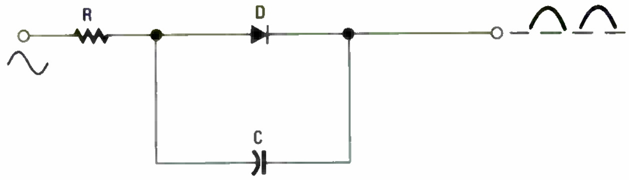


Fig. 12—Rectifier diodes need protection from "instantaneous" changes in current. Transformer start-up can cause damage with an onrush of current unless a current limiting resistor is used. Occasional voltage spikes can also cause damage unless they are shunted by a capacitor.

however, we see the so-called "proper" way to use a solid-state rectifier. The resistor in series with D (i.e. R) is used to limit the forward current. Many circuits, especially those with capacitor-filter circuits, exhibit a surge current at initial turn-on. That current can sometimes pop the diode, so R is use to limit the possible current. The value of resistance used for R is typically 5 to 20 ohms. In most cases, however, we can eliminate R by using a rectifier diode with a rating larger than the load current (for example, the two times rule).

Capacitor C (usually around .001µF) is used to bypass high-voltage transient spikes around the diode. Those spikes could possibly blow the rectifier diode. The working voltage (WVDC) of the capacitor should be equal to or greater than the PIV rating of the diode.

By use of 1000-PIV diodes, even in low-voltage circuits, we could eliminate much of the damage caused by transients and would not need capacitors. We could also eliminate the capacitors if a *metal oxide varistor* (MOV) spike suppressor is used across the AC supply voltage.

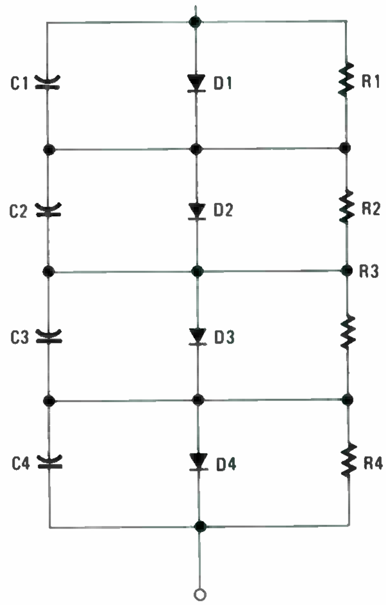


Fig. 13—For high-voltage applications, several diodes can be laid end to end to reduce the peak inverse voltage experienced by any one of them. Of course the ratings of the capacitors, resistors, and diodes must be the same to ensure a proper distribution of current.

Figure 13 shows the method for using several diodes in series to increase the PIV rating. Assuming that the PIV ratings of the diodes are equal, then the overall rating is four times the rating of one diode. In general, we use 1000-volt

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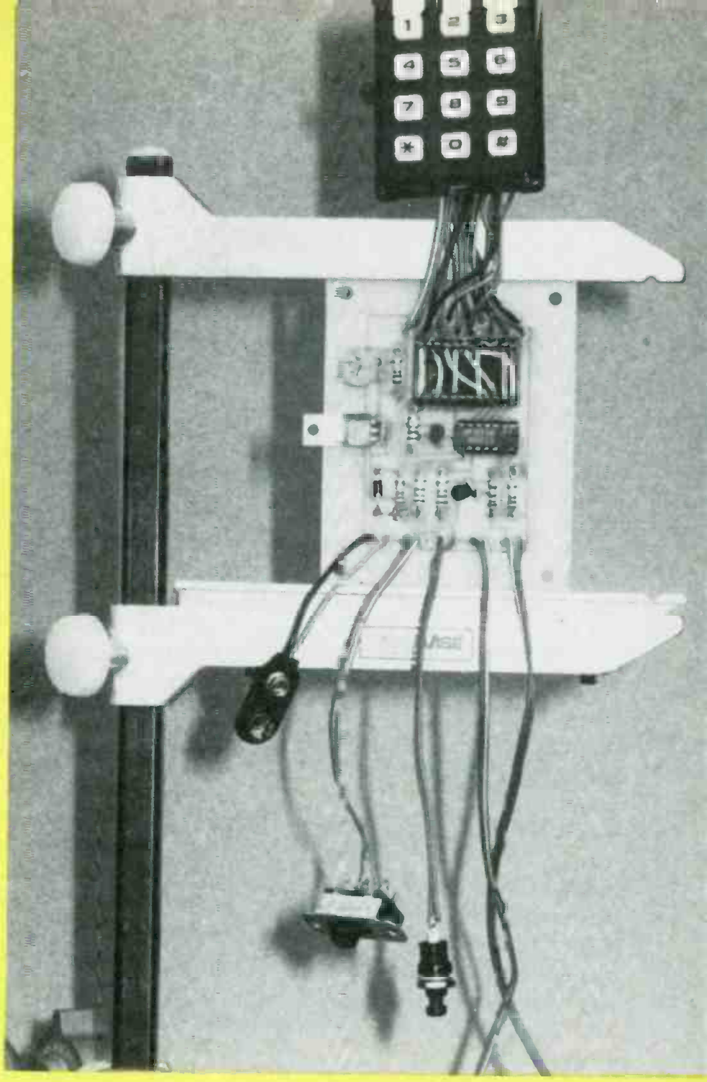

ELECTRONIC COMBINATION LOCK

Finally an electronic-security system that you can build and install—without having to mortgage the ol' homestead!

By Marty Knight

☐YOUR WORKSHOP IS A SACRED PLACE TO YOU! ONLY YOU can walk through he sawdust and trample on fallen resistors and diodes. Only you fully understand the dangers that other adults cannot see and your children don't understand. Thus, the workshop must be protected so that unauthorized entry will sound an alarm. What to do? Build the *Combination Lock/Alarm Control* from the kit, install it, and feel secure that your inner *sanctum sanctorum* will not be violated.

Here's what the Combination Lock/Alarm Control, a sophisticated control system, can do. Push just one button on the keypad and the circuit is armed. If anyone attempts to enter a protected location, an alarm is set off, which only you can disengage. When you wish to enter, however, the pressing of four buttons in a sequence (that you have determined in advance) will disarm the circuit and allow a quiet entry.

Added to that basic design is a light-emitting diode (LED) that lets you know when the circuit is armed. In addition, the unused keypad buttons (switches) help to frustrate any attempt to *break* the four-digit combination. All of those basic project features are made possible by a specifically designed integrated circuit, LSI Computer Systems' LS7220. Without the LS7220, a rat's nest of chips, transistors, diodes, etc., would crowd a printed-circuit board, raising the price of the project to a point where it would be impractical to attempt.

The Circuit

As you can see from the schematic diagram in Fig. 1, U1 is the heart of the Combination Lock/Alarm Control circuit. In analyzing the circuit, we'll first look at its armed state and then move on to its disarmed condition. The circuitry required to arm the Lock is almost entirely to the right of U1 in Fig. 1. In contrast, the disarming section—consisting of a series of switches—is to the left of U1.

The circuit is considered *armed* when an attempt to enter the unauthorized location triggers an alarm. You, of course, will want the circuit armed while you are away from the place that is being protected.

To avoid confusion, understand that any reference to a *button* means that the discussion is about one of the switches in keypad K1. Buttons S1 through S12, inclusive, identify switches whose buttons indicate *1, 2, 3, 4, 5, 6, 7, 8, 9, *, 0,* and *#*, respectively, that are part of keypad K1.

When button S12 (#) is pressed, a positive voltage fed through R1 appears at the base of transistor Q1, turning it on (see Fig. 1). With Q1 conducting, pin 1 of U1 is brought to ground (low) or the battery's negative terminal. With pin 1 low, two things occur: Pin 8 of U1 goes high (+9-volts DC), turning on LED1—indicating that the circuit has been armed—and pin 13 goes from high to low. A feature called *power-on reset*, which is a built-in feature of U1, causes the circuit to assume the armed status when power is applied as if S12 (#) had been pressed.

Transistor Q2 requires a low signal or negative voltage on its base in order to conduct (Fig. 1). It also needs a positive voltage on its emitter and a negative voltage on the collector. As long as the door switch (S15) remains open (with the door itself closed), Q2's emitter will not receive the necessary positive voltage. If, however, an unauthorized person opens

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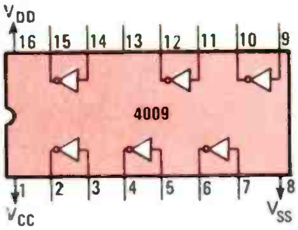
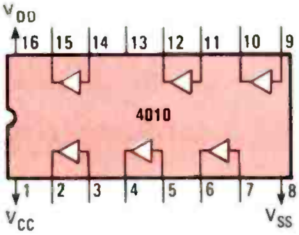
25 Hands-on Electronics FactCard — CMOS IC's: 4009 4010





MAXIMUM RATINGS *(Absolute-Maximum Values)*

DC SUPPLY-VOLTAGE RANGE, (V_{DD}, V_{CC})
(Voltages referenced to V_{SS} Terminal) .... −0.5 to +20V
INPUT VOLTAGE RANGE, ALL INPUTS .... −0.5 to V_{DD} +0.5V
DC INPUT CURRENT, ANY ONE INPUT .... ±10 mA
POWER DISSIPATION PER PACKAGE (P_D):
For T_A = −40 to +60°C (PACKAGE TYPE E) .... 500 mW
For T_A = +60 to +85°C (PACKAGE TYPE E) Derate Linearly at 12 mW/°C to 200 mW
For T_A = −55 to +100°C (PACKAGE TYPES D,F) .... 500 mW
For T_A = +100 to +125°C (PACKAGE TYPES D,F) Derate Linearly at 12 mW/°C to 200 mW
DEVICE DISSIPATION PER OUTPUT TRANSISTOR
FOR T_A = FULL PACKAGE-TEMPERATURE RANGE (All Package Types) 100 mW
OPERATING-TEMPERATURE RANGE (T_A):
PACKAGE TYPES D,F,H .... −55 to +125°C
PACKAGE TYPE E .... −40 to +85°C
STORAGE TEMPERATURE RANGE (T_{stg}) .... −65 to +150°C
LEAD TEMPERATURE (DURING SOLDERING):
At distance 1/16 ± 1/32 inch (1.59 ± 0.79 mm) from case for 10s max .... +265°C

RECOMMENDED OPERATING CONDITIONS

CHARACTERISTIC	LIMITS MIN.	LIMITS MAX.	UNITS
Supply-Voltage Range (For T_A = Full Package Temperature Range), V_{DD}	3	18	V
V_{CC}	3	V_{DD}	
Input Voltage Range (V_I)	V_{CC}	V_{DD}	V

26 Hands-on Electronics FactCard — dB Conversion Table

dB	Current or Voltage Ratio Gain	Loss	dB	Current or Voltage Ratio Gain	Loss	dB	Current or Voltage Ratio Gain	Loss
0	1.000	1.000	2.2	1.288	.7762	4.4	1.660	.6026
.1	1.012	.9886	2.3	1.303	.7674	4.5	1.679	.5957
.2	1.023	.9772	2.4	1.318	.7586	4.6	1.698	.5888
.3	1.035	.9661	2.5	1.334	.7499	4.7	1.718	.5821
.4	1.047	.9550	2.6	1.349	.7413	4.8	1.738	.5754
.5	1.059	.9441	2.7	1.365	.7328	4.9	1.758	.5689
.6	1.072	.9333	2.8	1.380	.7244	5.0	1.778	.5623
.7	1.084	.9226	2.9	1.396	.7161	5.1	1.799	.5559
.8	1.096	.9120	3.0	1.413	.7079	5.2	1.820	.5495
.9	1.109	.9016	3.1	1.429	.6998	5.3	1.841	.5433
1.0	1.122	.8913	3.2	1.445	.6918	5.4	1.862	.5370
1.1	1.135	.8810	3.3	1.462	.6839	5.5	1.884	.5309
1.2	1.148	.8710	3.4	1.479	.6761	5.6	1.905	.5248
1.3	1.161	.8610	3.5	1.496	.6683	5.7	1.928	.5188
1.4	1.175	.8511	3.6	1.514	.6607	5.8	1.950	.5129
1.5	1.189	.8414	3.7	1.531	.6531	5.9	1.972	.5070
1.6	1.202	.8318	3.8	1.549	.6457	6.0	1.995	.5012
1.7	1.216	.8222	4.9	1.567	.6383	6.1	2.018	.4955
1.8	1.230	.8128	4.0	1.585	.6310	6.2	2.042	.4898
1.9	1.245	.8035	4.1	1.603	.6237	6.3	2.065	.4842
2.0	1.259	.7943	4.2	1.622	.6166	6.4	2.089	.4786
2.1	1.274	.7852	4.3	1.641	.6095	6.5	2.113	.4732

27 Hands-on Electronics FactCard — dB Conversion Table

dB	Current or Voltage Ratio Gain	Loss	dB	Current or Voltage Ratio Gain	Loss	dB	Current or Voltage Ratio Gain	Loss
13.3	4.624	.2163	15.4	5.888	.1698	17.5	7.499	.1334
13.4	4.677	.2138	15.5	5.957	.1679	17.6	7.586	.1318
13.5	4.732	.2113	15.6	6.026	.1660	17.7	7.674	.1303
13.6	4.786	.2089	15.7	6.095	.1641	17.8	7.762	.1288
13.7	4.842	.2065	15.8	6.166	.1622	17.9	7.852	.1274
13.8	4.898	.2042	15.9	6.237	.1603	18.0	7.943	.1259
13.9	4.955	.2018	16.0	6.310	.1585	18.1	8.035	.1245
14.0	5.012	.1995	16.1	6.383	.1567	18.2	8.128	.1230
14.1	5.070	.1972	16.2	6.457	.1549	18.3	8.222	.1216
14.2	5.129	.1950	16.3	6.531	.1531	18.4	8.318	.1202
14.3	5.188	.1928	16.4	6.607	.1514	18.5	8.414	.1189
14.4	5.248	.1905	16.5	6.683	.1496	18.6	8.511	.1175
14.5	5.309	.1884	16.6	6.761	.1479	18.7	8.610	.1161
14.6	5.370	.1862	16.7	6.839	.1462	18.8	8.710	.1148
14.7	5.433	.1841	16.8	6.918	.1445	18.9	8.811	.1135
14.8	5.495	.1820	16.9	6.998	.1429	19.0	8.913	.1122
14.9	5.559	.1799	17.0	7.079	.1413	19.1	9.016	.1109
15.0	5.623	.1778	17.1	7.161	.1396	19.2	9.120	.1096
15.1	5.689	.1758	17.2	7.244	.1380	19.3	9.226	.1084
15.2	5.754	.1738	17.3	7.328	.1365	19.4	9.333	.1072
15.3	5.821	.1718	17.4	7.413	.1349	19.5	9.441	.1059
						19.6	9.550	.1047

25 Hands-on Electronics FactCard — 4009: Static Electrical / 4010: Characteristics

CHARACTERISTIC	CONDITIONS V_O (V)	V_{IN} (V)	V_{DD} (V)	LIMIT at 25°C (TYP)	UNITS
Quiescent Device Current I_{DD} Max.	—	0,5	5	0.02	µA
	—	0,10	10	0.02	
	—	0,15	15	0.02	
	—	0,20	20	0.04	
Output Low (Sink) Current, I_{OL} Min.	0.4	0,5	5	4	mA
	0.5	0,10	10	10	
	1.5	0,15	15	36	
Output High (Source) Current, I_{OH} Min.	4.6	0,5	5	−0.4	
	2.5	0,5	5	−1.6	
	9.5	0,10	10	−0.9	
	13.5	0,15	15	−3	
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	

CHARACTERISTIC	CONDITIONS V_O (V)	V_{IN} (V)	V_{DD} (V)	LIMIT at 25°C (TYP)	UNITS
Input Low Voltage, V_{IL} Max. 4009	4.5	—	5	1	V
	9	—	10	2	
	13.5	—	15	2.5	
Input Low Voltage, V_{IH} Max. 4010	0.5	—	5	1.5	
	1	—	10	3	
	1.5	—	15	4	
Input High Voltage: V_{IH} Min. 4009	0.5	—	5	4	
	1	—	10	8	
	1.5	—	15	12.5	
Input High Voltage: V_{IH} Min. 4010	4.5	—	5	3.5	
	9	—	10	7	
	13.5	—	15	11	
Input Current, I_{IN} Max.	—	0,18	18	$\pm 10^{-5}$	µA

26 Hands-on Electronics FactCard — dB Conversion Table

dB	Current or Voltage Ratio Gain	Loss
6.6	2.138	.4677
6.7	2.163	.4624
6.8	2.188	.4571
6.9	2.213	.4519
7.0	2.239	.4467
7.1	2.265	.4416
7.2	2.291	.4365
7.3	2.317	.4315
7.4	2.344	.4266
7.5	2.371	.4217
7.6	2.399	.4169
7.7	2.427	.4121
7.8	2.455	.4074
7.9	2.483	.4027
8.0	2.512	.3981
8.1	2.541	.3936
8.2	2.570	.3890
8.3	2.600	.3846
8.4	2.630	.3802
8.5	2.661	.3758
8.6	2.692	.3715
8.7	2.723	.3673

dB	Current or Voltage Ratio Gain	Loss
8.8	2.754	.3631
8.9	2.786	.3589
9.0	2.818	.3548
9.1	2.851	.3508
9.2	2.884	.3467
9.3	2.917	.3428
9.4	2.951	.3388
9.5	2.985	.3350
9.6	3.020	.3311
9.7	3.055	.3273
9.8	3.090	.3236
9.9	3.126	.3199
10.0	3.162	.3162
10.1	3.199	.3126
10.2	3.236	.3090
10.3	3.273	.3055
10.4	3.311	.3020
10.5	3.350	.2985
10.6	3.388	.2951
10.7	3.428	.2917
10.8	3.467	.2884
10.9	3.508	.2851

dB	Current or Voltage Ratio Gain	Loss
11.0	3.548	.2818
11.1	3.589	.2786
11.2	3.631	.2754
11.3	3.673	.2723
11.4	3.715	.2692
11.5	3.758	.2661
11.6	3.802	.2630
11.7	3.846	.2600
11.8	3.890	.2570
11.9	3.936	.2541
12.0	3.981	.2512
12.1	4.027	.2483
12.2	4.074	.2455
12.3	4.121	.2427
12.4	4.169	.2399
12.5	4.217	.2371
12.6	4.266	.2344
12.7	4.315	.2317
12.8	4.365	.2291
12.9	4.416	.2265
13.0	4.467	.2239
13.1	4.519	.2213
13.2	4.571	.2188

27 Hands-on Electronics FactCard — dB Conversion Table

dB	Current or Voltage Ratio Gain	Loss
19.7	9.661	.1035
19.8	9.772	.1023
19.9	9.886	.1012
20.0	10.00	0.1000
25.0	17.78	0.0562
30.0	31.62	0.0316
35.0	56.23	0.0178
40.0	100.00	0.0100
45.0	177.8	0.0056
50.0	316.2	0.0032
55.0	562.3	0.0018
60.0	10^3	10^{-3}
65.0	1.778×10^3	5.623×10^{-4}
70.0	3.162×10^3	3.162×10^{-4}

$$V(dB) = 20 \text{ LOG}_{10} \frac{V_{OUT}}{V_{IN}}$$

dB	Current or Voltage Ratio Gain	Loss
75.0	5.623×10^3	1.78×10^{-4}
80.0	10^4	10^{-4}
85.0	1.778×10^4	5.623×10^{-5}
90.0	3.162×10^4	3.162×10^{-5}
95.0	5.632×10^4	1.78×10^{-5}
100.0	10^5	10^{-5}
110.0	3.162×10^5	3.162×10^{-6}
120.0	10^6	10^{-6}
130.0	3.162×10^6	3.162×10^{-7}
140.0	10^7	10^{-7}
150.0	3.162×10^7	3.162×10^{-8}
160.0	10^8	10^{-8}
170.0	3.162×10^8	3.162×10^{-9}
180.0	10^9	10^{-9}

$$I(dB) = 20 \text{ LOG}_{10} \frac{I_{OUT}}{I_{IN}}$$

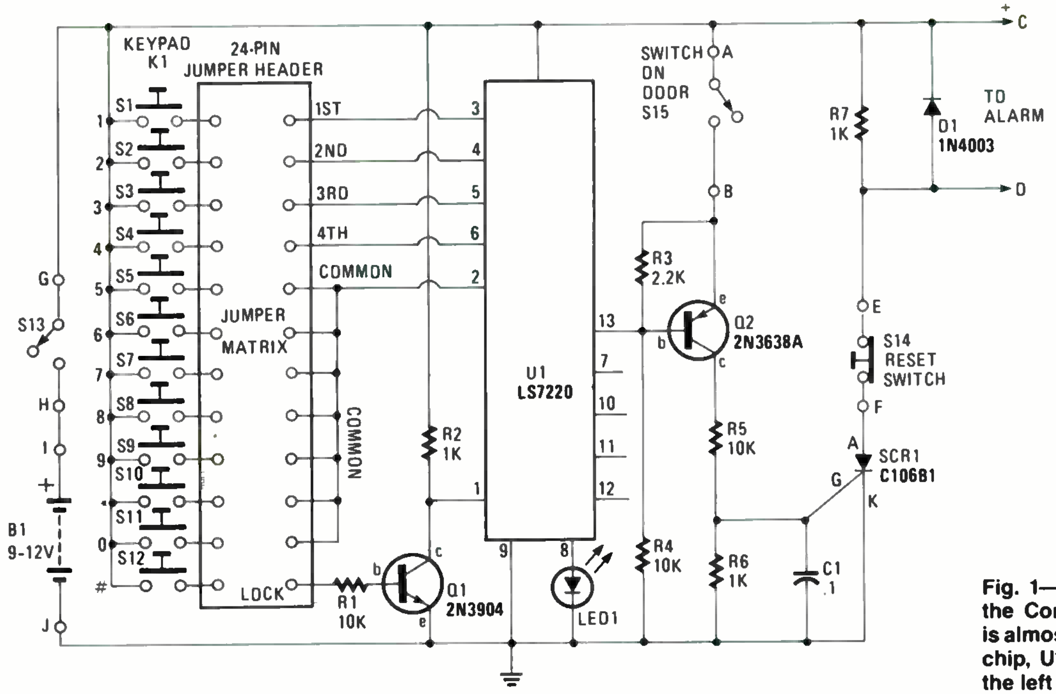


Fig. 1—The circuitry required to arm the Combination Lock/Alarm Control is almost entirely to the right of LS7220 chip, U1. The disarming section is to the left of U1.

the door, thus closing switch S15 and placing a positive voltage on the emitter of Q1, the following sequence occurs:

1. Transistor Q2 conducts, receiving the necessary biasing current through a current-divider network consisting of resistors R3 and R4.

2. As Q2 conducts, a voltage drop is developed across the voltage divider made up of resistors R5 and R6. With R5 at 10,000 ohms and R6 at 1000 ohms, approximately one volt appears at the gate of SCR1. That's enough voltage to trigger the SCR's gate.

The Heavy-duty Switcher

The SCR (Silicon-Controlled Rectifier) is an electronic switch that will turn on an alarm device when it's triggered into conduction. For SCR1 to conduct, it must have a positive voltage on its anode (A), negative voltage on the cathode (K), and a brief positive voltage to the gate (G).

Refer to Fig. 1. With reset switch S14 closed (the switch is normally closed until pressed), SCR1 already has its correct anode and cathode voltages. And with Q2 conducting, the SCR's gate receives the required positive gate voltage. Therefore, SCR1 conducts and current flows through the alarm device, which can be any noise making-device that you select.

Now here is what makes the SCR so valuable in an alarm circuit. Once the gate triggers SCR1 into conduction, it loses all control over it. Even if the positive voltage is removed from the gate—by closing the door for example—SCR1 will continue to conduct. The only way to turn it off is to interrupt current flow through the circuit by pressing reset switch S14. Resistor R7 is there to provide a *keep alive* current should the alarm device draw little or no current. That could be the case when the alarm device is itself triggered by an input solid-state circuit that draws so little current that SCR1 would see an open circuit, because the current drain was so small.

Diode D1 handles any *inductive kickback* if a relay or other inductive device is used in the alarm circuit. Relays use coils (inductors) to generate a magnetic field that in turn closes a relay contact. When voltage is removed from the coil, the relay and the magnetic field collapses, creating a voltage that's opposite in polarity to the voltage that created it. That reversed voltage (inductive kickback) can be strong enough to destroy the SCR, or other devices, unless it is shorted out by diode D1.

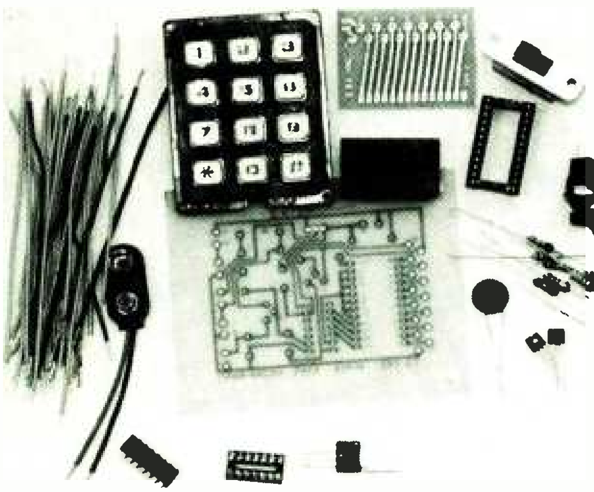
Disarming the Combination Lock

When you wish to enter the protected area, the Combination Lock circuit must first be disarmed. To do so is quite simple because you know the right sequence of keypad K1 buttons to press. Chip U1 is programmed such that if pins 3, 4, 5, and 6 are brought high (positive) in sequence, pin 13 goes high and the circuit is disarmed. Since you know (by a series of jumper leads that you connect) which buttons are connected to those pins, only you can disarm the circuit. It is conceivable that an unauthorized person could break the combination by systematically going through the four buttons if it were not for two added factors. First of all, when confronted with a twelve-button keypad, the intruder won't know which buttons are used to trigger the circuit. Second, and more important, seven of the remaining (unused) keypad buttons are all connected to pin 2 of U1. That's U1's void pin, and if it goes high (by pressing any of the seven buttons), the entire disarming sequence is interrupted and the combination must be re-entered. With that feature included, it becomes almost impossible to break the combination.

Putting It Together

The EKI (Electronic Kits International, Inc.) Combination Lock/Alarm Control Kit No. 80-155 is the center of this project, because it offers a rapid, easy, and inexpensive way to secure most any *nook* in a home. All the parts are supplied in the Kit, with the exception of the external relay or alarm device and the battery. In fact, the battery was used only to test the system. The final installation uses a wall-plug power supply to deliver 12-volts DC.

The Kit includes the printed-circuit boards; in fact everything you see in the photos (except the battery) comes with the Kit, which sells for $44.95 (refer to the Parts List).



All the parts you get with the EKI Combination Lock/Alarm Control Kit NO. 80-155, which includes pre-cut and trimmed insulated wires, two printed-circuit boards, and keypad.

PARTS LIST FOR THE COMBINATION LOCK/ALARM CONTROL

B1—9-V DC transistor-radio battery
C1—.1µF disc capacitor
D1—1N4003 rectifier diode
K1—Keypad (includes buttons/switches S1–S12)
LED1—Light-emitting diode, red
Q1—2N3904 silicon transistor
Q2—2N3638A silicon transistor
R1, R4, R5—10,000-ohm, ¼-watt, 10% resistor
R2, R6, R7—1000-ohm, ¼-watt, 10% resistor
R3—2200-ohm, ¼-watt, 10% resistor
S13—SPST slide switch
S14—Pushbutton switch, normally open
S15—Door-operated SPST switch, normally-open (type used in burglar-alarm systems—set flush in door sash)
SCR1—C106B1 silicon-controlled rectifier
U1—LS7220 digital lock, integrated circuit

ADDITIONAL PARTS AND MATERIALS
Transistor-radio battery clip, 24-pin jumper header, 14-pin IC socket, 24-pin IC socket, wire, solder, two printed-circuit boards, etc.

Parts and printed-circuit board for the Combination Lock/Alarm Control No. 80-155 as described in text are available from MCM Electronics, 858 E. Congress Park Dr., Centerville, OH 45459-4072: telephone 513/434-0031. Please allow 6 to 8 weeks for delivery. Sells for $44.95 plus $2.75 for shipping via UPS. MasterCard or VISA accepted.

Follow the assembly instructions if you are a neophyte, or do as we did: Wing it, using the schematic diagram and the wiring diagram supplied with the instruction booklet. If you are a hot-shot solderer, the project should work on the first try. If not, be sure to use a fine-tip soldering iron rated at about 37 watts. Inspect every soldering joint as it cools. Watch out for solder bridges.

During the assembly you'll have to put together the 24-pin jumper header. Its wire jumpers determine the number sequence that will open (disarm) the lock. Look at Fig. 1 and see that the simplest way to illustrate the jumper placement was used; that is, a straight-across, terminal-to-terminal hookup was used. Thus, the combination as shown in Fig. 1 is for a 1, 2, 3, 4 sequence. Press the keys in any other sequence, or any of the remaining buttons, and the lock will fail to open.

To illustrate to the point, the combination 4-1-6-3 is shown wired in the wiring diagram of Fig. 2. If the combination is entered in a sequence other then that (say, 1-3-4-6), the circuit does not respond. If you wish, button S10 (*) may be used as a digit, providing over 2800 more combinations.

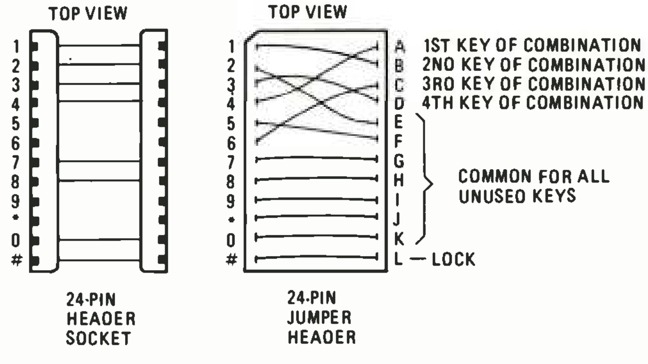


Fig. 2—The 24-pin jumper header is diagrammed here to display the sequential combination 4, 1, 6, 3. The bottom jumper in the header connects the # button of the keypad to the lock input of U1. The remaining unused buttons on the keypad are connected to the common terminal for unused numbers.

Quick Checks

Problems with the assembly of the Combination Lock/Alarm Control generally fall into two categories: The circuit cannot be armed, or the circuit cannot be disarmed.

If the circuit cannot be armed, proceed with the following checks:

1—Place a clip-lead across on/off switch S13. If the circuit now functions, you know that the problem is with S13—check the battery circuit and if necessary replace the battery or defective switch S13.

2—Place a clip-lead across S14. If the circuit now functions you know that the problem is with S14. Replace S14.

3—Place a clip-lead from the cathode to the anode of SCR1. The alarm device should function; if not, it's probably defective.

4—Place a clip-lead from SCR1's gate to its anode. If the circuit does not function, the SCR is probably defective. Replace SCR1.

5—Place a clip-lead on the base of Q2 and tap the positive battery terminal to generate a momentary positive pulse. If the circuit does not function, Q2 may be at fault. Inspect the circuit, check components and replace defective parts.

If the circuit cannot be disarmed (LED1 never goes off and opening the door always triggers the alarm), perform the following checks:

1—Carefully check your jumper wires to see if you have programmed the correct combination.

2—For the circuit to be disarmed, buttons S5 through S12 on the keypad must remain open. Remove the 24-pin jumper header from the 24-pin socket. "Clip-lead" an LED and a 100- to 470-ohm resistor in series with it, from the negative battery terminal to the jumper end of each button (S5-S12). Be sure that the cathode end of the LED is connected to the

(Continued on page 102)

PRINTER BUFFERS

Printer buffers eliminate a lot of waiting for things to happen

By Jeff Holtzman

AFTER LONG DELIBERATION YOU FINALLY MADE THE plunge: You bought a printer. The decision wasn't easy, but once you got your printer you found out quickly how much it means to be able to have a hard-copy printout. The problem now is that your printer takes a long time to print even a short document or program listing. And while it's printing, your personal computer can't be used for anything else. What can you do?

If price is no object, you could buy a $150,000 laser printer and print an entire document in the time it presently takes to print a few lines. If your budget is more modest, there is another alternative: a printer buffer.

What is it?

As shown in Fig. 1, the simplest kind of printer buffer is little more than an extra block of memory between your computer and your printer. The buffer accepts data from your computer as fast as it can send it, and then sends it on to the printer at a rate that the printer can handle.

Fig. 1—A printer buffer is little more than a block of memory positioned between your computer and its printer. A commercial printer buffer may have as little as 8K or as much 1 megabyte (or possibly even more!) of memory.

For example, we have an old Smith Corona TP-1 "Daisywheel" printer. It's built like a battleship, but it's slow as molasses. Printing even a short letter takes several minutes, during which time the computer can't be used. But by using a printer buffer, the entire letter is dumped to the printer buffer before the third line is printed!

So the main use of a printer buffer is to free up the computer for other use. But some printer buffers provide additional functions such as hardware conversion, software conversion, printer sharing, etc.

What It Can Do

Many printer buffers allow you to make a copy (or several copies) of a document at the press of a button. That might be useful if you had to print copies of your resume. You could send the file once to the printer buffer and go on to do other work while the buffer printed the first copy. When it finished, you would load a new sheet of paper, press the *copy* button, and continue with your work. Printer buffers that allow you to print copies usually allow you to print many copies sequentially, if desired.

Hardware Conversion

Another function provided by many printer buffers is signal protocol conversion. Why might that be useful? For example, assume your computer has only a serial output port and you can get a great buy on a printer with a parallel interface. You could kill two birds with one stone by buying the printer and a printer buffer with serial-in and parallel-out interfaces. Then, you've accomplished the protocol translation and gained buffer memory in the bargain. If you shop around, you'll find that you can purchase a printer buffer for little more than the cost of a plain serial-to-parallel converter.

Code translation

Another use for a printer buffer is code conversion. You might define the "\" (backslash) as a lead-in to indicate that the following character is to be translated to a special printer code. You would include the "\" codes in your text file. For example, whenever the printer buffer received a "\c" it would send the appropriate code to the printer to change to condensed type. A "\r" might return to normal mode. The codes for performing that translation with an Okidata 92 printer are shown in Fig. 2.

Some printer buffers can change the typeface of a printer completely. That kind of buffer accepts text in standard ASCII format, but places the printer in a graphics mode and prints each letter from the printer buffer's own built-in font as a graphic image.

Printer/Computer Sharing

Some of the more expensive printer buffers allow you to connect more than one printer to a computer, with switching handled electronically by special codes sent to the buffer.

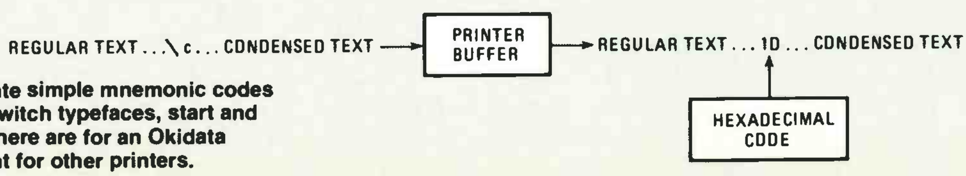


Fig. 2—Some printer buffers translate simple mnemonic codes into the special codes required to switch typefaces, start and underlining, etc. The codes shown here are for an Okidata Microline 92 printer; they're different for other printers.

Similarly, some units even approach the functionality of network print servers by allowing several computers to drive a single printer. The buffer keeps printing jobs from each computer separate, so that Mary's departmental memo is not printed in the middle of John's quarterly report.

There are other more specialized uses for printer buffers, but those mentioned above are the most important. If your needs are more specialized, contact the manufacturers listed below. But for now, let's find out how a printer buffer works.

How Does It Do It?

The block diagram of a simple printer buffer is shown in Fig. 3. It is composed of a microprocessor, I/O (Input/Output) circuitry, and memory. The I/O circuit might consist of any combination of serial and parallel interfaces. Although the RAM memory is shown as two separate sections, in reality the entire memory would be one contiguous block. The ROM memory contains the microprocessor's program code (and conversion tables, if necessary).

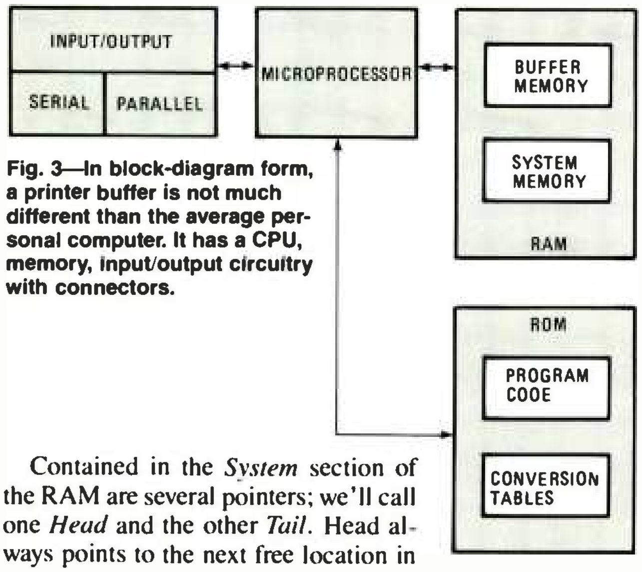


Fig. 3—In block-diagram form, a printer buffer is not much different than the average personal computer. It has a CPU, memory, input/output circuitry with connectors.

Contained in the *System* section of the RAM are several pointers; we'll call one *Head* and the other *Tail*. Head always points to the next free location in the buffer memory, and Tail always points past the last character that was sent. Whenever Head and Tail point to the same location, the buffer is empty.

Assume that we have a printer buffer with 10 bytes of buffer memory. As shown in Fig. 4A, after power is turned on, both Head and Tail point to location 1. Assume that one character is received. Head then points to location 2. Assume that several more characters are received, so that Head now points to location as shown in Fig. 4B. Now the buffer sends a character to the printer and Tail is incremented, as shown in Fig. 4C.

