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Volume 4, No. 11 November 1987

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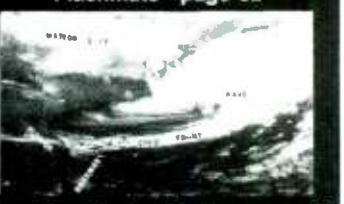

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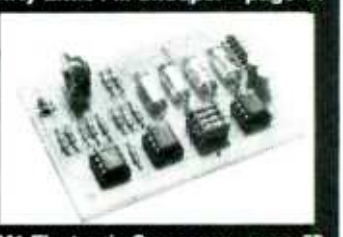

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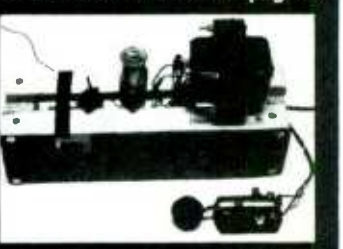

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Hands-on Electronics®

The Magazine for the Electronics Activist!

A look into the 2000's and other things!

Where are we going? Before that question can be answered, I should present a few facts.

I remember a statement made in 1960, "Every American closet should have a reel-to-reel tape recorder." Yes, audio buffs were buying up tape machines in a mad rush. Large computer users bought billions of miles of tape. Then came the cassette, and its makers claimed that it was good for voice recording; but for music, not so good. Well, the cassette grew up and found a place in every corner of the audio universe and elsewhere. Computers used them. I even saw a naval torpedo with a built-in cassette deck—why? I never found out. I even have a back-up tape drive in my PC, and more video tapes than the local video-rental store (according to my wife). Now consumers are talking about digital audio-tape recorders and the like.

Ferrous-, chrome-, and metal-coated tapes have come a long way! But, are they approaching the end of their useful life? Will magnetic tape follow the path of the dinosaur to its doom? Is the year 2000 Tape Deck Dooms Day? I believe so!

Optical-disk recorders will soon be mass-market items. CompuSonic of Palo Alto, CA, has a device that can record over two hours on an optical disk. What's more, the device can be interfaced with a compatible PC, and the computer can edit music, rearrange song playlists, restore old music, and permanently store it in digital form.

Will the tape and floppy disk of the future be a polished Mylar-like product? Without expensive coating, the cost will drop ten fold making it a shoe-in. So what if you can only record once, with all the space available on optical media, you can make thousands of revisions and still not use up a disc. And, as sure as *Superman V* will follow *Superman IV*, someone will find a way to erase optical disks before the decade is out.

Sell your magnetic-tape stocks now, folks, if you plan to retire in the 2000's.

Julian S. Martin, KA2GUN
Editor

STAFF

Volume 4, No. 11

November 1987

BUSINESS AND EDITORIAL OFFICES

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500-B Bi-County Boulevard
Farmingdale, NY 11735.
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President: Larry Steckler
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NATIONAL ADVERTISING SALES
(For Advertising Inquiries Only)
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Larry Steckler, Publisher
500-B Bi-County Boulevard
Farmingdale, NY 11735
516-293-3000

Composition by
Mates Graphics

Cover photography by
Walter Herstatt

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

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

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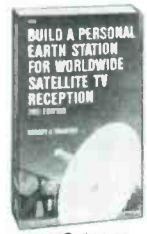

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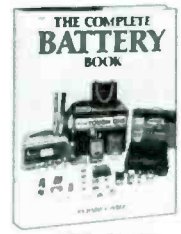

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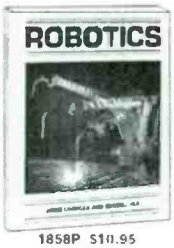

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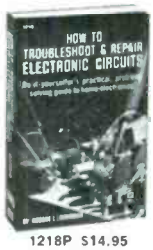

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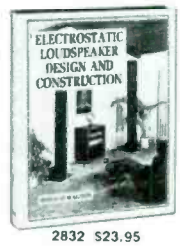

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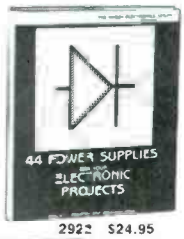

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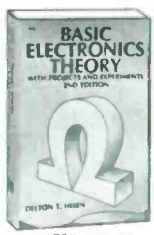

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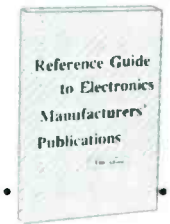

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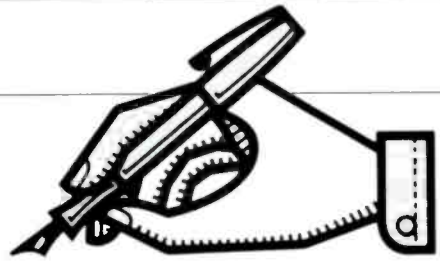


Hands-on Electronics, 500B Bi-County Boulevard, Farmingdale, New York 11735

Tank You

I enjoyed your article in the March issue of **Hands-On Electronics** entitled Electronic Fundamentals. You cover the *water front* very well. There are two areas to which I would invite your attention: In question 8 you should have gone through the algebra. If you had, I believe that your formula would read:

$$f_r = 1/6.28\sqrt{LC}$$

With the values given for L and C, f_r would equal 112 Hz. In question 9 your answer is correct - but no where do you show taking the square root of the LC product, although you did.

In question 20, you show that for a series circuit:

$$Q = X_L/R$$

However, in question 26 no mention is made of the fact that in a parallel circuit:

$$Q = R/X_L$$

The more you load the parallel circuit by decreasing R, the lower the Q, the wider the bandwidth, and the lower the Z. Also, any value of Q below 10 gives an incorrect answer for Z when using Q.

All in all, you did a lot of people a great service. I hope you will continue such a series.
—W.R., Silver Springs, MD

Thanks for the corrections. That first mistake occurred because the manuscript we received was done on a dot-matrix printer without square root symbols, so the roots had to be added after, and that one got by. The second mistake is just one of the reminders of just how human editors can be.

Gotta Have Heart

Would it be possible to modify the electronic stethoscope (HO Feb. 87) to function as a fetal monitor? Any information towards its construction would be greatly appreciated.
—S.D., Bothell, WA

I imagine that it can be done, but we have no experience in this matter, and could not suggest any such use in good conscience.

Location Unknown

I am interested in building metal detectors. Not the cheap ones that use transistor radios as receivers. Do you know where I could obtain plans for a more sophisticated unit, or do you know of any kits that are available?

The price of the top of the line commercial models runs around $600. That seems unreasonable to me when you can buy a mini-TV for fifty bucks. I also don't understand why the circuitry could not be put on a chip, but then I'm not an electronics expert.
—R.E.L., Molalla, OR

Last month there was a review for a book in bookshelf on building metal locators.

In regard to your technical question, most of a locator circuit can be placed on a chip, but not the most important part—the sensing device. That is because the sensors are either inductors and thus bulky, or capacitors and easily affected by other portions of the circuit.

Another Side

I was dismayed, and more than a little annoyed, to read, on page 15 of the July 1987 issue, the following: "Live near an airport, Coast Guard station, or ham who keeps screwing up your TV reception? Well you may not be able to trap them into admitting they're the source of the trouble..."

Shame on you! You, **Hands-on Electronics**, of all magazines, should know that it normally is the poorly-designed front end of the TV receiver, not the ham, that is the source of the trouble! Printed innuendo such as this, in supposedly knowledgeable magazines, helps to fuel the anti-amateur sentiment that seems to be on the increase in our society.

How about printing a retraction of that part of the writeup?
—G.E.M., Naperville, IL

Unfortunately, not everyone practices their hobbies in an inoffensive manner. There will always be people who spoil it for us all. For that reason that terrestrial traps can be marketed. No one supplies that for which there is no demand.

ID for an IC

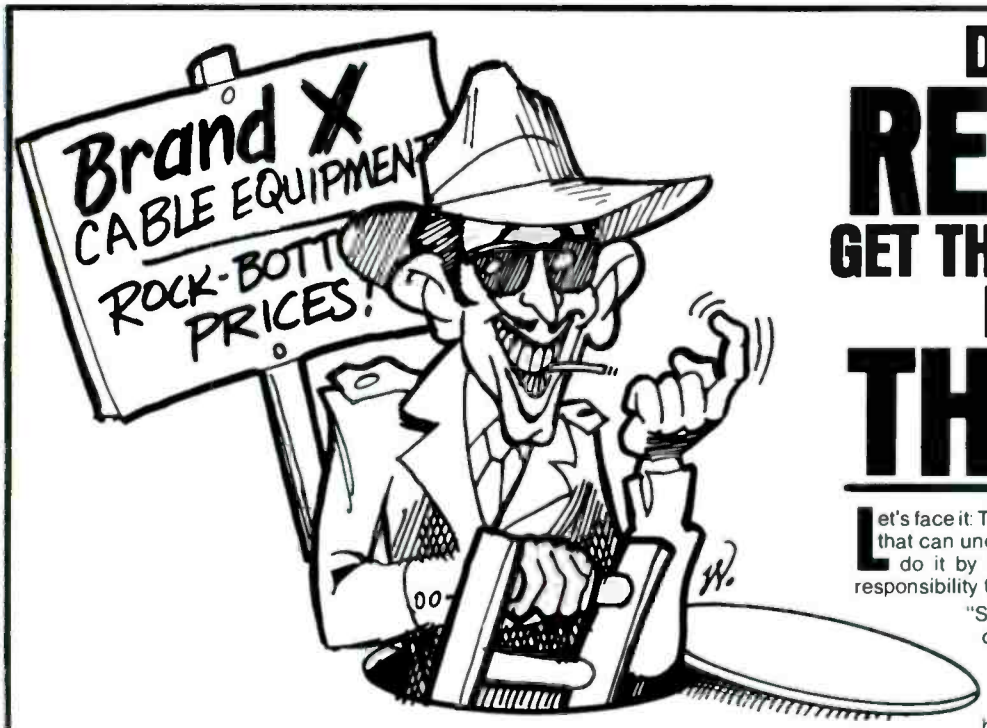
I would like to see an article on how to identify ICs. I got hold of about two dozen used ones at a second-hand electronic-parts place that stripped down everything from pinball machines to replaced Tele-communications equipment, for only 30 to 50 cents. The place has now closed down and I could only correctly identify about seven with a lot of research, and a lot more luck. But have not even come close with the others, although I know two of them are some type of memory chip. Some examples of numbers shown on ICs are: N825100F (V8302), D1-0165-5 (8047), SN7407 (8114), SN72720N (P7349), 916C102X55R (7543).

I would like to know what those are and I'm sure a lot of other readers have the same problem. Keep up the good work because I've learned a lot from your magazine and your sister magazine Radio Electronics. Thanks for the information and education.
—B.B.K., St. Louis, MO

That's a great idea. So great in fact, that the story ran in the January/February 1986 issue. If You don't want to get a reprint of the article from our reprint bookstore (see the ad in the back pages) then you may want to try the book How to Identify Unmarked ICs by K.H. Recorr. *It's available from Electronics Technology Today. PO Box 240, Massapequa, NY 11762.*

Lawful Letter

I never advocate censorship, but I do believe you should think twice about publishing articles which encourage readers to break the law—especially when doing so can directly endanger others. I am referring to the *Hide-a-way Stealth Radar Detector System* by J.L. Pearson in the August 1987 issue. Total disregard for the law is expressed in the cover-blurb about the "Trooper-Proof...system." The author even directly encourages the reader to ignore the law, claiming it is "....safer to drive with the flow of traffic." In exceptional circumstances it may be marginally safer, but that is very rare.



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"No, Steve isn't here. He moved out, the bum! And he owes me 437^{00} on the phone bill! No, I don't know about any guarantees on your Gerald, who's that? Listen, if you see that creep..." etc.

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In almost all circumstances, if you don't speed to please some moron behind you, he will either pass you, continuing on in his reckless fashion, or slow down to a safer speed. What Pearson suggests is both illegal and stupid.

If you must publish articles in support of radar detectors, I think you ought to include a disclaimer to the effect that the sole function of such devices is to aid in breaking the law. Why would anybody consider buying a radar detector if they didn't intend to speed?

Contrary to popular belief, radar detectors are not protected by the Communications Act. Those devices are not communications receivers. They only detect the presence or absence of an unencoded carrier signal.

Even if they were communications receivers, the Communications Act does permit the restriction of certain types of receivers in moving vehicles. For example, it is perfectly legal for airlines to restrict the use of radios on board. If you want to use a radar detector in your home, fine. But if you have one in your car it is reasonable (and 100% legal) to assume you intend to break the law. That is the only reason to have a radar detector.

—D.T.H., Columbia, MO

I will submit that most owners of radar detectors do intend to break the law, however we present articles on electronic circuits, not legal controversy. While radar detectors are used for mainly one purpose, the circuitry presented in the Stealth would be useful in a very wide variety of applications. To refuse to present such material would be to violate our resonsibility to the more-legal readers who would put our projects to good use. Anything can be put to a bad use, or a good use.

And what of our readers in states where use of a detector is lawful? Wouldn't we be doing them an even greater diservice by denying them of a directly useful project?

Further, the FCC has restricted use of receiving equipment for the sole pupose of preventing interference problems in special circumstances. Not so local legislatures can scrape more dollars up from their speed traps. To date I know of no report of a radar detector interferring with a transmission of any kind.

We do appreciate the opinion of all our readers, and if there are more people with strong feelings on this subject please write in and tell us what you think. This is your column, not just ours. Please voice your oppinions.

No Smoking

I read with interest your article on using a smoke detector for a security system, etc. in **Hands-on Electronics** of May 1987. Now I have a problem that I would like to use a smoke detector for, but don't know how; I hope you can help me. I have a coal and wood furnace that sometimes when I open the door smoke comes out, now I can put an upside down box on the ceiling above the furnace to catch the smoke and have a ceiling fan to drive the smoke outside.