That's simple enough, but what happens when a few more characters are received? After location 10 is filled, there's no more space, right? What happens is that the buffer knows when it has reached the top of memory. When it does, it sets Head to a value of one, as shown in Fig. 4D. When Head approaches Tail from the rear, the buffer tells the computer to stop sending for awhile until some space has been freed, as shown in Fig. 4E. Then, as shown in Fig. 4F, the lower locations can be re-used. The Head/Tail structure makes RAM appear as a continuous ring, so this type of buffer is called *a ring buffer*.

To give you some idea of what's available for a given price range, we picked three units from three different manufacturers, in three different price ranges. Obviously, this is no comprehensive survey; rather, we want to give you some idea of what's available and to give you our hands-on impressions so that you'll be better prepared to make your own decision.

Black Box

The Black Box Corporation sells many different printer buffers, as well as many other computer-interface products. Just reading their catalog can teach you a great deal about what's available.

We chose their PIC65C Micro Print Spooler for evaluation. It is a 64K serial-in/serial-out device that lists for $179. Other devices in the series provide various combinations of serial and parallel input and output ports. The two serial ports in our evaluation unit have independently settable baud rates—anything from 50 to 19,200 bps. In addition, you can set the number of data bits, the number of stop bits, and parity.

The Micro Print Spooler has a neat, uncluttered appearance and a built-in power supply. Two switches (Copy/Pause and Reset) control all functions. A single LED indicates status.

Lastly, you can choose the interface protocol (separately for input and output): X-ON/X-OFF, hardware "busy" line, or ETX/ACK. All selections are made via internal DIP switches. You must remove three screws and then the cover to get access to the DIP switches.

The PIC65C contains a built-in power transformer and a rear-panel mounted power switch. It comes with a brief 12-page manual that appears to have been adapted from another unit, as it discusses features not present on the PIC65C. However, we had no trouble in operating the unit.

As you can see in the photo, the PIC65C is packaged in a plain black box with an LED indicator and two pushbuttons. The LED lights steadily while the printer buffer is idle or when it is buffering data; it flashes during reset and during copy selection. One pushbutton resets the printer buffer, thereby halting any current printing and clearing the buffer memory. The other button serves two functions: copying and pausing.

Printing can be halted at any time by pressing the copy/pause button briefly, although the buffer continues to accept input data while paused. Printing resumes when the button is pressed again.

If six or more seconds have passed since any data was transmitted from the computer, pressing the copy/pause button causes the PIC65C to re-send its currently buffered data to the printer. You can also program the buffer to print multiple copies by pressing and holding the copy/pause button.

In use, the PIC65C performed flawlessly. We tested its ability to buffer both standard ASCII text and output to a Hewlett Packard plotter. It never lost any data. All in all, it is a good low-cost basic printer buffer.

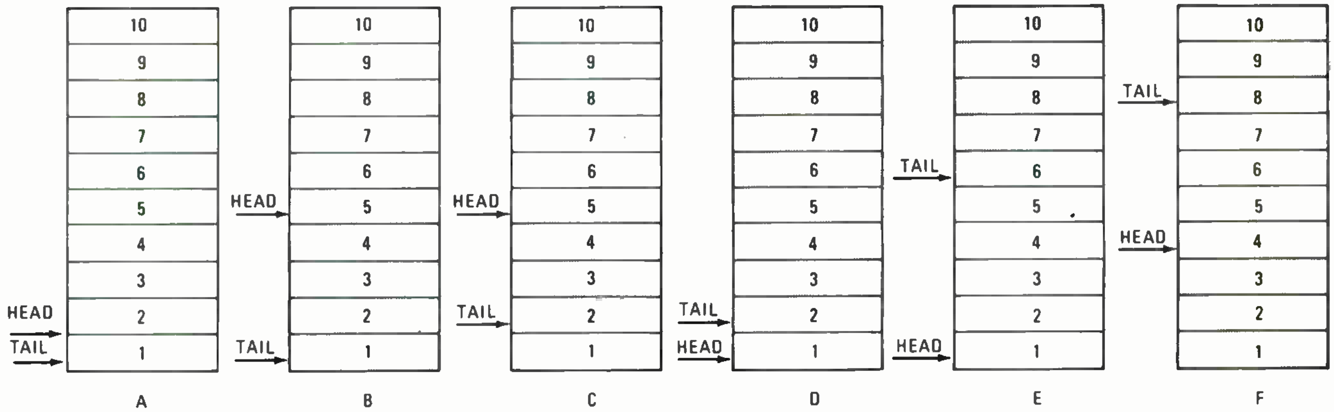
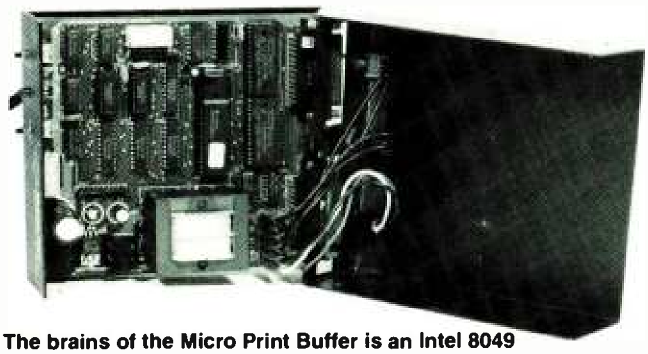


Fig. 4—A *ring buffer* is at the heart of most printer buffers. The ring buffer gets its name from the fact that it appears to be a circular (continuous) ring of memory.



The brains of the Micro Print Buffer is an Intel 8049 microprocessor. This buffer has a built-in power supply, so you don't have to accommodate a bulky wall-mount transformer.

Johnathon Freeman Designs

A step up, in terms of features, is the Johnathon Freeman Designs Universal Printer Buffer (UPB). It is sold by Jameco (and by Black Box). We evaluated the 256K unit which retails for about $230 (from Jameco). A 64K unit is also available for about $200.

What distinguishes the UPB is the fact that both the input and the output have built-in serial and parallel ports. That gives you much more flexibility than a printer buffer with only one or the other. That added flexibility allows you to buy with the confidence that, as your equipment changes, your printer buffer will not become obsolete.

The UPB box has an input side and an output side. Each side has parallel and serial connectors and a DIP switch for setting baud rate (50 to 19,200 bps), parity, and the number of bits per serial data word (seven or eight). Of course, if you're using a parallel-in/parallel-out configuration, you can ignore the settings of the switches.

You don't need to tell the UPB your what type of I/O you'll be using; it learns by itself where input is coming from, where output is going to, as well as the busy protocol—X-ON/X-Off and hardware "busy" line—you don't have to set switches to determine protocol.

The input side of the Universal Printer Buffer has serial and parallel connectors, a DIP switch for setting serial communications parameters (baud rate, etc.), and Copy and Clear switches.

The UPB also has internal jumper blocks that allow you to configure which connector pins are used for input, output, and busy signals. That way you can use standard printer cables.

Power is supplied to the UPB by a separate wall-mount transformer that connects to the buffer via a miniature plug. Operating the UPB is as simple as hooking up your cables, setting the switches (and jumper blocks, if necessary), and sending data. The UPB has Copy and Clear switches that function more or less the same as the corresponding switches on the Black Box unit discussed above.

The manual contains more detail than Block Box's, including a chart with pinouts for configuring the jumper blocks for various computers (Apple, IBM, Osborne, etc.) and printers (Diablo, Epson, NEC, etc.)

The output side of the Universal Printer Buffer has serial and parallel connectors, a DIP switch for setting serial communications parameters (baud rate, etc.), a power jack, and an LED that indicates status (ready and number of copies).

As with the Black Box unit, we had no difficulty at all operating the UPB; it never missed a byte. Our only complaints are that the arrangement of connectors makes it hard to tuck the unit on a shelf and have convenient access to the operating switches. For the same reason, it is difficult to see the LED that indicates reset and copy status. Lastly, the external transformer is relatively bulky.

Hayes

Our last report covers the Transet 1000 from Hayes. At $399 for the 128K model, $549 for the 512K model, it is quite a bit more expensive than the other printer buffers described above, but it is also much more versatile.

The Transet 1000 comes with 512K of memory (not expandable). It has three I/O ports that may be used in a wide variety of combinations. Two of the ports (S1 and S2) are bi-directional serial ports; the third port (P1) is an output-only port, but it has both serial and parallel interfaces. In order to fit the entire circuit and all the connectors into Hayes' standard modem-sized case, 9-pin sockets are used for S1 and S2, and a 15-pin connector for P1. So you'll have to make (or have made) special interface cables, depending on how use the device. There is also a rear-panel power jack (for connecting an external power transformer); on the front panel are three pushbuttons and eight status LED's.

Using the Transet 1000 can be simple or complex. To take a simple example, you could connect the serial output of a computer to either a serial or a parallel printer. Then you have 512K of memory that you can use pretty much as with any other printer buffer. You can make copies of a previously sent document, but, in addition, you can protect it from erasure, and you can append another document to it.

Another way of using the Transet 1000 is with a modem. A block diagram is shown in Fig. 5. In this mode, part of the Transet 1000's memory functions as a printer buffer, and part functions as a "modem buffer." In other words, the Transet can save information coming in via modem until you're ready

The Transet 1000 is the same size and shape as the Hayes line cf modems. The front panel has quite a few switches and LED's for controlling operation and indicating the operating modes.

to use it. You could leave the Transet and your modem connected to the phone line, thereby allowing people to send you electronic mail—all with no help from your personal computer. When you're ready to read your mail, a simple command from your computer lets you read and/or save the message(s).

A Transet setup can be used as a kind of computerized telephone answering machine: You could leave messages for your callers (who must know the password to gain access), who could then leave messages for you; and the Transet can do all that while simultaneously functioning as a printer buffer!

Also, the Transet can be set up to allow two printers to be driven by a single computer, or have two computers share one printer. There are many more options, but those discussed should give you a pretty good idea of what you can do with the Transet 1000.

Setting up a Transet isn't difficult, thanks to Hayes' typically well-written and well-produced manual, which includes charts for hooking up various computers, printers, and modems.

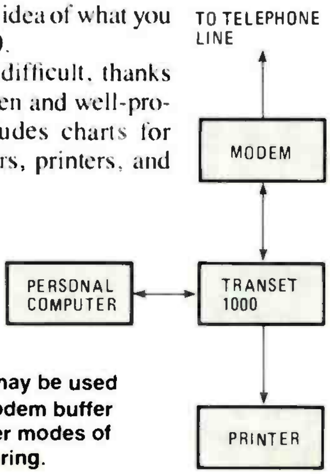
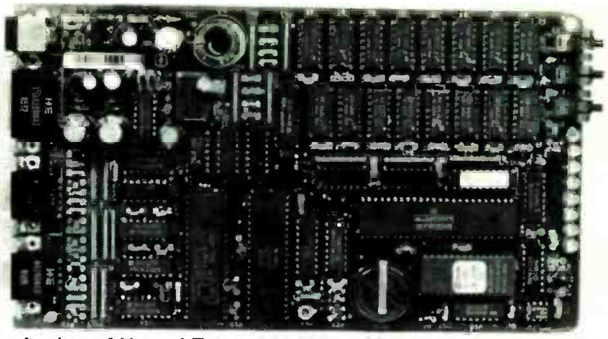


Fig. 5—The Hayes Transet 100 may be used as a printer buffer and as a modem buffer simultaneously. It also has other modes of operation, including printer sharing.



The brains of Hayes' Transet 1000 is a MC68008, the eight-bit data bus version of its 16-bit 68000 microprocessor. The Transet 1000 comes in two versions: with 128K and 512K of RAM.

How Much Memory?

You can guesstimate the size buffer you'll need as follows: If you mostly print double-spaced documents with 1-inch margins in a 10-character-per-inch typeface, each line will contain 75 (85-10) characters, and there are ((66-6-6)/2) or 27 lines of text. That makes for 2025 characters, not counting carriage returns and linefeeds, headers, footers, and special formatting codes. So round up to 2300 characters per page. Therefore, a 10-page document will take about 23,000 bytes, and a 20-page document about 46,000 bytes.

In fact, modern printers often have a small block (2K, or 2048 bytes) of built-in memory. A very brief one-page memo might fit in a 2K buffer, but little else. Occasionally you'll see a very small printer buffer with 8K or 32K of memory, but 64K is really the minimum that makes owning a printer buffer worthwhile. An even larger buffer (256K, 512K, or even 1 megabyte) can be useful if you print many graphics images, or if you want to use a buffer between a computer and a plotter or a modem.

Conclusions and Recommendations

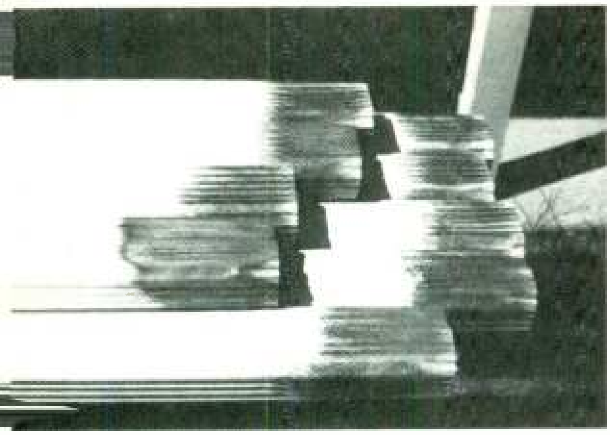
All of the printer buffers we have discussed are external devices. We chose not to evaluate any internal units because we wouldn't recommend their use in other than exceptional circumstances.

The reason is that an internal printer buffer, like an internal modem, is limited to use with only one type of computer. External units are universal. For example, if you buy an internal printer buffer for an Apple, and later upgrade to an IBM, the printer buffer would be obsolete.

Of the units we tested, all in all, given its versatility, the Transet 1000 is a heck of machine. Its price tag is a little steep, but if you need one, you probably need one bad, so price should be no object. But if you just need a simple buffer, the UPB is our choice. Its ease of set-up and built-in ports make it well worth its less-than-rock-bottom cost. However, if your budget is really tight, we wouldn't hesitate to recommend one of Black Box Corporation's Micro buffers. ■

Manufacturers and distributors mentioned

Black Box Corporation, P. O. Box 12800, Pittsburgh, PA 15241. 412/746-5530 Johnathon Freeman Designs, 1067 Dolores Street, San Francisco, CA 94110. 415/822-8451 Jameco Electronics, 1355 Shoreway Road, Belmont, CA 94002. 415/592-8097 Hayes Microcomputer Products, Inc., 705 Westech Drive, Norcross, GA 30092. 404/449-8791



The Antenna that Wasn't

Of all the words of mice and men, the sadest of these is what might have been

By Vince Luciani

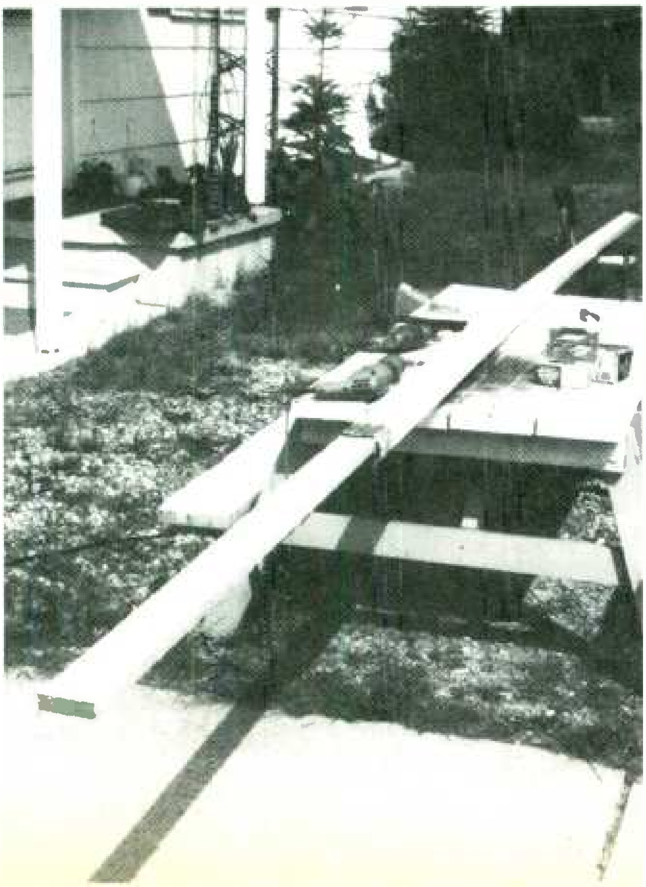
IT IS POSSIBLE THAT, UNTIL NOW, THERE MAY NEVER HAVE been an antenna article quite like this. The reason for writing this article being, that while others rejoice in the magnificent accomplishments attributable to their creations, readers will now have the opportunity to learn about an antenna that, though constructed, never made it off the ground—quite literally.

Then why write about it? Indeed, why not? Are we electronics-keen souls only permitted successes, or can we not learn something from our failures as well? Of course we can.

The antenna experiment about to be described, was a worthwhile effort whose time had come and, now, gone. An antenna, those of us in discussion agreed, had electrical merit alright, but it was the mechanical end we couldn't pin down.

Unfortunately, we never did get the opportunity to evaluate the electrical characteristics of the "nearly" antenna, as it's been called—nearly put into use, that is.

What kind of antenna? A simple vertical, is all. A *huge* vertical made of aluminum downspout sections for low Q and maximum bandwidth.



The slats fitted neatly inside the downspout sections and provided support. Unfortunately, they also provided the weight that would lay waste to my efforts and fondest hopes.

Local old timer, Sam Taggart, W2IU, who has been around long enough to have actually seen Marconi, sort of conned me into the now-famed "downspout caper." Sam talked, one day, about having once used an antenna made from three 10-foot galvanized sections. Such talk served to whet my appetite to create a bigger and better version. Antennas are always fun; they don't require an engineering degree to experiment with, and the materials are usually locally available.

Actually, I had been looking for a DX antenna by which to contact Australia on the 40-meter amateur band. Verticals, on the lower frequencies, generally have an edge over horizontals when it comes to DX. I have a lot of radio-chess pals down there, members of our CARI group—Chess & Amateur Radio International. The solar-flux cycle being what it has been the last two years—absolutely yukky—a vertical was the natural choice for me.

Low angles of radiation get maximum range for DX. Looking at a chart of such angles for verticals, one becomes impressed with the beauty of a ⅝ wave vertical. That's 80 feet high for the 40-meter band; my goal.

A few months and a handful of personal checks later, gleaming white downspouts, a dozen 1″ × 3″ cedar slats, rivets, nails, guy rope, and all were on hand. More expensive than I had guessed, but progress was never cheap.

Working with me on probably the hottest, most humid day of our South Jersey summer, was Min Bouchard, K2MB. The way we went about it was to slip a cedar slat, exactly the width of the downspout, inside the downspout. Another cedar slat was screwed into the preceding one. Downspout ends were sanded for electrical contact, and riveted together.

The slats were to be the main load bearer rather than the flimsy downspout. Lightweight but more costly than pine, cedar was the only way to go. Still, when we had 60 feet of it assembled in my back yard, we hefted it for feel and immediately concluded the 80-feet figure to be an impossible dream. We immediately downsized the design from an 80-ft ⅝ wave, to a 67-ft. halfwave—still a vetical with a quite respectable angle of radiation.

Four sets of guys were tied in place. Actually, my original construction plan was to build the sucker vertically, right in

The radials were the only portion of the project that were not in vain. What does not go up, does not have to come down, thus alleviating the possibility of a resounding thud.

place amidst the 34 quarter-wave (34 ft.) radials I'd long since strewn on the acre alongside the house, right in the middle of my spruce and pine grove.

If you think about the vertical construction idea, it really isn't too bad. You dig a hole about 3 or 4 feet deep, then work from scaffolding in order to put the slats inside the downspout, joining the respective downspouts and slats while keeping a sharp eye on the guy lines. Continue "Babyloning" the whole thing higher and higher. But we didn't try the vertical approach, and never will. Someone else may, someone who will write me about their experiences.

On the fateful antenna-erection day, a bunch of hams showed up—about 8 of us althogether and none too few—to witness what turned out to be progress in its most unglamorous form—nonexistent.

It was rather well organized, thank you, with prior preps accomplished: I had done my homework. All systems were "Go," but nothing went. We tried, my, but we tried. It simply would not fly; in no way would our skinny bean pole ever stand up, not what we were working with. We backed off in regret, to regroup for another assault, when I had reduced

The beginning of the end for the "nearly" antenna. A word to the wise: if you are going to fail, fail with only friends around (your enemies wouldn't let you live it down.)

measurements from half wave to ⅜ wave at 50 feet in order to make the antenna more manageable.

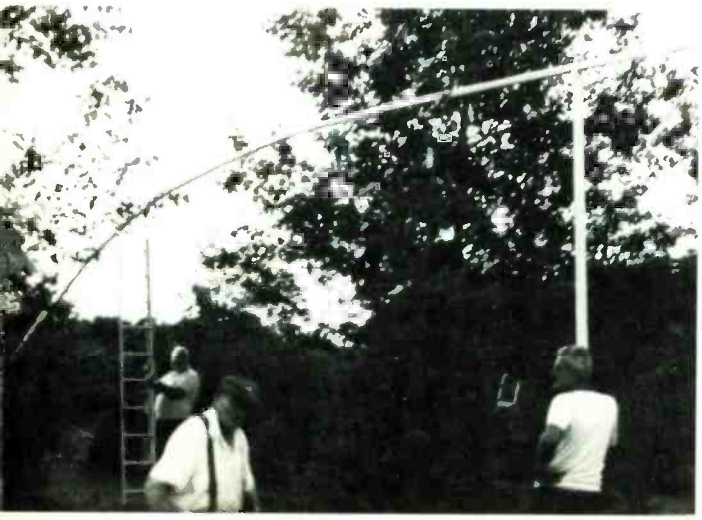
A week later, another group showed up; some being repeats from the previous session, some curious to see the effects of South Jersey summer weather on otherwise normal radio hams. The "system" had been fortified in several ways, including better guy line ties and placement; i.e., we were going to pull the bean pole up along its thinner and stronger dimension rather than the opposite. Hah!

As we looked into a fast-fading sunset, we had to accept the Great Umpire's call of strike two! You see, even at 50 feet it was still too flimsy. When strong man Rick McGonigle N2GEF, nearly had us vertical—at least past the 30-degree point—the support at the end slipped out and it all came tumbling down, with the quite obvious sound of a snapping cedar slat.

And there it sat, right where we dropped it, for the rest of the summer in which I carefully mowed around it. I didn't want to give up, thinking to cut back to a quarter wave using even more cedar slats to reinforce both inside and outside. But when it was accomplished, the dead weight seemed beyond coping. In a neatness mood, one day, I cut up the whole thing in 5-ft sections which neatly fit inside my stationwagon, hauling it to the keeping place where other modern rejections and mistakes go—the dump.

And so it was, the antenna that wasn't; the nearly antenna. I'd bragged all too often in the newsletter I publish (CARI

(Continued on page 104)



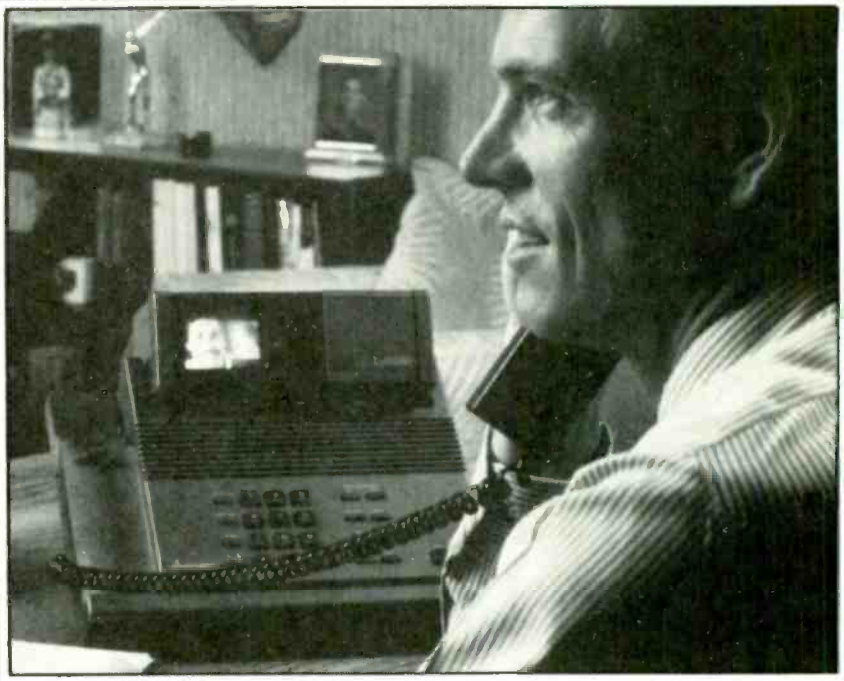
On the left and right sides are a ladder and a slat we used to temporarily support the downspout during erection. Near them are K2MB and W2IU, respectively. They could've used a good laugh at this point, what with the weather and all.

NUMBER 132

GADGET ©

FEBRUARY 1987 THE NEWSLETTER FOR GROWN-UP KIDS VOLUME XI/NUMBER XII

What's Inside . . .



Let There Be Luma

LUMA VISUAL TELEPHONE (LU-1000). Purchased from: Fred Segal Gadget Store, 8100 Melrose Ave., Los Angeles, CA 90046. Price: $1,450.

We always figured the AT&T "Picturephone" (proudly unveiled at the 1964 New York World's Fair) was done in by *Mad* magazine. The humor magazine published a spoof predicting that with the arrival of a visual telephone, people would begin utilizing fake backdrops in order to mislead those on the other end of the line as to their whereabouts.

The commuter in a bar would phone home with an office backdrop behind him, the fleabag hotel would "picturephone" a scene showing a luxurious lobby and so on. The punch line, naturally, involved a picturephone caller who got confused, setting up the wrong phony backdrop for the wrong caller.

The *Mad* parody did capitalize on real misgivings that consumers of the era had about a telephone over which you could be heard *and* seen. More important to the AT&T phone of the future flop were cost considerations and —after all the gee-whiz enthusiasm passed—the very considerable problem of defining the product's market niche. Who, after all, needed a picturephone?

Two decades after the original picturephone's arrival and departure, *Luma Telecom, Inc. (3350 Scott Blvd., building 49, Santa Clara, CA 95054)* has resurrected the picturephone, in a significantly altered form, and tackled some of the marketing obstacles which put the AT&T product out of commission.

In opting to have its instrument transmit video stills instead of moving images, *Luma* (a subsidiary of Mitsubishi Electric) has solved two important problems. According to the company, a moving picture transmitted electronically (as with a TV image)

(Continued on page 6)

Mini Can

CANOVISION 8 VIDEO SYSTEM (model VM-E1). Manufactured by: Canon, U.S.A., Inc., One Canon Plaza, Lake Success, NY 11042. Price: $1,699.

As the 8mm video market establishes itself, picture quality remains a primary concern for consumers considering the leap into this newest video format. By now, the inherent strengths of the smaller video format are well-known, with compactness and portability chief among these. Picture quality, however, has continued as a problem with the fledgling format, but with *Canon*'s entry into the field, that concern may be laid to rest.

Canovision 8mm is a bit bulkier than the Sony 8 system; it doesn't have the almost incredible palm-size miniaturization of its competitor's predecessor system. But at 4.4 lbs. and 5¼" by 13¼" by 5⅞", it can't really be called bulky. The *Canon* system fits well within the eminently portable "home-movie" standards that 8mm video has established and now must live up to. Rather than the box-like design of the Sony and Kodak 8mm models, *Canon* has instead given its mini-cam the lines of larger systems. Its camera resembles nothing more than the younger brother of the JVC VHS camera.

Canon has answered the portability challenge by slightly enlarging its mini-cam to enable it to hold its own in the field of picture quality. With dual rotary heads for both video and audio duplication, *Canon*'s picture quality is virtually indistinguishable from that achieved by the big boys—from Beta and VHS half-inch mini-cams, that is.

Ease of operation is another vaunted feature of the 8mm format, and *Canon* has been careful to emphasize this. The autofocus is incredibly fast and accurate, giving the user a dizzying effect of automatic video. Manual control of focus is also possible, plus one-shot focus to bring selected subjects into clarity. The f/1.2 6X power zoom can also be operated manually or with a push of a button conveniently located near the operator's hand-grip.

The *Canovision 8mm* has in-camera monitoring, something that surprisingly enough was missing from prototype 8mm systems, but which proves indispensable here. The monitor is equipped with an electronic signal display, telling the operator the exposure level of his subject and warning him when the end of the tape approaches. With 8mm tape offerings limited to 10, 30, 60 and 90-minute lengths, this feature must come in handy. Other interior display indicators include a function light, to signal the recording mode, and a white balance signal for white balance adjustment.

Another display window is on the side of the camera, above its operating controls. This indicates functions such as fast-forward and reverse, with a tape counter, memory finder and tape-end and battery-low warnings. The unit's automatic iris can be switched to manual, and the camera can be adjusted for interior or exterior light, as well as use of its built-in fade-out capability. The microphone is attached to the operator's eyecup, and is an unremarkable electret condenser type, with other optional models also available.

Canon has chosen to go with a modular approach to the 8mm playback problem, although not the elaborate "piggyback" approach *a la* Kodak. A very simple switching unit connects the mini-cam to television line input, to VCRs or to optional attachments like the character generator. Power options consist of a rechargeable battery which clips onto the mini-cam's back, a similar plug-in unit and an optional power pack.

The real pleasure with *Canovision 8mm* is the clarity and resolution of its picture. If the company had to sacrifice some portability, this may or may not have been the correct choice, depending on a consumer's individual needs. We used *Canovision 8mm* indoors and out, in various levels of light, and with the exception of one "eaten" videotape, our only problem with the system was we didn't get to keep it long enough.

Using the mini-cam, with its autofocus lens chugging away, the monitor reproducing the subject faithfully (there's even an instant playback button to check the last few seconds of tape) and the portability of the system fully exploited, the judgment is easily made that the video has finally eclipsed the home movie as the moving document-of-choice for Middle America.
—G.R.

Publisher: Al Goldstein **Editor:** George Arthur **Senior Editor:** Gil Reavill **Art Director:** C. Giordano **Associate Art Directors:** Kevin Hein, Rob Weisberg **Production:** Bill Mudie **Administration/Reader Service:** Kathryn Hartman **Contributing Editors:** Philip Eisenberg, Alan Freedman, Jordan Ari Goldstein, Steve Gruberg, Aprile Guarino, John Kois, Chris Stevens, Ken Swisher.

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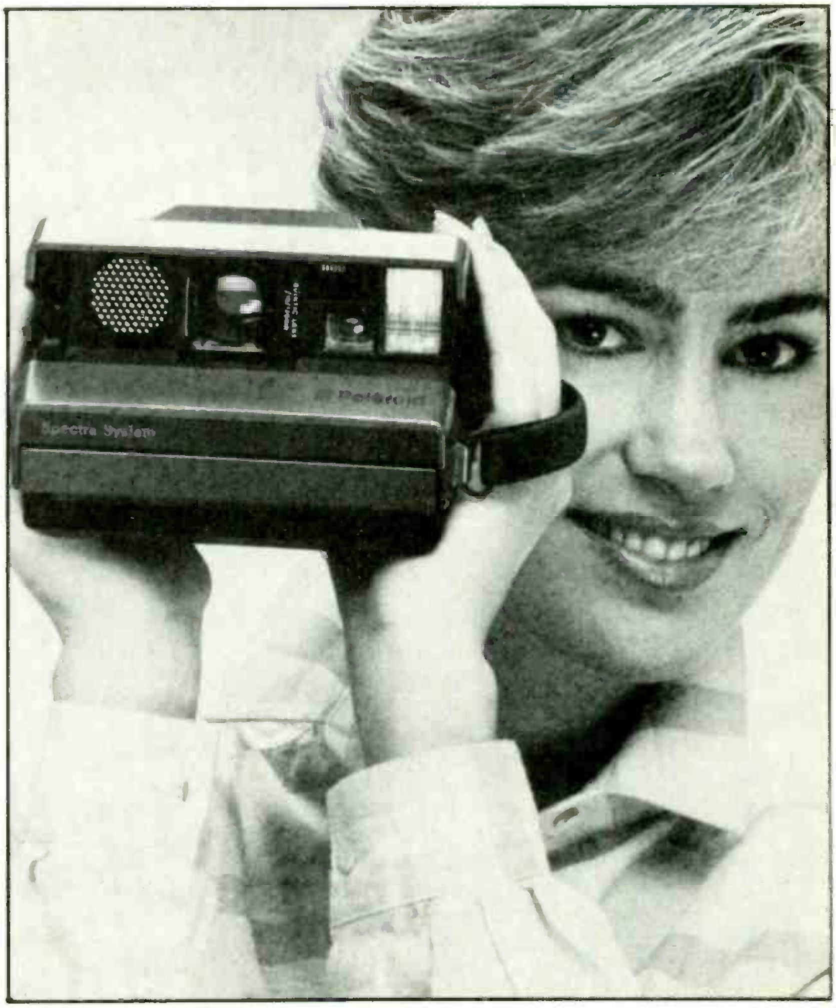
Cold Flash

POLAROID SPECTRA. Manufactured by: Polaroid Corporation, Technology Square, Cambridge, MA 02139. Price: $225.



This new instant camera is called the "*Spectra* System of Photography," lest the unwary consumer think this is merely the latest version of the instant photography with which *Polaroid* has made its mark. A little hands-on experience with the *Spectra*, introduced last spring, was enough to convince us that this was, indeed, something new under the photographic sun.

The *Spectra*'s appearance is the first tip-off; it doesn't look much like a device for taking photos—let alone something as mundane as a snapshot. In its folded position, the camera could easily pass for a contemporary clock radio or maybe a radar detector.

This *Polaroid* product incorporates some of modern electronics' favorite technologies, including laser and a microprocessor. Even its $11.75 film pack (which, besides ten exposures, includes the battery power source for the *Spectra* system) represents new technology. According to its maker, the camera is the result of "multiple innovations in photographic science, engineering, electronics, chemistry and camera design."

All of which seems entirely likely. From its "metallic taupe" case to the "system control panel" at the camera's back, the *Spectra* is very much a product of science, weird or otherwise. Even its name suggests a laboratory. *Polaroid* says the *Spectra*'s "Quintic three-element lens system" was named "for the five levels of polynomials in the equation used to compute its configuration."

The "system control panel" mentioned above seems a concession to the *Spectra*'s human users. Its five control switches allow the camera to be used in a non-automatic mode, overriding its microprocessor management system in favor of the picture-taker's own judgment.

These "special user-elective features" (as *Polaroid* dubs them) are a choice of digital distance readouts in feet or meters; an audible warning override (the camera chimes some electronic bells when it is out of film or signals a variety of "caution" picture-taking situations); sonar autofocus override; a disconnect switch for the unit's built-in electronic strobe for "natural-light-only exposures including automatic time exposures as long as 2.8 seconds" and a lighten-darken exposure control.

But why depend on the human brain when *Spectra* will do it all for you? When the user touches the camera's two-stage shutter release, lens-to-subject distance is "calculated by measuring the travel time of a high-frequency ultrasonic pulse as it reaches the subject and echoes back to the camera." A description which makes us wonder if the family dog isn't likely to bolt just as the shutter is tripped, given canine sensitivity to "ultrasonic" tones.

GADGET in its tests used the *Spectra*'s optional ($36) remote control. For that, *Polaroid* went to radio-controlled signals with a maximum reach of 40 feet. There's also a built-in self-timer switch with a 12-second exposure delay, signalled by tones and a blinking red light on the *Spectra*'s front panel.

Spectra's "dual silicon photodiode" "measures light intensity in both the visible and infrared portions of the spectrum." Judging from the brief gloss provided by *Polaroid*, it would take a scientific monograph to properly elucidate the workings of the "Quintic three-element lens system." Decicions by the Quintic system are "based on the camera's sonar ranging measurements," and it's capable of locking "into one of ten focus positions between two fixed lenses to set focus from as close as two feet to infinity."

The viewfinder—which bends light through no less than six lenses, two prisms and four mirrors—provides a variety of picture-taking data. An interior green light signals "'go' picture-taking conditions," a blinking yellow light warns if a subject is too close to the camera, too far for flash pictures or if an automatic function has been turned off.

All of these warnings are activated by the two-stage shutter release. At the first light touch to the release, the signals appear in the viewfinder. Further pressure will snap the picture, with the exposure appearing seconds later from the front of the camera. Within a few further seconds, the image comes up fully.

Spectra's "compact high-power strobe," designed for use under nearly all lighting conditions, is effective as far as 15 feet under "full-flash conditions." Besides explaining, to the best

(Continued on page 7)

Vidiot's Delight

VHS CAMERA-RECORDER/PLAYER (GR-C7U). Manufactured by: JVC Company of America, 41 Slater Drive, Elmwood Park, NJ 07407. Price: $1,495.

As *JVC* reminds us in the press release with the company's *GR-C7U VHS Camera-Recorder/Player*, last year marked the first decade for home video. The developments and changes packed into that span of time have made for a product transformation which in an earlier consumer era would have been spread over a more leisurely period of transition.

The past decade's first home video systems today look as antiqued as early home movie cameras or the first slide projectors, to name two products which video is on its way to rendering obsolete. Besides technological development, marketing imperatives help dictate this dizzying pace. Between those two forces, video equipment for the consumer has been simplified and streamlined, making VHS systems as easy to operate today as an earlier generation found 8mm movie cameras to be.

Easy and, in the case of the *JVC GR-C7U*, portable; according to the manufacturer this is nothing less than "the world's smallest, lightest VHS..." One which is, as the sales pitches of yore might have put it, "loaded with features." Using the charge-coupled device image sensor which has made Sony's 8mm system so widely acclaimed, the *GR-C7U* aims to fight the newest video format on its own turf—lightness and portability.

The only compromise readily apparent is the system's use of a compact VHS cassette. At "standard play" rates, these cassettes (which in their "high-grade T-20" form retail for about $6.75) offer 20 minutes of recording. On extended play, recorded at a slower speed, the maximum time is one hour. In order to play these VHS-C cassettes in a standard video player, an adapter (supplied) is necessary. Unless the user elects to merely view them through the viewfinder via the *GR-C7U*'s playback function.

The viewfinder is a first indication of how thoroughly the design of this system has been thought through. Besides displaying the usual array of interior warning signals, the viewfinder functions as a quick playback unit and can be mounted (it's detachable) for use with either the left or right eye. A small amenity, no doubt, but one which makes the *GR-C7U* all that much more flexible. Viewfinder images appear in a blueish black-and-white and the component is equipped with two useful features, monitor and quick review functions.

The monitor allows the user to "rehearse shots" before actually recording them. With "monitor" engaged, the viewfinder is fully functional without pushing the record control. Once the shot is set up, a press of "record" will capture the "rehearsed" scene. "Quick review," on the other hand, rewinds about two seconds of the last recording and plays it back automatically putting the camera into the record-pause mode when review is completed. Another oustanding *GR-C7U* feature is an impressive 6 to 1 zoom lens, with fingertip action via a control mounted on top of the camera, above the record button. As smooth as any professional zoom, it's particularly versatile when used in tandem with the automatic focus.

This is sensitive enough that in just moving the lens around a room, the auto focus constantly registers changes in illumination levels. One reason, perhaps, the directions several times warn against touching or interfering with the focus mechanism, activated when the lens cap is removed.

Playback using the camera/recorder is a simple matter of connecting the unit to a television via a supplied RF unit and using the *GR-C7U*'s case-mounted controls, grouped on the left front panel. One thing we discovered in playback is even when the viewfinder interior warnings blink "light" repeatedly, cautioning that levels are outside of the *GR-C7U*'s range of acceptable illumination, the resulting video recordings can be as crisp and clear as the accompanying audio track. It must be engineered that warning devices err on the side of caution.

Although we initially found the *GR-C7U*'s array of controls intimidating (their abundance a reflection of the unit's many capabilities), after a few sessions they were as well-placed and easy to use as those of any video camera we've used, including much simpler systems.

Complementing its camera/recorder/player capabilities, the *GR-C7U* has full audio/video editing functions, a special "fade" function for a professional "finis" for your home movies and can even be used with an (optional) character generator. All this in a package weighing just under 3 lbs.

While we're not too fond of the VHS-C format, within the totality of the *GR-C7U* system, it's a small and likely not too important drawback. The medium may have changed, but 20 minutes (or an hour on slow speed) is a tradition-honored length for home movies, the *GR-C7U*'s chosen arena in the consumer video wars.—G.A.

Back Rabbit

JAC-RABBIT RADIO-CONTROLLED OFF-THE-ROAD RACER. AIRTRONICS PISTOL GRIP RADIO CONTROL SYSTEM (XL2P). Available from: The Sharper Image, 680 Davis St., San Francisco, CA 94111. Price (assembled, plus shipping): $1,410.

The centerpiece of this gas-powered, two-stroke model racer is its electronic control system, which allows the 33-inch, Gran-Prix-style car to be operated from as far away as 60 feet. The *Airtronics Pistol Grip* can send the racer through its paces, dictating speed, steering and braking with a touch of the controls.

That's the good news; the bad news is that the car itself goes backwards. At least, GADGET's *Jac-Rabbit* test model, furnished by San Francisco's *Sharper Image*, ran backwards. To avoid the usual Christmas-morning-style frustration of assembling this complicated mechanical/electronic gadget, we ordered our test racer already complete. Speaking of Christmas, we were reminded once again that there isn't any Santa Claus.

According to the *Jac-Rabbit*'s manufacturer, *Raco Modelcraft, Inc. (1400-C E. St. Andrews Place, Santa Ana, CA 92705)*, the suggested retail price for the racer is $995 unassembled, with the completed version an extra $50. At *Sharper Image*, having the vehicle put together adds about $300 to the final cost. Still, we were eager. Just add gas, said the instructions, adjust a few controls and you're off racing.

We suppose there is a tournament somewhere for backward racing of tiny, radio-controlled model cars, but the races we've seen have all featured the usual frontward locomotion. Perhaps this model was rigged for a demolition derby, wherein all cars actually do race backward, to protect the delicate front end, radiator and steering chassis.

The *Jac-Rabbit does* have a pretty sophisticated steering mechanism, but under these conditions, it was a little difficult to check out. What was clear was that if the assembly was flawed, the product was nonetheless comprised of the highest-quality components throughout.

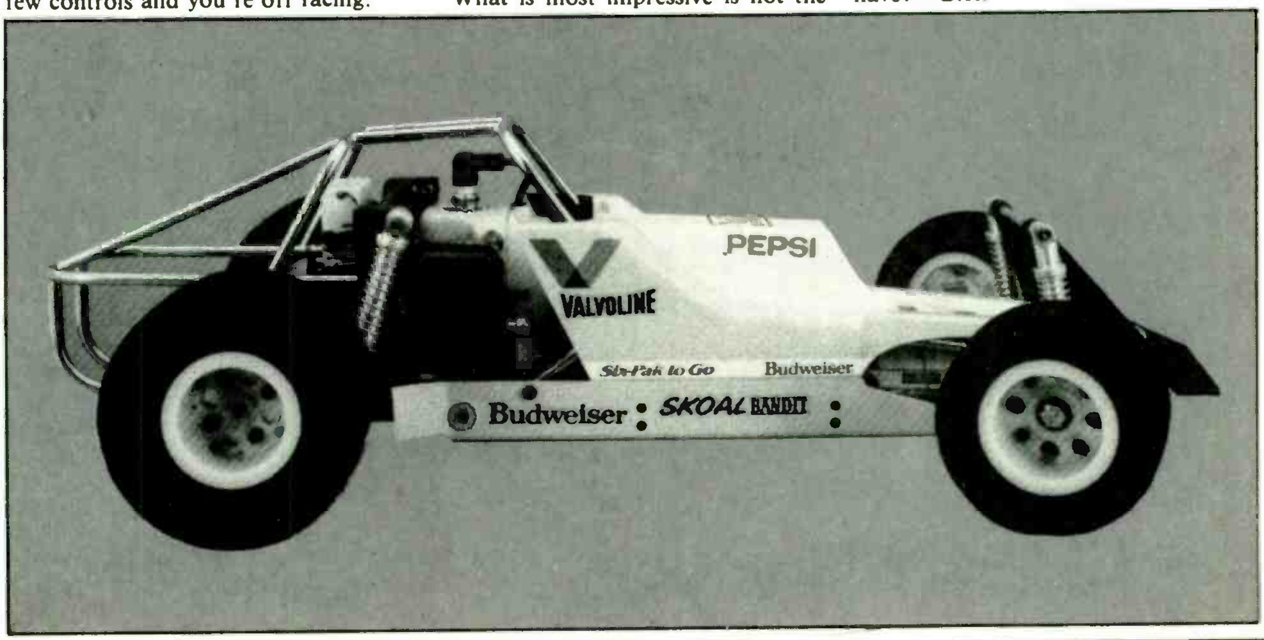
The welded steel tubular roll cage and formed aluminum chassis support a powerful Zenoah 140 engine, a 1.4 cubic inch (22.5 cc) 1.25 two-stroke that's fan-cooled and equipped with a solid-state electronic ignition. In our retrogressive GADGET test, the engine purred along perfectly—easy to start, idling evenly and revving smoothly. It uses readily available oil-and-gas mixed fuel, the same that powers most chain saws and other small engines. Running time seemed to approach the advertised 60 minutes on a single fill-up.

The outrigging also is impressive, even if seen with the car backing rapidly away from you. The four-wheel independent suspension is as elaborate as in some full-size cars, with fully adjustable coil-spring design featuring oil-filled hydraulic shock absorbers. Disc brakes, heavy-duty, sealed wheel bearings and neoprene tires complete the package.

What is most impressive is not the car—it is a little difficult to be impressed by a unit, no matter how well-built, that exhibits such a glaring flaw—but the control system. Heavy-duty high-load servo motors for steering and brake/throttle tune in to the *Airtronics* pistol grip transmitter for fingertip control. The design puts all functions within the reach of the fingers of one hand. The battery-powered, 500-milliwatt radio frequency output transmitter had a range of around 50 feet when we tested it. Its light weight—24 ounces with batteries—ensures ease of use over those long, endurance-style races. Frequencies can be changed or adjusted so as not to interfere with other transmitters.

It was understandably difficult to test the unit as a whole, but we did run it through its paces on a limited track. In fact, the steering capability was even more important in our *volte-face* trial, since it requires feather-fine control to drive backwards. The car, and especially the suspension system, which seemed suitable for difficult, off-the-road conditions, performed as well as could be expected.

However, it is difficult to imagine what was on the collective, corporate mind of Raco when it let this model go from its factory in such a flawed state—to a consumer test publication, no less. The problem, of course, will be easily remedied with just a gear change or two. But after paying for the luxury of factory assembly, one can commiserate even more with those do-it-yourselfers, gamely and lamely trying to assemble a *Jac-Rabbit* on Christmas morning. If the factory can't even get it right, what chance does the novice have?—G.R.



LUMA

(Cont. from p. 1)

Mitsubishi Video Printer (P60U)

contains "nearly 2,000 times more electronic information than the voice of a caller on the telephone. . . a conventional TV picture requires a great deal of transmission space, or bandwidth as it's called by engineers."

Existing telephone networks, wire and otherwise, don't have the capacity to transmit moving image information. Full-motion systems, *Luma* contends, "rely on ultra-expensive broadband networks or go on the less-expensive but still costly lines called 56 kb/s." This instrument, on the other hand, is fully compatible with existing standard phone lines, and its video snapshots don't cost any more to transmit than conventional voice-only information.

This snapshot approach, as well as each party's control of his or her image, via a "send" button which actually transmits the picture, goes a long way towards allaying those vague fears about privacy.

Although *Luma* says a good deal in its promotional literature about the instrument's resemblance to an ordinary phone, it's really quite different. Its design, however, has kept the controls simple and telephone-like. Above a keypad and control board much like a contemporary console phone's sits a unit containing a small screen and a video camera.

In its picture phone functions, the screen is divided into two images. On the right, the caller using the instrument appears, most of the time, in a "live" moving picture. On the left, the person at the other end appears as a black-and-white video snapshot. When the user transmits his or her image, the moving picture freezes for the duration of the transmission during which the phone will only communicate visual information. Neither party can speak when an image is being sent. Any number of snapshots can be transmitted during a conversation.

The transmitted image can be sent in three different sizes and, depending on the dimensions, takes either 1.5 seconds, 3.5 seconds or 5.5 seconds to reach the second *Luma Visual Phone*. The image is relatively low resolution (the instrument includes a picture brightness control).

To further enhance the *Luma*'s visual capabilities, a set of four snap-on lenses are available, three for close-up images and a fourth wide angle focus. *Luma*'s suggested retail price for the four custom lenses is $79.95. In GADGET's test, they seemed to have only a limited effect while the wide-angle lens required an object or person to be a considerable distance from the video camera, although still within the handset cord's reach.

Luma Visual Telephone (LU-1000)

In another gesture toward privacy, the video camera lens has a sliding door which must be manually moved for the camera to function. In its directions, *Luma* cautions that the camera's light-sensitive elements more or less require that the panel be in place when the phone is not in use in order to "prolong their life."

In its non-visual functions, the *Luma* is a well-designed telephone. The screen displays the instrument's built-in, one-hundred-entry capacity directory. In order to feed information into the directory, or edit existing entries, a switch at the right side of the *Luma* is flipped.

A plastic template (supplied with the phone) is then laid over the phone console's buttons which, with the directory switch engaged, function like a simple computer keyboard. A cursor is moved under letters, numbers and symbols displayed on the screen. Inputting information is a tedious task, but once memorized electronically, the *Luma*'s automatic dial function can call telephone numbers up at the touch, or two, of a button.

To access, the directory key is pushed and the telephone dial's standard letters are used to reach the desired letter of the alphabet. To access the directory's "L," the dial's "5" is pushed. "J" will appear, a second push brings "K" onto the screen and "L" comes up with a third touch. The directory automatically alphabetizes entries according to the first letter of the first word. When the directory is activated, the last number dialed always appears on the screen. The electronic memory also allows the user to scroll through it by pushing "up" and "down" buttons on the con-

SPECTRA

(Cont. from p. 3)

of *Polaroid*'s abilities, just how this perhaps overdue successor to the company's SX/70 (now no longer produced) works, all this technical description also helps explain why we found this such a sterile camera to use.

There's something slightly spooky about the unfailing perfection of *Spectra*'s instant pictures which definitely shows the effects of the chemistry which *Polaroid* says went into the film's design and fabrication. Nothing less than the "creation of new molecules" underlies the "hybrid imaging system" used by the *Spectra*.

Of course, if the user dares to stray from the straight-across automatic settings of the "system control panel," the resulting shots aren't always so picture-perfect. We'd liken the experience to what happens when a driver tries to apply reckoning skills to travel on an interstate freeway. Just as the highway is engineered to be driven more or less automatically, according to directional signs, so the *Spectra*'s preferred mode of use is fully automatic. Not that camera devotees won't have a fine time experimenting with the camera's non-automatic functions. Learning to effectively over-ride the *Spectra*'s various electronic decision-making systems would at least provide some challenge.

But for most who buy the *Spectra*, we're sure it will be primarily an automatic device for pictorial documentation. At that task *Polaroid* excels, and this camera could become one of the trademark consumer items of the 1980's. It is, in its conception and execution, very much a device of its times, clearly influenced by developments on the video front.

Despite its $225 suggested retail, prices for the *Spectra* vary. One of New York's leading low-ball camera merchants was selling it for $159. And we've also had reports that it's been tagged as low as $129 on sale. As with most of the items GADGET covers, it pays to shop around.

As for the camera's sterility, we're sure a *Polaroid* marketing campaign will provide the proper aura of human warmth and involvement. Even if the "*Spectra* System of Photography" takes a lot of the remaining fun out of snapshots, even instant ones. Which is something our era has learned to label "progress."—G.A.

sole keyboard.

The *Luma* also includes a powerful speakerphone and image-transmitting "send" buttons are found on both the handset and the phone keyboard. Speaker volume is adjustable and there's also a "mute" button. In its audio functions, the *Luma* is a modern capability-enhanced telephone.

But using it in its visual mode is a unique telephone experience, to say the least. In testing, we called both a second *Luma* visual telephone installed at our publisher's home and Los Angeles' The Price Of His Toys, one of the retailers selling this instrument.

Distance had no effect on image quality. A press of a button sent our image uptown and across the continent, while a request to the caller brought a black-and-white snapshot of the person we were talking with. Despite the *Luma*'s admitted (and carefully considered) limitations, it was a high-tech thrill to actually see the persons we were conversing with. It was also amusing to see our own image suddenly freeze on the screen, unfreezing seconds later after it had been sent.

Amusement and thrills, however, are slender supports for a high-priced consumer telephone. But *Luma* seems to think applications in a variety of fields will save this visual phone from merely being a high-ticket toy. Company publicity material mentions law enforcement use, sending pictures or verification via photographed documents and the like. Perhaps to make this point, we've read that the *Luma* is to be featured "extensively" on NBC's popular "Miami Vice" series.

Similarly, TV and movie casting directors, modeling agencies, theatrical agents and other fields concerned with appearances can utilize the *Luma*. Although larger dimension graphic material would be unwieldy, professions like engineering, architecture and banking may find uses for this instrument. *Luma* in its publicity packet, comes up with four pages of typewritten "real world" applications. The marketplace, undoubtedly, will make the final judgment on this product's usefulness.

In any commercial or professional applications, a Mitsubishi video printer (P60U) offered as an option at $1,150, would enhance the *Luma*'s utility considerably. Connected to the phone with a single line, and plugged into a wall outlet, the video printer makes a hardcopy duplicate of any image transmitted.

But this is an amazing piece of consumer engineering and design, simple to operate, requiring no special installation or equipment beyond the *Luma Visual Telephone* itself. As gadget fans, we certainly hope this time, the "picturephone" takes off. Primitive but exciting, with the *Luma* (as one of its promotional slogans puts it), "the future is in sight."—G.A.

Boxed In

SONY HANDYCAM SPORTS PACK (SPK-M8). Manufactured by: Sony Corporation of America, Sony Drive, Park Ridge, NJ 07656. Price: $180.

If there's anything that brings a warmer glow to corporate hearts than the successful launch of a new product line, it's the introduction of accessories to accompany new items. The customers for these accessories constitute a captive market, while sales of add-ons represent a cost-efficient way of recovering research and development money sunk into any new product.

Sony is a leader in the marketing of accessories, so it's not surprising the company is already surrounding its 8mm video camera with subsidiary items. Like the *SPK-M8 Sports Pack*, a shock- and water-resistant housing for the handycam. Given the cam's compactness and one-piece design, the development of the *Sports Pack* involved more than merely creating a shell to wrap around the camera.

Done up in the vibrant yellow *Sony* favors for outdoor products, the *Sports Pack* incorporates a battery compartment (the cam's own detachable battery/viewfinder/microphone component is removed), viewfinder, microphone and widows corresponding to the camera's external signal lights. There's also an external power/record control.

The housing includes a tripod mount, detachable external "sports finder" and a "leak sensor" warning window. In a rainy or snowy environment, *Sony*'s directions suggest using the sports finder instead of the view lens. Mounted on the *Sports Pack* battery pack, the sports finder is a larger, rectangular scope which performs the viewfinder's functions without the squinting.

Part of the *Sports Pack* package is a grease or lubricant *Sony* supplies for use on the unit's rubber tubing seal. Directions also suggest cleaning the *Pack* with a mild detergent solution after exposure to sea air while also cautioning against "foreign material between the rubber gasket" and the portion of the housing in contact with it. All of which should guarantee "water resistance."

The "leak sensor" on GADGET's test unit indicated a possible leak, as shown by a white exclamation point against a red background. We removed the camera, wiped out the inside of the pack and, as this was being written, were still waiting for the sensor window to return to white, as promised by the *Pack*'s directions. As no moisture could be discerned by touch, we took this as indication of the sensor's extreme sensitivity.

Although it adds both bulk and weight (1 lb., 15 oz.) to the handycam, the *Sports Pack* is an unobtrusive adjunct to the camera itself. Its design doesn't violate the qualities of the video 8mm camera. Even encased within, the handycam remains lightweight, portable and easy to use. Fully operational, with easy access to the cassette, the *Sports Pack* dresses up *Sony*'s handycam with both style and utility.

The *Sports Pack*'s bigger brother is represented by *Sony*'s marine pack (MPK-M8), a submersible housing which adapts the handycam to underwater use. The unit adds about 8 lbs. to the camera's weight and incorporates an underwater microphone and "wide conversion lens." As with the *Sports Pack*, the handycam is fully operational encased within this waterproof housing. Reflecting its more sophisticated capabilities, the marine pack carries a suggested retail price of $1,499.95. Something tells us that *Sony*'s engineering staff is probably already at work on a housing designed to make the handycam fully operational in outer space. —G.A.

Bits & Pieces

If memory serves, we reported on the prototype of this **Table Tennis Robot** at the 1985 International Inventors Expo (GADGET, August 1985). Then it was called a "mechanical Ping-Pong ball server," but if this product, available from *Hammacher Schlemmer (147 East 57th St., New York, NY 10022)* is the offspring of that invention, somebody's put a lot of research and development into it. Balls are captured in a 51" by 84" retrieval screen, vacuumed up a tube back into a hopper and served at speeds up to 60 mph. Ball speed, topspin and chop are all controlled via switches, while the Table Tennis Robot can throw as many as 120 balls per minute. The unit's oscillator can be set from 10 to 70 sweeps per minute, to hit shots from left to right and back and to various points on the table, either selected or random. The perfect gift for someone considering making a life out of table tennis competition. According to Hammacher Schlemmer, the product has been "approved by the U.S. Table Tennis Association" and is used by top players here and in Japan. Price: $599.50.

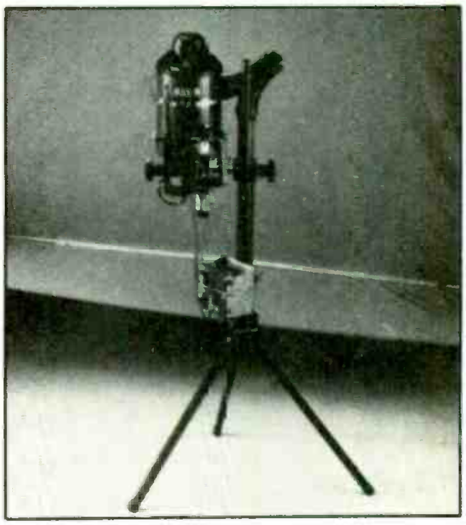


Table Tennis Robot

From the same folks who brought us the wiggling hand a few years ago, it's the **Electronic Trophy Fish**! That's right, *S.A.M. Industries (5112 Weber, Stokie, IL 60077)* is pleased to present a "realistic large mouth bass," which, when a concealed robot switch is turned on and an internal microphone activated via whistling or clapping, wiggles and squirms "as if freshly caught." S.A.M. calls it "the executive gift for 1987," and it comes, nicely mounted on a wooden trophy plaque, complete with two "AA" batteries. That "robot switch" is concealed in the bass's trademark large mouth and an "automatic timer" stops the squirming after about seven seconds. Direct from S.A.M. Industries, there's a $3.75 shipping charge. Price: $29.95.

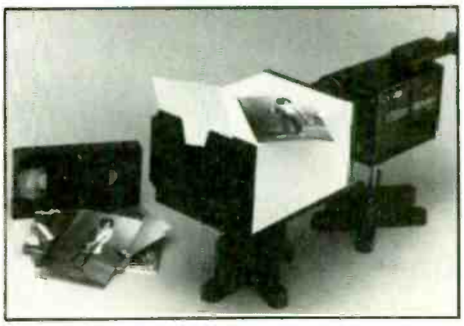
S.A.M. Electronic Trophy Fish

Officially available since September, the new **Apple IIgs computer** features high-resolution color graphics, high-performance sound capabilities (in a bow toward the fast-developing synthesizer music field), fast processing speeds and an expanded memory. According to *Apple (20525 Mariani Ave., Cupertino, CA 95014)*, the IIgs "combines the software compatibility and expandability of the Apple IIe with the graphic user interface of the Apple Macintosh." The new model can also run "the Apple II family's thousands of existing educational software packages." Featuring 256 kilobytes of random-access memory, 128 kilobytes of read-only memory and built-in expansion capacity, the unit's sound capabilities "have been dramatically enhanced over earlier Apple II's." The IIgs features a 32-oscillator chip capable of up to 15 voices simultaneously for synthesizing both music and human speech. As computer mavens confirm, the Apple IIgs is available, but barely, in "limited quantities at authorized Apple dealers." There's even a "limited edition" signed by Apple II designer and Apple Computer, Inc. co-founder Steve Wozniak, making this, we guess, the first designer PC. Price: $999.

Bondwell 8 Computer

The evolution of personal computers has reached the point where the introduction of a new model is no longer earth-shaking news. What does seem noteworthy is the debut of an 11-lb., IBM-compatible, lap-sized computer that's also moderately priced. Though we've not seen it, the **Bondwell 8** sounds like a tidy package. Featuring 512K RMM, one built-in 3.5" 720K floppy disk drive and serial and parallel ports, the Bondwell 8 also has an 80 CX 25L back-lit LCD graphic display. A built-in rechargeable battery, real-time clock and MS-DOS and GW BASIC software are also included. This unit, made by *Bondwell (3300 Seldon Court, #10, Fremont, CA 94539)*, will run IBM-compatible software including Lotus 1-2-3, Framework, Flight Simulator, Symphony and Sidekick. Price: $1,595.

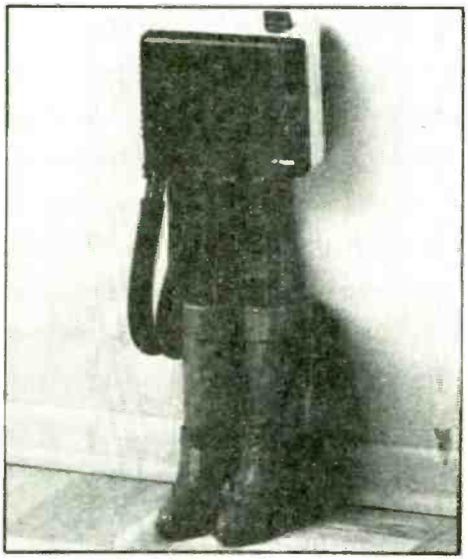
For transfer of still photos and snapshots, *Ambico (50 Maple St., P.O. Box 427, Norwood, NJ 07648-0427)* has added a **Teleprint Converter, model V-0614**, to its line of film-to-video transfer equipment. The Teleprint Converter accepts any photograph up to 3.5" by 5" and "illuminates the print evenly with an internal fluorescent light." A removable backing steadies prints while any video camera focused onto the Teleprint Converter's macro lens records the snapshots. The result is a continuous video of still photographs, easily viewed via your television and conveniently stored on cassette. Price: $79.95.



Teleprint Converter

Bits & Pieces

Small-Screen Portable TV



Svelvic Shoe and Boot Dryer

Christmas Ornament Smoke Alarm

Not since Philco's 1958 "Predicta" model have consumers been offered as futuristic looking a television set as the 3.5" screen **3LS36 TV** from *Sharp Electronics Corp. (10 Sharp Plaza, Paramus, NJ 07652).* Besides its back-to-the-future styling, which Sharp calls "fashion color electronics," the 3LS36 features a tinted screen, electronic tuning, audio/video input and output jacks and a headphone jack for "personal viewing." Power sources include an A/C adapter, car battery cord and an optional rechargeable battery. Available in black, white and pastel pink, the TV's table top stand rotates for convenient viewing. Price: $399.95.

There are winter mornings when any driver might long for a **Remote Control Car Starter**. Available from *Hammacher Schlemmer (147 E. 57th St., New York, NY 10022)*, this remote-control transmitter sends an individually coded radio signal, triggering a car starter, from as far away as 300 feet. The device operates in temperatures ranging from minus 25 degrees to 125 degrees and engages the ignition for 8 to 10 seconds, pumping the accelerator at an adjustable rate one to four times. A vacuum shut-off switch disengages the starter motor when the engine has been started. The car will idle from 10 to 12 minutes, depending on outside temperature and automatically shuts off unless the vehicle is driven away. The remote-control unit includes a shut-off switch and it doesn't unlock the car's steering wheel or shift lever. Weighing 4 ounces, the Remote Control Car Starter comes equipped for installation. Price: $289.50.

Drying fine-quality boots and shoes after exposure to bad weather can be a tricky business. Done improperly, it can crack leather, damage stitching and shorten the life of the footwear. Now, from Norway where they take both boots and bad weather seriously, the **Svelvic Shoe and Boot Dryer**. Imported exclusively by *Hammacher Schlemmer (147 E. 57th St., New York, NY 10022)*, this device heats air to 98 degrees, then expels it through four flexible 24" long tubes, allowing two pairs of boots or shoes to be dried simultaneously. An automatic timer can be set for any interval up to two hours. Also effective, according to Hammacher Schlemmer, "for reducing fungus growth...from prolonged dampness and for removing chill on cold days." The unit includes screws for wall mounting and plugs into any household outlet. Price: $84.50.

From our electronics for better living department, the **Portable Electronic Baby Sitter**, a 27 MHz FM listening system which lets you hear any sounds made in a baby's room, sickroom or other location while you go about your normal household activities. The set's transmitter features an omnidirectional microphone which picks up sounds and sends them by FM signal, even though walls, up to 300 feet to the receiver. *Hammacher Schlemmer (147 E. 57th St., New York, NY 10022)* suggests, "you can hear a baby's cry, keep track of children playing, listen for requests from the sick or elderly." The Portable Electronic Baby Sitter operates on either of two frequencies and the receiver will fit into a pocket or attach to a belt clip, included with the product. Also furnished, a 9-volt battery and AC adapter. The transmitter weighs 10 ounces and the receiver a mere 7 ounces. Price: $49.95.

We're sorry we missed this during the appropriate season, as we're sure a lot of people would have liked to have the **Christmas Tree Smoke Alarm Ornament** on their Yuletide tree. A 3.5" diameter ball-type ornament, inside is a dual-ionization chamber smoke alarm, sensitive to the presence of as little as .5 percent smoke in the air. The device sounds an audio alarm immediately upon detection. Power is supplied by a single 9-volt battery, and the 8-ounce ornamental smoke detector has a built-in push-button battery tester. When power is low, an indicator beeps twice a minute. *Hammacher Schlemmer (147 E. 57th St., New York, NY 10022)* sells them in sets of two. Price: $34.95.

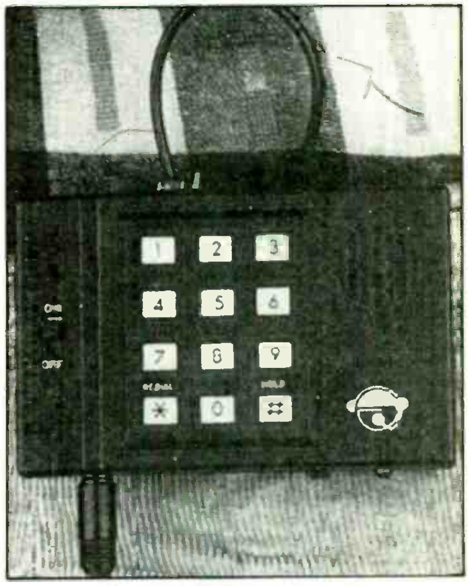
Bits & Pieces

Even a classic sometimes has to be updated. At least that seems to be the thinking behind the *Ohio Art Company (P.O. Box 111, Bryan, OH 43506)* decision to introduce an electronic version of the well-known Etch A Sketch. Called the **Etch A Sketch Animator**, drawings on the device are created in the more-or-less traditional Etch A Sketch way, but each creation is captured in an electronic memory. The remembered drawings are then combined "to create a moving picture of up to 96 frames," at seven different speeds. Suggested for ages six and up, the Animator operates on four AA batteries and "turns your drawings into jumping, waving, dancing creations." Definitely an Etch A Sketch for this high-tech era. Price: $59.95.

Etch A Sketch Animator

"Desk top publishing" is one of the computer field's more publicized advances. Now *Canon (1 Canon Plaza, Lake Success, NY 11042)* is offering a copier adjunct which seems keyed to the same development. The electronic **Image Editor**, according to the firm, "makes cutting and pasting a thing of the past" by offering "a fast and easy means to edit originals." The Image Editor's electronic pointer enables users to frame or blank up to three sections of an original. Six color conversion modes allow use of two colors on duplicated copies. Standard on Canon's NP-4540EF copier, the Image Editor is offered as an option on other NP-4000 series copiers. Price: $315.

The *8mm Video Council* offers consumers information on this newest of home video formats. In addition to a newsletter, the industry group has published a Q&A pamphlet on 8mm and a catalog of pre-recorded cassettes available in the format. For information, write: *8mm Video Council (99 Park Ave., New York, NY 10016)* or call the council's consumer information number, 1-800-Vid-8-Mil (843-8645) or 212-986-3978 in New York State.

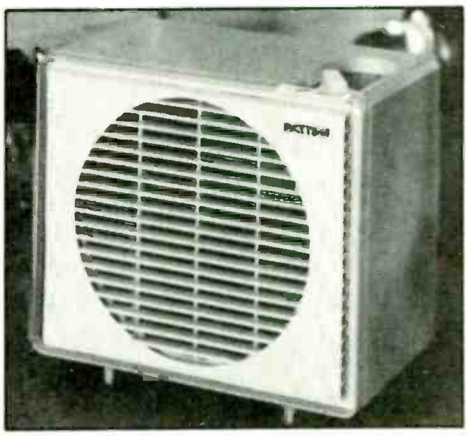


Walk N Talk Telephone

Introduced at last winter's Consumer Electronics Show, the **Walk N Talk** is billed as the "world's smallest phone" by *Exeters (6 Hughes, Suite 100, Irvine, CA 92718)*. The instrument features a stereo headset and an adjustable microphone. The mighty mite has automatic re-dial, volume control, tone-pulse dialing, a hold button, built-in ringer, on/off switch and an LED in-use indicator. The unit's 15-ft. cord plugs into a standard module phone jack and allows the user to make or receive calls "without interrupting other activities." Price: $69.

Providing even greater flexibility for its cellular phones, *Motorola, Inc. (Communications Sector, 1301 E. Algonquin Rd., Schaumburg, IL 60196)* has introduced the **Cellular Connection Accessory**. Compatible with telephone industry standard RJ11C modular interface plugs, with the Cellular Connection, a Motorola cellular mobile telephone will connect with such devices as an answering machine, portable facsimile machine, personal computers and can also be used as an interface for pay cellular telephones on public transportation such as trains, buses or ferries. The unit also features Touch-Tone signalling capability for use with US SPRINT or MCI long-distance service as well as electronic banking. Price: $395.

The compact (9" high, 6" deep, 9" wide) **Bathroom Heater Plus** incorporates two features which make it ideal for its intended uses. A "Dual Immersion Safety System" (patent pending) automatically cuts off power if the heater drops into water. The *Patton Electric, Inc. (P.O. Box 128, New Haven, IN 46774)* product also features an air filter to protect against mold, mildew and bacteria. The filter system absorbs odors, attracting and trapping air-born bacteria, molds, pollen, dust and other irritants. Equipped with a carrying handle, cord storage and a three-setting heat control (the unit also circulates cool air with a "fan only" setting), the Bathroom Heater Plus can be placed on cabinet tops, floors or mounted on its own wall bracket. The product also carries a five-year warranty from Patton Electric. Price: $44.99.

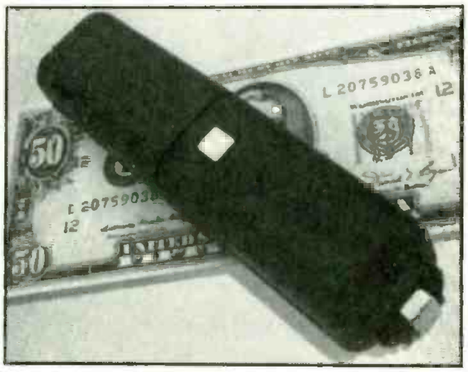


Bathroom Heater Plus

Bits & Pieces

Anglestar Electronic Protractor


Portable Answering Machine


IC Money Detector

Need to install, level and find the correct angle for a satellite dish? Have to have grade and tilt measurements while towing a boat or trailer with your vehicle? The product you need is probably the **Anglestar Electronic Protractor (MTools-0247101)** from *Metrifast (55 S. Denton Ave., New Hyde Park, NY 11040).* The AngleStar sensor has no moving parts, while its LCD readout unit furnishes readings of up to plus 45 degrees. A minus sign appearing on the LCD indicates a counterclockwise angle. Supplied with a 12-foot-long cable, the sensor can be located up to 200 feet away from the readout with additional cable. The entire system operates off a standard 9-volt battery, good for in excess of 1,000 hours of operation. The readout LCD also includes a low battery power indicator. The Anglestar Electronic Protractor is especially designed for use in cars, trucks, jeeps and tractors. Price: $159.95.

In this rapidly developing era of the personal computer, it's good to know that farsighted manufacturers have developed personal printers to go with them, like *Hewlett-Packard (1820 Embarcadero Rd., Palo Alto, CA 94303)* which has just introduced a new version of its battery-powered **ThinkJet Personal Printer** with a Centronics parallel interface that allows it to connect with PCs like the IBM. The unit's built-in battery powers up to 200 pages of printing between charges and prints at speeds of up to 150 characters-per-second. The entire package weighs a mere 5.5 lbs. and averages 500 pages of printing per ink cartridge. Price: $495.

Manufactured in Italy, this **Portable Answering Machine** is a complete unit small enough to use while traveling. The user programs any combination of 11 words and phrases to be replayed through a voice synthesizer and, when a call is answered, the voice-activated microcassette records messages of up to 30 minutes in length. The unit's tape recorder detaches for separate use as a pocket-size recorder while the remaining component functions as an announcement-only answering device. The entire assembly can also be operated via remote control, retrieving messages and changing announcement from any Touch Tone telephone. Available from *Hammacher Schlemmer (147 E. 57th St., New York, NY 10022),* the Portable Answering Machine in the remote mode has a special feature which signals the user that there are no messages, thereby avoiding toll charges. Manufactured by Brondi, Europe's largest maker of answering machines, the unit uses a microcassette and four AAA batteries (both included) and plugs into a standard modular phone jack and a household outlet. Price: $349.50.

Perfect for those in retail, the **IC Money Detector** will instantly identify counterfeit currency. Available from *Exeters (6 Hughes, Suite 100, Irvine, CA 92718),* this battery-powered device's sensor head is "run over the dark metallic ink on the front of the bill." If the greenback is real, a buzzer and small light verify its authenticity. In addition to U.S. currency, the IC Money Detector will work with the Japanese yen, Danish kroner, German mark, Italian lira, Australian dollar and British pound sterling. It operates on a single 9-volt battery and carries a 90-day warranty. Price: $39.

Coming in next month's GADGET newsletter

- **TVCR—Lloyd's budget-priced TV-VCR combo is a natural, so how come this product practically has the U.S. market to itself?**
- **Panasonic Penwriter—An electronic typewriter that's smart and versatile.**
- **Olympia Caffarex—High quality, big quantity espresso, cappuccino and . . . grog from Switzerland.**
- **Tiny TV—Casio's latest LCD Pocket Television, TV-70.**

Also in the next GADGET—Cotton candy at home, a zone-expanding "Two-Timer" for your watch, HotTopper hot, buttered popcorn, the CCS Supercar and lots more.

The SEMICONDUCTOR TESTER YOU ALREADY OWN

—How to use a VOM to test transistors

By Joseph J. Carr

THERE'S A SEMICONDUCTOR TESTER LURKING IN YOUR workshop. Don't believe me? Then take out your handy multimeter and give it a long, hard stare. With a little knowledge, an analog or digital multimeter becomes a transistor and diode tester. If you have a proper ohms scale, you can measure the diode's front-to-back resistance, and from that information determine whether or not the diode is leaking. You'll even be able to tell which end of an unmarked diode is the cathode or anode.