But I would like it to be automatic, using a smoke detector. How could I connect a smoke detector to a 110-volt fan to remove the smoke? Maybe you could have Mr. Mangieri or Mr. Pearson solve that problem for me.

Names of smoke detectors purchased in my town are: Dicon Systems, 719 Clayson Road, Toronto, Ontario M9M 2H4, Norton Industries, Mississauga, Ontario L5T IH9, Canadian Tire Master, Craft Models 52-0254-2, 522-0256-8c, 52-0259-2c.

—W.D., Cape Breton, Nova Scotia

Such a project is not a good idea. If a real fire were to start, the fans would only fume the flames. I don't think you would want that. ■

NEW PRODUCTS

200 MHz Digital Storage Scope

As wide-band scopes go this one is stacked. The PM3320 provides a 250 Megasample/s maximum sample rate for a high 4-ns resolution; glitch-catching circuitry ensures capture of details as small as 3 ns, even at the lowest timebase settings. Functions include DC offset, roll mode, and mathematical operations such as multiply, peak to peak, risetime, and mean value.

Versatile trigger facilities—dual slope, positive and negative delay, event and multiple shot—simplify signal capture. Memory length is 4096 × 10 bits for single-channel or 2048 × 10 bits per channel in dual-channel operation— and at least 512 × 10 bits can be stored in single-shot mode. Random sampling allows both pre- and post-trigger display over the full 200-MHz bandwidth.

A clear 10 × 12-cm screen with 8 × 10-cm trace area provides setting details and cursors for direct on-screen measurement. A sophisticated autoset speeds signal location.

Operation is simple, with main controls leading to softkey menu selection for subsidiary functions. Over 200 functions can be accessed using the logical control hierarchy with the softkey choice displayed on the edge of the CRT. Menu selection is fast and the front-panel control memory allows settings to be stored for regular routine measurements.

The large screen allows full details of instrument settings to be provided continuously on the top and bottom of the CRT—both for current and previously-stored settings.

Cursors and markers can be used to select signal details for mathematical operations or for re-recording with higher resolution.

A specially designed hardware data-processing unit allows realtime processing of the digitized signal and also performs the mathematical and storage functions. Realtime processing ensures fast measuring speeds and high throughput. The statistically-based random sampling system ensures maximum signal resolution and allows pre-trigger display even in sampling mode.

The PM3320 is fully programmable using an optional card for both GPIB (IEEE 488/IEC 625) instrument bus and RS232 serial interfacing. As well as being able to take the captured signal from the unit, a remote controller can use the oscilloscope display to provide instructions to the user.

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Multimaster bus operation internally makes it possible to use up to three different processors within the instrument. That allows easy integration of the programming facility and will simplify the addition of other options and upgrading to meet future requirements.

The PM3320 is priced at $9,900. For more information contact Philips Test & Measuring Instruments, Inc., 85 McKee Dr., Mahwah, NJ 07430; Tel. 201/529-3800.

Handheld DMM

Tegam's Model 135A is a 4-½ digit handheld multimeter that combines high precision with portability. The 135A's 4-½ digit resolution provides 3 to 4 times better accuracy than the best 3-½ digit DMM's. Its rugged ABS plastic case and shock-mounted circuit-board design protect it from the harsh use normally given to portable instruments.

The 135A provides 0.05% basic DC accuracy and measures 5 functions on 17 ranges from 100 microvolts to 1000 volts, 10 microamp to 10 amps, and from 100 milliohms to 20 megohms. Diode checks are easily made on the 20 kilohm range. The 135A's versatility and accuracy makes it well suited for any application where precision measurement is likely to be important.

The instrument has a color-coded front panel and two large rotary switches with thumbwheel notches and deep blades for easy operation with either hand. Large 0.6-in. digits on the LCD display are easy to read, and the input jack panel is slanted to keep test leads out of the way. The

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tough, durable, ABS-plastic case resists impact damage and features external access for the battery and fuse. For more information, contact Tegam, Incorporated, 7230 North Ridge Road, Madison, OH 44057; Tel. 216/428-7505.

Dual-Band Transceiver

Kenwood has updated their "FM Dual Bander." The second generation Dual Bander (called the TW-4100A) is 45 watts on 2 m, and 35 watts on 70 cm.

Features of the unit include: 45 watts on 2 m, 35 watts on 70 cm, and 5 watts (adjustable) on low; A high-performance Kenwood GaAs FET front-end receiver; Selectable full-duplex cross-band ("telephone style") operation; Cross-band repeater operation possible (A control operator is needed for repeater operation); A compact size of only 5.9 × 1.97 × 7.87-in. and weighs less than 4 pounds; Frequency coverage of 142–149 MHz (allows operation on certain MARS and CAP frequencies) and 440–449.995 MHz. Programmable band scan and memory scan with memory channel lockout are included.

The unit is easy to operate. Only 3 knobs and 8 keys are on the front panel containing a large, illuminated LCD display and main knob, for visibility in direct sunlight or darkness

The unit also has selectable frequency steps; Front panel-selectable CTCSS tone (when optional TU-7 is installed); 10 memory channels; Lithium-battery memory back up; Store frequency, offset subtone. Two channels store the transmit and receive frequencies independently for odd split- or cross-band operation. A non-volatile operating system (even after the memory back up cell dies, all operating features remain intact!) No reprogramming or board-swapping necessary!

Separate antenna ports for VHF and UHF minimize loss and increase reliability and performance.

Some options available are: a digital channel link, a multi-function voice synthesizer VS-2, MU-1 DCL modem unit, PG-2N Extra DC cable, MA-4000 dual band mobile antenna with duplexer (mount not included), and an MB-11 extra mobile mount. Suggested retail price is $649.95. For more information contact Kenwood, 2201 E. Dominguez Street, Long Beach, CA 90810; Tel. 213/639-9000.

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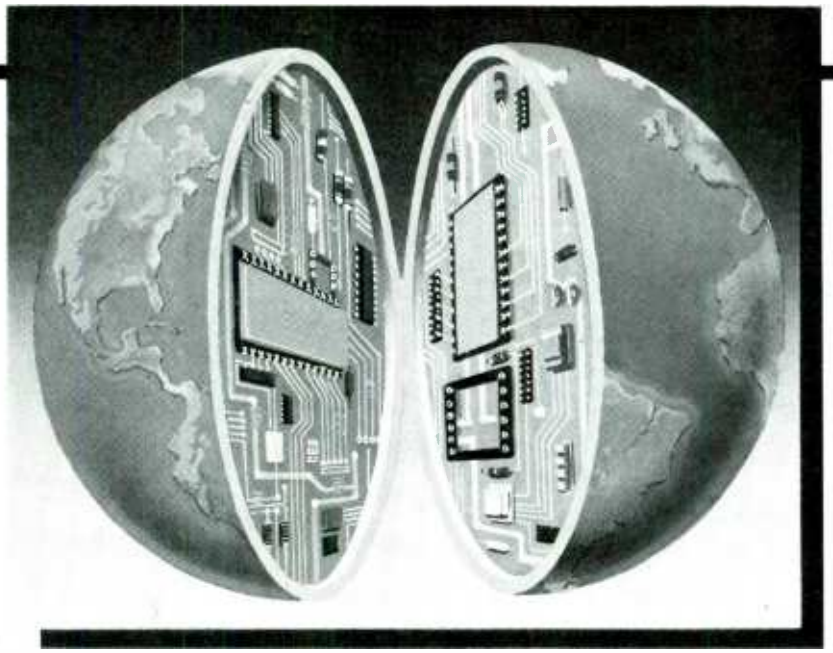

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popular solder links for ease of use by the inexperienced.

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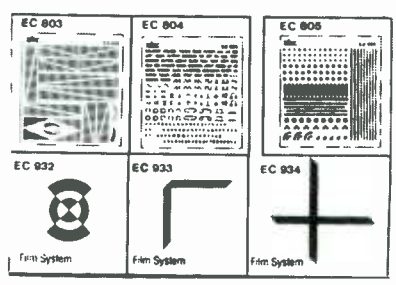
Alfac Rubdowns

Almost every amateur or professional involved in the production or design of printed-circuit boards will be interested in the ALFAC range of electro and electronic transfer PCB drafting aids. The range caters to the hobbyist who wishes to produce "one of" PCB, or to the professional designer who needs master-layouts for use with a photographic process.

The range of etch-resist transfers probably offers the widest selection of electronic symbols available in the US including terminal, solid, oval, square, and offset pads, together with connectors, curved and straight tracks, transistor symbols, dual in-line, etc.

In addition to the etch-resist transfers, ALFAC offers black, flexible, crepe paper tapes, specially formulated for high-quality photographic reproduction. ALFAC tapes are made in a variety of 36



CIRCLE 51 ON FREE INFORMATION CARD

different widths in both imperial and metric sizes. Each tape is individually blister packed for easy storage and permanent protection.

The ALFAC Electro products range is completed with an extensive number of symbols printed on film, and are produced primarily for the professional designer for master layouts. The symbols can be easily and accurately transferred onto polyester film or precision grids (also available) and each symbol has a thickness of 25 microns. They are tough, opaque, and extremely easy to use.

Alfac is one of Europe's best known manufacturer of rubdowns, and is known for its excellent quality. Their product-line includes rubdowns for direct-etch (presented in the Hobby Catalog) and an extensive line of professional products presented in a separate catalog.

Free ALFAC catalogs, and pamphlets are now available through Hobby Electronics by contacting Tapco Corp., PO Box 1339, Claremont, NH 03743.

Dial Modem 24+

The Dial Modem 24+ is compatible with many dial-up standards—CCITT V.22 bis and V.22, and Bell 212A and 103 A/J—enabling the user to link up systems internationally as well as expand lines of communication.

Because the Hayes Smart Modem command set is included, Dial Modem 24+ ($549) can be used with any of the popular software communications packages on the market. It also features automatic adaptive equalization, assuring that data is being transmitted and received at the same rate. In an answer mode this device can convert calls of 2400, 1200, or 300 bps to the host computer's baud rate, thereby eliminating the need to provide three separate ports for incoming calls.

CIRCLE 95 ON FREE INFORMATION CARD

A half-card version of the Dial Modem 24+ ($499) is adaptable to asynchronous and synchronous communication up to 2400 bps, and can be installed in PCs. It offers features identical to the Dial Modem 24+.

The newest issue of the Black Box Catalog contains seven pages of modems, including the Dial Modem 24+ and the Dial Modem 24+ Half Card. For your free copy of that publication write: Black Box Catalog, PO Box 12800, Pittsburgh, PA 15241; Tel. 412/746-5500.

Weatherproof Loudspeakers

A truly weatherproof indoor/outdoor acoustic-suspension loudspeaker system, the Model 55, will hit the streets in time to play your Christmas carols this year.

Sized (7 × 9-⅜ × 5-⅝-in.) to provide a variety of placement options, the Altec Model 55 can be used outdoors on decks and patios and indoors as a bookshelf or wall-mounted speaker system. Keyhole receptacles on the back of the loudspeakers enable them to be hung on a wall.

CIRCLE 77 ON FREE INFORMATION CARD

Unlike most other indoor-outdoor speakers which are ported and thus vulnerable to the elements, the Altec Lansing loudspeakers are housed in a thick-walled cabinet constructed of high temperature, glass-filled ABS. Special rubber gaskets are used to totally seal out weather. Polyurethane-foam hinges for the woofer cones provide additional weatherproofing. Two heavy-duty, spring-loaded input terminals assure firm contact for the wire leads even when under adverse weather conditions.

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

Specifications include: Frequency response of +3 dB 85-20 kHz, power handling is 40-watts nominal 80 watts-maximum, impedance is 4 ohms.

The loudspeakers, retail for about $250 per pair. For additional information contact Altec Lansing Consumer Products, Milford, PA 18337.

R1090 Scanner

Designed for beginners as well as veteran scanning enthusiasts, the Regency R1090 covers more than 15,000 frequencies from six of the most popular VHF and UHF bands. Coverage includes VHF-Low (30-50 MHz), VHF-Amateur (144-148 MHz), VHF-High (148-174 MHz), UHF-Amateur (440-450 MHz), UHF (450-470MHz) and UHF-T (470-512 MHz). Forty-five of the most popular frequencies are preprogrammed at the factory so that the unit can be operated right out of the box.

The scanner can be programmed to scan as many as 45 channels, or search entire frequency ranges to find active new frequencies. A numbered keypad and a dual-level vacuum flourescent display that flashes visual messages, makes entering frequencies as easy as dialing a pushbutton telephone.

For added convenience, frequencies can be grouped into any of four channel banks for bank scanning. (For example, bank one could include all common police frequencies, bank two can include fire channels, etc.) All four banks can be scanned at once, or individual banks can be scanned if necessary to speed up the scanning cycle.

While the scanner keeps listeners abreast of all of the latest developments in their community, it also provides up-to-the-minute weather bulletins from the National Weather Service at the touch of a single key. When the WEATHER SCAN key is pressed, the scanner automatically searches all National Weather Service frequencies to find the active frequency in seconds.

Other deluxe features include a priority channel, which overrides all other calls so that broadcasts are not missed; channel lockout, for skipping channels not of current interest; fast and slow scan speeds; and a memory back-up system that uses a capacitor instead of batteries to save frequencies during power outages and when the scanner is unplugged.

CIRCLE 73 ON FREE INFORMATION CARD

The Regency R1090 scanner has a suggested retail price of $239.95 and is backed by a full one-year warranty. The basic package includes an AC power-supply cord, telescoping antenna, and an easy-to-follow instruction manual.

Complete details are available from Regency scanner dealers or by writing directly to Regency Electronics Inc., 7707 Records Street, Indianapolis, IN 45226.

Tri-band CB Antennas

Midland Model 18-2985 is a cellular look-alike magnetic-mount antenna with

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KB-103

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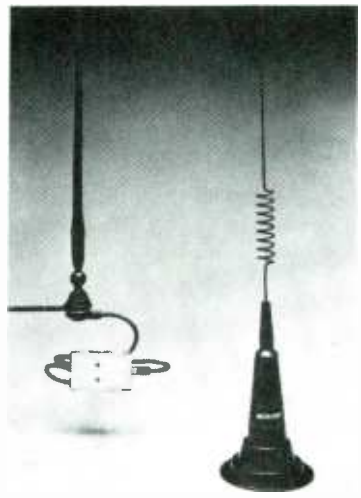

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the unique air-wound cellular style coil. The antenna's whip is tough 17-7 stainless steel in jet black. Midland's Hi-Pro coil assures maximum coverage and talk power. Model 18-2985 is prewired, factory tuned, skinpacked in a display package, and has a suggested list price of only $34.95.

Model 18-236, another Midland mobile antenna, includes a splitter to run AM/FM standard broadcast radio plus CB radio. With a rugged 16-in. rubber mast and 12 feet of cable, the antenna is well-suited for cars, trucks, vans, RVs, and motorcycles. Suggested retail price is a mere $29.95.

For more information on Midland's CB antennas, contact Midland International, Consumer Products Division, 1690 N. Topping, Kansas City, MO 64120.

Self-Study Ham Radio Course

Now there's a Novice Voice Class Course for people just getting started in ham radio. The course contains a 112-page fully-illustrated text book, two long-play stereo cassettes, an amateur radio Form 610 application, and a ready-to-go Novice examination in a sealed envelope, all enclosed in a colorful cassette binder. The course is authored by Fred Maia, W5YI and Gordon West, WB6NOA, both nationally known and respected amateur radio educators and examiners.

The package was commissioned and

CIRCLE 82 ON FREE INFORMATION CARD

professionally produced by a publishing house who have already received commitments for thousands of copies to be distributed across the nation.

The text book, with graphics, takes a fun approach to learning how to be a ham radio operator. Its chapters not only contain the Novice Element 2 question set, complete with multiple choice answers and explanations, but a general overview of the amateur radio hobby, history of the Novice class, how to complete the paperwork, how to find an examination, who may give the test, what to expect at an examination, how to pass the test, and even guidelines for the volunteer examiners on how to conduct the examination.

Its accompanying two audio cassettes, produced by Gordon West, WB6NOA stress that learning the code should be easy and fun. In short, everything needed to prepare for and pass the Novice Voice Class license requirements is included in the self-study package.

The package is retailed at $19.95. For more information contact VEC, PO Box 10101, Dallas, TX 75207; Tel. 817/461-6443.

EaZy PC

The EaZy PC—Zenith's lowest priced, personal computer ever—is a compact, one-piece PC/XT-compatible system offering superior video technology, advanced 3.5-inch disk drives and features needed by most PC users.

Working with Microsoft Corp., ZDS has designed an easy-to-use operating system interface for the EaZy PC, called MS-DOS Manager. MS-DOS Manager uses windows and drop-down menus which means on-screen instructions make the next steps obvious. That allows EaZy PC users first MS-DOS PC with the ease-of-operation usually attributed to Apple's Macintosh.

Tutorial software included with the computer provides simple instruction for fast and efficient use of the EaZy pc and MS-DOS Manager.

Microsoft's new MS-DOS Manager eliminates the need to memorize the many DOS commands. MS-DOS Manager and its easy-to-understand drop-down menus let you sail smoothly through complex directories using only the cursor and return keys.

The EaZy PC's all-in-one system design eliminates the sometimes confusing array of wires connecting the computer and monitor. To make it even easier to use, the EaZy PC's many connection ports are labeled in simple English. For example, ZDS has designated the keyboard connection "keyboard," the mouse port "mouse," and the printer parallel port "printer."

The EaZy PC features a 14-in. monochrome monitor that displays high-resolu-

CIRCLE 90 ON FREE INFORMATION CARD

tion graphics and text on a white background, resembling a printed page. The monitor uses the same double-scan CGA video technology employed by IBM's new Personal System/2 Model 30. That technology doubles the resolution of standard CGA video to 400 horizontal lines while maintaining full compatibility with all standard CGA software. The monitor can be adjusted to virtually any angle on its tilt-swivel base.

The EaZy PC uses an Intel 8088-compatible microprocessor running at 7.16 megahertz. Standard features of the three EaZy PC models include 512 kilobytes of random access memory (RAM) expandable to 640K, Zenith's standard professional desktop keyboard, MS-DOS 3.2 MS-DOS Manager, and mouse, and parallel ports.

Zenith Data Systems offers three configurations of the EaZy PC. Model 1 has one 720K 3.5-inch disk drive and a suggested retail price of $999. Model 2 feature two 720K 3.5-inch disk drives and has a suggested retail price of $1,199. Model 20 includes a 20 megabyte hard-disk drive and a 3.5-inch floppy drive. Its suggested retail price is $1,699.

The disk drives are located on the right side of the system. One red LED on the front panel signals when the drives are being accessed. A green LED indicates power on.

The EaZy PC's RAM can be expanded to 640K through two options available in August. Option EZA-1 provides a 1,200 baud modem, serial port, CPS communications software and 128K RAM. Option EXA-4 is a 128K RAM kit. ZDS also offers a real-time clock for the EaZy PC.

The EaZy PC's dimensions are 13 × 13 × 14-in., and the system weighs 28 pounds. The EaZy PC is covered by ZDS' one-year carry-in warranty. For further information contact Zenith Data Systems, 1000 Milwaukee Avenue, Glenview, IL 60025; Tel. 800/842-9000.

Personal Logic Analyzer

Finally, a full-function, truly portable, 16-channel, logic analyzer that fits in your tool kit or briefcase. Don't let the size of this powerful diagnostic tool fool you.

(Continued on page 23)

By Herb Friedman

FRIEDMAN ON COMPUTERS

Modemize! Let no one else's work evade your eyes!

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All you need is a personal computer, a computer-to-telephone-line hardware interface, and some kind of software that lets your computer communicate with another computer via the telephone lines.

The computer-to-telephone-line interface—called a *modem*—is a device that converts your computer's electrical signals to audio tones that are within the frequency passband of the dial-up telephone circuit. At the other end of the circuit, another modem interfaces the line to its computer. The problem is, however, that several kinds of modems are available for personal computers, and if the salesman in the store is primarily interested in pushing the stuff that brings the largest profit, there's a good chance that you'll end up with a modem that might not meet your specific needs.

The Modem

Let us avoid the hardware-hacker stuff and go right to the nitty-gritty details that make the system work. We'll start off with the *baud rate*—which, in plain English, means how fast the modem will transmit data. For all intents and purposes, baud rate means bits-per-second. Early modems were intended for the dial-up telephone system operated at 110 baud, then 300 baud, then 1200 baud; today we go as high as 2400 baud.

No matter what anyone says, 300 baud is much too slow except for hobbyists who must keep modem costs at rock-bottom. 1200 baud is the more-or-less universally accepted "standard" speed, and dual-speed, 300/1200-baud modems can be purchased for as little as $100. Most 300/1200 baud modems will automatically switch to the correct baud rate as determined by the software or the incoming signal.

The 2400-baud modems are relatively expensive and usually can communicate only with other 2400-baud equipment, so they are generally used only for dedicated communications, where speed is of utmost importance on the dial-up telephone. (Special telephone circuits are generally used for baud rates higher than 2400.)

Today, most modems—even the lowliest of the low-cost models—are auto-answer/originate, meaning they can be "sitting" on the telephone line, ready to automatically answer any other computer calling in, or they can call another computer or a computerized information service by using automated dialing.

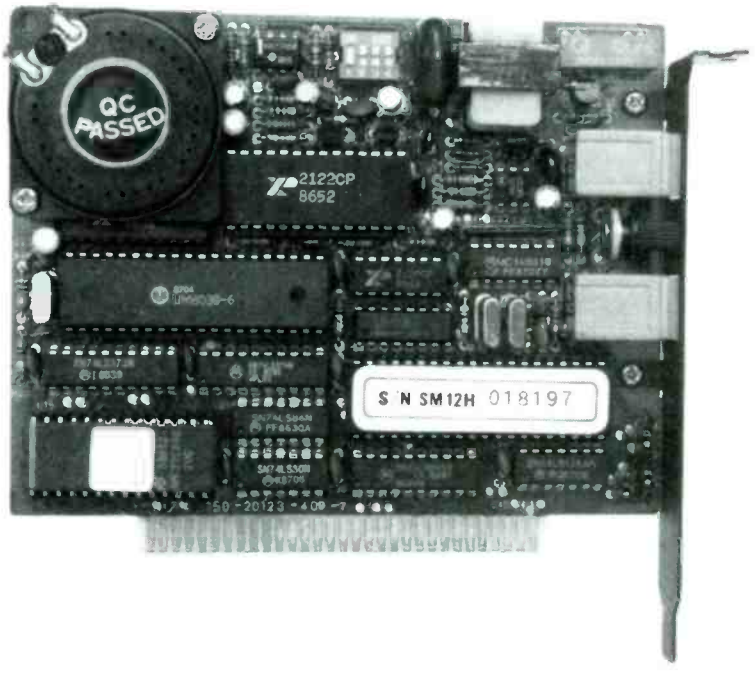
While there are many different kinds of modems, most use the *defacto*-standard "Hayes commands;" the commands used by the D.C. Hayes modems. The D.C. Hayes modems are the most popular; hence, their command-set has become the standard-of-reference for personal computers. Also, since many communications programs were designed for the hardware circuits and switching of the Hayes modems, virtually all modems attempt to emulate the Hayes modem's handshaking signals. Those modems that don't fully emulate the Hayes hardware have either fallen by the wayside, or have a tough time in the marketplace.

The Missing Handshake

Here's just one example why Hayes compatibility is so important. One of the features of a Hayes modem is that it outputs a signal when receiving the "carrier" from another modem. If the other modem drops off the line, the Hayes modem interrupts its carrier-handshake signal.

Now there is a popular bulletin-board, software package that allows inexpensive

(Continued on page 22)



This is what's called a "half-slot" internal modem; it fits the short slot of an IBM/PC/XT computer or compatible. While it functions well as a modem, what appears to be a speaker at the upper left hand corner functions more like a buzzer for dial tone. Its slight response to ringing and busy signals, and voice, is usually obscured by even the slight noise of the computer's internal fan.

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Already, advanced robotics systems are producing everything from electronic circuits to automobiles. By 1990, over 100,000 "smart" robots will be in use, creating over 30,000 new technical jobs.

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FRIEDMAN ON COMPUTERS

(Continued from page 18)

Radio Shack computers to function as a *Bulletin Board*, commonly referred to as a BBS. (Lot's of computer hobbyists enjoy running a local BBS for their friends.) The problem is, the software resets when it loses the carrier-detect handshake signal from the modem—that's how it knows the caller has signed off, or has simply left the BBS.

There's a very famous, budget-priced modem that's sold tens of thousands of units because it has good performance and responds to the Hayes commands. Unfortunately, as many BBS operators learned after many hours or days of troubleshooting, that particular modem saved a few pennies by not providing the carrier-detect handshake: the carrier-detect signal was always forced "high."

As far as the program is concerned, the modem is always receiving a carrier, so the BBS tries to hold the modem on the line. Either the modem must be modified to provide a real carrier-handshake signal, or the user must purchase a true Hayes modem or one that is truly 100% Hayes-compatible. Of course, it's somewhat disconcerting to expend the money and energy to set up and then troubleshoot a BBS, only to find the problem lies with a Hayes-compatible modem that isn't really 100% compatible.

Now even if you don't intend to run a BBS, some of the very best communications software requires that the modem provide all the Hayes' handshakes for optimum performance, so full-Hayes' compatibility is always a prime consideration when upgrading your computer with a modem.

Signal Lights

Another thing that you might want to consider are a modem's signal lights, which are usually a row of LED's. The Hayes standard includes lights for modem ready, terminal ready, sending data, receiving data, off-hook (the modem is connected to the telephone line), carrier detect, auto-answer mode, and high speed (1200 baud). As you can see, the Hayes' lights tell the user a lot about what's happening.

If anything goes wrong with either making connection to the telephone or the other computer, or if something goes awry with the connection itself, the user can get a reasonably-good idea of what's awry, or what went wrong.

Although some Hayes-compatible modems provide all the lights, some only provide the major lights, such as transmit and receive data, high-low baud rate, and carrier detect. Still others provide only a single light, for carrier detect; based, I guess, on the belief that if the carrier is lost, the modem connection is lost, so anything else is unimportant. (The Hayes-series of lights cannot be appreciated until every attempt to use the modem produces a screen full of garbage characters.)

Hear No Evil

Another outstanding feature of fully-Hayes compatible modems is complete telephone monitoring. Up until the two modems link up, a small speaker within the modem keeps you informed about what's happening on the telephone line. As soon as your software tells the modem to go on-line, you hear the dial tone, then you hear the dialing, next the ringing signal, finally, the other modem's carrier.

When the two modem's link, the speaker shuts off. If the telephone number you've dialed is busy, you'll actually hear the busy signal. If you have inadvertently dialed the wrong number, you'll hear a voice answer "Hello...hello." At all times you know what's happening. Some modems don't have a speaker; instead, they provide some or all of these screen cues: *Dial Tone, Ringing, Busy, Connect, Carrier Lost, Party Hung-Up, Disconnected.* While not as convenient as a monitoring speaker, it's the next best thing.

A variation on the usual modem is the internal design intended for installation within the computer. Some, like the Hayes models, provide almost the same features as their larger brothers. And while they don't have the signal lights, they do have a monitoring speaker, and screen cues. Lately, the size of the internal modems have been shrunk to half-size, such as the model shown in the photograph, which is intended for an IBM PC's "short" expansion slot.