Buying transistors by the bagful is a popular means of stocking a hobbyist's junkbox for forthcoming projects, repair jobs, or just fussing around the workshop. Unfortunately, many of those bargain transistors and diodes are less than useless. Some of them are just plain bad...they go "poof!" when installed in a live circuit. Others are unmarked, so you don't know whether the unit is NPN or PNP. By correctly tagging those unknowns after evaluation, you can predict with fair reliability those that will perk along in real circuits, and those which are fit only for the trash heap.

Ohmmeter Orientation

Before jumping into the diving area of the semiconductor test pool, let's wet our toes in the shallow end with a little bit of ohmmeter theory. The question is: "How do analog and digital ohmmeters work?" As shown in Fig. 1A, in analog ohmmeters, a battery (or other) power source is connected in series with a meter movement and some calibration resistors (R1 and R2). Battery current makes its way through the meter movement into an external circuit (R_X), and back to the battery. Since R_X limits the current flow in the series circuit, the meter pointer won't swing as far along the dial as when test probes (connected to terminals A and B) are simply shorted together. That's why you'll find high-precision resistors in any decent multimeter—they limit the meter pointer travel (and the current) so that the pointer always comes to rest at a specific point on the dial. Short an ohmmeter's leads

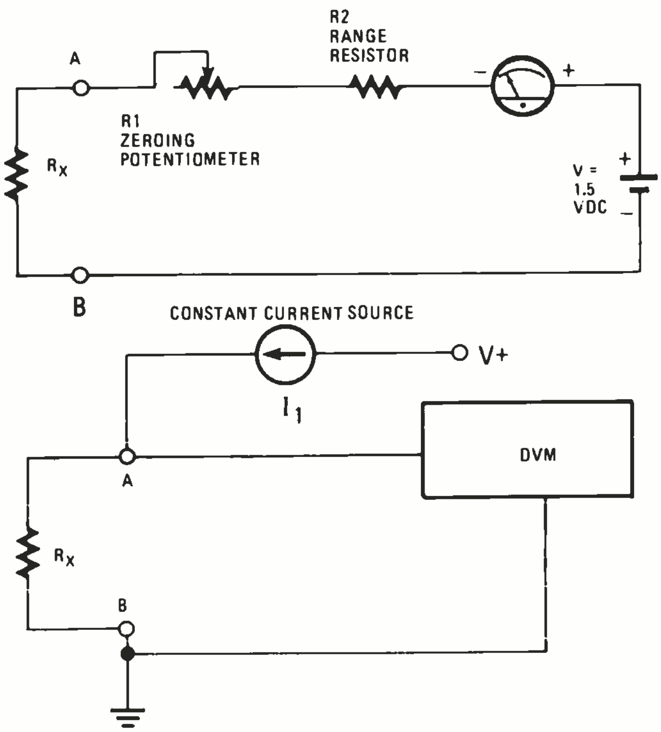


Fig. 1—In the more-common VOM-type ohmmeter circuit (A), the resistance is determined by measuring circuit current. In DMM ohmmeter circuits (B), the resistance is determined from the voltage drop across the unknown resistance.

together, and that place will be (of course) zero ohms.

When we connect our multimeter across external resistance R_X (with the multimeter in the ohms mode), the meter receives even less current than it did before; so there's less swing on the pointer's part.

Digital multimeters (DMM) use a different tactic for measuring resistance. In Fig. 1B we see that a constant current source is used to provide a precision reference current to the unknown resistance, R_X. The main circuit of the DMM is basically a millivoltmeter with a range of 0 to 1,999 millivolts. By passing a constant current through the resistance we can measure the resistance by measuring the voltage drop. For example, a 1-mA constant current produces a voltage drop of 1 mV/ohm. Typically, the constant current will be different for each range but the principle is the same.

Testing Diodes

Diodes are the easiest semiconductor devices to test, so we'll tackle them first. Besides, our method of transistor testing depends upon the fact that the diode also represents the base-emitter and base-collector junctions of a transistor. Like that famed airplane pilot Wrong-Way Corrigan, diodes do their thing best in a single direction.

We rely on diodes to pass electrical current *unidirectionally*. That unique ability forms the basis for our test. There are four states-of-being for a diode: they can be open, shorted, leaky, or OK. Before you start testing, it would be wise if you had a sheet of paper and a pencil or pen to jot down the readings.

Let's first assume that we are testing a rectifier diode. With the ohmmeter set to the R × 1 scale (Fig. 2A), place the probes across the diode's leads and record your readings. Then swap the probes or reverse the diode (Fig. 2B) and take a second resistance reading. After you take both readings you're ready to interpret what you've discovered.

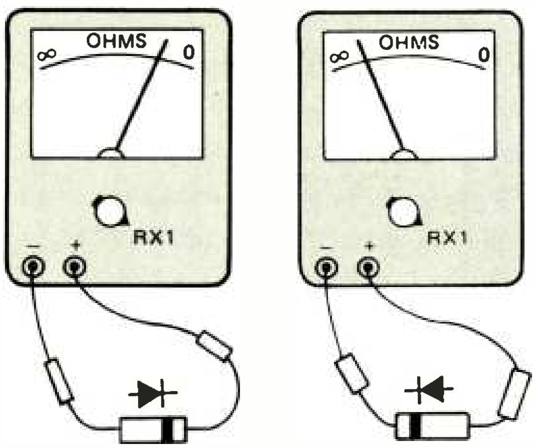


FIG 2A FIG 2B

Fig. 2—A good diode will measure low resistance in one direction and high resistance in the other.

Let's assume for the sake of simplicity that the diode checked out OK. How did we know? If the diode is healthy, then one of your resistance readings will be much higher than the other. The actual resistance readings aren't terribly important: it's the *ratio* between the readings that counts. Consider a ratio of five-to-one (5:1) or greater for older-style rectifier diodes and ten-to-one (10:1) for newer rectifier diodes and small-signal diodes as being "normal." For example, if the low reading is 500 ohms (a typical value), then the second reading should be 5000 ohms or more on a good diode.

Small-signal diodes are tested in exactly the same manner as rectifier diodes, except that the meter is set to the R × 100 scale rather than R × 1. The R × 1 scale produces a higher current flow in the external circuit, and can thus blow some small signal diodes.

Dead-shorted diodes often have a zero resistance regardless of the test-probe polarity (Fig. 3). Suppose, however, that your first and second readings are almost identical (but not zero ohms). That diode is leaky, and is almost as useless as a CB set at a hamfest.

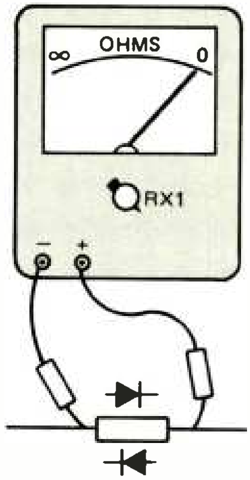


Fig. 3—A shorted diode will indicate low resistance in both directions. (Reverse the diode or the probes.)

Shorted and open diodes test exactly as you might expect. Open diodes show a very high (or sometimes infinite) resistance (Fig. 4). On analog meters the pointer doesn't budge off the ∞ (infinity) symbol, while on digital meters the display will flash the number 1999. A shorted diode will show either zero ohms in both directions, or a very low resistance (e.g. less than 100 ohms). Note that it is not always true that a shorted diode exhibits the same low resistance in both directions. In some cases, the resistances might be 50 and 80 ohms—that's very leaky and therefore to be considered "dead-shorted" for all practical purposes.

The ohmmeter can also tell us which end of an unmarked

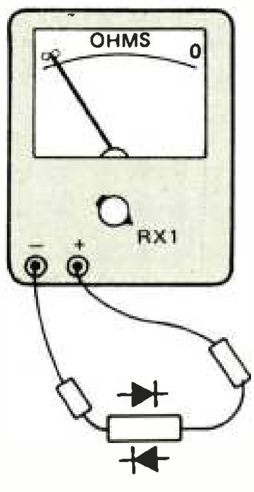


Fig. 4—An open diode will indicate a high resistance in both directions. (Again, reverse the diode or the probes.)

diode is the anode or cathode. Here's where you must know the relative polarity of your ohmmeter's probes. One way of determining polarity is to measure the voltage across the probes with a DC voltmeter, noting the polarity of the reading. Another method is to take a known good diode that is marked as to cathode and anode (the cathode end is usually marked with a stripe of paint, or an unusual shape) and connect it to the meter in a direction that produces a low resistance. In that state the ohmmeter's positive lead is applied to the diode's anode—and should be marked. Although it is not universally true, the red ohmmeter lead is positive.

Once you know which probe of the ohmmeter is positive you can use that information to tag any diode as to anode and cathode. Connect the diode across the leads to produce the low DC resistance reading—the positive lead is always connected to the anode end (and, of course, the other end is the cathode).

Testing Transistors

Transistor types can be (and often are) categorized in terms of family behavior. Look in any transistor catalog and you'll see that many consecutively-numbered transistor types share like characteristics. You will find that NPN and PNP types that are identical in performance, but have equal and opposite polarities. These are called "complementary pairs."

Let's start by examining a small-signal PNP unit first. The method for checking transistors with a VOM, VTVM, or DMM is no different from that for checking a diode. Perform your tests with the ohmmeter on the R × 100 scale for small-signal transistors and the R × 1 scale for power transistors. Connect the negative ohmmeter probe to the transistor's base lead. Separately touching the collector and then the emitter leads with the positive probe, you'll detect a high-resistance and then a low-resistance. Reversing the probe connections—placing the positive probe on the base—will show up as low collector-resistance reading and a high emitter resistance-reading (see Figs. 5A through 5D).

By now you're wondering what all that resistance hokus-pokus has to do with transistor testing. You've just killed two measurement birds with one stone. First, you found out if the transistor was leaky, shorted, or open between elements. That would become apparent as you made your resistance measurements and found very undiode-like behavior across the junctions. Next you either confirmed or discovered the transistor's polarity, i.e. whether it was PNP or NPN.

Suppose the base-emitter junction tests open. That situation is revealed as a very high resistance whether the positive probe is connected to the base, or the other way 'round. If the base-emitter junction tests shorted, then you'll see that that condition shows up as a very low resistance, no matter which way the ohmmeter probes are placed.

Leaky transistors give you a real run for your measurement money. Indicating abnormal base-emitter resistance values, they won't always test either open or shorted—normal resistance characteristics for that particular transistor family under examination simply won't show.

Finding out whether a transistor is PNP or NPN merely amounts to noting the lowest resistance values as you check base-emitter junctions (refer again to Fig. 5). For PNP units, the lowest reading occurs when the positive probe is connected to the emitter and the negative lead is hooked to the base. For NPN transistors it's just the opposite; that is, you'll get a low reading when the positive lead is connected to the base and the negative is connected to the emitter.

Explaining the Unknown

Even if you didn't know that it was a PNP transistor being tested, you could still play the switch-n-swap ohmmeter probe game. The procedure isn't more difficult: you'll simply need to pay more attention to your readings. First, mount a transistor to a surface that's easy to write on—a piece of paper or cardboard will do. Label the transistor leads X, Y, and Z.

Now pick a lead at random (say X), and attach the positive ohmmeter probe to it. Connect your negative probe to another transistor lead, say lead Y. Take a reading, and write the value recorded between the leads on the paper. Then reverse your ohmmeter probes, taking another set of readings between the same two transistor leads. Again, write the value on the paper between the leads measured.

Move your ohmmeter probes to a second pair of leads (Y and Z, for instance). Repeat the resistance recording operation. Eventually, you'll want a set of values between all transistor leads.

Let's interpret our readings. One set of resistance readings will be almost identical. You've found the collector and emitter—label one lead E and the other C (for the moment, it's entirely arbitrary which lead receives which letter). Since you've located both emitter and collector, it stands to reason that base is your only unmarked lead. Write B next to that lead.

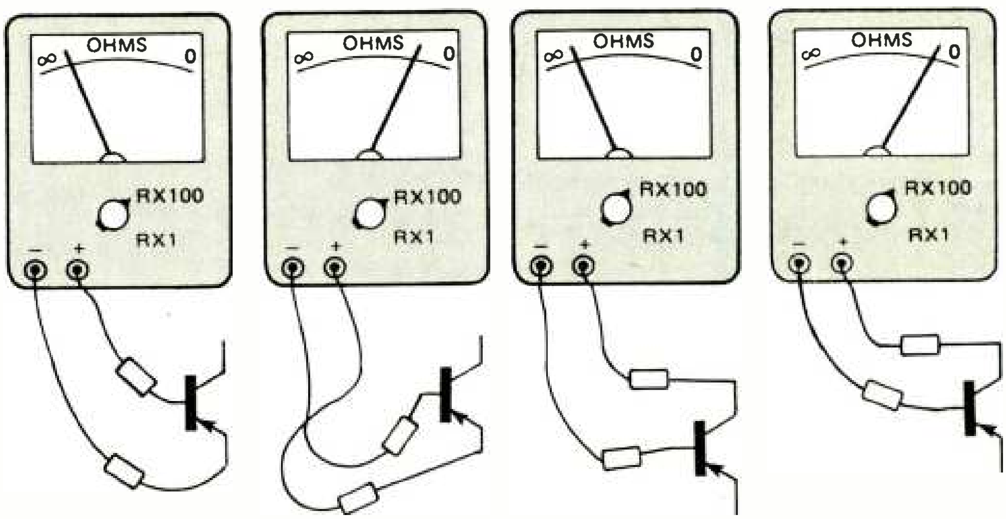


Fig. 5—A transistor's base-emitter and base-collector junctions test like diodes because *they are* diodes

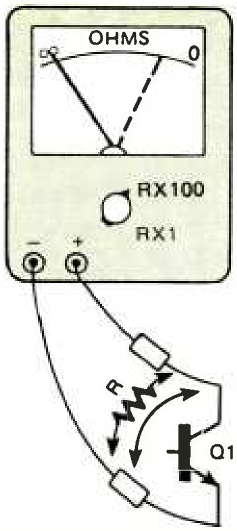


Fig. 6—While they won't tell you much about gain values or frequency limits, ohmmeter tests on transistors can indicate whether or not the device can amplify.

Assume for a moment that you've got an NPN transistor labeled. If your base-emitter resistance reading was lower with the positive ohmmeter probe connected to base (base-emitter junction test), and the base-collector reading was higher with the positive ohmmeter probe base connected (base-collector junction test), then you're looking at an NPN unit. That's why the emitter and collector were arbitrarily marked—you might have to switch E and C around in order for things to make sense.

We won't deny that the process takes a little practice. Therefore, you might want to mount a known transistor to the paper first and experiment with that unit in order to get the hang of things.

As expected, PNP units give opposite resistance readings with that method. Always remember to find the emitter and collector first, then go ahead and make your measurements between base-emitter and base-collector junctions.

We've gone through a lot of work sorting out good, bad, and indifferent NPN and PNP transistors. Was it worth the effort? Our more-immediate test result enables us to sort the wheat from the chaff in bargain bags of transistors. We can also test transistors using that method in troubleshooting situations—and get projects or ready-built equipment back in service faster.

Testing for Gain

No transistor is worth much at all if its base terminal does not control collector-emitter current flow. All of the test methods listed above will give us some gross indications of failure—an open emitter, shorted C-E junction, and so forth—but they don't really tell us anything about whether or not the transistor will amplify. Figure 6 shows a method used by some service technicians to determine whether or not a transistor is good. Connect the ohmmeter across the collector-emitter leads in the polarity that would normally be found in circuit. For PNP units connect the negative probe to the collector, and the positive probe to the emitter; for NPN units connect the positive probe to the collector and the negative probe to the emitter. If the transistor is good, the reading will be very high, or infinity. Next, short the base lead to the collector lead. If the transistor works, then the resistance reading across C-E terminals will drop. Some people prefer using a 100,000-500,000 ohm resistor instead of a short circuit (R in Fig. 6).

Checking Leakage

Leakage in a transistor is the unwanted flow of current from collector to emitter (or vice-versa). Checking a transistor for leakage is simply measuring resistance across C-E twice. Measure first with one polarity, and then switch the ohmmeter leads and measure again. The leakage reading is the higher of the two resistances (because of junction action, one reading is normally quite low). For germanium transistors the leakage will be lower than for silicon. Typically, silicon transistors will show nearly infinite resistance on the three scales normally used: R × 1, R × 10 and R × 100. Germanium transistors may have 100K of leakage and still be good enough for use.

Using Digital Multimeters

The digital multimeter (DMM) has largely (but not entirely) replaced the old-fashioned VOM/VTVM. Earlier in this article we discussed the method used in DMM's to measure resistance. Unfortunately, that method does not lend itself well to our semiconductor-test method, because the voltage produced across the probe tips is not sufficient to forward-bias PN semiconductor junctions. Although that feature makes it easy to make in-circuit resistance measurements without removing the semiconductors, it also prevents us from testing semiconductors. However, most recent DMM's are designed to overcome that massive evil. There will be a special ohms scale that will forward-bias diode junctions. Those scales are marked with either words such as "high power" or (more commonly) with the diode symbol.

Safety Rule

Diodes and small transistors can be damaged by ohmmeter currents. Always start at the higher scales (R × 100) and then drop down to lower scales (R × 10 or R × 1) only if necessary to get a readable deflection of the meter. In any event, stay on the same scale for both readings. The typical ohmmeter circuit changes currents on different ranges, so comparing readings taken on different scales means interpreting the results of two different bias levels—and that's comparing apples and mangos. ■

The Radio Shack Model 22-211 Fold-Up Multitester is unusual in that the meter movement itself is built into a hinged cover that folds so that all parts of the instrument—the meter, the controls and the connectors—are protected when not in use.

A basic project that may be the beginning of something bigger

VARIABLE STROBE LIGHT

By Marty Knight

THERE IS ALWAYS A NEED FOR A STROBE LIGHT. YOU CAN use one as a house marker should you live on a dark road. It can pep-up a party by visually adding excitement to disco music. Photographers can make some unusual sequence shots. Other uses for a strobe light are: warning lights, ignition timer, and stroboscope applications. And, a strobe light can be used just for the heck of it!

The Variable Strobe Light is an excellent device for producing high-intensity white light for very short durations. The speed or flash rate can be varied from one or two light pulses per minute, to twelve or more per second. The circuit uses a 5-watt flashtube, which has a lifetime of many hours, even with continuous use. The project can also be converted into a manual strobe light for use with camera equipment by the ambitious experimenter.

The Flashtube

Stroboscopic devices would not be practical were it not for the development of the flashtube. This device (see Fig. 1) is a sealed glass tube that is filled with an inert gas such as xenon. Each of the two ends has electrodes, one is the anode (+), the other the cathode (-). Strapped around the outside of the glass tube in the vicinity of the electrodes, is a third electrode called the trigger. The tube provides white light of high intensity for a very short period of time.

To operate the flashtube, two voltages are required: 320-volts DC or more, between the cathode and the anode, and pulses of approximately 4000-volts on the trigger electrode. When 320-volts DC is placed across the flashtube (from cathode to anode) with the use of a large storage capacitor, the flashtube will not fire. The 320-volts is not enough to cause current to flow through the flashtube. However, when the trigger electrode receives a pulse of 4000 volts, some of the xenon in the tube is ionized, because of the high-voltage gradient developed in the vicinity of the anode and cathode. The high-voltage gradient strips orbiting electrons from the xenon-gas atoms inside the flashtube. The free electrons flow through the inert gas to the positive anode at a very high speed. Impacts between inert gas atoms and the fast moving free electrons create more free electrons in an avalanche fashion, until enough free electrons exist to rapidly discharge the capacitor in an *instant*—a fraction of a millisecond. The result is a flash of bright light as the sudden, large current passes through the flashtube.

In any strobe-light project, two circuits are needed: one

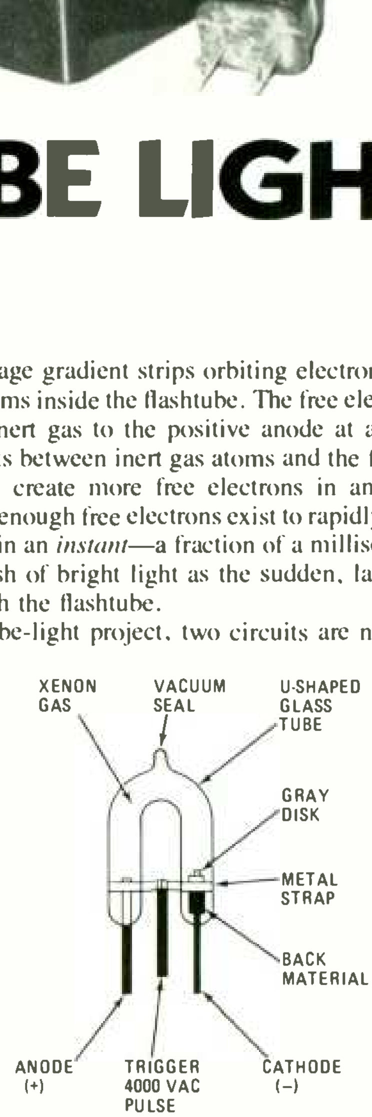
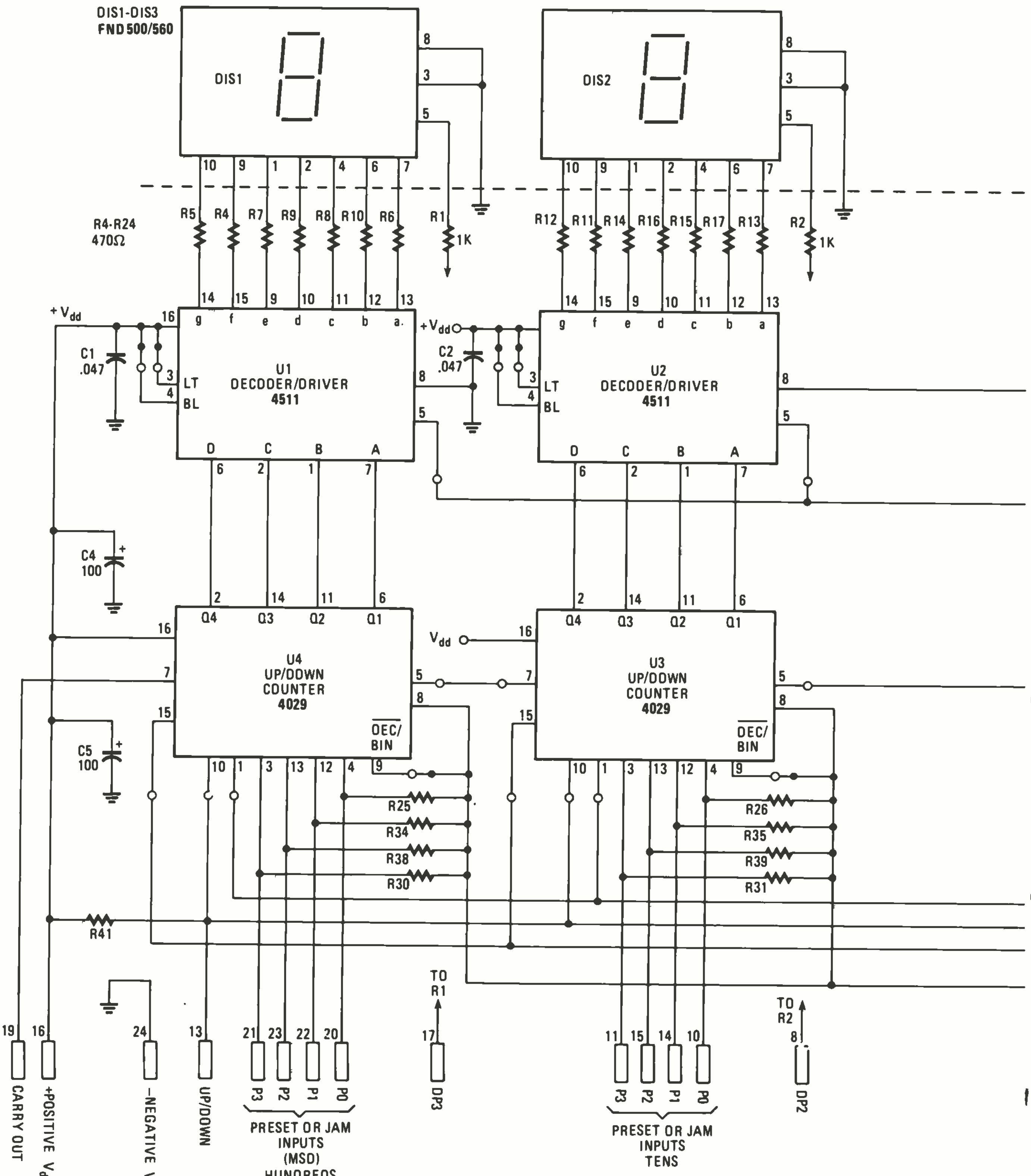


Fig. 1—The flashtube is a sealed piece of glass tubing shaped into a "U" with two implanted electrodes, and evacuated except for a small amount of inert xenon gas. A metal strap is placed near both ends of the glass tube as a third electrode. The cathode has a gray disc on the end of it with some black material deposited where the cathode lead enters the glass tube. The anode is a straight bare wire inside the glass tube. About 320-volts DC is placed between the anode and cathode electrodes, and approximately 4000-volts AC is pulsed on the trigger electrode.



asynchronously with the clock. A low on each PRESET line, resets the counter to zero.

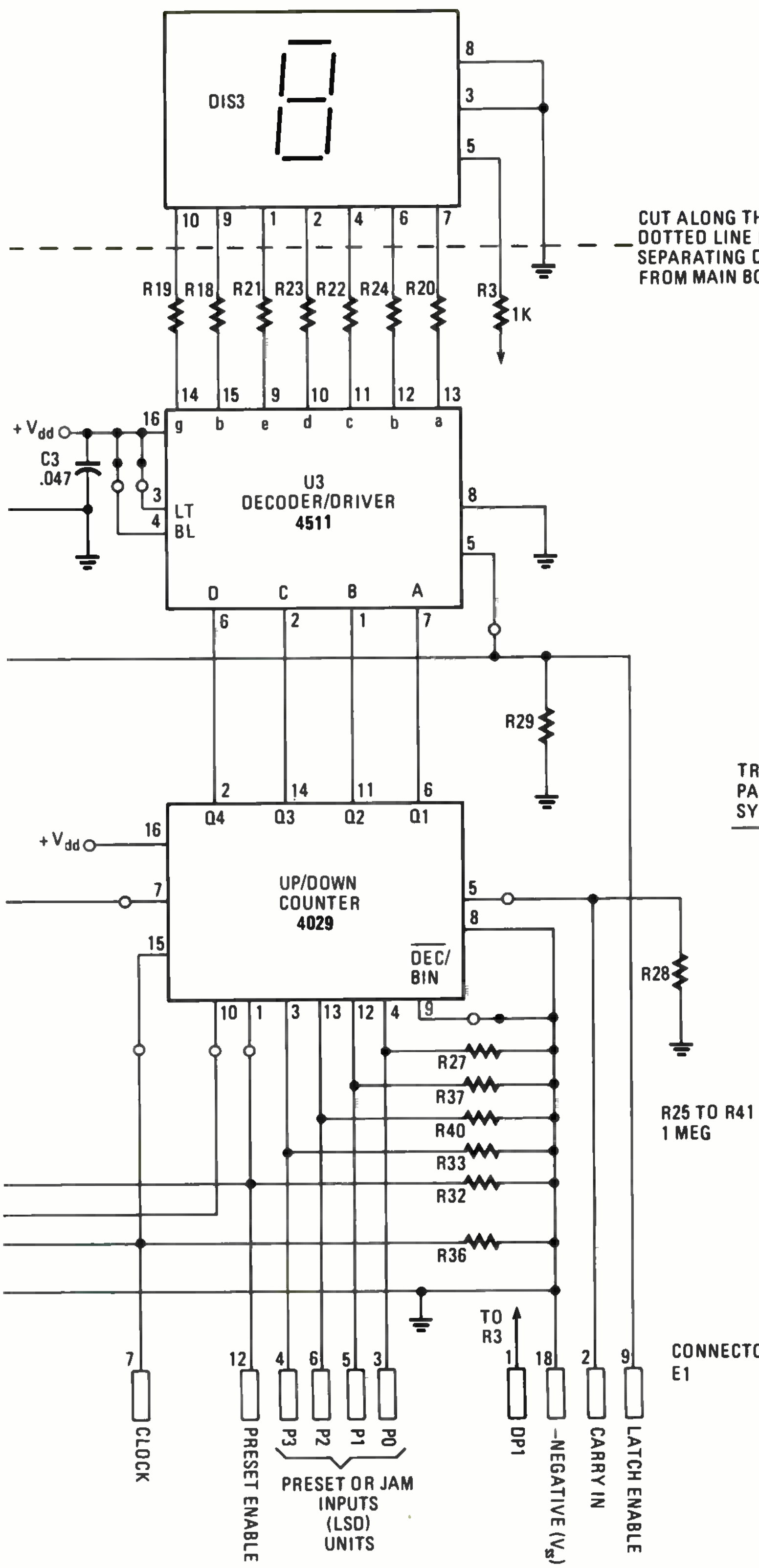
The 4029 counter advances one count for each positive pulse of the CLOCK signal when the $\overline{\text{CARRY-IN}}$ and PRESET ENABLE signals are low. Count advancement is prohibited when either signal is high.

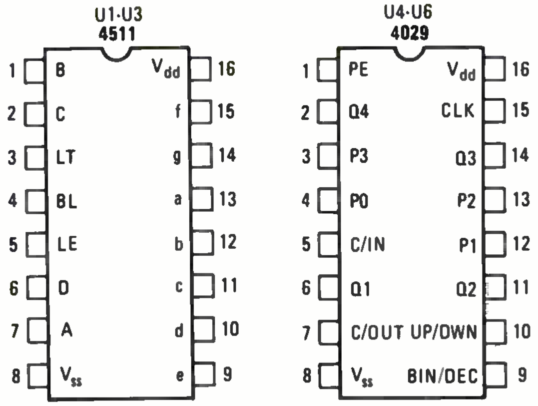
The $\overline{\text{CARRY-OUT}}$ signal is normally high and goes low when the counter reaches maximum in the UP mode, or the minimum count in the $\overline{\text{DOWN}}$ mode, provided the $\overline{\text{CARRY-IN}}$ is low. The $\overline{\text{CARRY-IN}}$ signal in the low state can thus be considered a $\overline{\text{CLOCK ENABLE}}$. The $\overline{\text{CARRY-IN}}$ terminal must be connected to V_{ss} (low) when not in use.

The 4029 counter counts up (0, 1, 2...7, 8, 9) when the UP/$\overline{\text{DOWN}}$ input is high, and down when the UP/$\overline{\text{DOWN}}$ input is low.

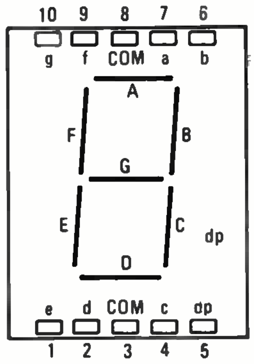
4511 and FND500/560

The 4511 decoder/driver integrated-circuit (U1–U3 in Fig.





PIN CONNECTIONS
(TOP VIEW)
DIS1–DIS3
FND 500/560



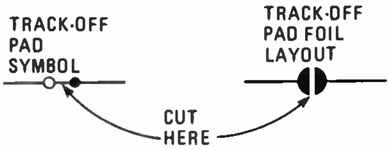


Fig. 1—Circuit diagram of the Dick Smith Electronics 3-Digit Counter Module Kit wired as a parallel clocked (synchronous) counter. The connector strip E1 consists of a row of contact pads located on the printed-circuit board.

1) is a BCD-to-7 segment latch/decoder/driver with CMOS logic and bipolar-transistor output stages. LAMP TEST or LT (pin 3), BLANKING or BL (pin 4), and LATCH ENABLE or STROBE (pin 5) inputs are provided to test the display, shut off, or intensity modulate it, and store or strobe a BCD code, respectively.

The LAMP TEST and BLANKING inputs are set in the 3-Digit Counter Module circuit by their connection to a high (V_{dd}). If these controls are required, the tracks-off pad between pins 3 and 4 of the 4029's and the positive bus (V_{dd}) can be cut; connections can be made to the track-off pads as required for experimenting purposes. Refer to Fig. 1.

The capacitors (C1–C3) tied to the V_{dd} bus near pin 16 of each 4511 chip (Fig. 1) short out power-supply pulses, reducing the possibility of a glitch in the display indication.

Printed-circuit Board Adaptability

The printed-circuit-board construction in the Dick Smith Electronics kit is a flat, single-surface layout, the external size of the assembly being 4⁹⁄₁₆-in. × 3⁷⁄₁₆-in.

To reduce the overall length, the printed-circuit board can be cut along the line separating the three displays from the board, and then the two boards are joined together at right angles as shown in Figs. 2 and 3. A light sanding of the broken surface on the display board will provide a better mechanical joint. The solder points are at the cut or break-point of each foil lead. There are a sufficient number of solder points to firmly unite the boards as one again.

The two parted boards may also be soft wired so that their relationship to each other can be changed to suit mounting requirements. Consider using 32-lead ribbon cable for long runs.

If the Counter Module is to be used in a two-board layout, it is wiser that the original board be cut prior to mounting the first component.

Assembly Instructions

The single-sided printed-circuit board for the 3-Digit Counter Module has been designed for maximum flexibility of the control signals to the 4029 CMOS counter and the 4511 display driver/latch integrated circuits. By configuring links L3 thru L15, the module can be made to operate as required for a specific need. Resistors R25 through R40 (1-Megohm each) have been included in the circuit as passive "pull-up" or "pull-down" devices to protect and correctly terminate the input control lines of the CMOS circuits. It should be realized that resistors are not necessary if control lines are driven from some other CMOS device or suitable interface circuitry. If the module is to be used for learning experiments, the experimenter is advised to include those resistors in the original assembly.

The links (wire jumpers) can be put into the board first. L1 and L2 are common to all configurations. The other links included and shown in the parts placement diagram (Fig. 3) configure the module as a parallel clocking (synchronous mode), cascaded, 3-digit counter. If you are unsure of the mode of operation required, leave out those links till after final assembly so that it is possible to experiment with various combinations. Table 1 provides the necessary information to connect the appropriate links.

TABLE 1—LINKS FOR FIG. 3

Links (Parallel Clocking)	Links (Ripple Clocking)
L3, L4—Clock	L5, L6, L7—Clock and Carry In
L8—Carry out to Carry In	Remove—L3 and L4
L9, L13—Up/Down	Others as shown in Fig. 3
	L11, L12—Latch Enable
	L14, L15—Preset Enable

The kit is supplied with uninsulated wire, and this thick-fingered experimenter opted to use insulated wire because of the closeness of the links. After the board was finished, I realized that my move was correct!

All the resistors were loaded in the board as the next step. The capacitors C1 thru C5 are common to all circuitry and configurations, and they now can be included. Trim the excess off the leads. Check that the polarization of the electrolytic capacitors (C4 and C5) are correct as they are placed on the board. Refer to Fig. 3.

The integrated-circuit chips, U1–U6, now are inserted into the appropriate positions and soldered into place. Note the orientation of the chips' notched ends in Fig. 3. Insert the FND500/560 seven-segment LED displays, DIS1–DIS3. Again, note the orientation; then solder in place.

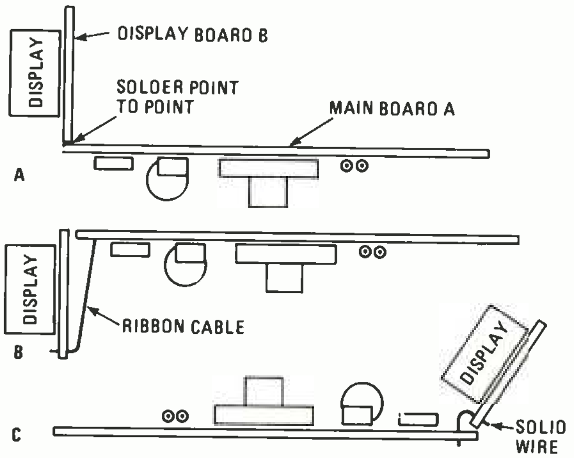


Fig. 2—The printed-circuit board can be used as one piece. However, the section that holds the three 7-segment LED displays can be cut free (prior to construction) and reconnected to the board. Three possible positionings for the display board are: A—Right-angle mount with point-to-point solder connections at foils near cut edges; B—Right-angle mount with "soft-wire" connection (32-lead ribbon cable can be used for longer runs); and C—Angle mount with "soft-wire" or angle-bracket connections.

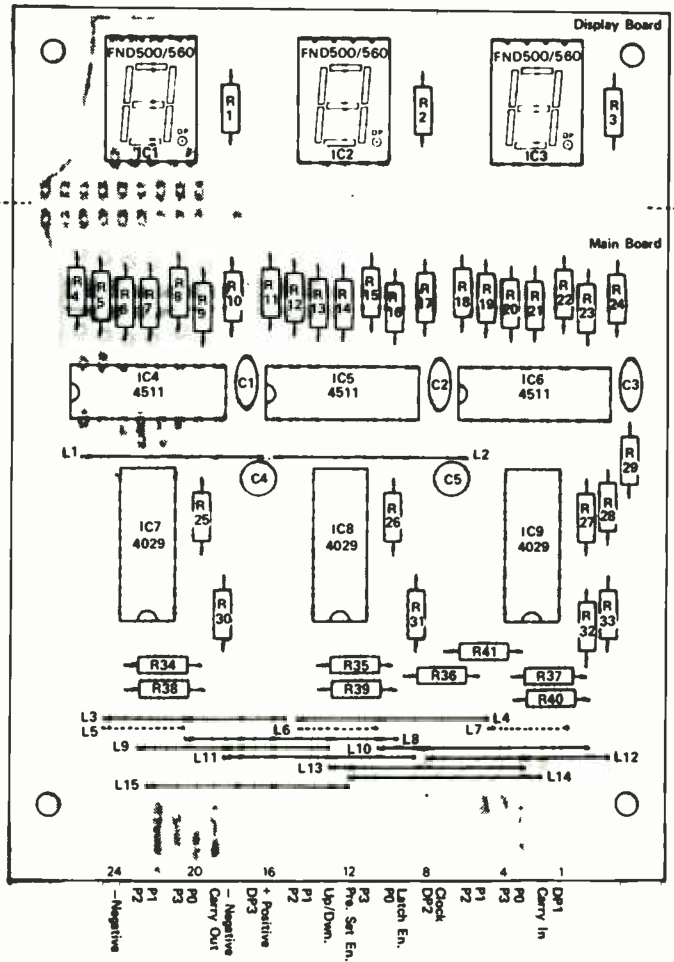


Fig. 3—The printed-circuit board showing the 3-Digit Counter Module component locations with links, L1, L2, L3, etc., in place for parallel clocking (synchronus mode). Dotted lines near the top of the board (between the two rows of solder pads) indicate where the board is cut apart so that the seven-segment LED displays can be positioned.