Unfortunately, while some of the internal modems appear to have a built-in speaker, the speaker is really a buzzer that is most efficient at the dial-tone frequency. When the modem goes on line, you can hear the dial done, and maybe even the dialing pulses or tones. But response to the ringing and busy signals, and voice, is so low that the sounds are essentially impossible to hear over the sound of the computer's cooling fan. In short, they are a pain-in-the-bit to use.

Of course, they do provide screen cues, but is the cue *No Carrier* a substitute for a voice shouting "Who is this?" While "No Carrier" or "No Connection" can mean anything from dialing the wrong number to the BBS being shut down, an irate voice really tells you that you've made a dialing mistake.

As a general rule, at least for personal communications, even if you must cut communication costs to rock-bottom, try to get as much Hayes compatibility as you can, along with all-signal speaker monitoring of the telephone line. ■

NEW PRODUCTS SHOWCASE

(Continued from page 17)

CIRCLE 84 ON FREE INFORMATION CARD

The PrimeLine Model PLA-3300 Personal Logic Analyzer performs three analyzer functions—State, Timing and Signature Analysis. The analyzer uses LCD technology to provide a large, low-power display that allows operation from a built-in rechargeable Ni-Cad power source or operates from conventional line power without the need for an AC adaptor. External DC can also be used.

The Model PLA-3300 has just about everything: a 10-MHz clock rate that yields up to 100 nanosecond resolution; 16 channels for data input with 256 bits/channel of acquisition memory and a reference memory of 256 bits/channel for comparative analysis; 15 nanosecond glitch detection; powerful triggers using words; 3 function display of state, timing and signature, with state display being provided with choice of binary, hexadecimal, ASCII or octal, data acquisition in 3 modes including ×4 expanded window display, histogram and variable-delay trigger function. And, if this is not enough, how about an auto power-off function if you forget to turn off the unit (yes, all data in memory is preserved for analysis later). The PLA-3300 will even run a diagnostic self test to let you know all is working at top performance.

Priced at $1,995.00, complete with manual and input probe. For the name of a local distributor, call 800/525-5554, or in California 818/764-5400. Or write: PrimeLine, Division of Soltec Corporation, PO Box 670, San Fernando, CA 91341-0670.

Car-Stereo Amplifiers

If you'd like to switch between sets of auto speakers this item will be of interest to you: The new Deltasonik line of amplifiers offers some new features, such as choice of two, three, or four channel operation.

CIRCLE 55 ON FREE INFORMATION CARD

The D-360, is capable of two, three or four-channel operation, depending on the molex harness specified with the product. The power output of the D-360 is 180-watts per channel, 4 ohms, into two channels, 1.0% THD or 150-watts, per channel, 4 ohms, at 0.01% THD.

Features on the D-360 include a pulse-width modulated power supply for tight bass and performance immune to battery-voltage surges. The unit also features Deltasonik's exclusive Permateet protection circuitry, low and high level inputs with continuously variable sensitivity for maximum source compatibility, discrete power output transistors and mil-spec epoxy printed-circuit boards for years of reliability, discrete power-output transistors and mil-spec epoxy printed circuit boards for years of reliability and sonic excellence

Suggested retail price of the D-360 is $475.

For complete information and specifications on the Deltasonik line, contact Alphasonik, Inc., 701 Heinz Avenue, Berkeley, CA 94710; Tel. 415/548-4005.

(Continued on page 99)

BOOKSHELF

Understanding Digital Computers
By Forrest Mims, III

Computer users who want to understand the fascinating circuits and principles behind the digital computer will discover the basics of binary, sequential, and arithmetic logic in this text. The book also discusses the power of computer memories and memory devices, from magnetic tape and floppy disks to magnetic bubbles and laser disks. Topics covered include: what's a computer?, number systems, binary logic, combinational logic, sequential logic, arithmetic logic, memories, and computer programming.

CIRCLE 63 ON FREE INFORMATION CARD

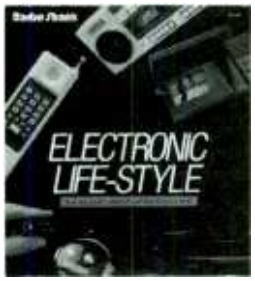
Understanding Digital Computers, is 320 pages and retails for $15.95. It's available from: Howard W. Sams & Co. Inc., Dept. R40, 4300 W. 62nd St., Indianapolis, IN 46268; Tel. 800/428-SAMS.

Electronic Life-Style
By Gordon McComb

Whether it's a sophisticated home security system, an elaborate stereo system, or merely a dishwasher, the explosion of electronics technology has affected our everyday lives. Not since the Industrial Revolution has such an impact been made on our society.

This book describes in everyday language how the Electronic Revolution came into existence, how it has impacted our lives, and what kind of products and conveniences it has made possible. The book differs from other books on electronics because it explains what the electronic-managed products do and how they do it. Thus the reader has the opportunity to make more intelligent purchases.

Full of color photos and illustrations, the 160-page book offers a refreshing, fun look at the many facets of life that have been influenced by electronics. Interesting reading for the entire family, the book allows the



CIRCLE 52 ON FREE INFORMATION CARD

reader to enjoy learning about electronics that are the products used everyday—TVs, stereos; Telephones, appliances, automobiles. A wide array of products including shop tools, security systems, home computers, entertainment systems, and exercise equipment are reviewed.

In non-technical language, the book clarifies the somewhat mystifying world of electronics for those who are overwhelmed by modern technology. Intended for the everyday consumer, as well as the professional, meaningful information is given on the history, applications, affects, and future of consumer electronics.

Electronic Life-Style may be purchased at Radio Shack stores for $9.95.

IBM PC 8088 Assembly Language Programming
By Richard Haskell

Here's a book designed to make learning 8088 assembly language easier. In an introductory offer a person may purchase the book, for $28 (shipping included) and receive free, a powerful 8088 tutor monitor program that will run on any IBM PC or PC compatible (including XTs and ATs).

The memory can load any disk file for detailed examination, will disassemble any 8088 code, and has breakpoint and single-step capabilities that can be used to debug any EXE or COM file generated with the IBM macro assembler. The book uses the tutor monitor as an integral part of its detailed discussions of the 8088 assembly language and the inner workings of the IBM PC. If the customer is not completely satisfied

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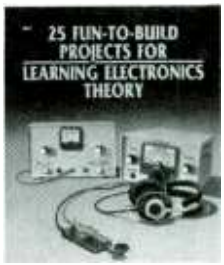
with the book, he or she may return it for a full refund and keep the tutor monitor free of charge.

For further information, or to order the book and software for $28 including shipping and handling, contact REH Books, 54 N. Adams, Suite 130-N, Rochester Hills, MI 48063; Tel. 313/375-0629.

25 Fun-to-Build Projects for Learning Theory
By the Editors of Elementary Electronics

This is a collection of projects that makes learning electronics theory incredibly easy and enjoyable. With its hands-on, here's-how-it's-done approach, even the most elusive concepts of electronics and electricity become easy to understand and apply...making it the ideal first book



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of projects for the beginning hobbyist and a perfect supplementary text for high school and vo-tech courses.

You'll get complete instructions, diagrams, and schematics for 25 fascinating and useful electronic devices that can be put together in only a few hours time from easily available and low-cost components. The projects you'll build range from a supercharger battery charger, battery monitor, and U-pick-It guitar box to a tape tester, spiderweb receiver, radio antennas, a dashboard digital voltmeter, and many more. Best of all, these are projects that not only teach electronics—they're devices that really function when they're completed.

Not only will you find many exciting projects which you can build, you will also find clear, easy-to-understand information on the electronics theories these projects demonstrate. Starting with a quick overview of electrical and electronic basics, this indispensable guide will introduce you to transformers, transistors, regulated power supplies, the breadboard system, inductance and capacitance, phase and frequency, logic circuits, and much more. Well-written and designed to inspire you to go on to develop your own original project variations and improvements, this is a teach-yourself-electronics

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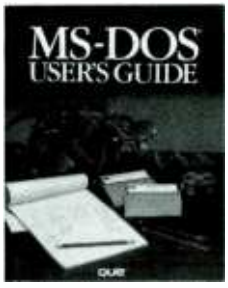
BOOKSHELF

guide that would be hard to beat at any price!

25 Fun-to-Build projects for Learning Electronics Theory sells for $7.95. Order from Tab Books, Inc., Blue Ridge Summit, PA 17214.

MS-DOS User's Guide —2nd Edition
By Chris DeVoney

MS-DOS is the standard operating system for more than 50 of the most popular personal computers on the market today. If you are one of the millions of users of MS-DOS, you will find a wealth of information in MS-DOS User's Guide, 2nd Edition, that



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will give you ultimate control over your computer's most important software: the operating system. The text is the combination of a beginning tutorial, advanced guide, and lasting reference that will meet your changing DOS needs. Whether you're interested in DOS basics, ready for more advanced DOS topics, or looking for a handy DOS reference manual, MS-DOS User's Guide, 2nd Edition, has the information you need, presented in an easy-to-understand, quick -to-locate format.

If you're a beginning user, you'll learn how to: prepare your diskettes, manage DOS directories, erase, rename, and copy files, print what appears on your screen, and avoid disastrous errors. If you're a beginning user, you'll enhance your productivity by learning to master path names, maneuver through directories, customize DOS, use RAM disks, and create AUTOEXEC.BAT files.

Regardless of your level of expertise, you can use the Command Reference section to gain quick access to 70 most-frequently used DOS commands, also, you will recognize valid DOS command phrasing and learn to cope with frustrating DOS error messages.

If you use the COMPAQ, EPSON, or Leading Edge versions of MS-DOS you can easily reference, in a separate appendix, the special commands for your version.

The text sells for $21.95 and is available from Que Corporation, 7999 Knue Road, Suite 202, Indianapolis, IN 46250; Tel. 317/842-7162.

Electronic Test Instruments: A User's Sourcebook
By Robert Witte

To use electronic test instruments effectively, it's necessary to understand basic measurement theory and how it relates to practical measurements. Written for hobbyists, students, technicians, and engineers, Electronic Test Instruments: A User's Sourcebook is for people who want to learn more about how electronic measurements are made and who want to build on their existing electronics knowledge.

This important sourcebook simplifies the internal workings of test instruments through the extensive use of easy-to-understand circuit models and conceptual block diagrams. Thus the behavior of a complex circuit or

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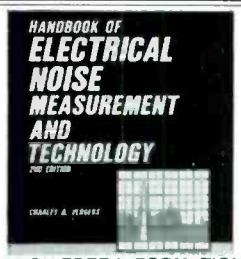
instrument can be described by conceptually replacing it with a much-simpler circuit.

An excellent supplement to existing instrument operating manuals, Electronic Test Instruments: A User's Sourcebook will help you understand: basic measurement theory and fundamentals, meters, signal sources, oscilloscopes, circuit concepts and how they relate to electronic measurements, and frequency domain instruments, such as analyzers, wavemeters, narrowband vs. broadband measurements, and gain/phase meters.

The text sells for $14.95. Published by Howard W. Sams & Company, A Division of Macmillian, Inc., 4300 West 62nd Street, Indianapolis, IN 46268; Tel. 800/428-SAMS.

Handbook of Electrical Noise: Measurement and Technology—2nd Edition
By Charles A. Vergers

This book has been completely revised and greatly expanded to include all the newest developments in



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the field. Here are the answers to virtually any question on electrical noise—its origins, causes, and effects—fully supported by equations, examples, drawings, diagrams, and experiments. You'll learn how to identify all types of electrical noise, how to predict and calculate its levels in electronic systems, how to measure noise, how to design low-noise circuits, and much more.

Taking a direct, no-nonsense approach to the subject, Vergers gives you a thorough explanation of noise types, terminology, and statistical terms. You'll also gain a better understanding of signals and systems for noise, thermal noise, electronic noise, noise calculations in advanced networks, and many other sophisticated concepts.

Whether you're an electronics novice or an advanced technician, you are sure to find the coverage of noise measuring instruments and equipment of particular value in both your work and your hobbies. With an abundance of examples, and end-of-chapter summaries, questions, and problems, this guide will also prove to be indispensable to electrical engineering students.

Plus there are now a total of 12 experiments that you can perform with a minimum amount of electrical equipment. Five of those exciting projects are brand new: lowpass and highpass filters, a bandpass filter, a notch filter, compressor and expander circuits, and a transistor voltage amplifier using optimum collector current.

The text sells for $39.95, and is available from Tab Professional Books Inc., PO Box 40, Blue Ridge Summit, PA 17214.

Handbook for Sound Engineers: The New Audio Cyclopedia By Glen Ballou

This reference book discusses all aspects of audio technology, including the most recent methods of producing, reproducing, changing, controlling, reinforcing, and measuring sound.

The 31 chapters are combined into 7 parts as follows: Acoustics—fundamentals; psychoacoustics; small room acoustics, common factors; acoustic design; recording studio design; rooms for speech, music, and cinema, open plan rooms. Electronic Components for Sound Engineering—resistors, capacitors, and inductors; transformers; tubes, discrete solid-state devices, and integrated circuits; heat sinks, wire, and relays. Electroacoustic Devices—microphones; loudspeakers, enclosures, and headphones; Audio Electronic Circuits and Equipment—

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amplifiers; attenuators; filters and equalizers; delay; power supplies; constant-and variable-speed devices; VU and volume indicator meters and devices; consoles and systems. Recording and Playback—disk; magnetic; digital. Design Applications—sound system design; systems for the hearing impaired; the broadcast chain; image projection. Measurements—audio measurements; fundamentals and units of measurements

Handbook for Sound Engineers: The New Audio Cyclopedia, No. 21983, is 1,248 pages and retails for $79.95. The book is available through bookstores, electronics distributors, or direct from Howard W. Sams & Co. Inc., Dept. R40, 4300 W. 62nd St., Indianapolis, IN 46268; Tel. 800/428-SAMS.

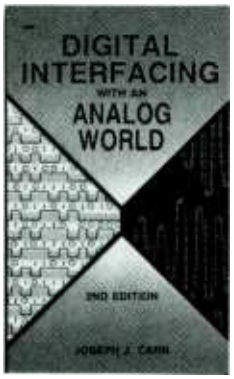
Digital Interfacing with an Analog World—2nd Edition By Joseph J. Carr

A completely revised and updated edition of a guide that over 14,000 hobbyists and technicians have depended on for nearly a decade! Completely up-to-date with the most recent technology. Digital Interfacing with an Analog World—2nd Edition, makes it possible for you to really put your microcomputer to work.

It explains how to convert energy produced by pressure, force, position, temperature, and other sources into an electrical voltage or current that a microcomputer can deal with. It presents information for users of microcomputers who want to design a device or system with a microcomputer at its heart.

BOOKSHELF

You'll get information on all types of transducers—elementary position transducers, digital code position sensors, velocity acceleration transducers, temperature transducers, capacitance transducers, inductive transducers, and more! Operational



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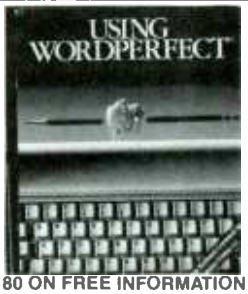
amplifiers and operational-amplifier circuit design are covered, along with isolation and other amplifiers. In addition, you'll learn about analog function modules such as universal V/F–F/V converters, mulifunction modules, and some useful digital circuits such as one-shot multivibrators and the 74100 latch. Digital Codes—straight binary, twos complement, division and multiplication, number system conversion, octal and hexadecimal numbers, binary-coded decimal, excess-3, gray, alphanumeric.

How to Design and Build Electronic Instrumentation—2nd Edition, and Digital Electronics Troubleshooting—2nd Edition. Sells for $19.95. Published by Tab Books Inc., Blue Ridge Summit, PA 17214; Tel. 717/794-2191.

Using WordPerfect—3rd Edition

Using WordPerfect, 3rd Edition, makes learning the expanded version 4.2 pure pleasure! Using WordPerfect, 3rd Edition,is a helpful text because it offers hands-on quick start learning modules that present basic WordPerfect features and functions in "real-life" applications. It provides chapter previews that help you decide what content is most pertinent to your needs, and chapter wrap-ups that summarize and reinforce each chapter's most important concepts. Add to that a unique step-by-step format that encourages you to use the book as a self-teaching tool, as a reference manual, or as a desktop quick guide. The text also supplies expanded drawings, tables, screen



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displays, and charts that help you "see" exactly what WordPerfect can do for you!

Using WordPerfect—3rd Edition, is divided into functional sections targetting user groups beginners, those already familiar with WordPerfect and many advanced users.

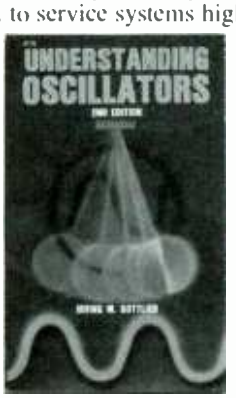
The text presents comprehensive coverage of the consistently best-selling software, including how to: add hidden comments that do not appear in your printed documents, use the Document Summary feature important to file-management—especially in the corporate environment, enter line numbers in your reports and manuscripts, create outlines and columns of text; and use the expanded Dictionary, Spell-checker, and Thesaurus to write correctly, clearly and dramatically.

Put WordPerfect to work for you in the frustration-free learning environment created by this expanded version of Using WordPerfect, 3rd Edition.

The text sells for $19.95 and is available from: Que Corporation, 7999 Knue Road, Suite 202, Indianapolis, IN 46250; Tel. 317/842-7162.

Understanding Oscillators—2nd Edition
By Irving M. Gottlieb

Here's a guide to designing, operating, and using oscillators that brings theory and hardware together with minimal mathematics. This practical guide provides you with the information you need to devise oscillators with optimized performance features, to service systems highly



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Does fighting the crowds at Christmas short-circuit your holiday fun? Don't blow a fuse this year ... for the friend who shares your love of project-oriented electronics — or a youngster who may need only a spark to ignite a life-long interest — give a gift subscription to Hands-On Electronics!

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Send no money, unless you prefer. We'll be glad to bill you in January, Next Year. Just take a brief moment to go over your gift list and make sure you haven't forgotten anyone who might appreciate the "Hands-On" experience. Then write the names on the attached Gift Certificate and mail it back in the postage-paid reply envelope ... we'll take it from there!

Your friends will receive a handsome gift announcement card signed with your name just before Christmas. And all through the new year they'll remember and appreciate your thoughtful gift of "Hands-On" experience!

So don't blow a fuse ... take it easy and enjoy the holidays. Give Christmas gifts of Hands-On Electronics!

Hands-on electronics
NOVEMBER 1987

Seeing the light FLASH

YOU MAY HAVE A CAMERA THAT HAS ALL THE AUTOmatic features a photobuff would ever ask for. Almost every shutterbug has one these days. But look ahead. In the future you may want to step up to studio photography with more than one electronic flash going off at a time. Then that little computer wheel on the back of the flash unit cannot pick the right *f*-stop for you. What if the unit has aged some or the batteries are not at full charge? What if you are using more than one flash unit and each one is a different type, and placed at different distances from the subject? Do you average their readings? Do you guess and bracket your exposures widely? Do you punt?

At today's film and processing prices, you are better off knowing the right *f*-stop on the first shot, with all the variables cranked into the equation. If you are a bad guesser like me, the smiling young lady in the yellow hut in the mall parking lot should be listed as one of your dependents come next April 15.

What you really need is a professional flash meter. Or, maybe if you are a smart cooky, you'll build *Flashmate* and take your first step to *pro-dom*.

For years, professional photographers have been using flash meters to overcome the myriad of variables which affect flash photography. The meters come in a variety of packages from those the size of a cigarette pack to those the size of a cigar box. They all have varying features, but they share one common denominator—a price tag of $100 and up, and up, and up! You, however, can build one tailored to your own needs, or to needs you haven't even discovered yet, for the price of a restaurant meal. Take a hard look at the easy-to-understand theory and construction of Flashmate, and you will be making your very own gadget tomorrow.

The Theory of It

An insulated-gate, field-effect transistor (IGFET), Q2, and a silicon photo cell, Z1, form the heart of a fairly simple circuit. Refer to Fig. 1. The transformer, T1, is an ordinary audio-output type, but it's reversed in the circuit. A sudden flash from a photoflash unit detected by Z1 sends a voltage pulse through the low-impedance winding of T1 via R1. That voltage pulse is stepped-up in T1's 500-ohm, primary winding before being rectified by Q1. Transistor Q1 is used as a diode; its emitter lead was snipped off close to the case. Q1 then charges C1 to a value proportional to the amplitude of the electrical pulse generated by the light from a flash unit.

Capacitor C1 controls the current flowing through Q2, which has a very high-input impedance. The current through Q2 is read by meter M1 (a 0-50-μA DC unit) which has been calibrated in *f*-stops. The extremely high internal resistances of Q1 and Q2 will allow C1 to retain its charge for several minutes: more than enough time for you to take your reading of M1. The charge on C1 is shorted to ground and returned to zero volts by depressing RESET button, S1. Flashmate is ready to read the next photoflash.

Trim potentiometers, R7 through R14, are adjusted to values which will yield correct readings for corresponding film sensitivities, or exposure indexes. Depending on your age or photo experience, you may refer to the exposure indexes as ASA, ISO, or even EL. All are indicative of your film's *speed* and Flashmate must be calibrated to measure the proper exposure for each type of film you anticipate using, now or in the future.

Putting It Together

The main consideration in selecting a cabinet or plastic box, is having space enough to mount all the controls and meter along with the photo cell. Some thought to layout should be given to provide a practical configuration. Remember, the photo cell, Z1, must face the flash when it is fired, and since you would be near the camera, you would want the meter, M1, either facing you or upward for easy reading. Place some window material (clear plastic) over the photo cell to protect it from damage and dirt.

Wiring of Flashmate does not introduce any critical parts or lead layout. A printed-circuit board or a piece of perfboard will do the job. Take the easy way out—use perfboard.

Start by laying out the parts to be mounted on the panels of the box. Make sure you leave enough room to operate all switches. The perfboard can be cut to fit behind meter M1; mount it by the two contact posts of the meter. If you do this, indicate on the board next to the posts which is positive and which is negative.

with... MATE

Know once and for all what to set your camera lens at no matter how many lights and reflectors you use!

By Frank I. Gilpin

Consideration is given to layout components and controls. The meter (M1) and ASA selector switch (S3) are on top of the front panel. Reset and Power switches (S1 and S3) are on side panel and the photo cell (Z1) is on the top panel. The exact layout can be made differently to suit the plastic or metal box you use and views you may have as to what is best for you.

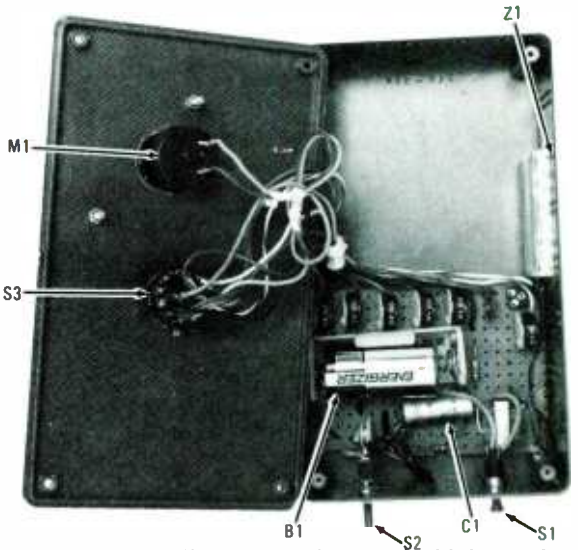
Be cautious: The manufacturer of the IGFET, Q2, has wrapped a shorting wire around all four of its leads. Keep the wire in place until the transistor has been wired into the circuit completely to prevent the IGFET from self-destructing. Even a tiny static charge is enough to zap the unit into Never-Never Land.

Calibration

After the wiring of Flashmate is completed and double-checked, you will need to calibrate your device for the eight most-used ASA values. The schematic diagram in Fig. 1 indicates the most popular exposure indexes between 25 and 1,000, but you can substitute your own choices with wide latitude offered by the large values of trimmer potentiometers R7 through R14. Before you begin, set all trimmer potentiometers to their mid-range position.

To calibrate your finished unit, you'll need a reliable flash unit, a tape measure, and a long hallway, empty garage, or big room. The best kind of flash unit to use for calibration is the type which has an AC adaptor. That type is more likely to operate consistently at a full charge.

An easy method of putting the meter at a good working level is to set it on a stool such as a bar stool, or a short ladder.



Set the computer dial on your flash to the highest ASA used on your meter, say 1,000. Read the distance required for an exposure at *f*-22. For most small electronic flash units it will be in the neighborhood of 25 feet. Measure to a spot 25-feet distant from Flashmate. Make sure the ready-light on the flash unit is lit and fire the flash at Flashmate after turning the unit on and setting ASA switch, S3, to its highest setting. The needle of meter M1 should have gone way upscale, possibly even pegged. Adjust R14 until the needle rests just inside the full-scale mark. Adjust R4 so that the final setting of R14 is close to the stop for minimum resistance. That initial setting will provide enough resistance range for adjustment of the remaining trimmer potentiometers.

You will, of course, have to remove the transparent cover from the meter face to mark the calibrations. Do this very gently so as not to damage or bend the sensitive needle and coil movement. With a sharp pencil, mark the first calibration of *f*-22. *(Turn page)*

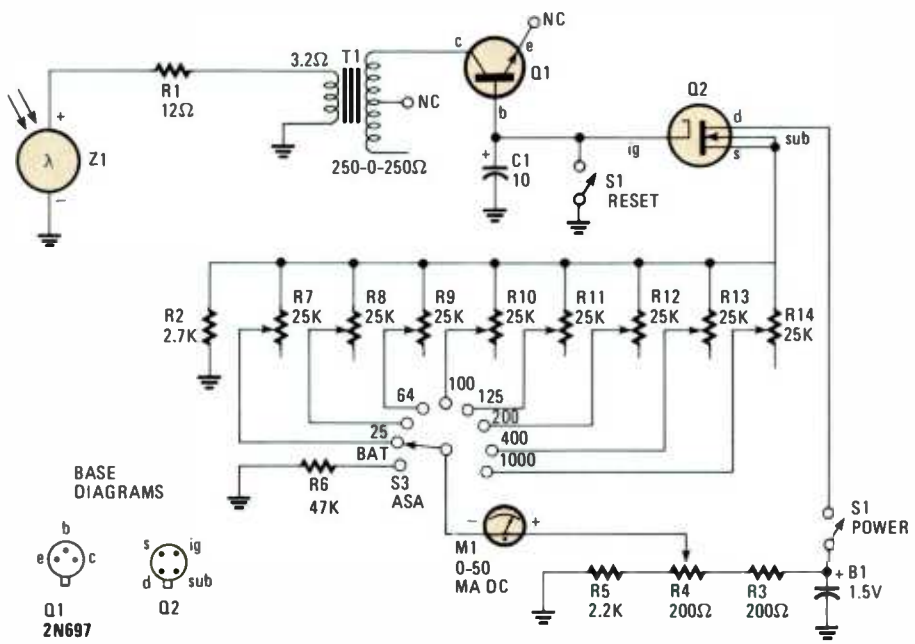
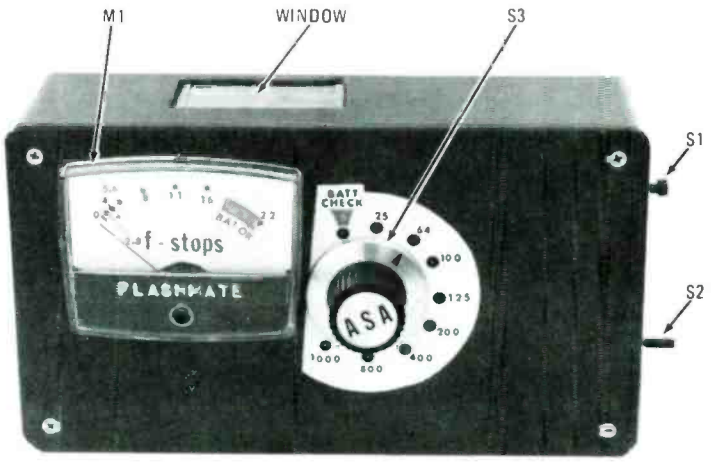


Fig. 1—You know a project will be accurate when everything is adjustable. You won't have to rely on the tolerance of the parts or how effective the circuit design handles the pulses created by Z1.