A word of caution: The integrated circuits are CMOS types and are subject to permanent damage by incorrect handling procedures. Static charges from your person or tools can destroy an un-fixable chip. Use the necessary preventive measures to reduce overall solder-heating and static build-up.

If you have chosen to operate the Counter Module in a two-board layout, it will be necessary to solder the connections point-to-point or use soft wiring as required. Fig. 2 offers three possible display positionings.

Initial Operation and Testing

Carefully inspect the 3-Digit Counter Module assembly after it is completed. Look for components missing or loaded into the wrong position. Carefully check all solder joints, and look for solder that may have bridged tracks or pads. Should you find one or more solder bridges, use a solder sucker such as a copper braid or vacuum device to remove the excess solder.

If no errors, omissions, nor defects are found, power may be applied to the Counter Module. A regulated DC power supply or battery pack in the range of 5 to 10 volts should be used. Observe polarity when making the connections.

Although voltages from 10 to 15 are within the specifications of the 4029 and 4511 devices, the driving current to the FND500/560 displays will be too high for normal operation. If the Counter Module is to be used at these higher potentials, the series resistors R4 thru R24 must be increased to 1200 ohms to give a more reasonable supply-current to display-brightness ratio. The decimal-point series resistors, R1, R2, and R3 should also be increased to 2200 ohms. Considering the extra cost for resistors, a 9-volt DC battery supply was used to power up the Counter Module during test. The final application showed that a 9-volt DC wall power-pack proved to be perfect. A 6-volt unit would work equally as well with a very slight dimming of the display LED elements.

With power applied, the seven-segment LED displays should now be showing some random number. By applying a high (temporary jump to positive bus—V_{dd}) to the pre-set enable input (tab 12 on the connector strip, E1), the display should read "000." This indicates that the basic display and reset functions are operational and the Counter Module is ready for experiment. Obviously, the necessary links will have to be in position to perform this test. Refer to Table 1.

If correct counter operation does not occur, go back over your visual checking routine. The most common fault with assembling the unit is soldering. Dry (rosin) joints or shorted foils are very commonplace with experimenters and even seasoned technicians. If you find nothing wrong, look for incorrect component position or orientation. A diode connected backward or a chip with its notch incorrectly placed is a common fault.

Assuming that the assembly is correct, it is possible that a component has been destroyed during construction. Return the power to the Counter Module and wait a few minutes. In many cases, when a CMOS device breaks down, excessive current dissipation takes place and this will be indicated as heat in the defective part's DIP package.

Feel each DIP package individually, any device that is warmer than another is more than likely at fault. Note that the 4511 will normally be warmer than the 4029 in operation.

Experiments with the Counter Module

A simple up-counter, with pushbutton controls and relay output, is diagrammed in Fig. 4. The pushbuttons START (S32), STOP (S33), and RESET (S31) the counter to zero (000).

The input to the clock line (tab 7 of the connector strip, E1) on the Counter Module can be from a simple positive-going pulse circuit as shown in Fig. 5. The pushbutton switch is pressed once for each event that occurs—patrons entering a theater or cars passing an intersection.

In conjunction with the count direction switch (UP/DOWN; S34), the Preset Inputs of the Counter Module can be set by (switches S11–S13, S21–S24, S1–S3), to give a starting-point counter number in either the up direction or the down direction.

If "500" is the setting input to the Counter Module via the PRESET switches (use binary summing to close the correct switches as shown in Table 2) and the RESET button (S31–brings the DIS1–DIS3 displays to read the selected number), the counter will count down from 500 to 0 when the UP/DOWN switch S34 is set to DOWN and the START button (S32) has been pressed. When "000" is reached on the display indicators, relay K1 will latch on and the counter will be disabled. Press the RESET button (S31) and the original "500" count will be reset. The STOP button will interrupt the count at any time and hold that count until the START switch or RESET switch is pressed.

The same basic counter configuration may be used in conjunction with the circuits of Figs. 6 and 7. The 3-Digit Counter Module then becomes a timer with a 1-second time-base. To count up, set UP/DOWN switch S34 to UP.

PARTS LIST FOR 3-DIGIT COUNTER MODULE KIT

R1–R3—1000-ohm, ¼-watt, 5% resistors
R4–R24—470-ohm, ¼-watt, 5% resistors
R25–R41—1-Megohm, ¼-watt, 5% resistors
C1–C3—.047-µF, ceramic capacitors
C4–C5—100-µF, 16-WVDC, electrolytic capacitors
DIS1–DIS3—FND 500/560 7-segment display LED's
U1–U3—4511 CMOS driver/latch integrated circuits
U4–U6–4029 CMOS counter integrated circuits
Hardware, printed-circuit board, wire, solder, etc.

The 3-Digit Counter Module Kit is available by mail from Dick Smith Electronics, Inc., P.O. Box 8021, Redwood City, CA 94063. Orders: telephone 1-800/332-5373; inquiries: 1-415/368-8844. The price is $14.95 plus $1.50 for packaging and handling and 1.50 for shipping. California residents add 6½% sales tax. Orders outside U.S. must include U.S. funds and add 20% of total price for shipping.

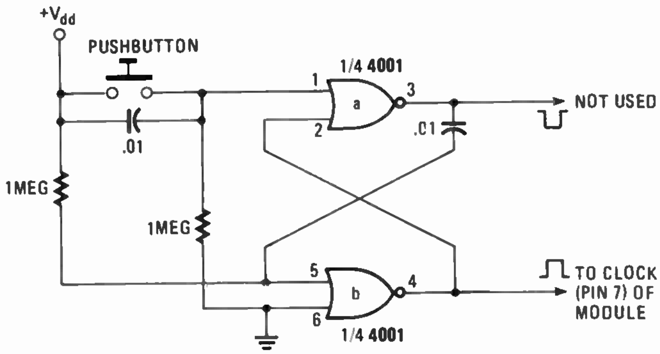


Fig. 5—A simple pushbutton generator that develops a positive pulse for each event. The switch can be activated by a thumb, door switch, or any other mechanical action.

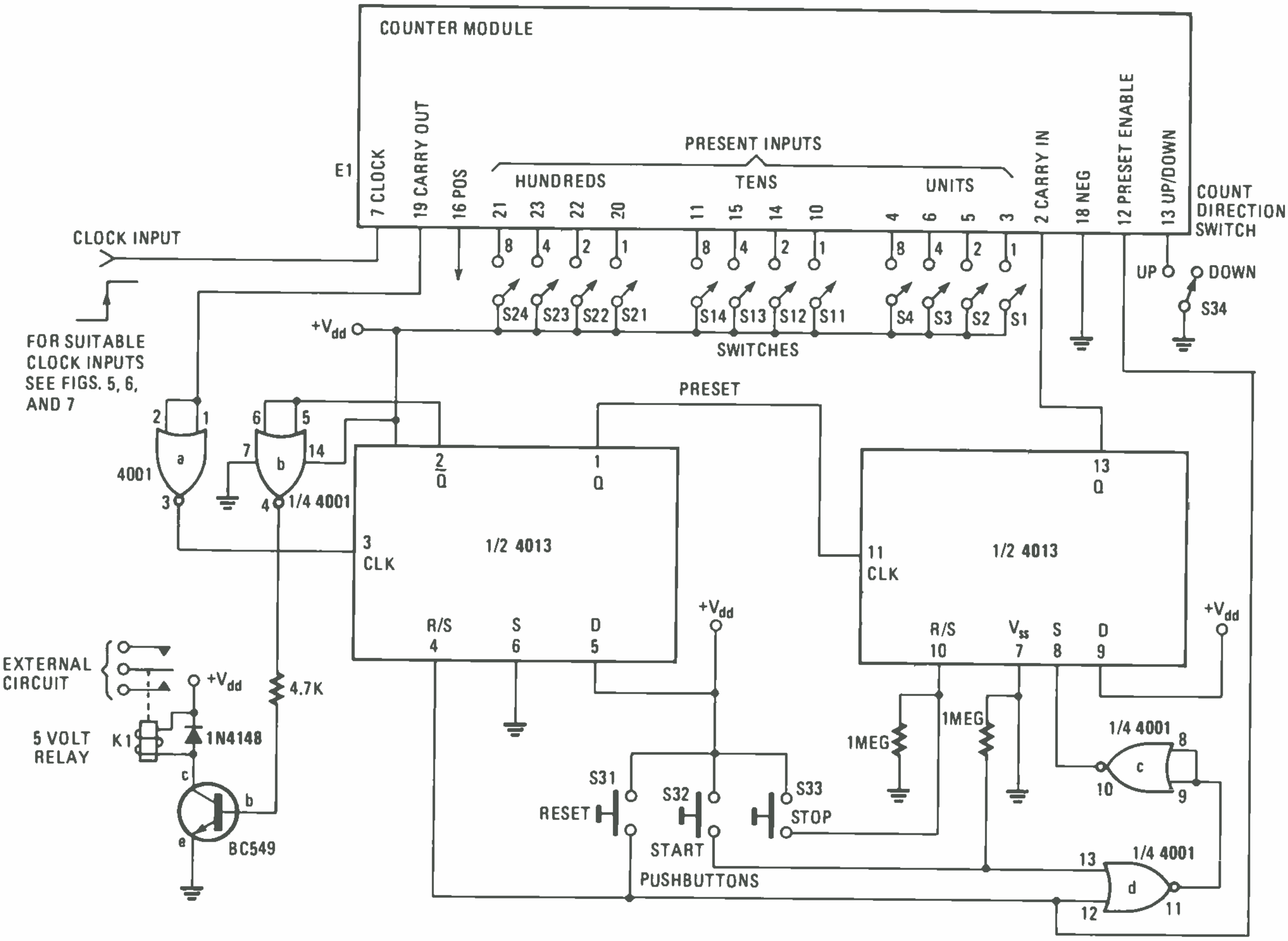


Fig. 4—Here's a simple counter with pushbutton control using the 3-Digit Counter Module plus a handful of other parts. Relay K1 isolates the circuit from an external power line that can be used to ring a bell or start up a giant crane. For suitable clock inputs refer to Figs. 5, 6, and 7.

The power circuit shown in Fig. 6 can be the basic supply for all experiments with the module. Most step-down transformers can be used for T1, provided that the output voltage from the diode bridge is not excessively high. As the voltage increases, the DC voltage regulator will operate at a warmer level.

The circuit of Fig. 7 uses a simple 555 timer as the clock. The actual clock rate is set by the 470,000-ohm potentiometer which is part of the R/C timing circuit.

The clock in Fig. 6 divides the 60-Hertz AC power frequency by 6 to give a 100-millisecond clock pulse (10-Hertz pulses), and a further division by 10 gives a one second pulse at the output.

The PRESET switches shown in Fig. 4 are simple single-pole, single-throw slide or toggle types. They are coded in binary and are set as indicated in Table 2 as required. Four switches are required per decade, a total of 12 for the Counter Module of three decades. This type of switch could be replaced by a BCD thumbwheel (expensive compared to slide switches). The thumbwheel switch replaces one bank of four preset switches per decade.

The other pushbuttons may be any simple single-pole, single-throw type. The UP/DOWN switch (S34) is a single-pole, double-throw type.

More on the Module's Circuit

The Counter Module is configured as a ripple counter (Fig.

TABLE 2
BINARY-TO-DECIMAL CODING

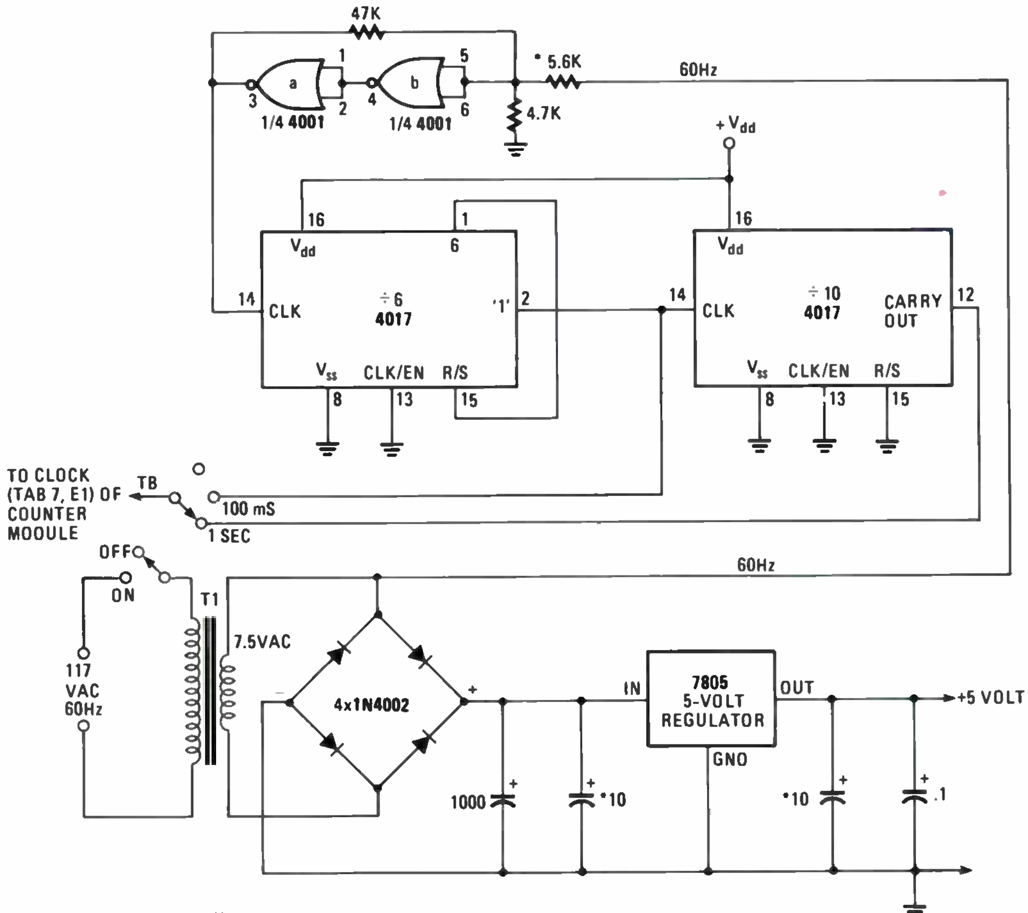
Binary Number				Decimal Number
S4	S3	S2	S1	
0	0	0	0	0
0	0	0	1	1
0	0	1	0	2
0	0	1	1	3
0	1	0	0	4
0	1	0	1	5
0	1	1	0	6
0	1	1	1	7
0	0	0	0	8
1	0	0	1	9
'1' Switch ON				'0' Switch OFF

Example: Count required—952

Set Switches											
'9'				'5				'2'			
S24	S23	S22	S21	S14	S13	S12	S11	S4	S3	S2	S1
1	0	0	1	0	1	0	1	0	0	1	0

Example: Count required—316

S24	S23	S22	S21	S14	S13	S12	S11	S4	S3	S2	S1
0	0	1	1	0	0	0	1	1	0	1	0



*25-WVDC TANTALUM

Fig. 6—The clock circuit (top) senses the 60-Hertz power line by tapping a signal off the transformer's secondary winding. The 5600-ohm resistor (*) should be increased in value in proportion to increase in the supplied 60-Hz tap-off signal voltage increases due to transformer substitution. The circuit provides 100 millisecond and one second pulses. The power supply is a standard 5-volt, regulated-DC circuit that can be substituted by a bench-top supply.

8). In this mode links L5, L6, and L7 are in, and links L3 and L4 are removed. Refer to Table 1. This circuit setup assures that the carry-out signal (pin 7) does not have any of the glitches that can appear in a parallel-clocked (synchrunus) operation as shown in Fig. 1.

Now flip to Fig. 4 for the following discussion. The carry-out signal (tab 7 on E1) is inverted by the 4001-a gate as the clock pulse for the first half of the 4013 flip-flop. This latches the end of count and turns on the relay via the inverter 4001-b and the transistor. At the same time, the output at "Q" (pin 1 of the left half-section of 4013) clocks the second flip-flop to disable the incoming clock pulses at the Counter Module tab 7 on E1 by enabling the carry-in tab (tab 2 on E1). This second flip-flop also latches the control functions Stop/Start. The whole function of the module is preset via the RESET button S31, to the value set by the Preset Switches. If these switches are all off, the counter would be set to "000." The counter action is initiated by the START button S32.

A Simple Frequency Counter

The 3-Digit Counter Module can be configured to operate as a simple frequency counter by using a few external components. The basic module can to wired in a parallel clocked (synchronous) mode as shown in Fig. 1.

The circuit of Fig. 9 shows a 4013 dual flip-flop used as a housekeeping circuit to provide the necessary control over

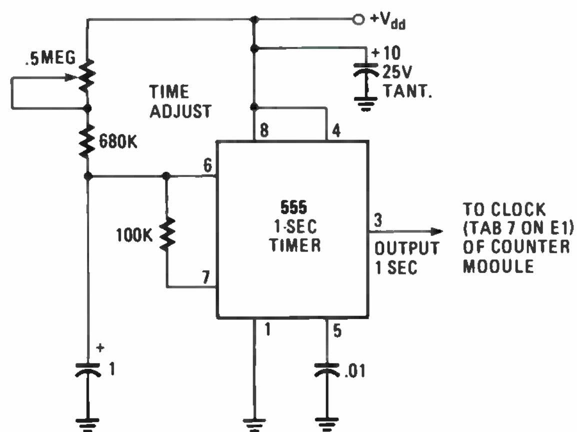


Fig. 7—Diagram for a simple one-second time-base using the common 555 timer. The clock is adjusted by using a trimmer.

timing and logic functions. The 555 timer provides a 10-millisecond clock as the basic time-base, the 4017 on the left divides by 10 to give an output of 100-millisecond, and the right 4017 divides by a further 10 to give a 1-second rate. The three outputs can be switched by S40A into the Carry In (Clock Enable, pin 2) of the Counter Module to give full-scale readings of 99.9 kHz, 9.99 kHz, and 999 Hz, respectively. The other half of the double-pole switch, S40B, can be used to change the decimal points.

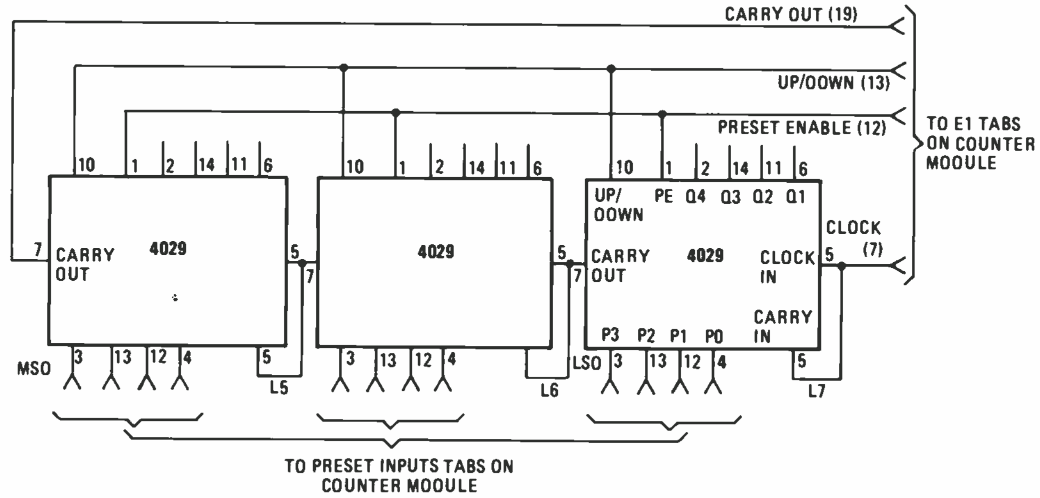


Fig. 8—By changing the links, the 3-Digit Counter Module can be configured for ripple counting. This is accomplished by using links L5, L6, and L7, and removing links L3 and L4. Refer to the text discussion, Table 1, and Fig. 3.

As with all external signals to the module, the clock input logic amplitude must be within the V_{dd} limits; if the supply is 9-volts DC, then the input signal must not exceed 9-volts DC.

The incoming frequency to be measured is applied to the clock line (7) of the Counter Module. Remember that the 4029 triggers on the negative to positive transition of the waveform. If this waveform is not clean on the transition, false triggering may occur. Some signal pre-conditioning circuit may be necessary to convert the waveform to logic level and shape. The circuit of Fig. 10 is an example of a configuration that can be used. The field-effect transistor (FET) is used as a high-impedance input stage, the transistor is a simple amplifier, and the 4093 Schmitt trigger shapes and tailors the waveform.

The time-base clock pulse from the 555/4017 circuit shown in Fig. 9, triggers the 1st 4013 on the negative to positive transition. It also disables the incoming signal on the module Clock Line (7) by using the Carry In (2) as a Clock Disable. The 4013 is connected as a monostable multivibrator by the use of the 10,000-ohm/.001-µF time-constant components. This creates a narrow pulse that is applied to the Latch Enable (tab 9) of the Counter Module. That action latches and holds the contents of the 4029 counters in the 4511 display driver that in turn displays this number as a readout on the FND500/560.

The back edge of the pulse triggers the second half of the 4013 that is also connected as a monostable multivibrator. The resultant pulse resets all the counters to zero via the "Q" output and the Counter Module's Preset Enable (tab 12 on E1) is readied for the next count sequence.

(Continued on page 98)

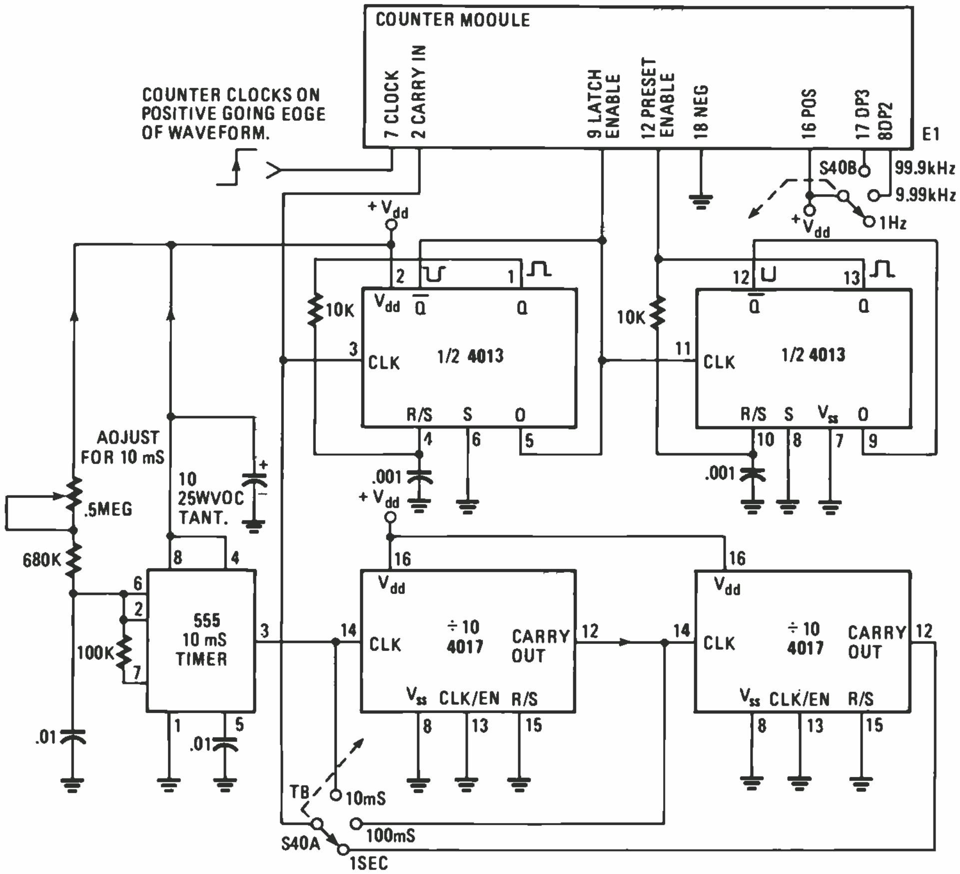


Fig. 9—Using the Counter Module as a frequency meter is diagrammed here with three time-bases—10-millisecond, 100- millisecond, and 1-second sweeps. The clock signal measured should be a positive-going pulse whose amplitude is not higher than the V_{dd} used by the Counter Module.

Electronic Fundamentals

By Louis E. Frenzel, Jr.

Capacitors come in a wide variety of shapes, values, and ratings. Your knowledge of their operation and application will increase your capacity for circuit understanding.

IMAGINE IF YOU WILL, TWO METAL PLATES STANDING ON A table. They aren't connected to anything—there are no concealed or "invisible wires" of any kind—they are simply two metal plates. But if you should simultaneously touch both, it's *ZAP!*, a really nasty shock: perhaps enough of a shock to stun.

Sounds like Star Wars stuff? It isn't—it's just the stored energy in a *capacitor*, the subject of this month's *Electronics Fundamentals*.

Capacitors are strange components: You can make them, but they also make themselves. Many a service technician has been bedeviled by circuit failures or other problems caused when two seemingly innocuous wires actually create a capacitor, passing signals through to what should be mutually isolated circuits.

This month's lesson should help you understand capacitance, how it's used, and the problems it can cause or cure.

The lesson uses the *programmed instruction format*, whereby the information is presented to you in "chunks" called *frames*. You will read the information in each frame and then immediately answer a question based on the material by filling in a question blank(s) with approriate words. The answer to each question is given in parenthesis at the beginning of the next frame in sequence.

As you progress through the lesson, use a piece of paper to keep the frame immediately below the one you are reading covered so that you won't accidentally see the correct answer. The easiest way to do that is to slide the paper down until it just touches the line separating the frames.

We hope you enjoy learning about electronics through programmed instruction. Please write and let us know how you like it. Start now with Frame 1.

Capacitors and Capacitance

1. A capacitor is an electronic component that stores an electrical charge. A charge is the electrical energy represented by an excess or shortage of electrons that can do some useful work. *A capacitor is used to store a(n)* ____________ ____________.

2. (electrical charge) Capacitors receive a charge from some external voltage source. That process is called charging. Then, the charge on a capacitor is consumed or used by some external component or circuit. That process is called discharging. Those operations allow the capacitor to perform useful functions. *A capacitor operates by* ____________ *and* ____________.

3. (charging, discharging) The basic physical configuration of a capacitor is two conducting plates separated by an insulator, as shown in Fig. 1. The plates can be made of any conducting material. The insulator can be air, or a vacuum, or any one of many different kinds of insulating materials. The insulating medium is called the dielectric. The schematic symbol in Fig. 2 is used to represent a capacitor. *The insulator between the two plates is called the* ____________.

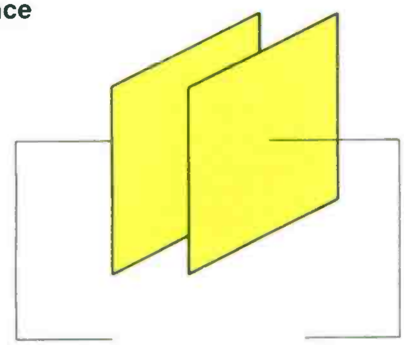


Fig .1—Two metal plates are all that are needed to fabricate a basic capacitor, whose value depends on how far apart the plates are positioned from each other.

*This article was derived from the soon-to-be published book *Crash Course in Electronics Technology* by Louis E. Frenzel, Jr. Its use is by the courtesy of the publisher, Howard W. Sams and Co. (Macmillan).

Fig. 2—This is the schematic symbol used in the U.S. to represent a capacitor. Considerable variations in the symbol are used in other countries throughout the world.

4. (dielectric) Some common dielectric materials used in typical capacitors are ceramic, oil, mica, and various kinds of plastics, such as polystyrene. Capacitors are often classified by the type of dielectric used. Now let's take a look at how a capacitor works. Refer to Fig. 3. When switch S1 is closed, the battery is connected to the capacitor. That external voltage source charges the capacitor. The positive terminal of the battery pulls the free electrons from plate 1, thus plate 1 has a

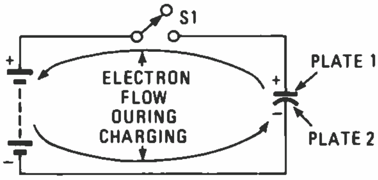


Fig. 3—Capacitors are charged by electrons flowing from a power source. In this instance, a battery is the power source.

shortage of electrons or a positive charge. The negative terminal of the battery feeds its excess of electrons to plate 2, giving it a negative charge. *A charge on a capacitor consists of a(n)* ______________ *of electrons on one plate and a(n)* ______________ *of electrons on the other.*

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5. (excess, shortage) In charging the capacitor, the number of excess electrons on plate 2 exactly equals the number of electrons missing from plate 1. That charge, designated Q, is measured in coulombs. The coulomb is a measure of the quantity of electrons in an electrical charge. One coulomb is equal to 6.28×10^{18} electrons. *The charge on a capacitor is measured in* ______________. *A coulomb represents* ______________ *electrons.*

---

7. (Coulombs 6.28×10^{18}) If the battery is disconnected from the capacitor by opening S1, the capacitor retains the charge. The positive charge on plate 1 attracts the negative charges on plate 2 through the dielectric. Remember the law of electrical charges: "Unlike charges attract, like charges repel." No electrons flow between the two plates, however, because the insulating dielectric prevents that. However, the electrons in the atoms in the dielectric are shifted out of their normally circular orbits. See Fig. 4. That shift is a stress on

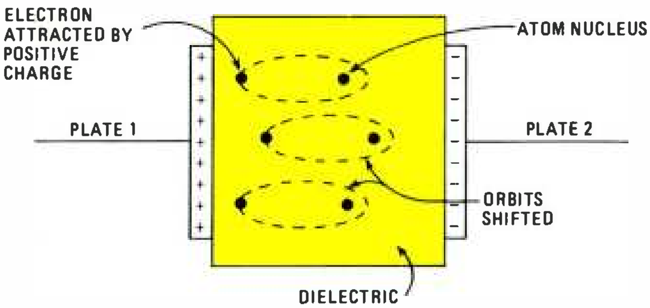

Fig. 4—The charges on a capacitor's plates attract one another and set up an electric field in the dielectric.

the dielectric. The mutual attraction of the plates and the stress in the dielectric is called an electric field. *The attraction of the charges on the capacitor's plates sets up a(n)* ______________ ______________ *in the dielectric.*

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8. (electric field) Now, assume that the external leads of the capacitor are shorted together when S2 is closed, as shown in Fig. 5. Immediately, all of the electrons on plate 2 rush through the external connection to plate 1 in an effort to neutralize the positive charge there. The excess of electrons on plate 2 cancels the charge on plate 1. Thus both plates are

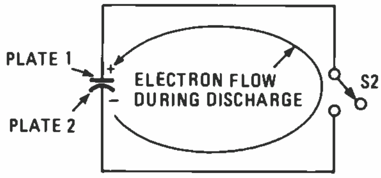


Fig. 5—When a capacitor discharges, the electron current flows from the negative plate to the positive plate.

returned to their normal uncharged condition. That process is called "discharging the capacitor." *When the charge on one plate completely neutralizes the charge on the other, the capacitor is said to be* ______________.

---

9. (discharged) The discharge process, of course, causes electron flow between the two plates through the external short. The current flows only momentarily as the charge is neutralized. Ordinarily, the discharge occurs through a resistor, as shown in Fig. 6, or through some other component or circuit. That slows the discharge process but allows some

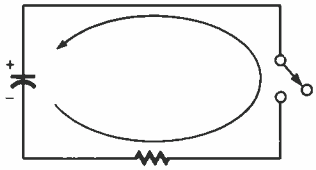


Fig. 6—If a series resistor is added to the discharge path the discharge current flows through the resistor.

control over it, as you will see. *A capacitor is usually discharged through a* ______________ *or* ______________.

---

10. (resistor, circuit) Because of the insulating dielectric in a capacitor, current does not actually flow through it. When a capacitor is connected into a DC circuit, it actually blocks the flow of current. In the circuit of Fig. 7, no current will flow through the resistor because electrons cannot pass through

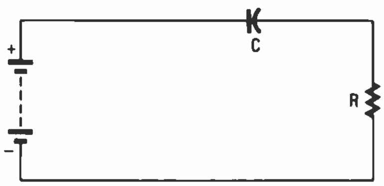


Fig. 7—The capacitor blocks the flow of DC current from the power source from passing through to the resistor.

the capacitor. A capacitor used for that purpose is called a "blocking capacitor." *A capacitor* ______________ *the flow of DC in a circuit.*

---

11. (blocks) However, while the capacitor blocks DC, electrons can flow in the circuit. That happens, of course, when DC is first applied to the circuit. At that time, the capacitor charges to the applied DC voltage. Electrons don't flow through the capacitor but will flow through the resistor momentarily during the charging process. Once the capacitor is fully charged, no further current flows. But if the capacitor discharges, electrons will flow briefly in the resistor until discharging ceases. *In a DC circuit containing a capacitor, electrons will flow momentarily during* ______________ *or* ______________.

---

12. (charging, discharging) Refer to Fig. 8. Assume that the capacitor C is initially discharged. When S1 is closed, the battery voltage is applied to the capacitor. At that instant, the charge on the capacitor (the voltage across it) is zero. But instantaneously a high current flows as electrons begin to be pulled off one plate and fed to the other.

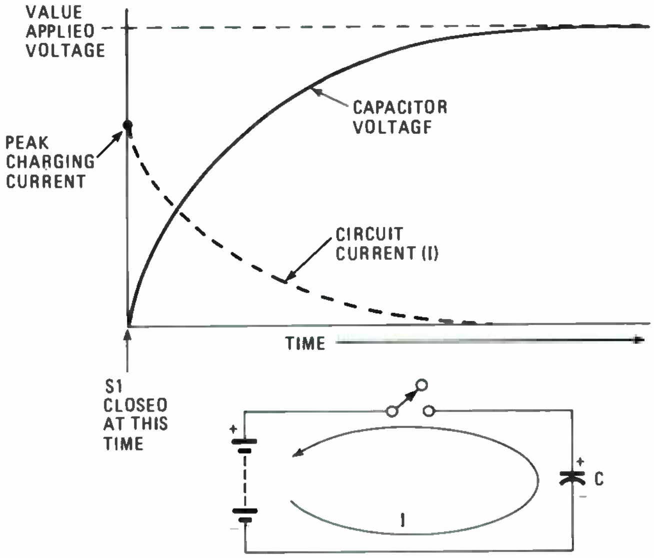


Fig. 8—The charging current for a capacitor leads the voltage, being greatest at the moment power is applied.

Now the charge on the capacitor increases. The voltage across the capacitor acts as if it, too, were a voltage source. And, in fact, its voltage will affect the current flow in the circuit. Its voltage polarity is in opposition to the source voltage. As a result, the total effective circuit voltage is the combination (algebraic sum) of the battery and capacitor voltages. As the capacitor charges, its voltage increases thereby giving more opposition to the battery voltage. With a lower overall voltage, the current decreases. *As the capacitor charges, its voltage* ______________ *the applied voltage.*

---

13. (opposes) Figure 8 shows the total effect. As the capacitor charges, its voltage increases and charging current decreases. When the capacitor is fully charged to the applied voltage, it completely cancels the battery voltage, thus the current is zero.

As you can see, the capacitor voltage opposes voltage changes in the circuit. If the battery voltage increased, the capacitor would again try to charge to this higher value. Current would flow momentarily until the capacitor voltage was equal to the battery voltage. That opposition to voltage changes shows up as an opposition to current flow which affects AC circuits. *A capacitor opposes* ______________ *changes.*

---

14. (voltage) Go to Frame 15.

Capacitors in AC Circuits

15. As you saw in Fig. 8, the capacitor voltage is zero, the charging current was maximum. When the capacitor voltage is maximum, the current is zero. That relationship holds true when an AC voltage is applied to a capacitor. Figure 9 shows a capacitive AC circuit and the current-voltage relationship.

The AC voltage source is a sinewave, which reverses its polarity every half cycle. With one polarity, the capacitor charges to the peak of the applied voltage. When the polarity reverses, the capacitor discharges, then recharges in the opposite direction to the negative peak. That process continues as long as the AC is connected. *A capacitor charges and discharges continuously when* ______________ ______________ *is applied.*

---

16. (AC voltage) Note in Fig. 9 that the current and voltage are out of phase. That is, the current and voltage do not vary in step with one another. They are shifted by 90°. We say that the current leads the applied voltage (and capacitor voltage) because its peak occurs earlier in time than the voltage. *In a capacitive circuit, the current* ______________ *the voltage by* ______________ *degrees.*

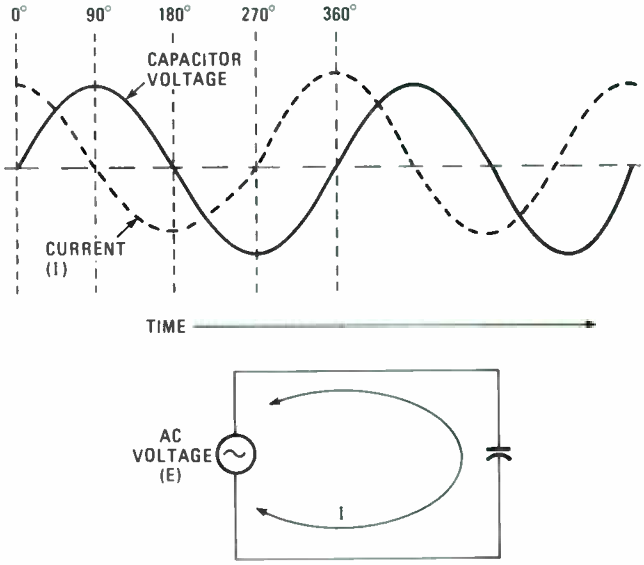


Fig. 9—When the power source is AC, the current leads the voltage by 90° throughout the entire cycle.