The Flashmate light meter is an evolved version of a unit designed for one ASA film speed and was one-quarter of the size. The final model, as featured here, was used for studio work. A smaller version might travel with you in your gadget bag for on-site sessions. The window at the top of the unit protects he photo cell from dirt and damage.



One neat technique is to cover the original meter faceplate with an adhesive-backed label big enough to cover the markings. Trim off the excess label with a sharp modeller's knife or razor blade. Make a small pencil mark at each calibration and make a note of its value on another piece of paper. Later, use transfer letters on those marks for a professional-looking meter faceplate.

With your unit now calibrated for *f*-22, check the dial on the flash unit once more. Set the ASA at the next lowest used on your meter, say 800. Note the distance required for an exposure at *f*-16; it would probably be about 21 feet. Measure 21 feet from the flash meter. Set S3 to the next calibration, 800, press the RESET button, S1. Then, from 21 feet, fire the flash unit at Flashmate. Adjust R13 until the needle of M1 rests about one half-inch or a little less from the first upscale calibration. Make that calibration *f*-16.

Things get very repetitive from here on. Reset the Flashmate and switch S3 to the next highest ASA, 400, and set the ASA on your flash unit to 400. Measure the distance required for an exposure at *f*-16; probably about 17 feet. Pop the flash at Flashmate from 17 feet and adjust R12 until the needle rests on the *f*-16 mark previously made on the meter faceplate.

Use the next setting on the flash meter, 200, set the flash for ASA 200, measure the distance for *f*-16, fire the flash, adjust R11 for *f*-16. Repeat this process for each remaining ASA on S3, adjusting potentiometers R10 through R7 until the needle reads *f*-16.

When you have adjusted each of the variable resistors, set ASA switch S3 to a mid-range, say 200 ASA. Measure off the distance for *f*-8 at 200 ASA, fire the flash and note the spot where the needle comes to rest and mark that *f*-8. Repeat this process at ASA 200 for *f*-5.6, *f*-4, *f*-2.8, and *f*-2 if there is room on the face, though it's unlikely you will ever use the last setting in the practice of your art.

The only remaining calibration is the voltage check. With a fresh C-type dry cell in Flashmate, switch S3 to BAT. An acceptable range is from full-scale, or *f*-22 to about two thirds of the way toward *f*-16. You can color this small range on the

(Continued on page 103)

PARTS LIST FOR FLASHMATE

SEMICONDUCTORS

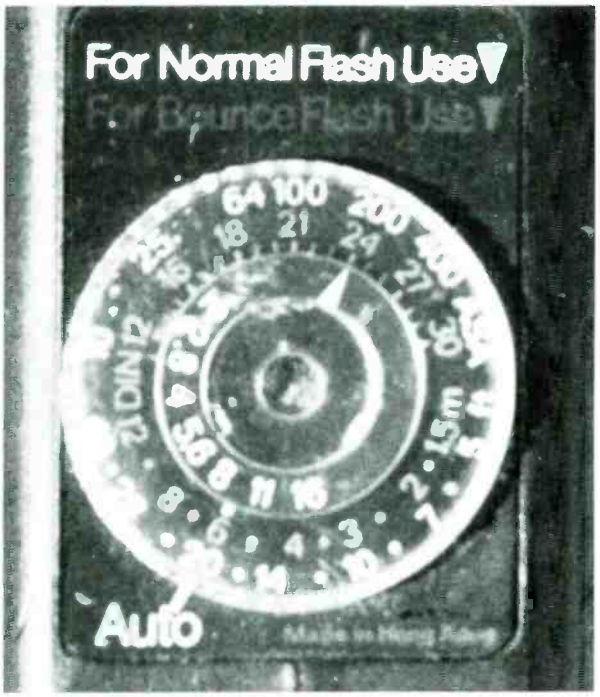
Q1—2N697 NPN silicon transistor (any similar type transistor will do)
Q2—3NI28 IGFET (ECG-220, Radio Shack 276-2036, or equiv.)
Z1—Silicon photo cell, such as Radio Shack's 276-124 rated 0.2 amp at 0.42-volt DC

RESISTORS

(All fixed resistors are ½-watt, 5% units)
R1—12-ohm
R2—2700-ohm
R3—220-ohm
R4—200-ohm trimmer potentiometer
R5—2200-ohm
R6—27000-ohm
R7–R11—25,000 trimmer potentiometer
R12—10,000-ohm trimmer potentiometer
R13, R14—5,000-ohm trimmer potentiometer

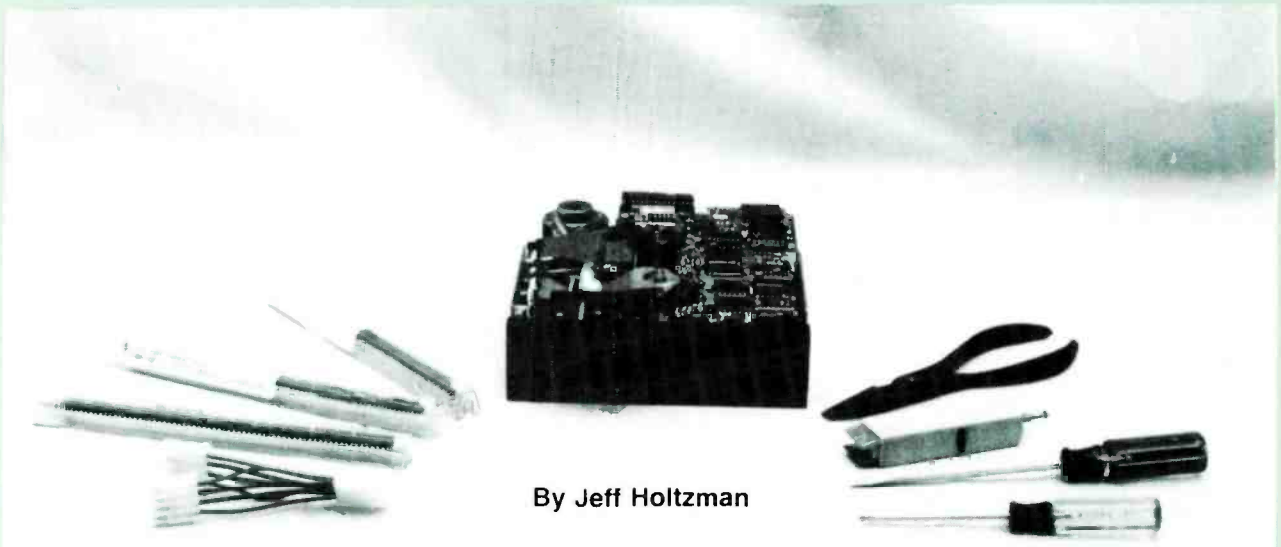
ADDITIONAL PARTS AND MATERIALS

B1—1.5-volt, C-size, dry-cell battery
C1—10-μF, 200-WVDC, electrolytic capacitor
M1—0–50-μA, DC meter (Radio Shack 270-1751, or equiv.)
S1—SPST, momentary-contact, pushbutton, switch
S2—SPDT, toggle switch
S3—1-pole, 12-position, non-shorting, rotary ASA switch (Radio Shack 275-1385 or equiv.)
T1—Miniature, audio-output transformer; 500-ohm center-tapped primary winding; 3.2-ohm secondary winding; turns ratio of 12.5 to 1
Plastic cabinet, battery holder for B1, knob, clear plastic window, wire, solder, etc.



The wheel calculator on the back of your photoflash unit provides a good rule-of-thumb guide for most strobe situations using a single photoflash, but it is the least accurate part of the unit. The setting shown above tells you that the camera should be 10 to 14 feet away from the subject, you should use an f-16 lens setting if you are shooting with 200 ASA film. Any number of light reflecting and absorbing variables, however, can spoil the shot. The Flashmate will save the day by providing the correct camera setting for the shot.

UPGRADING YOUR PC



By Jeff Holtzman

Expand your PC's memory and add a second disk drive

THE PRICE-CONSCIOUS PURCHASER OF AN IBM-COMpatible personal computer usually finds after using it for awhile that cost is not the only factor that determines the value of a PC. A limited machine—one with not quite enough memory, disk capacity, I/O ports, or speed—can actually be detrimental to work efficiency; thereby, compounding the very problem it was intended to solve!

Of course, it can be difficult to predict just how powerful a machine is necessary, because people often find more uses for a PC than they originally anticipated. And even those with accurate *crystal balls* find that they must upgrade their equipment from time to time.

So whether you're a fly-by-the-seat-of-your-pants type or an organized pocket-book-planner type, someday you're going to want to know how to squeeze a little more *horsepower* out of your PC—economically. So here's a couple of suggestions based on the author's experiences.

Adding Motherboard Memory

The first aid to greater PC productivity is to fill out motherboard RAM to the maximum possible. In most PC's, XT's, and compatibles, that maximum is 640K. Even IBM, after years of pretending it wasn't possible, now allows 640K of RAM on the XT motherboard, and the new Model 30 comes standard with 640K.

On 640K motherboards, memory is usually organized as two 256K blocks and two 64K blocks (256K + 256K + 64K + 64K = 640K). Banks 0 and 1 (those nearest the expansion-card edge connectors at the rear of the machine) usually contain the 256K blocks, and banks 2 and 3 (those closest the front panel) usually contain the 64K blocks.

Even though data is stored in memory in eight-bit bytes, IBM (and many clone) machines use a ninth bit to detect parity errors, which may arise from power-line glitches, cosmic rays, and other sources. Consequently, many companies selling memory upgrades for IBM's sell IC's in sets of nine. If your machine uses only eight IC's per bank, don't worry about buying an extra IC—someday you may need to use it to replace a defective one.

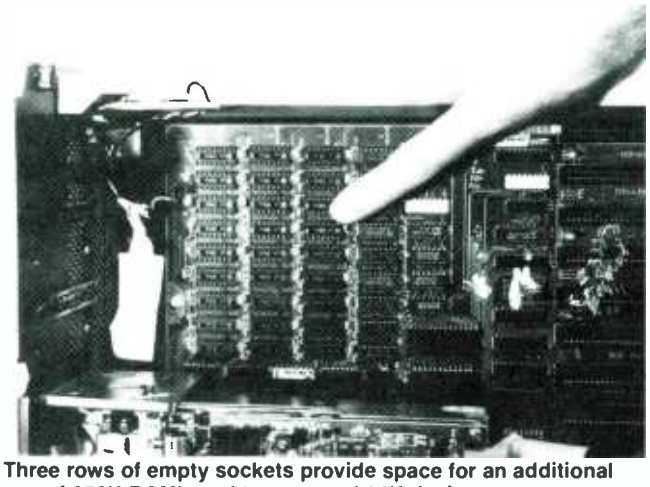
It's best to purchase RAM IC's only from reputable dealers, unless you're willing to gamble and possibly pay dire consequences. For the 256K banks, you'll need IC's with the part number 41256; for the 64K banks, you'll need 4164's. Both types of IC's have the same number of pins (16), so be careful to insert the right IC's in the right sockets.

The only technical specification that you must worry about is called *access time*, and nearly all reputable dealers specify RAM access time in their price lists.

In general, the shorter the access time, the faster the chip and, therefore, the higher the price. For a standard PC running at 4.7 MHz, 150-ns IC's are sufficient. Turbo models running between 7 and 10 MHz will require 120-ns IC's. Above 10 MHz, you'll need 100-ns or even 80-ns chips.

The cost of RAM IC's varies enormously. When this was written (early June 1987), however, nine 150-ns 41256 IC's were being sold by a volume mail-order distributor for about $22, and nine 150-ns 4164 IC's were selling for about $10. President Reagan's trade sanctions on Japan probably will increase memory prices, so shop around. The author purchased nine 256K RAM's and 18 64K RAM's at a local computer festival in early spring for under $40.

Installing the IC's is simple if you're careful. (Follow along with the photographs.) First remove the cover of your machine; then remove all expansion cards that obstruct access to the IC sockets on the motherboard. Next install the IC's *one-by-one* using an IC inserter. If you don't own one, pick



Three rows of empty sockets provide space for an additional row of 256K RAM's and two rows of 64K devices, so you can realize your machines full potential.

one up at Radio Shack or your local parts supplier. Don't skimp—the $5 or $10 that you'll spend on the tool will provide you with a reliable means of inserting your RAM's. One bent pin can render the whole machine useless.

After inserting all IC's, check your work to make sure all IC's are inserted in the proper orientation, with no bent pins, etc. After checking your work, check your work again—one mistake could create havoc not only with your new memory IC's, but the motherboard IC's that drive them.

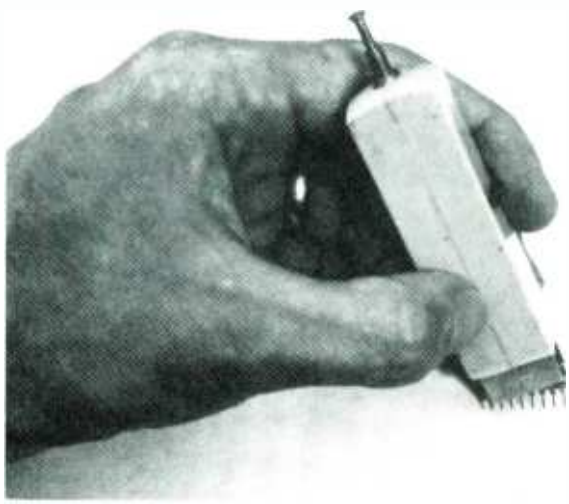
When you're sure everything is OK, set your motherboard switches to indicate the new RAM size, plug your video-adapter card back in—but no other expansion cards yet—and apply power to your PC. Your power-on self-test should cycle through the full 640K. If your machine does not execute a power-on self-test, run the MS DOS program CHKDSK.COM. It should indicate 655360 bytes total memory. If it doesn't, check your motherboard switches; they're probably set incorrectly.

Then run a memory-test program, if one is available. You can download MEMTEST.EXE from our BBS (516-293-2283, 300/1200 baud, 1/1/N). The program executes a series of tests designed to detect most faults. It's menu driven, and even helps you to locate the exact IC that's causing the problem (if any).

If your machine won't boot at all, power down and remove all IC's from bank three (by the front panel). Then power up. If things work as you expect, an IC from that bank may be bad, may have been inserted incorrectly, or may have a bent pin. If you still can't boot, remove the IC's from the next bank, and the next if necessary. Don't forget to reset the motherboard switches after altering the contents of each bank.

Then gradually add banks of IC's one by one until a problem re-occurs. Try swapping a known-good bank for a problematic one if necessary. If all your IC's seem to work, but not in all banks on the motherboard, your motherboard may be bad, specifically the address decoders.

Only after you've got all the motherboard RAM's working correctly should you re-install the expansion cards that you removed earlier. If, like me, you have a multi-function card with EMS memory (memory that is switched in and out of a special "window" outside normal 640K DOS memory), part of which you use to *backfill* DOS memory, don't forget to set the switches on the EMS board to indicate that memory on the card is no longer to be used for DOS memory.



An IC inserter is invaluable when it comes to avoiding bent pins when installing the RAM chips. While holding the locking bar with your index finger, gradually press the tool down diagonally over the IC until all pins are seated. Then release your forefinger and press the IC into its socket.

Adding A Floppy-disk Drive

Many times a person will buy an XT (or clone) with one floppy and one hard disk. However, a second floppy can be useful and, in some cases, necessary. For example, some backup programs (KeepTrack, for example), can back up files to two floppy-disk drives more-or-less simultaneously. And, although backup time is not cut in half, it is cut significantly, so you're more likely to back up your disk more often. Further, should the hard disk develop a problem and become unusable, it's much easier to work with two floppies while the hard disk is being repaired. And simple operations like DISKCOPY take much less time with two drives than one.

Your mechanical skills may well be tested more than your electrical ones in installing a new floppy-disk drive. It's not absolutely necessary to buy a drive that is identical (same model from the same manufacturer) to your original drive, but the installation will probably go easier if you do. Mounting brackets and connecting cables will more likely match up. However, if a drive is advertised as being IBM-compatible, it should work—just be prepared for a bit of experimentation.

First remove all expansion cards to gain access to the disk-drive bays. If you have a hard disk, you needn't remove the cables from the controller card; they usually are long enough so that you can swing the card out of the chassis and rest it on your work surface. But if you must remove cables, mark each one as to location and orientation.

The floppy-disk drive was initially mounted on a frame with a plastic front panel.

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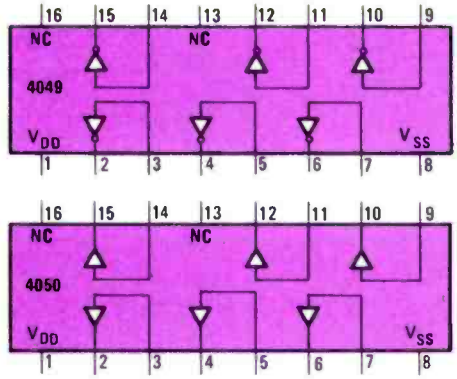
52 Hands-on Electronics FactCard — 4049: Hex Inverting Buffer 4050: Hex Non-Inverting Buffer



Features
- Wide supply voltage range — 3.0V to 15V
- Direct drive to 2 TTL loads at 5.0V over full temperature range
- High source and sink current capability
- Special Input protection permits Input voltages greater than V_{DD}

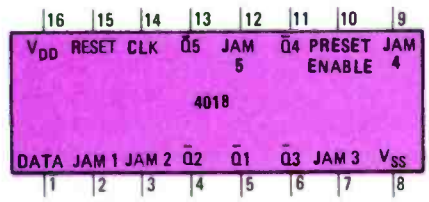
Absolute Maximum Ratings

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

Recommended Operating Conditions

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

53 Hands-on Electronics FactCard — 4018: Presettable Divide-By-N Counter



Applications
- Fixed and programmable divide-by-10, 9, 8, 7, 6, 5, 4, 3, 2 counter
- Fixed and programmable counters greater than 10
- Programmable decade counters
- Divide by "N" counters/frequency synthesizers

Features
- Wide supply voltage range — 3.0V to 15V
- High noise immunity — 0.45V_{DD} (typ.)
- Lower Power TTL compatibility — fan out of 2 driving 74L or 1 driving 74LS
- Fully static operation

Absolute Maximum Ratings

V_{DD} Supply Voltage	−0.5 to +18V
V_{IN} Input Voltage	−0.5 to V_{DD} +0.5V
T_S Storage Temperature Range	−65°C to +150°C
P_D Package Dissipation	500 mW
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	−40°C to +85°C

54 Hands-on Electronics FactCard — Opto Isolator/Coupler Selection/Replacement Guide

OPTOISOLATOR/COUPLER SELECTION/REPLACEMENT GUIDE

Device	OUTPUT DEVICE	ISOLATION VOLTAGE (VIS)	CURRENT-TRANSFER RATIO	NTE/TCG	RCA/SK	SYLVANIA/ ECG	PINOUT DIAGRAM
MOC5005	DIGITAL LOGIC	7500	——	——	——	——	A
MOC5006	DIGITAL LOGIC	7500	——	——	——	——	A
MOC5010	LINEAR AMPLIFIER	7500	——	——	——	——	H
MOC8030	DARLINGTON	7500	300%	3044	——	——	G
OPI1150	TRANSISTOR	50,000	10%	——	——	——	F
OPI1264	TRANSISTOR	10,000	25%	——	——	——	F
OPI2151	TRANSISTOR	1,500	20%	3040	2040	3040	F
OPI2152	TRANSISTOR	1,500	20%	3040	2040	3040	F
OPI2153	TRANSISTOR	1,500	50%	——	2041	3041	F
OPI2252	TRANSISTOR	1,500	20%	——	2040	3040	F
OPI2253	TRANSISTOR	1,500	50%	——	2040	3041	F
OPI3150	DARLINGTON	1,500	300%	——	2083	3084	G
OPI3163	DARLINGTON	1,500	500%	——	——	——	G
OPI3250	DARLINGTON	2500	300%	——	2084	——	G
OPI7002	TRANSISTOR	1500	20%	——	——	——	F

52 Hands-on Electronics FactCard — 4049: Hex Inverting Buffer / 4050: Hex Non-Inverting Buffer

STATIC ELECTRICAL 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	
Output Low (Sink) Current I_{OL} Min.	0.4	0,5	4.5	5.2	mA
	0.4	0,5	5	6.4	
	0.5	0,10	10	16	
	1.5	0,15	15	48	
Output High (Source) Current I_{OH} Min.	4.6	0,5	5	−1.2	
	2.5	0,5	5	−3.9	
	9.5	0,10	10	−3.0	
	13.5	0,15	15	−8.0	
Input Current I_{IN} Max.	—	0,18	18	$\pm 10^{-5}$	µA

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

53 Hands-on Electronics FactCard — 4018: Presettable Divide-By-N Counter

STATIC ELECTRICAL 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	0.04	µA
	—	0,10	10	0.04	
	—	0,15	15	0.04	
Output Low (Sink) Current I_{OL} Min.	0.4	0,5	5	1	mA
	0.5	0,10	10	2.6	
	1.5	0,15	15	6.8	
Output High (Source) Current I_{OH} Min.	4.6	0,5	5	−1	
	2.5	0,5	5	−3.2	
	9.5	0,10	10	−2.6	
	13.5	0,15	15	−6.8	
Input Current I_{IN} Max.	—	0,18	18	$\pm 10^{-5}$	µA

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

54 Hands-on Electronics FactCard — Opto Isolator/Coupler Selection/Replacement Guide

OPTOISOLATOR/COUPLER SELECTION/REPLACEMENT GUIDE

Device	OUTPUT DEVICE	ISOLATION VOLTAGE (VIIS)	CURRENT-TRANSFER RATIO	NTE/TCG	RCA/SK	SYLVANIA/ ECG	PINOUT DIAGRAM
OPI7340	DARLINGTON	6000	400%	——	——	——	G
SCS11C1	SCR	7500	500%	——	——	——	D
SCS11C3	SCR	7500	500%	3046	2046	3046	D
SCS11C4	SCR	7500	500%	——	——	——	D
SCS11C6	SCR	7500	500%	——	——	——	D
TIL111	TRANSISTOR	1500	13%	3042	2042	3041	F
TIL112	TRANSISTOR	1500	2%	——	2040	3040	F
TIL113	DARLINGTON	1500	300%	——	2084	3084	G
TIL114	TRANSISTOR	7500	8%	3042	2041	3041	F
TIL116	TRANSISTOR	2500	2%	3043	2043	3041	F
TIL117	TRANSISTOR	2500	50%	——	2041	3041	F
TIL119	DARLINGTON	1500	300%	——	2084	3084	G
TIL127	DARLINGTON	7500	300%	——	2084	——	G
TIL128	DARLINGTON	7500	300%	——	2084	——	G
TIL153	TRANSISTOR	7500	10%	——	2041	——	F
TIL154	TRANSISTOR	7500	20%	——	2041	——	F

The frame on the right occupied the space of the lower floppy-disk drive until the latter was installed. Two mounting plates, like the one shown propped against the drive, are used to secure the drives to one another.

Next, disconnect the power and data cables attached to your present floppy-disk drive. Mark them also. Then remove the drive itself. Floppy-disk mounting schemes vary, but on a true-blue XT, you'll have to remove two screws from the left mounting bracket and one beneath the machine. You shouldn't have to remove the power supply to gain access to the floppy-disk drive; push the drive toward the rear of the machine and gradually angle the back side of the drive up. There should be enough room to clear the power supply.

My single floppy was mounted on a bent sheet-metal frame with a plastic front plate, and all chassis screws were secured to that frame. Two side-mounted steel plates held the drive to the frame. I removed the screws holding the frame to those plates and slid my new drive in. The old screws wouldn't work in the new drive, however; those screws were finely threaded metric units, whereas my new drive (a Tandon TM50-2) used good old 6-32's.

You will undoubtedly have a different mounting scheme. Most clone and electronics suppliers sell mounting brackets, screws, etc. If you're not sure just what you need, you may want to purchase a mounting kit to have a variety of components on hand. You can easily drill alternate mounting holes in the brackets to match the holes in your drive.

You may also have to provide for data and power cables to the new drive. Some machines come with the necessary connectors already in place, but many don't; and even those that do may be unusable because of different connector locations. For example, my data cable was unusable because the original drive and the new drive have connectors on opposite sides, and the cable, even though it had the second connector, simply wasn't long enough.

Many clone and electronics suppliers sell those cables; you can also wire your own. Radio Shack sells 34-pin edge connectors and 36-wire ribbon cables. Cut a suitable length of the ribbon cable, remove two wires from the entire length of the cable, and then carefully press the edge connectors on in the appropriate positions. Make sure that all three connectors have pin 1 oriented the same way.

Note well: You'll have to split the cable near the end that connects to drive A: so separate the first nine wires (beginning at the pin-1 end) and the next seven wires from the remainder of the cable. Then twist the group of seven 180 degrees as shown in the photograph and insert all three groups in the edge connector, and press it together carefully. Install the connector for drive B: below the twisted section, and the connector that goes to the controller card at the opposite end of the cable. There's nothing tricky about the procedure as long as you're careful.

To build your own data cable, obtain a 34-conductor ribbon cable, and separate seven wires, after the first nine wires, from the pin one end of the cable. Then twist the seven wires 180 degrees, insert the first edge connector, and press it on. Then insert the second connector beneath the twisted section and press it on. Press the last connector on at the opposite end of the cable.

As for the power connector, if your machine doesn't have the second connector installed already, you'll have to purchase the Molex sockets and shells from an electronics supplier (other than Radio Shack). Then build a "Y" adapter as shown in the photos.

Next, install the resistor block in the drive attached to the end of the data cable, and make sure that the resistor block in the other drive has been removed. Now set up the on-board jumpers. On some drives, they're scattered about the PC board; on others, they're collected together at an IC socket, in which a shorting header is located. If your drives are identical (the same type from the same manufacturer), set up the new drive identically to the old one (except for the resistor block).

If your drives are from different manufacturers, don't change any jumper settings except the Drive Select jumper, if necessary. Both drives should be set to respond as the second drive. Some manufacturers start counting from zero, so the DS1 jumper should be installed on that type of drive. Others count from one, in which case, the DS2 jumper should be installed.