17. (leads, 90) Electrons do not pass through the capacitor in an AC circuit, but the continuous charging and discharging causes current to flow in the external circuit. For that reason, it appears as though alternating current flows through the capacitor. Even though it doesn't, we say that capacitors pass AC but block DC. *In an AC circuit, electrons flow through a capacitor. True or False?*

---

17. (False) Go to Frame 18.

Factors Influencing Capacitance

18. Capacitance is the ability of a capacitor to store an electrical charge. That ability is embodied in the physical characteristics of the capacitor. In other words, the capacitance depends upon the physical dimensions of the capacitor and the type of dielectric. More specifically, the capacitance is a function of the plate size, the plate spacing, and dielectric material. *The capacitance is a measure of the amount of ______ a capacitor can store.*

---

19. (charge) *The capacitance depends upon the ______ ______ of the capacitor.*

---

20. (physical characteristics) The capacitance of a capacitor is directly proportional to the area of the plates. The larger the plates, the greater the area, the higher the capacitance. For a given applied voltage (E), the larger the plates, the greater the number of free electrons available, therefore, the greater the charge (Q) and capacitance (C).

The relationship between applied voltage, charge and capacitance is expressed by the simple formula:

$$C = Q/E$$

The greater the charge for a given voltage, the larger the capacitance. *If a smaller voltage (E) produces the same charge (Q), then the capacitance is ______.*

---

22. (larger) We can rearrange the above formula to express the charge:

$$Q = CE$$

What that says is that the charge in coulombs is greater if either the capacitance, voltage or both are greater. *Decreasing C or E causes the charge to ______.*

---

23. (decrease) As we said, the larger the plate area, the greater the charge for a given voltage, which means higher capacitance. *Capacitor 1 has plates 2-in. × 2-in. and capacitor 2 has plates 3-in. × 4-in. Capacitor ______ has the smaller capacitance.*

---

24. (1) The area of capacitor 1's plates is 2 x 2 = 4 square inches. Capacitor 2 has a plate area of 3 x 4 = 12 square inches. Capacitor 1 has the lower capacitance.

One way to increase the plate area is to use multiple plates of the same size as shown in Fig. 10. The plates are connected together to multiply the area. *The greater the number of plates, the greater the area and the ______ the capacitance.*

---

25. (greater or larger) One way to make a variable capacitor is to use the multiple plate idea of Fig. 10. One set of plates is fixed while the other set is made moveable. A common way to do that is to make the plates a half circle, as shown in Fig. 11. Mount the moveable plates on a shaft that can be rotated. When the plates are meshed, they overlap with maximum area producing maximum capacitance. If the plates are unmeshed, the plate area overlap is minimum and the capacitance is minimum. Varying degrees of overlap produce intermediate values of capacitance. *When the plates are fully meshed or overlapped, C is ______.*

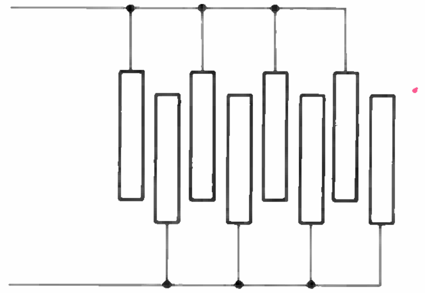


Fig. 10—The total capacitance can be increased by using multiple plates which are connected as two independent banks.

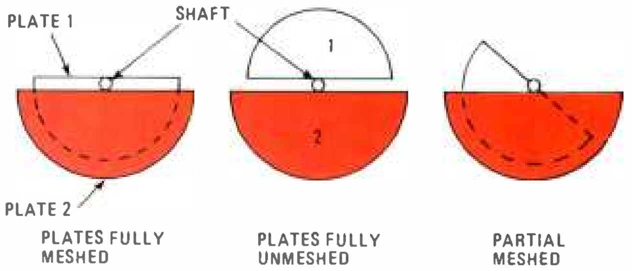


Fig. 11—Variable capacitors are really multiple-plate capacitors having user-determined plate-mesh.

26. (maximum) Plate spacing also affects the amount of capacitance: The closer the spacing, the greater the capacitance. If the plates are very close together, the charge on the plates puts greater stress on the dielectric. A smaller voltage can produce a larger charge, the closer the plates. That, of course, means that C is greater. *Moving the plates of a capacitor farther apart causes the capacitance to ______.*

---

27. (decrease) The thickness of the dielectric material determines the plate spacing in most capacitors.

The dielectric material also determines the capacitance. Some types of materials are better at supporting an electric field than others. That is, the orbiting electrons in the atoms are more easily distorted by the charged plates. That represents a greater capacitance. A number called the dielectric constant tells which materials better increase the capacitance. Air or a vacuum has a dielectric constant of 1. Other typical dielectric constants are listed in Fig. 12. *The higher the dielectric constant, the ______ the capacitance.*

DIELECTRIC CONSTANTS FOR VARIOUS MATERIALS

Insulator	Dielectric Constant
Ceramics	80-1200
Glass	8
Mica	3-8
Oil	2-5
Paper	2-6
Plastic Film	2-3

Fig. 12—These are the dielectric constants for common insulating materials that are used in capacitors.

---

28. (greater) *Based on Fig. 12, ______ di-*

electric will produce the greatest C.

---

29. (ceramic) To achieve very high values of capacitance, the plates can be placed extremely close together. One way to do that is to use the process of electrolysis to form a super thin insulating layer between two plates. The result is called an electrolytic capacitor.

Electrolysis is the process of changing the chemical composition of a material by passing current through it.

A typical electrolytic capacitor has two aluminum plates separated by a thin, gauze-like material that is soaked in an electrolyte, a material that will cause a chemical reaction when current flows in it. When a DC voltage is applied, the electrolyte reacts with the aluminum on the positive plate, causing a very thin layer of aluminum oxide to be formed. That is the dielectric. It has a dielectric constant of about 7. The gauze forms the negative plate which contacts the other aluminum plate to which a lead will be connected. The result is a very high value capacitance. *A high value capacitor created by chemical action is called a(n) ______________ capacitor.*

---

30. (electrolytic) Electrolytics are widely used in electronic circuits because they pack a high capacitance in a small space. Their main limitation is that they are polarized. That is, they must be connected into a circuit so that the applied voltage maintains the polarity originally used to create the dielectric. If the wrong polarity is used, a reverse chemical reaction takes place. That causes heat and gas to be developed internally and the capacitor will be damaged or may even explode. Electrolytics have their leads marked + and − so that the proper connections can be made. *Electrolytic capacitors are ______________.*

---

31. (polarized) The dielectric and its thickness (plate spacing) also determine how much voltage can be applied to a capacitor without the dielectric breaking down so that arcing occurs. Arcing means the dielectric breaks down and electrons flow between the plates. Dielectric strength is the measure of a dielectric to withstand a high voltage. All dielectrics will break down at some upper-voltage level. The closer the plates or the thinner the dielectric, the lower the breakdown voltage. *When a dielectric breaks down, arcing occurs and ______________ flow in the dielectric.*

---

32. (electrons) Some dielectrics resist breakdown better than others. That dielectric strength does not affect capacitance but it does set the upper voltage rating of the capacitor. Common voltage ratings range between 10 volts and tens of thousands of volts. *The voltage rating of a capacitor is set by the ______________ ______________ ______________ ______________.*

---

33. (dielectric strength, plate spacing or dielectric thickness). Go to Frame 34.

Units of Capacitance

34. The unit of capacitance is the farad. That is, the amount of capacitance is measured in farads. A farad is the capacitance when one volt will produce a charge of one coulomb (6.25×10^{18} electrons). *Capacitance is expressed in a unit called the ______________.*

---

35. (farad) A farad is a very large capacitance. In practice, few—if any—capacitors that large are ever used. Most common capacitors are measured in smaller units called microfarads and picofarads. A microfarad is one millionth (1/1,000,000) of a farad. A picofarad is even smaller. It is one millionth of a microfarad or one trillionth (1/1,000,000,000,000) of a farad. Very small indeed. *Most practical capacitors have values measured in ______________ or ______________.*

---

36. (microfarads, picofarads) You will see farad abbreviated as F, microfarad as µF and picofarad as pF. Some typical values are .001 µF and 220 pF.

When making computations with capacitor values, you will often need to convert between the various units. Most electronics formulas containing capacitance (C) require the value to be in farads. You will need to convert microfarads or picofarads to farads. An easy way to do that is to use the table in Fig. 13.

FIGURE 13
CAPACITIVE UNITS CONVERSION TABLE

To Convert	To	Then
F	µF	× by 1,000,000
F	pF	× by 1,000,000,000,000
µF	F	÷ by 1,000,000
µF	pF	× by 1,000,000
pF	µF	÷ by 1,000,000
pF	F	÷ 1,000,000,000,000

Fig. 13—To convert to or from smaller units of capacitance, multiply by the appropriate factor.

For example, to convert 50 µF to F all you do is divide 50 by 1,000,000 to get .00005 F. *2.2 µF is the same as ______________ F.*

---

37. (.0000022) *A value of .00012 F is equal to ______________ µF.*

---

38. (120) *750 pF expressed in F is ______________*

---

39. (.00000000075) *750 pF expressed in µF is ______________.*

---

40. (.00075) *1000 µF is the same as ______________ pF.*

---

41. (1,000,000,000) The multiplication and division are easy, but be careful where you put the decimal point. Go to frame 42.

Capacitors in Series and Parallel

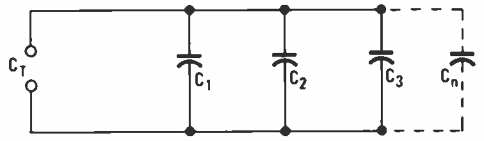
42. Capacitors are sometimes connected in various series or parallel combinations to achieve some special effect. The total capacitance of such combinations is easy to compute if the individual capacitor values are known.

Figure 14 shows capacitors connected in parallel. The total capacitance of that combination (C_T) is simply the sum of the individual capacitances:

$$C_T = C1 + C2 + C3 + \dots Cn$$

If C1 = .002 μF, C2 = 680 pF and C3 = 27 pF, then what is C_T?

First, before you can add up the different values, you have



$C_T = C_1 + C_2 + C_3 + \dots\dots C_n$

Fig. 14—The total value of capacitors in parallel is calculated the same as for resistors in series.

to convert all values to the same units, pF or μF. So we convert .002 μF to pF by multiplying by 1,000,000 to get 2000 pF.

Now, we can add up the individual values:

$$C_T = 2000 + 680 + 27 = 2707 \text{ pF}$$

The total capacitance of a .047 μF capacitor in parallel with a .0015 μF capacitor is ____________ μF.

---

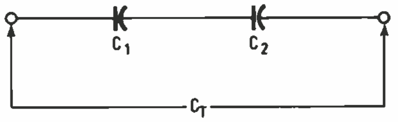
43. (.0485) When capacitors are connected in series as shown in Fig. 15, the total capacitance is computed using the formula:

$$C_T = (C1 \times C2)/(C1 + C2)$$

If C1 = 200 pF and C2 = 300 pF, then the total of the combination is:

$$C_T = (200 \times 300)/(200 + 300)$$
$$C_T = 60000/500 = 120 \text{ pF}$$

If two 100 pF capacitors are connected in series, the total capacitance is ____________ pF.



$$C_T = \frac{C_1 \times C_2}{C_1 + C_2}$$

Fig. 15—Capacitors in series are calculated the same way as you would calculate the total value for resistors in parallel.

44. (50) Actually, any time that the series capacitors are equal, you can just divide the value of one by the number in series to get the total value. For example, if three .0015 μF capacitors are connected in series, the total capacitance is:

$$C_T = .0015/3 = .0005 \text{ μF}$$

If the capacitors in series are different values, you use the formula given earlier. Here's an example. Three capacitors are connected in series: C1 = 6 pF, C2 = 9 pF, C3 = 10 pF. What is the total?

First, using the formula find the equivalent of C1 and C2 in series, or C1-2.

$$C1\text{-}2 = (6 \times 9)/(6 + 9) = 54/15 = 3.6 \text{ pF}$$

Now, combine C1-2 with C3 to get C_T.

$$C_T = (3.6 \times 10)/(3.6 + 10) = 36/13.6 = 2.65 \text{ pF}$$

The total capacitance of three capacitors C1 = 3 pF, C2 = 5 pF, and C3 = 7 pF is ____________ pF.

---

45. (1.49) A key point to note here is that the total capacitance of series capacitors is always less than the smallest value in the combination. Go to frame 46.

Capacitive Reactance

46. Capacitive reactance (X_C) is the opposition a capacitor offers to alternating current. That opposition comes from the capacitor's reluctance to charge and discharge quickly as the applied AC voltage varies. Like resistance, capacitive reactance is measured in ohms. *Capacitive reactance is a(n) ____________ to AC and is measured in ____________.*

---

47. (opposition, ohms) Two factors affect how much opposition a capacitor offers to AC, capacitance and frequency. As either the capacitance (C) or frequency (f) is increased, X_C decreases. *If either f or C decreases, X_C ____________.*

---

48. (increases) Figure 16 shows how X_C varies with changes in f or C.

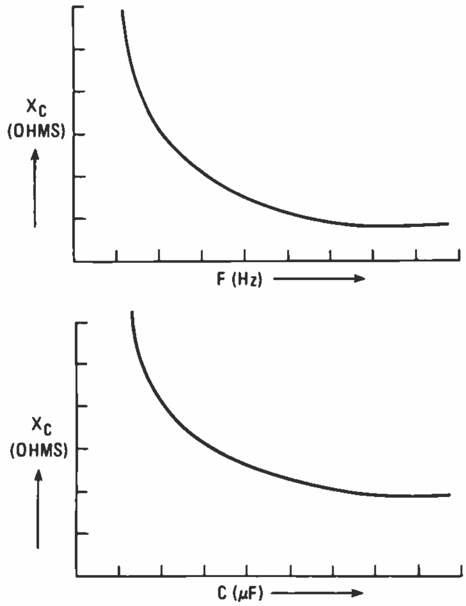


Fig. 16—Capacitive reactance (X_C) decreases with frequency and capacity. The higher the frequency and the higher the capacity the lower the reactance.

Figure 17A shows an AC generator operating a light bulb. *Figure 17B shows the same bulb and generator but with a capacitor added in series. With this arrangement, the bulb is:*

A. brighter
B. dimmer

C. the same

49. (B. dimmer) The capacitor adds opposition, capacitive reactance, so the current is less and the bulb glows dimmer. Some of the generator voltage is dropped across the capacitor.

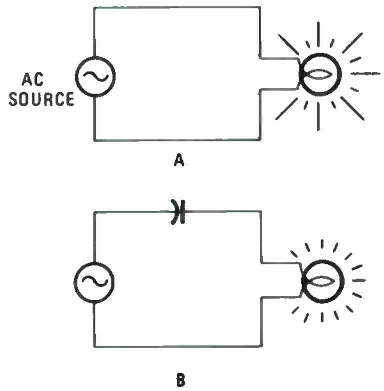


Fig. 17—Inserting capacitive reactance in a series circuit will reduce the current flowing in the circuit.

In Figure 17B, if the value of the capacitor is increased, the bulb will be:

A. brighter
B. dimmer
C. the same

---

50. (A. brighter) If the capacitance is increased, the capacitive reactance decreases. With less opposition, the current is greater so the bulb is brighter.

Capacitive reactance is computed with the formula:

$$X_C = 1/6.28fC = .159/fC$$

X_C is in ohms, C is in farads and f is in Hz (cycles per second). Here's an example: What is the X_C of a .1 µF capacitor at 60 Hz? We first have to express C in farads. .1 µF is .0000001 F.

$$X_C = .159/60(.0000001)$$
$$X_C = 26500 \text{ ohms or } 26.5 \text{ kohms } (k = 1000)$$

If the frequency in the above problem is doubled, the X_C is ______________ ohms.

---

51. (13250) Doubling frequency to 120 Hz halves the opposition.

Since most calculations involve capacitor values in µF or pF and frequencies in kHz or MHz, the X_C formula can be rewritten to simplify calculations. Here is another version that is convenient to use on a calculator:

$$X_C = 159/fC$$

where f is in kHz and C is in µF, or where f is in MHz and C is in pF. *The X_C of a 22 pF capacitor at 8 MHz is ______________ ohms.*

---

52. (.903) You can use algebra to rearrange the formula to compute f or C if X_C is known:

$$f = 159/X_C C$$
$$C = 159/X_C f$$

For example, what size capacitor will give you 10 ohms at 3.5 MHz?

$$C = 159/10(3.5)$$
$$C = 159/35 = 4.54 \text{ pf}$$

The frequency at which a .001 mF capacitor will have X_C = 200 ohms is ______________ kHz.

---

53. (795) Go to frame 54.

Impedance

54. Capacitors usually appear in circuits with other components, such as resis.ors. In such cases, both the capacitor and the resistor offer opposition to current flow. That total opposition is called impedance. It is expressed in ohms.

Figure 18 shows a circuit containing a resistor and a capacitor in series. The impedance Z is computed with the formula:

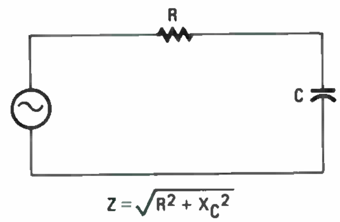


Fig. 18—The total opposition to current flow in a series circuit is called the impedance, indicated by the letter Z.

$$Z = \sqrt{R^2 + X_C^2}$$

For example, if R = 10 and X_C = 8, then Z is:

$$Z = \sqrt{10^2 + 8^2}$$
$$Z = \sqrt{100 + 64}$$
$$Z = \sqrt{164}$$
$$Z = 12.81$$

The impedance of a circuit of R = 12 and X_C = 9 is ______________ ohms.

---

55. (15) The impedance formula is simply a variation of Pythagoream theorem for computing right triangles. The right triangle in Fig. 19 is used to show the relationship between R, X_C and Z. R is the horizontal leg, X_C is the

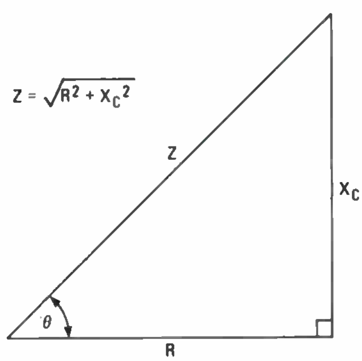


Fig. 19—This is what is known as an "impedance triangle." The impedance is a value other than that of either the reactance or the resistance, or their simple addition.

vertical leg, and Z is the hypotenuse. The angle θ (theta) is the phase shift between current and applied voltage. Remember that in a purely resistive circuit, the current and voltage are in phase (0° phase shift). In a circuit containing only capacitance, the current leads the voltage by 90°. In a circuit with both resistance and capacitance, the phase shift is between 0° and 90° depending upon the values of R, C and f.

The basic impedance formula can be rearranged to calculate either R or X_C.

$$R = \sqrt{Z^2 - X_C^2}$$

$$X_C = \sqrt{Z^2 - R^2}$$

If Z = 256 and R = 128, X_C = ______ ohms.

---

56. (221.7) Go to Frame 57.

Capacitors in DC Circuits

57. A capacitor blocks the flow of direct current. However, remember that current flows when a capacitor charges or discharges. This can be useful in various kinds of timing and control applications. With no resistance in the circuit, the capacitor charges instantaneously with the applied voltage. Shorting C causes it to discharge instantaneously. But realistically, there is some resistance in all circuits. Because of that resistance, it takes a finite amount of time for the capacitor to charge or discharge. *When a capacitor charges or discharges, ______ flows in a DC circuit.*

---

58. (current) The time that it takes for a capacitor to charge or discharge depends upon the values of R and C in the circuit. Refer to Fig. 20. That relationship is known as the

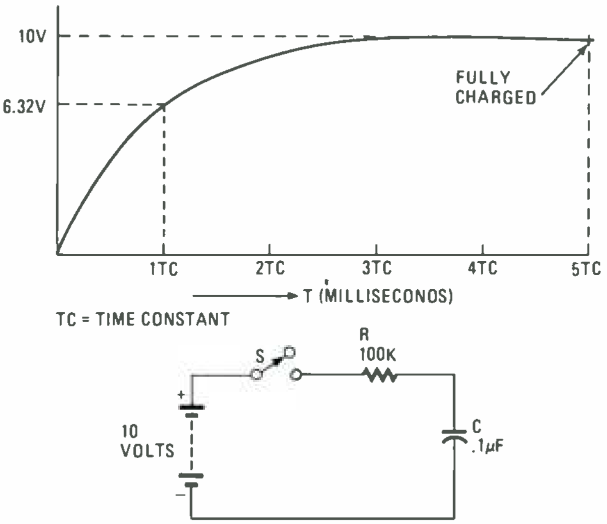


Fig. 20—A charging capacitor requires five time-constants to reach full charge: equal to the applied circuit voltage.

time constant (TC), which is the product of R and C.

$$TC = RC$$

The time constant is the time it takes for a capacitor to charge to 63.2% of the applied voltage. In Fig. 20, the time constant is:

$$TC = 100{,}000 \times .1 \times 10^{-6}$$

$$TC = .01 \text{ seconds, or } 10 \text{ milliseconds}$$

That means that it takes 10 milliseconds for C to charge to 6.32 volts. *It takes ______ seconds for a 20 mF capacitor to charge to ______ volts through a 2 megohm resistor with a 50 volt supply.*

---

59. (40, 31.6) It takes five time constants for the capacitor to fully charge to the applied voltage. For example, in the example above, it takes 5 x 40 = 200 seconds for the capacitor to charge to 50 volts. *It takes ______ milliseconds for the capacitor in Fig. 20 to charge to 10 volts.*

---

60. (50) Time constant also applies to discharging. It takes one time constant for a previously charged capacitor to discharge to 36.8% of the original charge. Refer to Fig. 21.

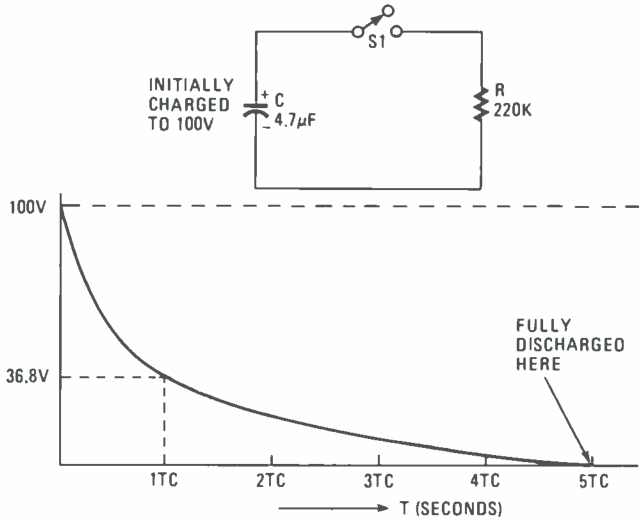


Fig. 21—A discharging capacitor requires five time-constants for its stored charge to fall to zero.

Assume C is charged to 100 volts. When S1 is closed, C will discharge through R. The time constant is:

$$TC = RC$$

$$TC = 100{,}000 \times 4.7 \times 10^{-6}$$

$$TC = 1.034 \text{ second}$$

In just a little over a second, C will discharge to 36.8 volts. *If the original charge is 30 volts in the above example, the time constant will be ______ seconds and the capacitor will discharge to ______ volts in that time.*

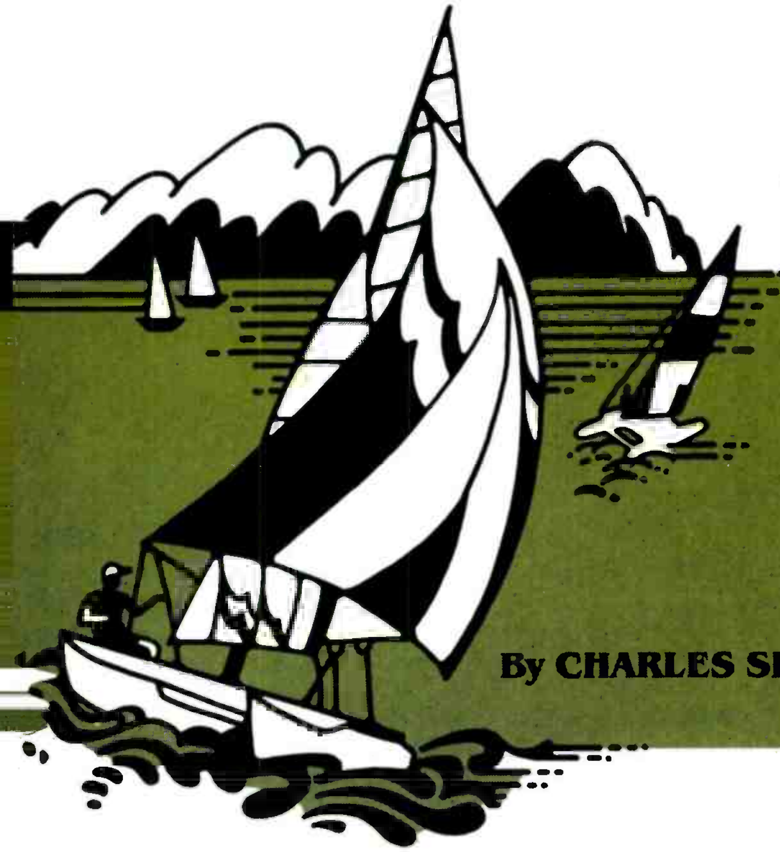
---

61. (1.034, 11.04) The time constant is the same since it is not affected by the applied voltage. Time constant is strictly a function of the R and C values. But, with a different applied voltage, C will discharge to a different value in the same time.

It takes five time constants for the capacitor to fully discharge to zero. See Fig. 21. *In the example above, the capacitor will take ______ seconds to fully discharge.*

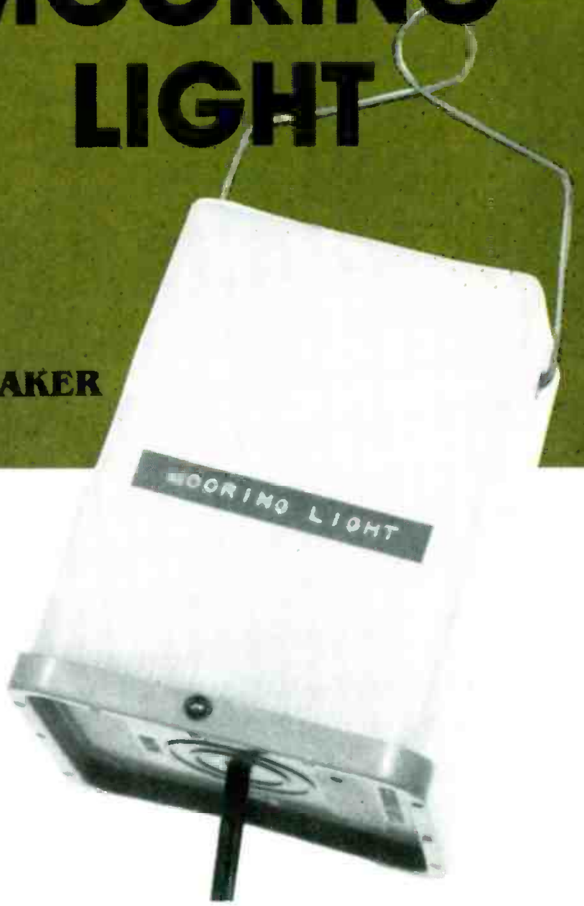
---

62. (5.17) The charging and discharging action of a capacitor is widely used in producing a variety of useful effects, such as producing delays and controlling time intervals. ■



AUTOMATIC MOORING LIGHT

By CHARLES SHOEMAKER



This mooring light knows when to turn itself on and off.

AN AUTOMATIC MOORING LIGHT THAT TURNS ON AT NIGHT and off during the day is necessary for all boats anchored in navigable waters. While you can always purchase an expensive light having bright, shining, brass, you can easily build an inexpensive version using commonly available parts and scrap material that you're likely to have lying around.

The housing itself can be a clear plastic bottle, such as those sold at pharmacies, or it can be a quart-size plastic freezer container from your local supermarket (they provide a larger reflective surface.) We used an Arnoldware Rogers, Catalog No. 132 Freezer Box because it has a stiff lid that snaps firmly in place, thereby making a secure connection between the box and the lid. Also, the box has striated sides, which gives good light diffusion.

The mooring-light circuit shown in Fig. 1 will operate from a 6- to 12-volt-DC power source: the model shown uses a 12-volt storage battery for a longer seasonal life.

To ensure a constant light output, the 12-volt power source is regulated to 5 volts by U2, a three-terminal regulator. That is a distinct advantage compared to a non-regulated supply voltage, which would produce a diminishing light output coincident with a decrease in source voltage.

How The Circuit Works

Integrated-circuit U1—an LF351 or 741 op-amp—is used as a comparator to control the light. Resistors R2 and R3 provide a reference voltage of about 2.5 volts at pin 3 of U1. When daylight falls on light-dependent resistor LDR1, its resistance is low: about 1000 ohms. In darkness, the LDR's resistance rises to about 1-megohm. Since R1 is 100,000 ohms, and the LDR in daylight is 1000 ohms, the voltage-dividing ratio is 100 to 1; the voltage drop across the LDR is less than the 2.5 volt reference voltage and pin 2 of U1 is held at that voltage. In that state, the output at pin 6 of U1 is positive at about 4.5 volts, a value that reverse-biases Q1 to cutoff, which in turn holds Q2 in cutoff, thereby keeping lamp I1 *off*.

When darkness falls, the LDR's resistance rises above R1's value and the voltage at pin 2 of U1 rises above the reference voltage of 2.5 volts. U1's output terminal (pin 6) falls to less than a volt and Q1 is biased on. The base-to-emitter current flow turns Q2 on, which causes current to flow through the lamp.

When daylight arrives, the LDR's resistance falls sharply, which causes the lamp to be turned off, ready to repeat the next night/day cycle.

A Substitute

If desired for some reason, a photo-transistor can be substituted for the LDR. Use an NPN type, and be sure that the photo-transistor's collector connects to R1. (The photo-transistor's base connection isn't used.) When light strikes the photo transistor it is biased on and will saturate, dropping most of the supply voltage across R1; hence, the voltage at U1 pin 2 will be below the reference voltage and the lamp will be off. In darkness, the photo-transistor is cut off and the collec-

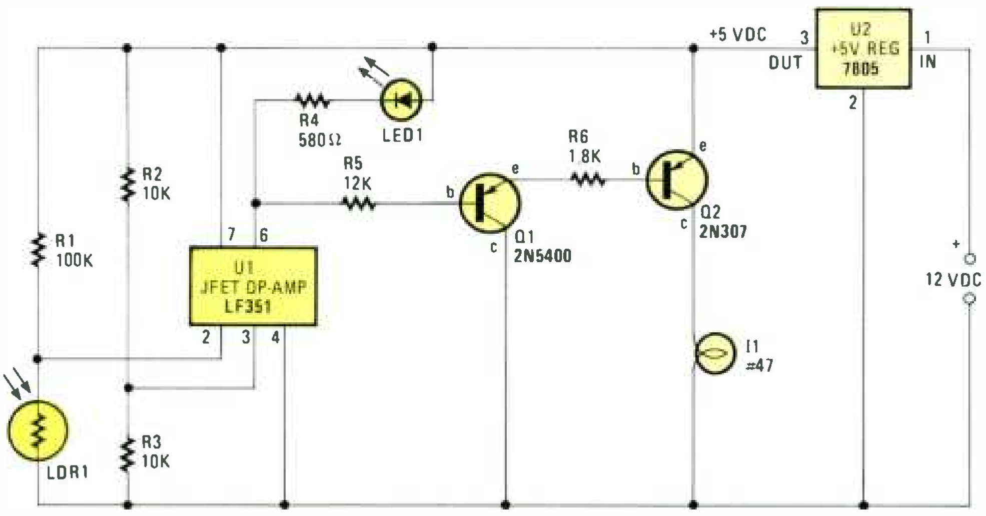


Fig. 1—Most "general replacement"-type components can be used, so try whatever you have in the junkbox.

tor rises to about 5 volts, that is well above the reference voltage, so the light goes on. If you wish to observe that change with a voltmeter, use a model with a very-high input impedance—such as a DVM—to prevent circuit loading.

Some Interesting Parameters

Lamp I1 is is a #47 "pilot lamp" rated 6.3 volts at 150 mA (.15 A). It is operated in a slightly starved state at 4.8 volts and 110 mA, which produces a somewhat reduced brightness. Although the difference in brightness is difficult to distinguish with the human eye, under that operating condition the life of the lamp is sharply increased.

The circuit functions at 5 volts/135 mA, of which 110 mA is used for the lamp. The LED, which is in the circuit to monitor the action of U1 in case of lamp faliure, draws 2.2 mA. U2, the 5-volt regulator, uses approximately 7 mA.

Q2's base current is approximately 3.75 mA, which comes from Q1. The gain, or *Beta*, of Q1 is 200, which means that the base current of Q1 (base-to-emitter path) is .0000187 mA or 18.7 microamperes. The standby current during daylight hours is 7 mA, which is a negligible drain on the battery.

You can see that the total current for U1 is well within the capability of the op-amp.

A wide variety of signal and power PNP transistors can be used in the circuit: At worst, you'll need to tweak only the values of R5 and R6. However, it might be necessary to place a heatsink on Q2, because it will get warm with a 110 mA current drain.

For example, we assembled several versions on a *Proto board* in order to try several "surplus"-type transistors. In one instance, a Motorola SPS1129 signal-type transistor and an older RCA SC7305 power transistor were used. The circuit worked with values shown on the schematic, but the light was not as bright because of reduced voltage (3.7 volts) across the lamp. Resistor R6 was changed to 680 ohms to produce approximately 4.8 volts across the lamp. Keep in mind that for maximum lamp brilliance, you should get as close as possible to the regulated 5 volts.

Power Consumption.

You can determine the operating power-rate use of the circuit by dividing the battery's AH (Ampere Hour) rating by the AH rate of the circuit for a 24-hour period. For example, assume that the light is on for 10 hours: The AH rate is 10 × .135, or 1.35 for the night period. The day standby current of .007 for 14 hours produces an AH of .098 during daylight hours. If we combine both of those, we have a 1.448 AH in a 24-hour period. If the AH rating of the 12-volt storage battery is 60, we divide it by 1.448 (or 60/1.5) and we have 40 days of operation before a battery recharge is necessary.

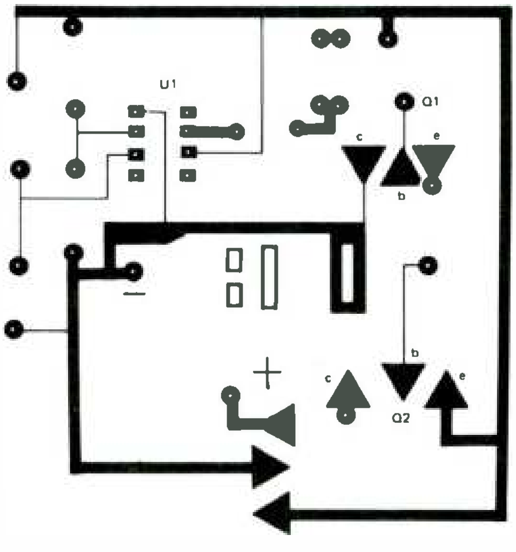


Fig. 2—This full-size printed-circuit template will fit in just about any kind of suitable freezer-type container.

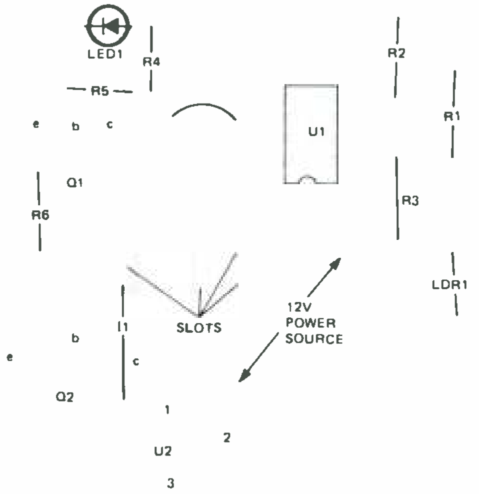


Fig. 3—Make sure that you install U1 correctly. The slots are used to mount the lamp holder and provide relief for the power wire.

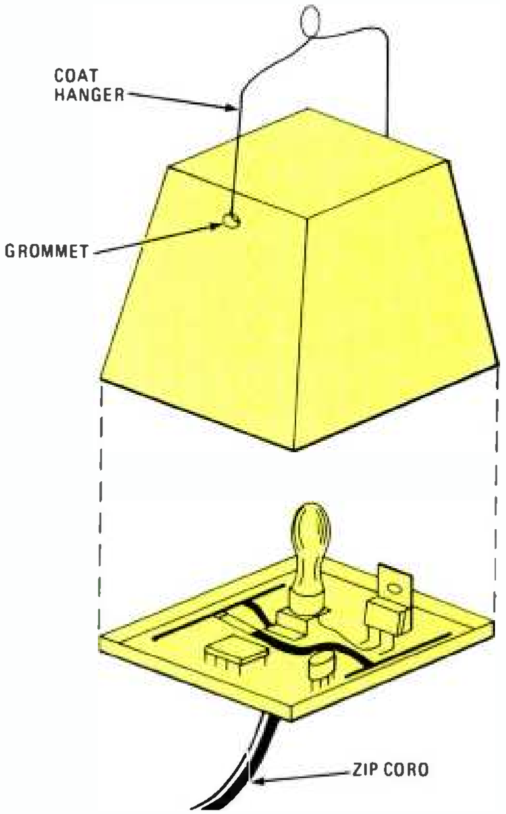


Fig. 4—An ordinary wire coat hanger, shaped to fit, makes an excellent mounting bracket. Form a loop at the top of the bracket wire so that the light can be hung from a lanyard or a rope.

Design Considerations

The printed-circuit board must be sized to fit within the selected case. If the project is assembled in a freezer container, the printed-circuit board must fit inside the lid as shown in Fig. 4. We provide a template for a printed-circuit board that will fit just about any convenient-size container.

The LDR must be positioned to read the natural light, but not the light from the lamp, else feedback will shut down the light. In the freezer-container package, the LDR is placed on the underside of the lid. Some LDR's will sense light from the back. If that happens, place black material on the back.

A good way to shield the LDR from lamp I1 is to install the LDR on the bottom of the printed-circuit board, tack-soldering its leads to the copper foils. All kinds of apertures can be designed to restrict the natural light to the LDR (for additional control).

Drill small holes in the lid's edges so that water running down the sides can drain away without contaminating the circuit board. Another way to protect the circuit is to waterproof the container by taping the lid-to-case joint.

The Printed Circuit

Several slots are indicated on the printed-circuit board's template. One slot is used to mount the lamp holder; the remaining slots are a loop-through for the power wires so that any strain on the wires is passed on to the board rather than to the solder connections. The mooring light shown uses conventional *zip* cord for the power wires. If you use *zip* cord, keep in mind that some kinds are polarized by different-color leads or a fabric tracer strand. Other wires aren't polarized. If the wire you use isn't polarized, take extreme care that you get the negative and positive battery connections correct. The best bet is to check the wires with a continuity tester and mark the wires yourself.

All components are mounted on the non-foil side of the printed-circuit board except for the LDR, which is the last component installed: It is mounted last on the foil side of the board because it will project through the lid, facing away from the lamp. You will need to drill a hole through the lid so that the LDR will project through when the board is finally mounted to the lid.

Because the LDR will be facing down, natural light to the LDR will be reflective rather than direct. That is preferred to direct sunlight.

The *zip* cord power wires extend through the center of the lid and downward toward the boat, thereby keeping the container upright and balanced. An automotive-type two-wire molded connector can be used for making connection to the storage battery. We suggest installing an in-line fuse.

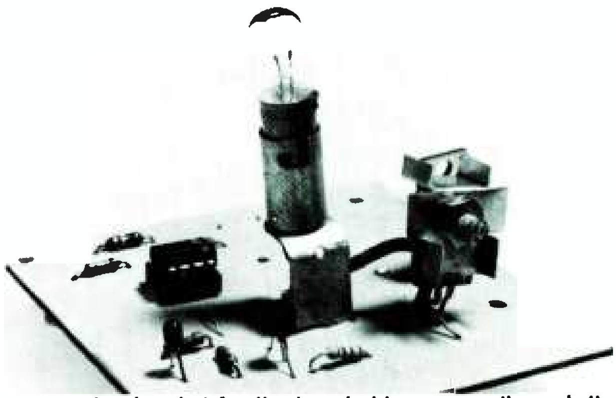
A gimbal-type mounting bracket can be shaped from an ordinary wire coat hanger. Fashion a loop at the top of the bracket so that the lamp can be suspended by a rope. ■

PARTS LIST FOR AUTOMATIC MOORING LIGHT

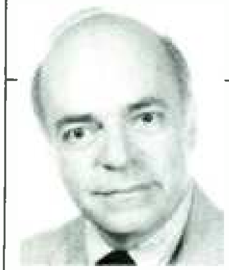
SEMICONDUCTORS
LDR1—Light dependent resistor, see text
LED1—Miniature light-emitting diode
Q1—2N5400 PNP transistor
Q2—2N307 PNP power transistor
U1—LF351 or 741 op-amp
U2—7805, 5-volt regulator

RESISTORS
(Resistors ½-watt, 10%)
R1—100,000-ohm
R2, R3—10,000-ohm
R4—580-ohm
R5—12,000-ohm
R6—1800-ohm

ADDITIONAL PARTS AND MATERIALS
I1—#47 lamp
Holder for #47 lamp
Printed-circuit materials
Container (see text)
Wire, solder



The mounting bracket for the lampholder passes through the larger slot in the printed- circuit board and is soldered to the foil pad surrounding the slot. It provides one of the two connections to the lamp. Notice the small heat sink secured to the transistor immediately to the right of the lampholder. You can make it yourself from a piece of scrap metal.



By Marc Ellis

ELLIS ON ANTIQUE RADIO

Vacuum-tube Round-up: Battery Types

THIS COLUMN WILL BE THE FIRST IN AN ongoing series, covering vacuum tubes—starting with some of the earliest. We'll discuss the tube-types that you're most likely to come across in your collecting activities. That means we'll be concentrating on American-made, receiving tubes dating back to the time that they first began to be mass-produced for home broadcast sets. So don't expect to find source material on the DeForest Audion, the Fleming valve, or other such rarities!

Conversely, we couldn't even begin to cover every common tube that you might encounter. Far too many different types were produced, and a complete discussion of them would be beyond the scope of a column such as this. What we can do is to review the major categories of tubes, touching on the major design developments that will help you understand—and date—the tubes that you find and the sets that you find them in.

Early Storage Battery Tubes

Our story begins in the year 1920. World War I was barely over, and the technological advances it had sparked—including those relating to the radio art—were just beginning to find their way into civilian life. The broadcast industry had not yet come into being and, for the most part, the airwaves were dominated by amateur, military, press, marine, and various types of business communications.

At that time, direct current was universally used to light tube filaments. Nobody had yet found a way to use alternating current without introducing a strong AC hum into the signal. The most convenient source of low-voltage direct current for powering receiving-tube filaments was the automobile-type storage battery, and it was widely used for that purpose.

Late in December of 1920, the newly-formed RCA Company offered for sale its first two receiving-tube types. Their manufacture was made possible by a landmark cross-licensing agreement concluded earlier that year by the major tube-patent holders, allowing the sharing of critical technology. The two three-element (triode) tubes were designated UV-200 (a detector) and UV-201 (an amplifier). The tubes were similar, except that the UV-200 contained a small amount of argon gas to make it more sensitive in its application. Both contained tungsten filaments designed to operate on 5 volts at 1 ampere.

An operating voltage of 5 was chosen so that the tube could be effectively powered from a 6-volt storage battery even after the battery was partly exhausted. Control rheostats were provided to cut down the 6-volt output of a fresh battery to the proper value; they could be readjusted to keep the filament voltage fairly constant as the battery became depleted.

Though the tubes were effective for their day, their 1-ampere filament-current drain proved to be quite a drawback. Operating time between battery recharges was quite limited—particularly for multi-tube sets. That situation was significantly improved in 1923 with the release of the UV-201-A (by GE).

The new tube was identical to the UV-201 except that, combined in its tungsten filament, was a small amount of the element thorium. The new design provided greatly increased filament emission—so much so, in fact, that the tube could perform efficiently with a filament rating of 5 volts at 0.25 amperes.

Not long after its introduction, the UV-201-A was to become the most widely used tube in American broadcast receivers. It held that distinction until near the end of the decade, when the emergence of AC operated receivers led to the development of new tube types.

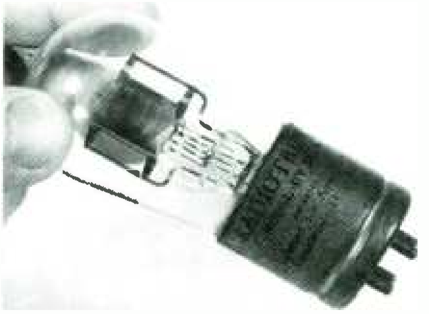
Nomenclature and Tube Basing

The nomenclature used for those early post-war tubes included a prefix containing one or two letters followed by a three-digit number. Neither the prefix nor the first digit of the number were unique to the tube type. They were often arbitrarily assigned by the manufacturer to serve as a sort of trade designation. The specific tube type was indicated by the last two digits in the number. For example the UV-201, marketed by RCA, and the C-301, marketed by Cunningham, were identical tubes.

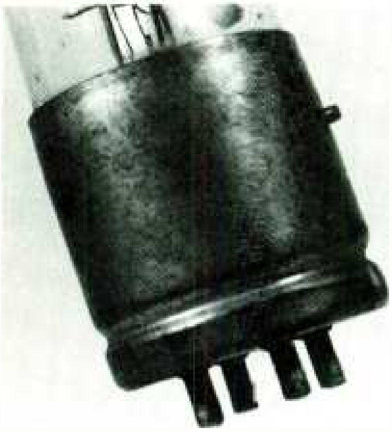
However, RCA's prefix letters eventually came to be used generically to rep-

Early Exide ad shows automobile-type storage battery used to light filaments of the first commonly available receiving tubes.

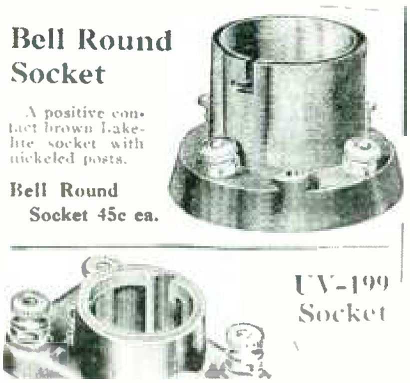
The filament-voltage rheostat (center knob) was standard equipment on early battery-powered sets.



The UV-201 was one of the first two receiving tube types produced by RCA.



Close-up of UV-style base shows horizontal *locating pin* and four stubby contact pins.



Sockets for UV-style bases as depicted in a 1925 ad. Upper socket was for standard base; lower socket was for scaled-down version as used in '99-style tubes.

A '01-A-type tube with UX-style base. Elongated contact pins slip into mating socket holes.

resent the tube's base style. All of the original "00," "01," and "01A" tubes, regardless of manufacturer, had the same standard UV-type base. The base had four stubby contact pins at the bottom, and a small horizontal *locating pin* extending from the side. Through the use of that locating pin, the tube was properly positioned in its socket and bayonet-locked (similar to an auto tail-light lamp) so that its contact pins were firmly pressed against the socket's spring contacts.

In 1925, the UX style replaced the UV as the standard tube base. Where the UV base had four stubby contacts, the UX style had four elongated pins. The pins slid into mating holes in the matching socket, which contained contact springs that firmly grabbed the pins. The new sockets provided more dependable electrical connections to the tubes, took up less room, and were probably cheaper to manufacture.

The horizontal locating pin from the UV base was retained in the UX version. But it was dropped to a lower position so that the longer-pin UX base could still be bayonet-locked into the UV-style socket. Hence, the new UX-201-A tubes could be used as replacements in sets designed for UV-201-A's.

Early Dry-Cell Tubes

GE released a second new tube type along with the UV-201-A in 1923. Called the UV-199, it was intended for use with dry-cell batteries rather than automobile-type storage batteries. Because of the lighter-weight, less-bulky batteries, sets using the UV-199 could be moved around more easily and even be made in portable styles.

The UV-199 filament (which, like that of the UV-201-A, was made of thoriated tungsten) was rated at 3.3 volts, .06 amperes. It was typically lit by three series-connected dry cells. A rheostat was used to reduce the 4.5 volts delivered by the dry cells to the value needed by the tubes. The rheostat setting was changed to compensate as the dry-cells' voltage decreased with age.

The UV base used on the 199 tube was identical in design with that used on the UV-201-A. But it was scaled down in size to match the smaller bulb used on the 199. When UX bases were introduced in 1925, the 199 was also provided with one. However, a UX base of standard dimension was used rather than a special scaled-down version.

Those of you who've acquired multiple-tube sets using UX-199's may have noticed that the audio output socket is occupied by a tube designated UX-120. Almost identical to the UX-199 in appearance, the UX-120 was designed to have greater power-handling capability so it could deliver more volume to the loudspeaker.

The UX-120, which appeared in 1925, had a filament-voltage rating identical to that of the UX-199, but also had a higher filament current and maximum plate voltage. To prevent them from being confused with UX-199's, many UX-120's bore

Close-up of UX-style base. The horizontal locking pin of the UV-type base was retained, allowing UX tubes to be used in older UX sockets.

stickers carrying the warning: USE IN FINAL AUDIO SOCKET ONLY.

Another very interesting dry-cell tube was introduced in 1922 by Westinghouse. The WD-11, as it was called, had a filament rating of 1.1-volts at 0.2 amperes. That meant that it could be operated from a single dry cell. Such efficient performance was made possible, in part, because the filament was oxide-coated rather than thoriated. Oxide-coated designs would eventually completely replace thoriated designs for the filaments of battery-operated tubes.

The WD-11 had a unique 4-pin base. It was a long-pin rather than a bayonet-mount style—similar to the UX-type that would become standard in 1925. But instead of having two *fat* pins to ensure proper orientation in the socket, the WD-11 had one—the plate connection. So far as I know, that base style is unique. I've never seen it on any other type of tube commonly found in antique radios. A year after its release, the WD-11 was made available in a new version having the then-standard UV-type base. That made it possible to convert older sets with standard sockets to single dry-cell operation. The re-based version of the WD-11 was known as the WD-12.

Next Installment

Look for this column next month for another installment of *Vacuum Tube Roundup*. We'll talk about some of the tubes that were developed for the first *plug-in* sets, and discuss some of the physical characteristics that you can use to roughly date your early tubes. In the meantime, as always, I'd like to hear from you. Contact Marc Ellis, C/O **Hands-On Electronics**, 500-B Bi-County Blvd., Farmingdale, NY 11735. ■

By Charles D. Rakes

CIRCUIT CIRCUS

Signal and electrostatic detection using low-cost components

THIS MONTH I REACHED OUT TO TWO knowledgeable experts in the field of science and scientific investigation to aid me in bringing you the following specialized circuits that deal with electronic investigation and detection. In doing so, it's only proper to introduce those two distinguished gentlemen—the Honorable Professor H. V. Goodmeasure, PUD, of Hexrod University, and the renowned Master Detective, Sir Shedrock McBones, Esq., of Snoop International, Inc.—who've been so helpful in this and past projects. So if any good and honorable deeds come from using any of the circuits herewithin the credit must go to those two men.

The first circuit was suggested to me by Sir McBones, Esq., and was similar to the one he used to locate the misplaced satellite downed in the far cold north that, had it remained undiscovered, could have deactivated all of the flying reindeer in the region. Since the search area was so near to Santa's workshop and corral, it's easy to see the seriousness of the problem...but not to worry, McBones solved the case in short order and all flew well.

RF Path Finder

The circuit shown in Fig. 1, uses four different semiconductors to make up a sensitive *RF Sniffer* that's designed to locate lost or unauthorized transmitters or other sources of interfering RF energy. The Sniffer circuit responds to RF signals from below the standard broadcast band to well over 500 MHz, and provides a visual and audible indication when a signal is received. The circuit is designed to receive low-powered signals as well as strong sources of energy by adjusting the bias on the pick-up diode, D1, with R2. A very sensitive setting can be obtained by carefully adjusting R2 until the LED just begins to light and a faint sound is produced by the Piezo sounder.

A small piece of perfboard is a good choice to build the circuit on; just keep the leads on the front-end parts—D1, C1, C2, L1, R1, and R2—as short as possible, and use a good wiring scheme for the remaining circuitry. A small metal cabinet can be used to house the circuit and give an added degree of stability when used around

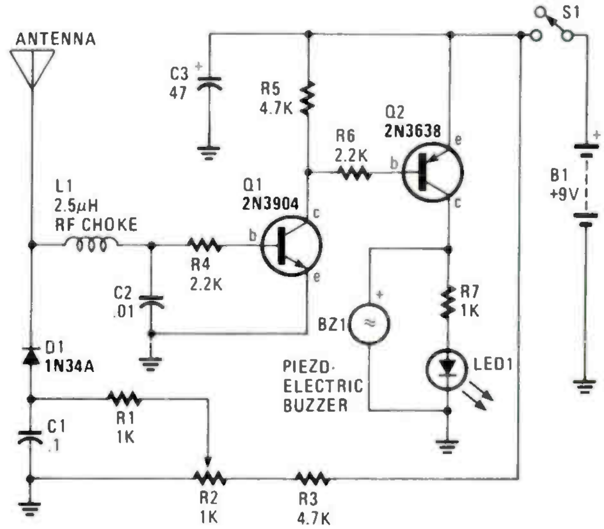


Fig. 1—The RF Sniffer locates transmitters or other sources of interfering RF energy by detecting RF from below the standard broadcast band to well over 500 MHz.

PARTS LIST FOR THE RF SNIFFER (FIG. 1)

B1—9-volt transistor radio battery.
BZ1—Piezo-electric buzzer (Radio Shack #273-065 or similar)
C1—0.1-µF, ceramic disc capacitor
C2—0.01-µF, ceramic disc capacitor
C3—47-µF, 16-WVDC electrolytic capacitor
D1—1N34A germanium signal diode
L1—2.5-µh RF choke (most any similar size will work)
LED1—Jumbo light-emitting diode
Q1—2N3904 NPN silicon transistor
Q2—2N3638 PNP silicon transistor
R1—1500-ohm, ¼-watt resistor
R2—1000-ohm, potentiometer
R3, R5—4700-ohm, ¼-watt resistor
R4, R6—2200-ohm, ¼-watt resistor
R7—1000-ohm, ¼-watt resistor
S1—Single-pole, single-throw (SPST) toggle switch
Misc: Telescoping antenna (20 to 26-inches long), perfboard, cabinet, wire, hardware, solder, etc.

high RF-signal sources; even though our Sniffer performed just fine without a metal case.

If a room or area is to be swept for a hidden low-power transmitter, set the sensitivity of the Sniffer to its maximum setting and extend the antenna to its full length.

Electrostatic Detector

The circuit offered in Fig. 2 (an FET Electroscope) is an exact copy of the one used by the Professor to seek out and discharge the dastardly *Staticman* that was only a single spark away from destroying a major semiconductor manufacturer located in that famous *Germanium Valley*.

Comb your hair and shuffle your feet, while waving your hand near the circuit's pick-up, and the meter will flip and flop indicating an *air* of charging static. One practical use for such a circuit is to test for static charges on tools, soldering irons, our hands, etc., when working with sensitive semiconductors that are very shy of anything that sparks.

The very heart of the Electroscope is the two junction field-effect transistors (JFET), Q1 and Q2, which are connected in a balanced-bridge circuit. The gate in-

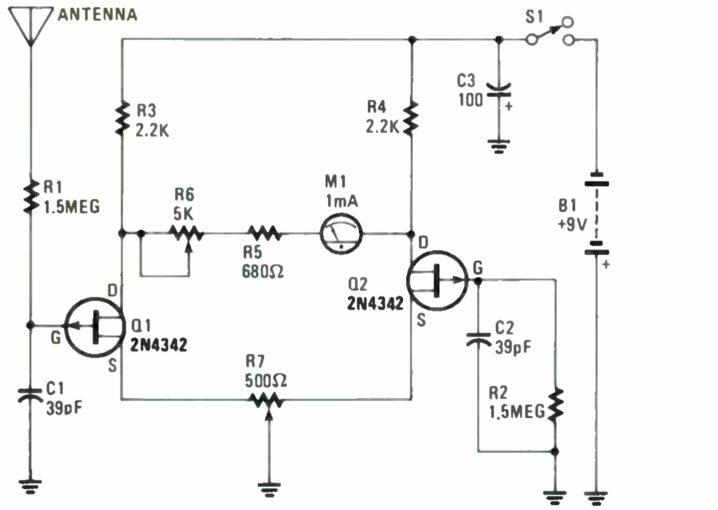


Fig. 2—The FET Electroscope, which can be used to detect electrostatic charges, is based on a dual JFET balanced bridge circuit), with Q1's gate to a wire pick-up.

PARTS LIST FOR THE STATIC DETECTOR (FIG. 2)

B1—9-volt transistor radio battery
C1, C2—39-pF, ceramic disc capacitor
C3—100-µF, 16-WVDC electrolytic capacitor
M1—0–1-mA current meter
Q1, Q2—2N4342 (or similar) P-channel junction field-effect transistor (JFET)
R1, R2—1.5-megohm, ½ or ¼-watt resistor
R3, R4—2200-ohm, ¼-watt resistor
R5—680-ohm, ¼-watt resistor
R6—5000-ohm, potentiometer
R7—500-ohm, potentiometer
S1—Single-pole, single-throw (SPST) toggle switch
Misc: Antenna, 6-inch length of # 12 solid-copper (or similar); wire, cabinet, perfboard, wire, hardware, solder, etc.

put of Q1 is connected to the wire pick-up (antenna), while Q2's gate is tied to the circuit's common ground through R2. That type of bridge circuit offers excellent temperature stability; thereby, allowing Q1 to operate in an open-gate configuration. Potentiometer R7 is used to balance the bridge circuit, and R6 sets the maximum meter swing. Capacitors C1 and C2 help to reduce the 60-Hz pickup and adds to the short-term stability of the circuit.

Use a good quality section of perfboard to mount the parts on, as a porous or damp board material will not work at all for this circuit. The pickup wire can be as long as you want, but if the circuit is to be used in an area where RF or 60 Hz is at a high level, a short pick-up wire of 1 to 6 inches works best. Experiment to find the best circuit sensitivity.

Caution: If you expect to use the circuit more than one time, *do not* let static discharge directly into the circuit's pick-up.

Electronic Stethoscope

A few years ago when the US and Iran were on more friendly terms, our two consultants worked together to solve a major international case for the Shah. The Minister of Wheels and Movement was at his wit's end in trying to locate a *ticking* sound in the Shah's favorite Rolls.

The circuit shown in Fig. 3 is an updated version of the one used by the famous twosome in pin-pointing the tick and saving the day—unfortunately, the quiet and tranquil times did not prevail. A special vibration pickup and an LM324 quad op-amp work together to produce a super-sensitive electronic Stethoscope. Op-amps U1a and U1d of the LM324 are used to better match the impedance of the input and output circuits (U1b and U1c provides gain for the pickup).

The secret to the success of the circuit is in the construction of the special pickup. A small 1-½-inch, 8-ohm speaker, a new penny, and one of mom's sewing needles is all that's required to duplicate our pickup. Stand the needle up in a perpendicular position on the center of the new penny and solder in place. A word of caution is in order: Watch that needle, it stabs without warning. So be careful.

(Continued on page 107)

PARTS LIST FOR THE ELECTRONIC STETHOSCOPE (FIG. 3)

B1—9-volt transistor radio-type battery
C1, C2—330-µF, 16-WVDC electrolytic capacitor
C3, C4—4.7-µF, 16-WVDC electrolytic capacitor
C5—0.1-µF, mylar capacitor
J1—Normally-open phono jack
R1–R3—1000-ohm ¼-watt resistor
R4, R5—100,000-ohm, ¼-watt resistor
R6—4700-ohm, ¼-watt resistor
R7—5000-ohm potentiometer
S1—Single-pole, single-throw (SPST) toggle switch
SPKR1—1-½-inch, 8-ohm mini-speaker modified for vibration pickup only (see text)
U1—LM324 quad-op-amp, integrated circuit
Misc: Headphones 2000-ohms or better, cabinet, perfboard, sewing needle, copper penny, wire, solder, etc.

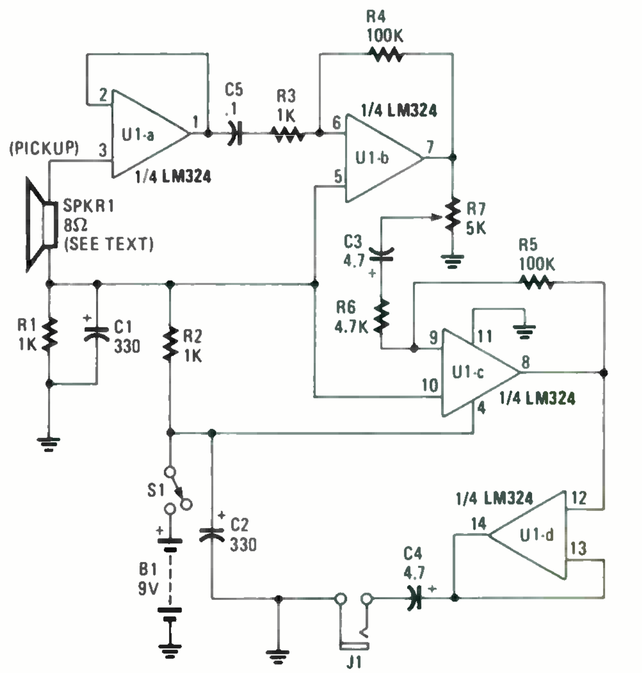


Fig. 3—The Electronic Stethoscope circuit consists of a special vibration pickup (made from a small 8-ohm speaker, a new penny, and one of mom's sewing needles (see text for details), and an LM324 quad op-amp.

By Marc Saxon

SAXON ON SCANNERS

Ever wonder what ever happened to Cobra—the CB people?

THOSE WHOSE HERITAGE IN COMMUNICATIONS extends back to they heyday of CB radio will surely know the name Cobra, a company known throughout the land as purveyors of fine transceivers. Even after the bloom was off the CB rose, Cobra remained as one of the few major manufacturers to continue (to this day) producing fine CB equipment.

Cobra has also, I'm happy to report, entered into the growing scanner marketplace. Recently the company introduced several interesting scanners that are most worthy of your consideration.

Cobra's top of the line scanner is the Model SR-925—a programmable desktop 16-channel job with 12-band coverage and eight operational modes. It features an eight-digit LCD display for frequency and channel readouts, plus five status indicators in a highly-styled gray console with telescoping antenna. It has switchable scanning speeds (16 or 5 channels per second), plus instant access for NOAA weather broadcasts. An internal four-hour memory back-up retains channel memories during power outages. This unit carries a $259.95 price tag.

CIRCLE 81 ON FREE INFORMATION CARD

Cobra's SR-925 programmable desk-top scanner features 16 channels with 12 band coverage and eight optional modes; an 8-digit LCD display, five status indicators, switchable scanning speeds, instant access for NOAA weather broadcast, all crammed into a gray console with telescoping antenna, and priced at $259.95.

The Cobra Model SR-12 premium hand-held scanner is geared to sell at $299.95 (suggested retail). It offers nine-band coverage and 16 user-programmable memories. The rugged unit (only 3" by 7") features a multi-function, backlit (eight-digit) LCD display that's used for channel and frequency readout, and status indicators.

The SR-12 incorporates eight operational modes, including normal scan, selective scan delay, priority, channel lockouts, auto search, frequency limit, channel hold, and manual selection. The unit has a 30-minute internal memory back-up. Standard accessories include six AA rechargeable nickel-cadmium batteries, AC adaptor/battery charger, earphone, rubberized antenna, and carrying case. More information on the SR-12 and SR-925 can be obtained from Cobra Consumer Electronics Group, Dynascan Corporation, 6500 West Cortland Street, Chicago, IL 60635.

A Mystery Voice

Scanner owners in the area of St. Petersburg, FL were recently alarmed when odd and unexplained transmissions began appearing on the local police dispatching channel. It sounded as though several people were planning or executing a burglary, and the transmissions continued for several hours each day for several days. It was so bad that the police had to switch over to an alternate frequency just to pass their messages!

Of course, they were busily trying to locate the source of the mysterious transmissions, not knowing if they were "real" or a deliberate hoax, intended to jam law-enforcement communications. At first, the police thought that someone had stolen one of their radios, but a check of their units showed that all had been accounted for. When the mystery voice (or voices) mentioned Ohio cities, police agencies there were checked to see if any of their radios were missing. None reported missing radios. Police came to believe it was someone clowning around.

Then one night, during the height of the mystery transmissions, Brevard County sheriff's deputies stopped a rented car whose driver was *yacking* away on a radio as it passed them while they were inspecting a disabled vehicle. What made them suspicious was a voice that came over their sheriff's frequency announcing, "Look at those two cops on Badcock Street playing with their flashlights. It sure looks like they're looking for something."

Inside the car was their suspect, accompanied by no less than *two* transmitters (which the operator was hurriedly trying to de-program), and a newspaper story about the mystery voice. The suspect turned out to be 25 years old, a bouncer in a Cincinnati bar who was on vacation in Florida. The suspect's father, who was on vacation with him, told police that his son had been interested in radios for many years and had built his first set when he was only 13 years old.

After the arrest, St. Petersburg police received calls from three different Ohio police departments because they had had a series of similar hoax transmissions on

(Continued on page 107)

By Don Jensen

JENSEN ON DX'ING

SWL lets you hear more than just chit-chat!

"*CINCO-UNO-OCHO-CERO,*" THE mechanical-sounding voice drones. In Spanish, the woman announcer is stringing out a series of numerals—5-1-8-0. "*Cuatro-seis-dos-siete;*" more numbers. You may have stumbled across one or more of those so-called *numbers stations* on shortwave and wondered what was up.

Since the 1950's at least, many SWL's have puzzled over those strange-sounding transmissions. And, while listener research has provided some answers over the years, much remains a mystery. Those operations have been dubbed *spy stations* by some SWL's; and the best evidence available suggests that the name usually is appropriate!

It appears that most of the numbers transmissions on shortwave do involve clandestine, coded communications directed to espionage agents of one sort or another, of varying nationalities and ideologies. In short, it seems that such communications are used by both *them* and *us*.

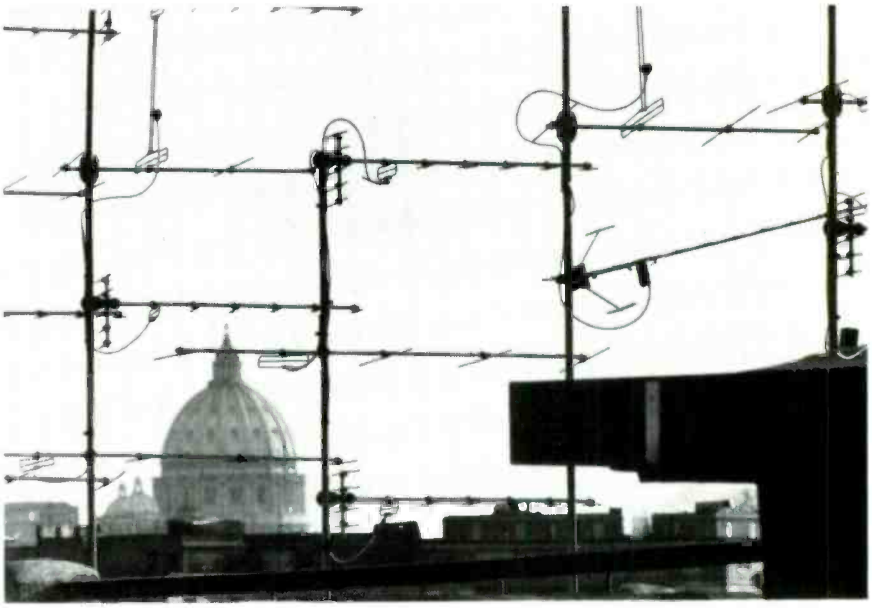
Most of the transmissions heard by North American SWL's are in the Spanish language, but signals in both English and German are not uncommon. There are occasional reports of other languages being used too; Czech and other eastern European tongues, for example, and even Korean and Chinese.

There are exceptions to every rule. Not all numbers stations broadcast numbers; sometimes the message is made up of phonetic letters. There are odd tones and bits of music involved, and sometimes even a gypsy fiddler. But the majority of those transmissions—particularly those in Spanish—consist of groups of numbers, either four-digit or five-digit series. Most, too, are sent in normal AM-mode transmission, though some SSB (single sideband) can be heard.

If those messages are indeed coded, can a clever amateur with a flair for cryptology decipher them? Not likely, according to the experts. Even the National Security Agency's electronic Puzzle Palace with its jumbo computers hasn't much chance to break the code.

The reason is that the coded communications apparently rely on so-called one-time pads. Cryptographic messages can be broken when repeated use of a system establishes patterns. Codes used once, then discarded, make the technique well niegh impregnable. To get the message, you've got to have the key and (so goes the theory) only sender and receiver have it.

So numbers-station fans have turned their attention to the transmissions themselves.



Through this geometric pattern of RAI UHF antennas can be seen a rooftop panorama of the Eternal City, Rome.

From Whence Do They Originate?

Over the years, radio direction finding techniques have turned up some interesting information. At least some of the five-digit Spanish numbers transmissions are originating from Cuba. And a goodly number of the four-number airings seem to be broadcast from a U. S. Army facility in Virginia, not far from the nation's capital. Others originate from Puerto Rico and southern Florida. And East Germany appears to be a point of origin for some numbers signals in English and German.

Over a quarter century ago, an American serviceman tried on espionage charges as a Soviet spy, confessed he received his instructions while serving at a Montana military base by listening to such transmissions on a relatively simple shortwave set.

Much more recently, Nicaragua has contended that the U. S. Central Intelligence Agency is sending numerically-coded messages by shortwave to agents in Central America, even citing one of the commonly-heard frequencies, 9,074 kHz.

SWL's may find numbers transmissions at any time of the day or night, but the North American evening hours will probably be the most rewarding.

What frequencies? They've turned up all over the shortwave bands, but here are some spots to watch: 3,050–3,090; 5,800–5,820; 6,500–6,520; 6,800–6,900; 8,050–8,150; 9,460–9,465; 10,010–10,020; and 11,530–11,550 kHz.

Station Profile

The chirping of a bird gives way to the announcement: "This is the Italian Radio and Television Service calling from *(Continued on page 105)*

By Herb Friedman

FRIEDMAN ON COMPUTERS

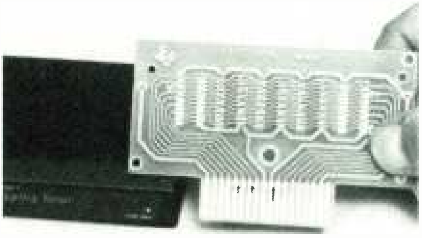
Do gadgets and gizmos really have any value?

FOR MANY YEARS I HAVE HAD A GOOD friend who is what one would call *conservative* because he is unwilling to risk squandering the family fortune on any new fad, hobby, venture, or whatever. Rather than going for broke—becoming either a millionaire or a pauper—he is content with being *extremely well off*. He's gotten the ranch with an in-ground pool and the two Mercedes in the garage by selling gadgets and gizmos.

When quality cameras came into vogue he sold camera handles, lens caps, filters, flash mounts, special pens to write on glossy photographs—products which did no real good, but no real harm either.

When we went through the Citizens Radio craze, he was out there selling REACT and Emergency stickers, power mikes, SWR and modulation meters by the carload; and more bottom-, center-, and top-loaded antennas than there were licensed CB'ers. Again, the world would have been just as well off without any of those so-called *accessories*, but more often than not they did no harm.

Now he has struck it rich again in personal computing, because he can come up with a *must have* accessory for almost every conceivable purpose, although his *biggies* are maintenance accessories. For example, a popular seller is contact-cleaner for plug-in ROM cartridges (see photos). Almost without exception, excluding the very early computers, which used solder-coated cable-connector contacts—that oxidized into an insulation coating—all modern connectors are either gold-plated or tinned copper.



Finger-contacts on ROM cartridges and other connectors are usually gold- or tin-plated and are designed to have self-cleaning, self-wiping contacts.

The modern stuff is self-wiping; meaning that should they ever become intermittent due to some sort of film coating (which is almost never), they are best cleaned by simply removing and re-installing the plug. The self-wiping action, as the contacts slide against each other, cleans the contacts.

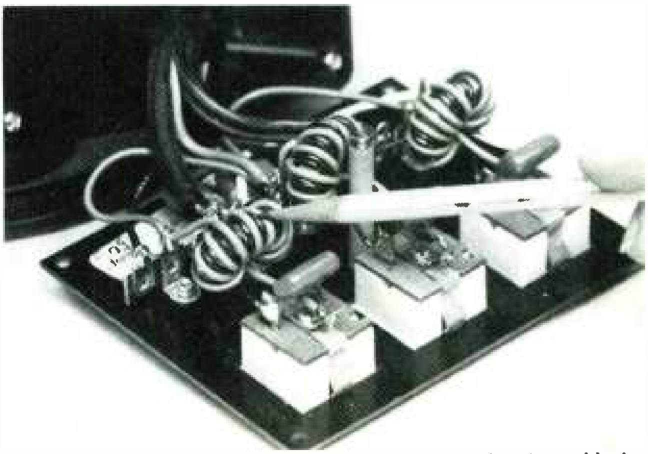
Another useless but popular gizmo, particularly for *hackers* who are constantly experimenting with their computers is a *ground bracelet* (see photos). Although you should be grounded when working on a computer, to prevent static build-up in your body from zapping CMOS semiconductor devices, there's no need to spend, $20, $10, or even $5 for a *ground bracelet*.

All you need is a length of insulated wire in series with a 1-megohm resistor and an alligator clip. You connect the free end of the wire to ground—say, the nearest grounded electrical box or a water pipe (no, the little finger-stop on a telephone dial is not grounded)—and clip the alligator clip to the metal buckle of your watchband. If your watchband is all leather or fabric (as in the photos), simply apply the clip so that part of it is between the strap and your skin, and make certain that the clip stays in place.

If there's a possibility that the metal strap can come in contact with a computer circuit, causing damage to the circuit or injury to you, simply cover the clip with a length of adhesive tape. What's the reason for the 1-megohm resistor? So that you don't unwittingly come face-to-face with your maker. If the computer system's ground should open (some computers don't even have a linecord ground), and a short should develop that makes the chassis or common connection *hot* to AC, you will get one heck of a shock—a possible killer across the chest—if you're in contact with the chassis when you ground yourself. (That's true even of 100%-insulation bracelets; the kind that usually cost almost $30.)

(Continued on page 108)

The buckle of your watchband becomes a ground bracelet when it's connected to a ground wire through an alligator clip.



Small toroid-wound filter chokes will stop just about any kind of power line RFI from getting in to or out of a computer.

By Joseph J. Carr

CARR ON HAM RADIO

Phasing Vertical Antennas

THE VERTICAL ANTENNA IS A PERENnial favorite with hams, especially those who lack either the finances or space to erect a three-element tri-bander (with 40-meter expansion kit, of course) on a 50-foot tower. The vertical however, is either praised or cussed depending upon the luck of the owner, or to be more precise, on whether he installed it properly or hoped to get away with a minimum effort by doing a quick-and-dirty installation.

In a future article we will discuss the proper installation of verticals, but for this month let's look at another problem attributed to vertical antennas.

It's Omnidirectional

For some users, a major problem with vertical antennas is that they are omnidirectional; that is, they transmit and receive equally in all directions. While some people complain that this pattern dissipates their power, and gives them a weaker signal "out where it counts," the main disadvantage of the omnidirectional pattern is noise-pickup.

There are two kinds of noise: QRN and QRM. QRN is natural noise from thunderstorms and other sources. QRM is man-made noise: It manifests itself as interference from undesired stations or "jamming." All forms of noise, however, have one thing in common: they are directional with respect to the amateur station. In other words, if you could null signals coming from the direction of the noise source (or undesired station), you would be able to better hear the desired station.

Although some amateurs think that the effective radiated power (ERP) increase that the directional antenna gives them is the real reason to own one, the main benefit is often for receiving. Think about it for a moment. Under certain circumstances—as when a signal is booming in at 40-over-9—the increase or decrease in signal strength due to the directivity of the antenna results in a minimal difference at the receiver...especially during good conditions. If we rotate the directional pattern to null out interference, then we usually find that the change in the perceived signal strength is minimal (and the S-meter reading of the desired station is minimally affected), but the amplitude of the interference source plopped down a lot! The overall effect is an apparent increase in the received signal, even though the S-meter tells a slightly different story.

So how does the user of a vertical antenna get the benefit of directivity without the kilobuck investment a beam or quad costs? The usual solution is to use phased verticals. AM broadcast stations with more than one tower are using that type of system (although for different reasons than hams). The idea is to place two or more antennas in close proximity and feed them at specific phase angles to produce a desired radiation pattern. A lot of material is available in the literature on phased vertical antenna systems, and it is far too much to be reproduced here. There are "standard patterns" dating from before World War II that are created with different spacings and different phase angles of feed current. In this article, we will consider only one system.

Half-wavelength Spacing

Figure 1 shows the patterns for a pair of quarter-wavelength vertical antennas spaced a half wavelength (180°) apart. There are basically two phasings that are easily obtained: 0° (antennas fed in-phase) and 180° (antennas fed out of phase). When the two antennas (A and B) are fed in-phase with equal currents, the radiation pattern (shown somewhat idealized here) is a bi-directional "figure-8" that is directional perpendicular to the line between the two antennas. A sharp null exists along the line of centers (A-B).

When the antennas are fed out of phase by 180°, the pattern rotates 90-degrees (quarter-way around the compass) and now exhibits directivity along the line of centers (A-B). (Fig. 1B.) The interference-canceling null is now perpendicular to line A-B.

It should be apparent that we can select our directivity by selecting the phase angle of the feed currents in the two antennas. Figures 2 and 3 show the two feeding systems usually cited in books for in-phase (Fig. 2) and out-of-phase (Fig. 3) systems. In Fig. 2, we have the coax from the transmitter coming to a coaxial Tee-

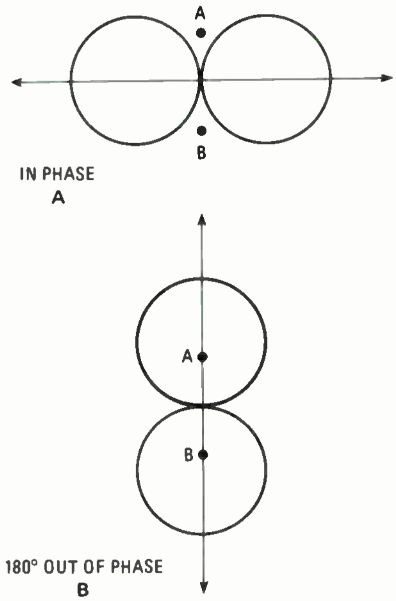


Fig. 1—If A and B are vertical antennas, the radiation pattern can be rotated 90° by simply feeding one antenna 180° out of phase.

connector. From the connector to the antenna feedpoints are two identical lengths of coax (L1 and L2). Given the variation between coaxial cables, I suspect that it would work better if the two cables were not merely the same length (L1 = L2), but came from the same roll!

The second variation, shown in Fig. 3, produces a 180° phase shift between antenna A and antenna B when length L3 is an electrical half-wavelength. Unfortunately, Fig. 3 has a feed problem because of the coax cable's *velocity factor* (VF), which is the fraction of the speed of light at which signals in the cable propagate. The VF is a decimal fraction on the order of 0.66 to 0.82, depending upon the type of coax used. Unfortunately, the physical spacing between A and B is a real half wavelength (L3 = 492/F), while the cable length is shorter by the velocity factor: L3 = ((VF) × 492)/F.

For example. A 15-meter phased vertical antenna system will have two 11-foot radiators spaced 22-feet apart (approx-

(Continued on page 105)

*Joe Carr, K4IPV, can be reached at POB 1099, Falls Church, VA 22041; he would like to have your comments and suggestions for this column.

3-DIGIT COUNTER

(Continued from page 78)

When the time-base clock returns to "0," the Counter Module Clock Input (tab 7) is enabled and the count sequence repeats.

An alternate time-base and an adequate power supply is shown in Fig. 6. The power supply can be used to power all experiments with the module.

This time-base derives it's clock pulses from the AC line frequency as interrupted DC at the 60-Hz rate. The waveform is shaped by the 2 inverters connected as a Schmitt trigger. This 60-Hz pulse train is divided by 5 by the 1st 4017 to give an output of 100 millisecond (10 Hertz), and a further division by 10 by the following 4017 gives an output of 1 second (1 Hertz).

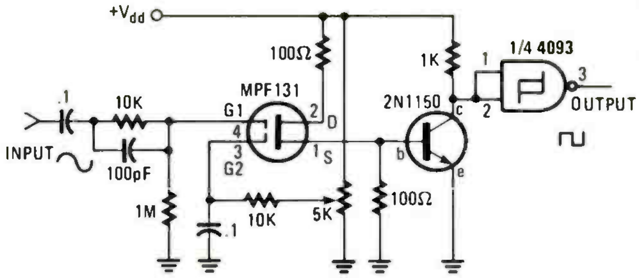


Fig. 10—The above signal preconditioning and shaping circuit whips the irregular pulse of a clock or pushbutton input into clearly-defined square pulses.

Up/Down Clocking

The 4029 Clock and Up/Down inputs are used directly in most applications. That is, the up/down terminal (tab 13 on E1, Fig. 1) is either tied to V_{dd} (high) or V_{ss} (low). In applications where the Clock Up and Clock Down are provided as separate signals, conversion to the 4029 Clock and Up/Down input can be realized by the application of the circuit in Fig. 11.

The 4029 (Fig. 1) changes count on positive transitions of Clock Up or Clock Down inputs. For the gate configuration shown in Fig. 11, when counting up, the Clock Down input must be maintained high, and conversely, when counting down the Clock Up input must be maintained high.

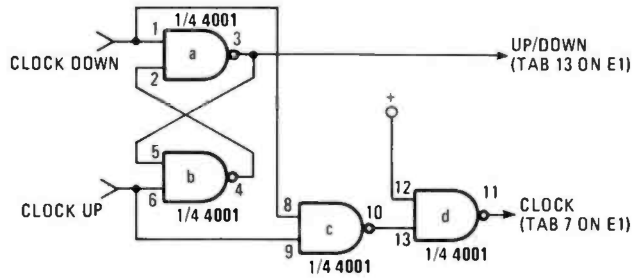


Fig. 11—Should there be a reason to reverse the signal count, such as reducing or increasing the remaining time in a basketball game, the above circuit provides the necessary control of the up/down input to the Counter Module.

Was It too Much?

All I wanted was a simple 3-digit counter and I ended up with a discussion that dug deep into the theory on counters. I want you to know that the original purpose of the counter resulted in the addition of a set of barrier doors to the shop area so that the cool air would not be wasted to the outside, and the Counter Module is now being used to count our incoming calls at the service desk. If I can prove to the big boss that there are sufficient calls, I'll hire a gal to answer the phone. See, counters are productive! ■

TIME CAPSUL

(Continued from page 28)

unknown capacitor across the binding posts, being careful to observe polarity. The unit will have started clicking audibly as soon as you've turned on the power switch. Now, on the beat, depress Test Switch S2. The LED will light. Count the beats until LED1 extinguishes.

For example, say you have a fairly large capacitor and you are in doubt about its value. If you follow the above procedure and LED1 stays lighted for only a second or two, switch the Range Switch to the next lower range and depress the Test Switch again. If the LED stays lighted for 20 beats and you are set to the × 10 range, it means the capacitor under test is a 200-µF unit.

Trust your Time CapSUL to transport your old, unmarked capacitors to a useful and productive future. ■

PARTS LIST FOR THE TIME CAPSUL

SEMICONDUCTORS
U1, U2—555 timer IC
LED1—Jumbo red LED

CAPACITORS
(Capacitors are rated at 15 WVDC unless otherwise indicated.)
C1, C3—0.1µF ceramic disc, 35 WVDC
C2—100-µF electrolytic
C4—1.2-µF tantalum
C5—50-µF electrolytic
C6—25-µF electrolytic

RESISTORS
(All fixed resistors are 10%, ½-watt units)
R1—100,000-ohm
R2—560-ohm
R3—910,000-ohm
R4—91,000-ohm
R5—9100-ohm
R6—680-ohm
R7—150-ohm
R8—1-Megohm miniature trimmer potentiometer (see text)

ADDITIONAL PARTS AND MATERIALS
B1, B2—9-volt, transistor-radio batteries
BP1, BP2—Multi-way binding posts (one red, one black)
SPKR1—Miniature speaker (see text)
S1—Single pole, 3-position rotary switch (SP3P)
S2—Normally-open, momentary-contact pushbutton switch
S3—Double-pole double-throw (DPDT) switch; either toggle, slide, or push-on push-off (such as Radio Shack 275-1553)
LED Panel lamp holder, Radio Shack 276-080; cabinet, Radio Shack 270-627; battery clips, perf board, solder, wire, etc.

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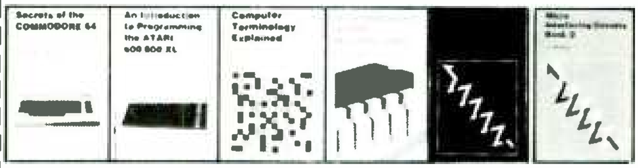

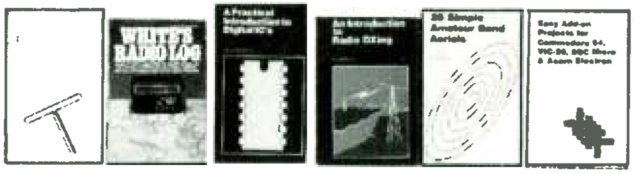

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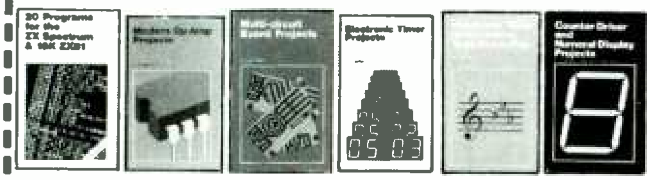

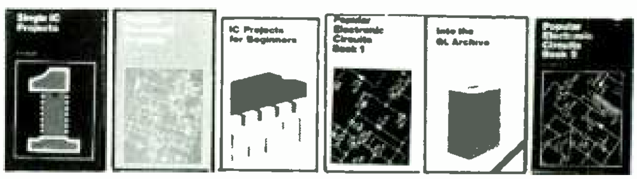

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AUTO SECURITY SYSTEMS

(Continued from page 26)

future expansion. There is the conventional power output for a siren, and for an *accessory protector*. The accessory protector is somewhat unusual, and you might want—or need—to use one to protect the stereo radio, or even a toolbox on the floor of a van. If the accessory protector wire is connected to, through, or on anything that's grounded to the vehicle's chassis, the computer will automatically arm the circuit. If the ground is broken—say by the removal of the radio, the breaking of window foil, or the lifting of a tool box—the alarm system will be triggered.

Like the panic switch, the *accessory protector* alarm is instantaneous. It goes off instantly and can only be silenced by turning off the alarm. Replacing the stereo, toolbox, or whatever does not stop the alarm.

Accessories include a *valet switch* so you can disarm the system if authorized persons must move the vehicle (remember, the system arms passively). The valet option also includes a *glass-guard loop*, which can connect to window foil, a glass-breakage detector, or even an ultrasonic alarm.

Another option is a dash-mounted keypad, which allows you to control the system by punching in a code number instead of fumbling with a key.

Multiple Remote Control

Once a system is digitized or computerized, it's possible to do just about anything by remote control. Early key-fob transmitters could only open a vehicle's doors from some 50-feet out. Later versions could open doors or set the alarm. Still more sophisticated models could control two vehicles with separate codes, and the latest versions have miniature keypads that allow you to open selected doors, turn on the headlights, even trigger the alarm from a remote location.

As with most other things in life, just about anything can be done with electronic circuits and a computer. So if you have some far-out idea on vehicle security don't let anyone convince you that your ideas are "off the wall." If you look hard enough, you'll probably find the security equipment that you need is already available somewhere. ■

Remote control transmitters that will open car doors and the trunk from almost 50-feet away are small enough to mount on a key-fob. This one has two buttons for control of two vehicles.

ELECTRONIC COMBINATION LOCK

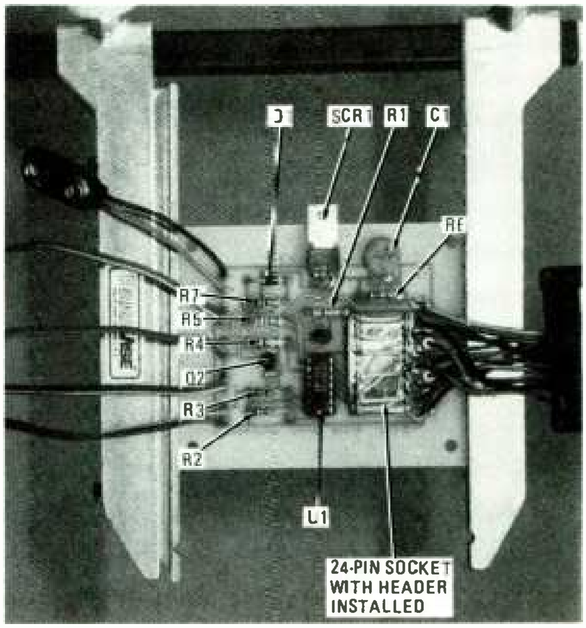
(Continued from page 42)

battery. If, when testing any of the buttons, the LED comes on, that particular button is closed. Repair or replace it. Now would be a good time to check the operation of buttons S1 through S4 using the LED. Check each button carefully, to be assured that they close when pressed and open when released. Should any button fail the test, repair or replace the keypad. Be sure to replace the 24-pin jumper header.

3—Place one end of a clip-lead to the positive battery terminal. With the other end of the clip-lead touch in sequence pins 3, 4, 5, and 6 of U1. If the circuit still does not disarm, U1 may have to be replaced. Switches S1 through S4 had been checked in the previous step.

Think Time

Now you have a fully-assembled Combination Lock/Alarm Control, ready for installation, to guard your workshop. You may want to make some modifications and additions. Earlier, it was mentioned that a wall-plug power supply was used to energize the Control. Better still, you may want to tap power from an alarm system that has battery backup. That way you have uninterrupted coverage even during power failures. The door switch should be of good quality. Visit a local electrical supply house and purchase a Nutone door



A close-up view of the main circuit board showing the 24-pin jumper header in place. Back-lighting of the circuit board clearly shows four foil leads traveling from the top right of the header to pins 3, 4, 5, and 6 of U1. Thus the photo reveals the builders sequential numeric combination code.

switch that is normally closed. Don't use a "radio" type pushbutton switch. They all require special adaptation during installation and are not as rugged.

Do not keep LED1 in view. Instead, tuck it away where it can not be seen under normal circumstances but is in view to the discerning eye. After all, why help out some hacker.

Pin 8 of U1 provides a low, entry signal (LED1 is off) that can be used to control power to an electric door latch for a keyless entry. If the door is spring-loaded to open when unlatched, the low, entry signal can activate a 3- to 5-second timer that operates an optoisolator/coupler that powers the 12- to 20-volts AC door latch. Open sesame!

Secure It!

Now you know how it is done. The Combination Lock/Alarm Control Kit No. 80-155 provided the bulk of the parts required to assemble the project including the pre-etched printed-circuit boards. Buying the parts separately will only mean increased costs, making your own printed-circuit boards, and the possibility of being unable to acquire all the parts. Start planning today to protect what you don't want to lose tomorrow. ■

FASTER KEYBOARDING

(Continued from page 32)

Dvorak. If that occurs, I suggest that you contact the Dvorak International Federation for advice (see below).

The hardware system costs under $300, and the software costs about $40 or less. New typewriter keys cost about $80 for an IBM selectric, and an electronic chip costs about $15-$20.

If you purchase the software conversion, you should buy keyboard-overlay stickers for your keys; they are sold by the Hooleon Company, Box 201, Cornville, AZ 86325. The price is $26.95 postage paid. The Dvorak letters are printed in large red, and the qwerty commands are printed in small black on the same overlay so that people can input either system. The letters are printed on the underside to prevent wear.

The best authority on the Dvorak keyboard-conversion process is Virginia Russell, a consultant for the Dvorak International Federation, 11 Pearl St., Brandon, VT 05733, phone 802/247-6020. She has consulted with the federal government, Fortune 500 corporations, and countless businesses and individuals. She can give advice about any of the businesses listed below, or you may contact those firms directly. In addition, you may also want to subscribe to an informative newsletter called "Dvorak Developments," from *Freelance Communications*, Box 1895, Upland, CA 91785, for $12 per year. ■

TABLE 1—SOURCES FOR DVORAK HARDWARE AND SOFTWARE CONVERSIONS

Apple Computers:
(Note: The Apple IIc has a built-in Dvorak switch.)

Faultline Micro, Box 3147, Fullerton, CA 92634.
Toggle conversion for Apple IIe—$39.95.

Switch to Dvorak Co., Box 162, Cape Canaveral, FL 32920.
Toggle conversion for Apple IIe—$25.00.

Commodore:

Mindscape, 3444 Dundee Rd., Northbrook, IL 60062.
Training software—$39.95.

Prelco, 14292 Galy St., Tustin, CA 92680.
DV-switcher ROM kit for Commodore 64—$39.95.
Typing conversion and tutor for Commodore 64 and 128—$36.95.

Upstart Publishing Co., Box 22022, Greensboro, NC 27420.
Software conversion for Commodore 64 and 128—$15.00.

Macintosh:

Paragon Courseware, 4954 Sun Valley Rd., Del Mar, CA 92014.
MacQuerty Software conversion to Dvorak—$35.00.

Palantir Software, 12777 Jones Rd., Houston, TX 77040.
MacType software conversion and training—$39.95.

Radio Shack Computers:

TriMike, 33 Virginia Dr., Apt. 22, Monroe, WI 48161.
Radio Shack Model 100 software conversion—$24.95.

The Covington Group, 310 Riverside Dr., New York, NY 10025.
Software conversion for models 100 and 200—$14.95.

Wang Computers:
Contact local Wang sales office.

Digital Equipment Corp:
Contact local DEC sales office for optional keyboard, or telephone the special Dvorak Keyboard hotline: 617/480-3111.

IBM and Compatibles:

Maxiswitch, 9897 E. River Rd., Minneapolis, MN 55433.
Keyboard for IBM PC, AT, and XT—$150.00.

KeyTronic, Box 14687, Spokane, WA 99214.
Keyboard for IBM PC—$256.00.

Sigma Integrated Systems, Box 10661, McLean, VA 22102.
Keyboard—$299.00.

Mindscape, 3444 Dundee Rd., Northbrook, IL 60062.
Training software—$39.95.

Acutype, 819 W. 6th St., Winona, MN 55987.
Software conversion—$24.95.

QED Information Inc., Box 181, Wellesley, MA 02181.
Software training teaches touch-typing—$59.95.

Seasoned Systems, Box 3036, Chapel Hill, NC 27514.
Software conversion and training tape—$99.00.
Software available from major computer stores such as Computerland: Smartkey, Superkey, Xywrite, Prokey, Xtrakey.

DVORAK CONVERSION: TYPEWRITERS

IBM Selectric:

Camwill, 875 Waimanu St., Honolulu, HI 96813.
Printing elements—$85.00.
Also printwheels for Diablo, Canon, Vydec—$65.00.

Silver Reed:

Silver Reed, 19600 S. Vermont Ave., Torrance, CA 90502

SOLID-STATE RECTIFIERS

(Continued from page 37)

PIV diodes in those circuits, so for the circuit shown the PIV rating is 4000-volts.

The capacitors used in Fig. 13 are for exactly the same purpose as in Fig. 12. The resistors, however, are needed for a different purpose. They equalize the forward-voltage drop across each diode. A 470-Kohm, 1-watt resistor is typically used for 1000-volt PIV diodes. The wattage rating is required not because of the power dissipation of the resistors, but for the voltage rating (yes, resistors do have voltage ratings). Note that for good regulation the values of the resistors should be extremely high (at least equal to the rectifier diode resistance in the reverse-bias state).

Figure 14 shows the proper method for mounting an axial lead rectifier on a perf-board or printed-circuit board. That method is used any time except where excessive vibration is

SOLID-STATE RECTIFIERS

(Continued from page 103)

expected. The space beneath the rectifier-diode body allows air to circulate (keeping the rectifier diode cooler) and prevents rectifier-diode heat from damaging the board.

Conclusion

Although solid-state rectifiers are among the most common electronic components used by hobbyists, they are also among the most common causes of failure in electronic projects or repaired equipment. By following the rules given above, you can successfully select the correct rectifier diode—and prevent reliability problems. ■

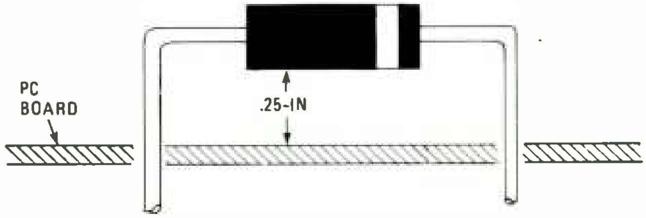


Fig. 14—Since rectifier diodes have to dissipate heat in order to function properly, it is wise to space them adequately above the PC board, and away from other components which could be damaged by their heat.

VARIABLE STROBE LIGHT

(Continued from page 68)

to measure the voltage across C2 with a voltmeter.

A quick way to check SCR1 is to momentarily bypass it or short it out. Place one end of an insulated clip-lead on the SCR's anode (use the tab). Then momentarily touch the other end of the lead to the cathode pin. If the xenon tube still does not flash but the neon bulb fires, the problem is most likely with capacitor C3. If the neon bulb does not fire, the problem could be with C3 or, the neon bulb itself.

Wrap Up!

The Variable Strobe Light was put to good use in the apartment of a deaf friend. When the doorbell was depressed, it caused a relay to close applying the 117-VAC line to the project. The strobe flashed and its light could be seen in every room of the apartment. You will be able to think up many other valuable applications for the Variable Strobe Light, making it worth many times its low cost and short assembly time.

The Variable Strobe Light parts and printed-circuit board are available in a kit—refer to the Parts List for purchasing details. The kit price, $21.95, is a budget value you'll find hard to beat when shopping for the parts. Obtain more information on all the parts kits marketed by MCM Electronics by writing to MCM Electronics, 858 East Congress Park Drive, Dayton, OH 45459, or circling No. 58 on the Free Information Card in this issue. ■

THE ANTENNA THAT WASN'T

(Continued from page 48)

News) and on the air about my planned 80-foot downspout vertical. I've since been rather quiet on the subject.

I think, as does Sam within cautious limits, that the downspout idea has considerable electrical merit. Obviously, it has got to be done right physically; obviously, I don't know how. I'd appreciate hearing from anyone who has had success with downspout antennas of any significant lengths.

Two or three downspout sections, by the way, should make an admirable SWL DX antenna for multi-band use. Just be sure to make good electrical contact between sections. Apartment dwellers who are not permitted outside antennas might look into "invisible" feeders to a nearby downspout. The problem there is your hope that the rivets are doing an electrical connection so that more than one section is effectively in use. Keep the downspout in mind for a disguised antenna too. Disguised as a downspout, that is, even if it has no gutters feeding it. So let the neighbors ask silly questions.

We failed, but we learned. It's always been that way, hasn't it? Get out there and do some hands-on antenna work yourself. The satisfaction quotient can be splendid. And as you can see, even a trio of high-class hams don't always have all the answers. ■

After cutting the antenna back for halfwave operation, we got smart and built a hand held scaffold (foreground).

CARR ON HAM RADIO

(Continued from page 97)

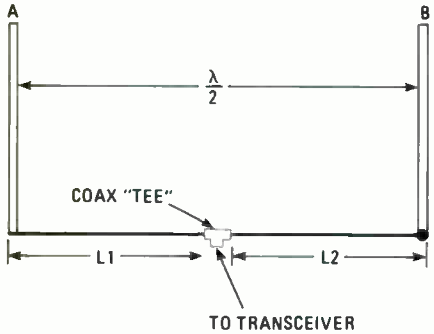


Fig. 2—To feed the vertical antennas in-phase, equal lengths of coax must be used between the common transmission line and each antenna.

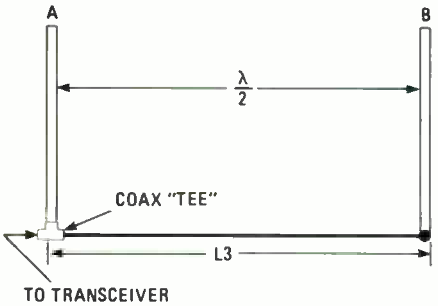


Fig. 3—An out-of-phase condition is attained by connecting the transmission line directly to one vertical and then branching out to the other .

imately, depending upon exact frequency). If we use foam coax, with VF = 0.80, the cable length is (0.8) x (22-feet), or 17.6-feet, and the cable won't fit between the towers..

Second, the patterns shown in Fig. 1 are dependent upon the condition that the antenna currents are equal. If both antennas are the same impedance and are fed from the same transmitter, then it is reasonable to assume that the currents are equal...right? No, wrong! What about coax loss? Because of normal coax loss, which is worse at higher frequencies, the power available to antenna B in Fig. 3 is less than the power available to antenna A. Thus, the pattern will be distorted because the current produced in B is less than the current in A, when they should be equal.

The first problem is sometimes fixed by using unequal lengths for cables L1 and L2 (Fig. 2), and using it for the out of phase case. For example, if we make L1 ¼-wavelength, and L2 ¾-wavelength, antenna A is fed with a 90° phase lag (relative to the Tee-connector signal), while antenna B is fed with a 270° phase shift. The result is still a 180° phase difference.

There is still another problem that is generic to the whole class of phased verticals. Once installed, the pattern is fixed. That problem doesn't bother most point-

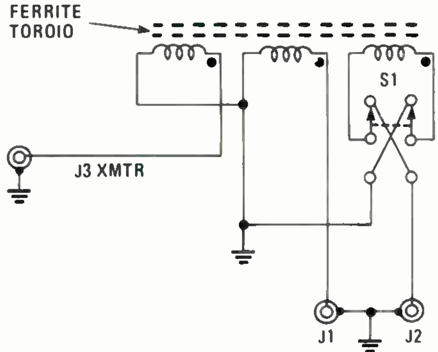


Fig. 4—Phase shift can be provided by coax transmission line sections, or by a toroidial BALUN, which can provide either 0° or 180° phase outputs.

to-point commercial stations or broadcasters because they tend to transmit in only one direction. But amateurs are likely to need a rotatable pattern. Neither Fig. 1A nor Fig. 1B is rotatable without a lot of effort—like changing coax feeds around or physically digging up and repositioning the verticals.

Fortunately, there is a single solution to the problem. Figure 3 shows a two-port phasing transformer made from a toroid Balun kit. Use the kind of kit that makes a 1:1 Balun transformer. Although we are not making a Balun, we will need enough wire to make three windings, and that is the normal case for 1:1 Baluns. (Amidon Associates and others make toroid Balun kits.)

Wind the three coils trifilar style, according to the kit instructions. The dots in Fig. 3 show the polarity of the coils, and are important for correct phasing: Call one end the "dot end" and the other end the "plain end" to keep them separate. If the dot end of the first coil is connected to J3 (and the transmitter), then connect the dot end of the second coil to antenna jack J1, the 0° output. The third coil is connected to S1, a DPDT RF relay or switch. In the position shown, S1 causes the antennas to be 180° out of phase. In the other position, the sense of the third coil is reversed, so the antennas are in-phase.

Conclusion

Vertical HF antennas installed over a good ground system often prove to be excellent DX antennas. The main objection to such antennas, once the angle of radiation is down low enough to do some good, DX-wise, is its omnidirectivity. But using a pair of verticals in a phased array system can reduce that objection considerably. Using two verticals in the array shown in this article allows you to select either of two bidirectional patterns that are at right angles to each other. Placing three verticals in an equilateral triangle system results in a system that will allow one to squirt signals in all directions . ■

JENSEN ON DX'ING

(Continued from page 95)

Rome!" Every evening, the Italian shortwave broadcaster called *RAI* beams its brief English language program to listeners in the U. S. and Canada.

Broadcasting in Italy began way back in 1924, when daily programs were first aired by a pioneer transmitter in Rome. It was in WWII, in 1944, when the government station acquired its present initials, RAI, which stands for Radio Audizioni Italia. It's more commonly called *RAI-Radiotelevisione Italiana* today.

RAI is, indeed, one of the major European shortwave stations, even though its English programming is somewhat limited.

The station has five SW transmitters, ranging from 50 to 100 kilowatts of power, and it puts a decent signal into North America on most nights. Its daily English schedule to North America is only 20 minutes long, from 0100 to 0120 UTC, consisting of 10 minutes of news and, usually, a 10-minute music program. The SW broadcast frequencies are 9,575 and 11,800 kHz.

RAI may also be heard during its 1935 to 1955 UTC English language program to Great Britain on 11,800 kHz.

North Americans of Italian heritage who speak the mother language may enjoy programming in Italian beamed to North America on the same frequencies from 2230 to 0100 UTC daily.

Listeners' reports are answered with QSL cards. The Italian foreign-broadcasting service also will send you, without charge, its three-times-a-year schedule and listeners' magazine, called—after the station identification announcement.

Letters should be addressed to RAI-Radiotelevisione Italiana, Casella Postale 320, Centro Corrisponcenza, 00100 Rome, Italy. ■

**(CREDITS: Richard D'Angelo, PA; John Tuchscherer, WI; Dustin Brann, MO; Harold Levison, PA; Christos Rigas, IL; Rufus Jordan, PA; Tom Laskowski, IN; North American SW Association, 45 Wildflower Road, Levittown, PA 19057)

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ADVERTISING INDEX

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LETTER BOX

(Continued from page 4)

been specified as a 5.1-volt, 1-watt unit.

Questions have also come in about the pitch control. You'll note that the schematic diagram shows two R3's, PITCH is R2—a 20K potentiometer. The reason that R9, R3, and R2 seem to be tied to the same point is because physically they are: All of them have one leg connected to the +5 volt source that is regulated by the Zener diode, D1.

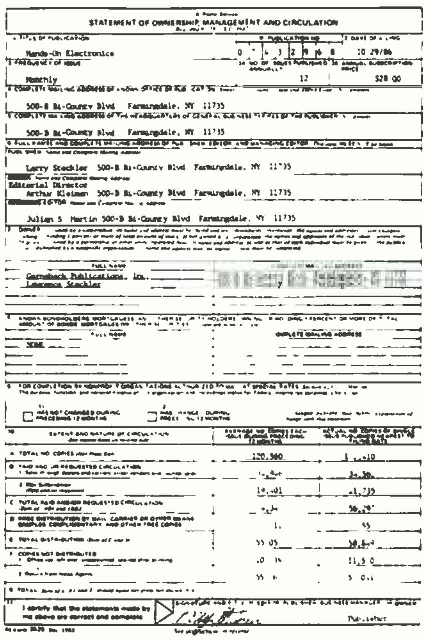
Tied in a String

We have gotten some letters from people experiencing difficulty with the calendar program from the November '86 issue. The source of trouble is line 100. Many readers are interpreting it as setting up a null string, but it actually set up a string composed of 21 spaces (ASCII 32). The spaces are used to format the last line of each month properly, which goes to show that space is more than nothing!

Opening Doors

I have two questions about garage door openers. Firstly, do you know of a text providing a detailed description of operating theory? And also, do you know of a way to extend the transmitter range; possibly by adding an amplification circuit? My "opener" seems exceptionally short ranged. I have written to a manufacturer in Los Angeles but have received no reply.
J.S., Lake Oswego, OR

I think we've got just the thing. Wade through Wels' Think Tank in the next month or so and you'll find a light activated circuit that will let you throw your transmitter away! ■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NONE

SAXON ON SCANNERS

(Continued from page 94)

their own frequencies. It could very well come to pass that the clever communications enthusiast may have plenty of spare time to learn about electronics when he's not on duty at the license-plate stamping machine!

Calling Dr. Kildare

Sam Berlin, Brooklyn, NY notes that he often hears doctors and nurses being summoned on 152.00 MHz and wonders if we can offer any comments.

The actual frequency you're hearing , Sam, is 152.0075 MHz and it's popularly used throughout the nation for medical paging within hospitals. Most likely, that frequency will be in use in every metropolitan area and other readers are invited to take a listen to see what it has to offer.

Also try 157.45 MHz.

United We Stand

Several readers have asked if we could mention the frequencies used by aircraft belonging to package courier services. The one we have is: Federal Express on 130.75 and 131.925 MHz. If readers have others, please send them in to us.

Our address is: *Saxon on Scanners*, **Hands-on Electronics**, 500-B Bi-County Boulevard, Farmingdale, NY 11735. We welcome comments, frequencies, questions, news items, and general what-have-you! ■

CIRCUIT CIRCUS

(Continued from page 93)

When the needle and penny assembly feel cool to the touch, use contact cement to attach the penny to the center of the speaker's cone with the needle sticking out in front. Since the penny covers the majority of the speaker's cone, the pickup responds only to the vibration transferred through the needle and not to sounds through the air. The pickup assembly can be housed in a plastic or metal tube to protect it *and the user* from damage.

The electronics of the circuitry can be built on a piece of perfboard and housed in a small metal or plastic cabinet. No special construction techniques are required, just use a good layout and wiring scheme.

In searching out a low-level tick or mechanical vibration, touch the pickup (needle) against the suspected area and set the amplifier's gain to a comfortable listening level. A 2000-ohm or better set of headphones will work fine with the circuit. Have fun!

Maybe you too can become world famous by using one of the electronic detection circuits to crack a big case. Who knows? ■

FRIEDMAN ON COMPUTERS

(Continued from page 96)

The 1-megohm resistor will limit the current to a safe value, yet it doesn't interfere with grounding for static electricity. It's simply a safety feature that should be used even if some commercially-manufactured grounding bracelets don't use the 1-megohm resistor.

Interference-Free

The "surge suppressor' has turned out to be the *mother lode* of gadgetry. The earliest consisted of a MOV (metal-oxide varistor worth less than $2) connected across the power line. The whole assembly—MOV, plug and integral socket—sold for well under $10. But there isn't much profit to be made at $10, so indicator lights, common-mode MOV protection (three MOV's), and multiple outlets brought the price up to the $50–$100 range, and yet the basic protection was the two-buck MOV across the power line. (You can purchase the MOV at Radio Shack and put it in a multiple-outlet box yourself.)

On the other hand, a very valuable device is the telephone surge-suppressor, which is a lower-voltage MOV in a small box that has a modular telephone jack and plug that connects between the telephone outlet and your modem. A surge on the telephone line from a lightning strike in the general area—it doesn't even have to strike the telephone line itself—can zap the modem and the computer: The damage can run into the hundreds of dollars. While the MOV isn't the ultimate in lightning protection (so what is?), the gizmo is reported to be effective most of the time.

The whole device, including the MOV and modular connectors, can be purchased for about $10. Unlike most other gadgets, it can really do some good, and it can't do any harm. The problem is that you won't really know when it's working because if your modem or computer isn't "fried," how can you really know if it would have been "fried?" (You must simply trust the gods.)

Squashing RFI

Another valuable device—that's if you need it—is a power-line outlet box with built-in toroid line filters (like the one in the photos). The filters aren't needed to prevent interference from getting into the computer, but to prevent interference from getting out of the computer and into the telephone, the TV, and the stereo. Because all modern computers must meet F.C.C. standards regarding RFI (radio-frequency interference), all new computers won't interfere with anything. The power-line filters cost *big bucks*, although you could build one yourself for under $10; and it's just wasted money for gadgetry if you don't need it. (It does no harm, but might not do any good.)

On the other hand, older computers generated enough hash (RFI) to literally wipe out a telephone call or TV reception. If you've got an old "clunker" giving the family or a neighbor fits, the problem might well be resolved with a toroid power-line filter. But if the RFI is being radiated through the air rather than through the power line, no kind of power-line filter is going to help.

How do you know if the RFI is being radiated or carried on the powerlines? You must guess. Early home computers did not use grounded metal cabinets, nor grounded metallic coatings on plastic. If your computer predates F.D.C. certification, you can assume there is a good possibility that the computer-generated RFI is being radiated.

Does It Work

The thing to ask yourself when you get the itch to "improve" your computer with some highly-touted gadget or gizmo is: "Will it really do anything of value, or simply serve as a status symbol?" ■

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