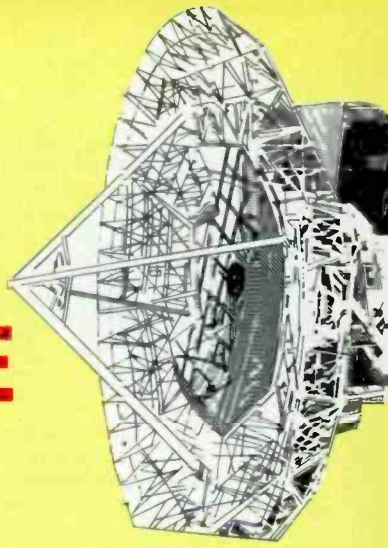
After setting the jumpers—but before mounting the drives in the chassis—connect the cables to both drives, and try booting your machine. Because the cables aren't very long, the drives may be propped at uncomfortable angles. Just be careful not to short any PC-board traces, test pins, etc., to the chassis or any other metal surface.

If the machine boots, try reading diskettes in both drives. If you can, power down, install the drives, close up your system unit, and enjoy. Otherwise, power down and disconnect the data cable to the old drive, and install the new drive as A: without re-installing the old drive. Then try booting. If you can boot with either drive installed, but not both, the Drive Select jumper is installed incorrectly. If you're sure it is correct, but can't access the new drive, you'll have to contact the company that you bought the drive from, or possibly the drive's manufacturer, to ascertain how the other jumpers should be set.

After working out the electrical problems, bolt the two drives together and then slide them into the chassis from the rear. Don't force anything—you could make an expensive mistake! Watch out for protruding screw heads, connector shells, etc. There's not much clearance, so work patiently.

Then re-install the cables and expansion cards, and screw the expansion-card mounting brackets to the rear panel.

That's about all there is to installing a new drive. It's not difficult, but you must work carefully. Doing so can save you a bundle, though—so go to it! ■



RECEIVING WEATHER-SATELLITE PHOTOS

By Hank Brandli

Here's how one man decided to receive weather-satellite photos for fun and profit

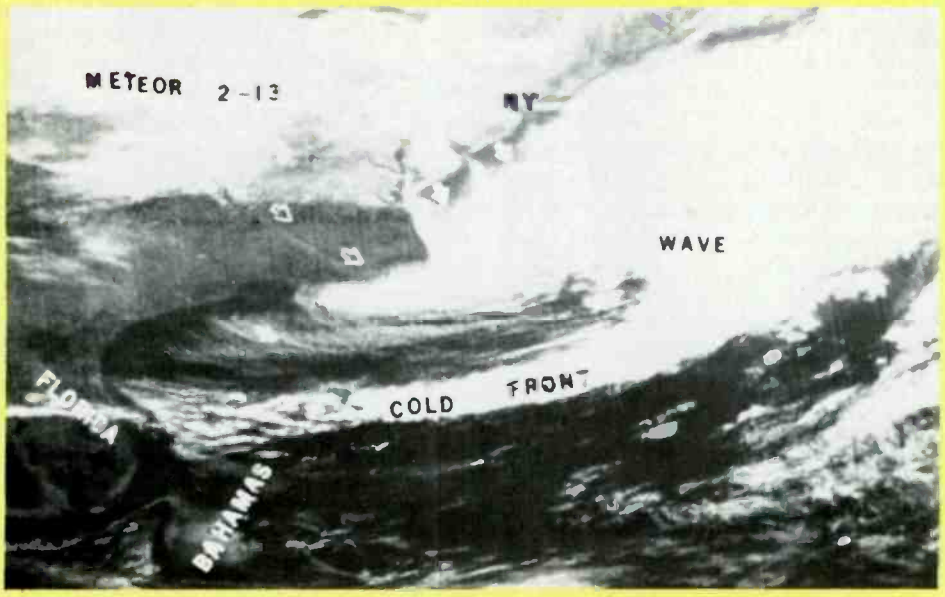
I ALWAYS BELIEVED IN THE OLD ADAGE THAT A PICTURE IS WORTH a thousand words. That understanding became a vivid reality to me when I first looked at weather-satellite photographs. To the meteorologist, environmentalist, oceanographer, and even the layman, those images taken and transmitted from American and Russian space cameras merit much more than a thousand words—at least a magazine article

Every day and night, polar-orbiting, meteorological satellites of the United States and Soviet Union take visual and/or infrared images of every place on Earth from altitudes of 400 to 600 miles. Those unmanned spacecraft pass over our planet every 100 minutes or so from north to south, or vice versa.

Two American NOAA (National Oceanic and Atmospheric Administration) weather satellites in sun-synchronous orbits take, record, and transmit photos of the same North American east-coast location twice a day. Satellite NOAA-10 transmits at approximately 9 AM and 9 PM each day. Likewise, NOAA-9 transmits at 3 AM and 3 PM. Those transmissions provide four weather shots from space of the North Atlantic and the eastern half of North America. Other satellites cover the remaining portions of North America and ajoining ocean areas. Here on Earth, simultaneous visual and infrared (thermal) imagery 1600-miles wide are processed from satellite transmissions during the day while the night-time pictures are infrared only.

The Russians' Meteor spacecrafts transmit mostly visual images that are 1200 mile-wide swath pictures from prograde or retrograde orbital platforms. Those near polar paths allow photo-taking at different times during the day. Since the Russian satellites are not orbitting at a fixed time interval that offers space shots at whole-hour intervals or multiples of hours, you will need more than a watch to know when they are transmitting. Whereas the 1600-mile wide NOAA images can spot areas of clouds as small as 2 miles on a side across the image scan, the Russian Meteor "shots" record locales as small as 1-mile square. Previous U.S. and U.S.S.R. meteorological spacecraft had poorer resolutions and distorted images on the edge. (Refer to Table 1)

Since my USAF retirement, I have been working as a consultant for several major companies as well as writing and lecturing. My love has always been weather-satellite analysis. Harris Corporation in Melbourne, Florida, gave me a sophisticated laser photocopying machine and a special telephone line to receive the 22,000-mile high geostationary weather photos day and night from Washington, DC, via Miami, Florida. Most readers are familiar with those images, which appear on TV and in newspapers.



Here is what the Russian Meteor 2-13 satellite saw on a day when the weather picture over the Atlantic Ocean was very dynamic. Ocean water appears as black and land masses are dark gray. Clouds are white. The cold front across the ocean is pronounced. The weather on the eastern coast of North America is moving rapidly. Photograph was taken with author's gear.

How I Did It!

Since my Vietnam days, I have always wanted to get the true current photos from polar-orbiting American and Russian satellite spacecraft.

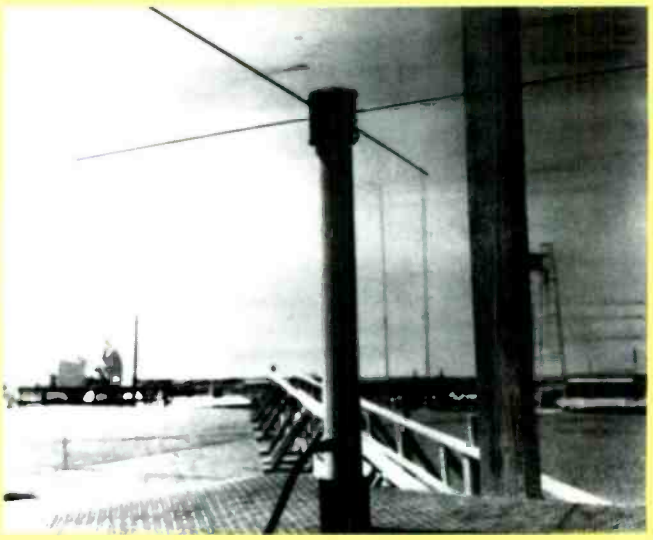
I use a wheelchair (no war wounds, a victim of multiple sclerosis), so that condition required my seeking expert assistance to put together the required equipment to process

TABLE 1
CURRENT RUSSIAN ORBITAL PARAMETERS FOR METEOR SATELLITES

Data	Meteor MTR2-4	Meteor MTR 3-1
Number	16735	16191
Epoch year	86	86
Epoch day	195	197
Fraction of day	.8303239	.89937475
Decay rate	6E+-07	2.3E+-06
Elset no.	14	276
Inclination	82.5386001	82.54655001
Right ASC of node	15.5152	269.7211
Eccentricity	1.55E-03	2.1082E+-03
ARG of perigee	124.8895	85.19376
Mean anomaly	235.372	275.1542
Mean motion	13.83738007	13.1694031
Epoch revolution	670	3492

weather-satellite pictures from overhead satellites while at home. I asked Holly Johnson, a technician at Cape Kennedy Air Force Station, to build for me an inexpensive antenna to be placed on my roof. Holly designed one using a two-inch diameter PVC pipe and four welding rods. He bought the PVC pipe at a local hardware store for approximately $3.00. He purchased welding rods from a local welding shop for 50 cents each. The stainless-steel welding rods are about 43-inches long and 1/8 inch in diameter. He put them together, connected the welding rods, as illustrated in Fig. 1. What I didn't see at first were the two phasing cables (made from RG62B coax) inside the pipe. I thought the antenna was a spoof and remarked, "Is this a bird roost or an antenna?" Holly replied, "Believe it!"

An amateur radio operator told me about a small company in New York (Vanguard Labs) that could send me a receiver



The satellite receiving antenna shown here is identical to one used by the author. The roof site is a commercial plant that requires satellite reception for accurate weather information. Even the pros use the author's home-brew antenna.

for less than $200.00 and that it was the size of a small book. I remarked, "It's not thousands of dollars?" I was told to "believe this, too!" I called Vanguard Labs, in Hollis, New York, and spoke to a gentlemen named Andre. Andre told me that he could ship the receiver to me with whatever crystals I needed. I purchased it with five crystals to get signals from the 500-mile-high polar-orbiting Meteor vehicle and NOAA *birds* of the United States. He suggested a preamplifier and sent that along also.

Holly brought the antenna over to my home with the appropriate cable that he had purchased from Radio Shack for about $4.00. He had what they call *hardware cloth*, which he had purchased from Scotty's hardware store for $1.00. It was actually just plain ordinary chicken wire, to be used as a 4-foot x 4-foot ground plane for the antenna.

For the first test, Holly placed the chicken wire on the lawn, with the coax cable running through the garage to the

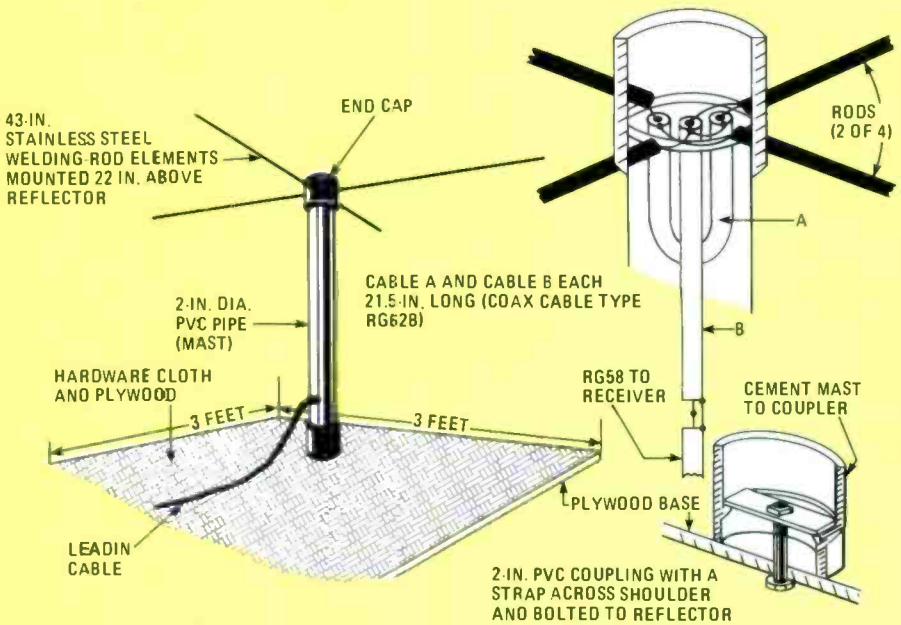
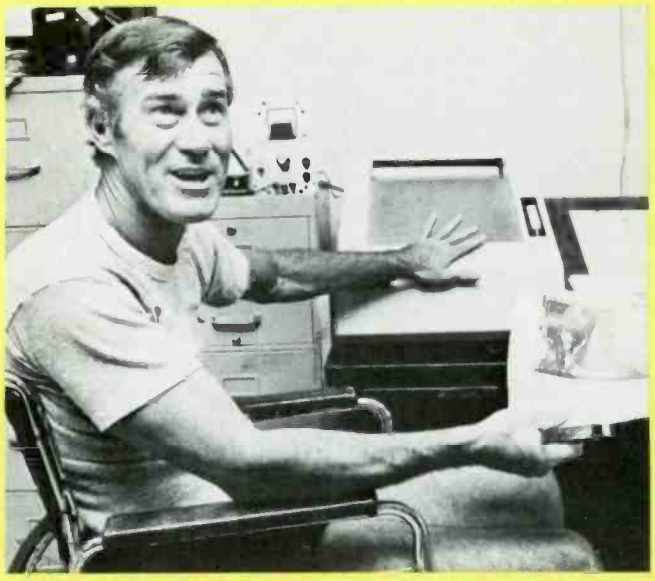


Fig. 1—It doesn't take much to assemble a turnstile antenna for use as a satellite skyhook. The roods must be 22 inches above the ground plane that is made from stock plywood and hardware cloth. Don't get fooled by some nylon screen cloth. Make sure that it shines like copper or aluminum. The mast should be about 24-inches long—it can be cut down later to the correct height. The end cap will keep rain from soaking the cables inside the pipe (mast).

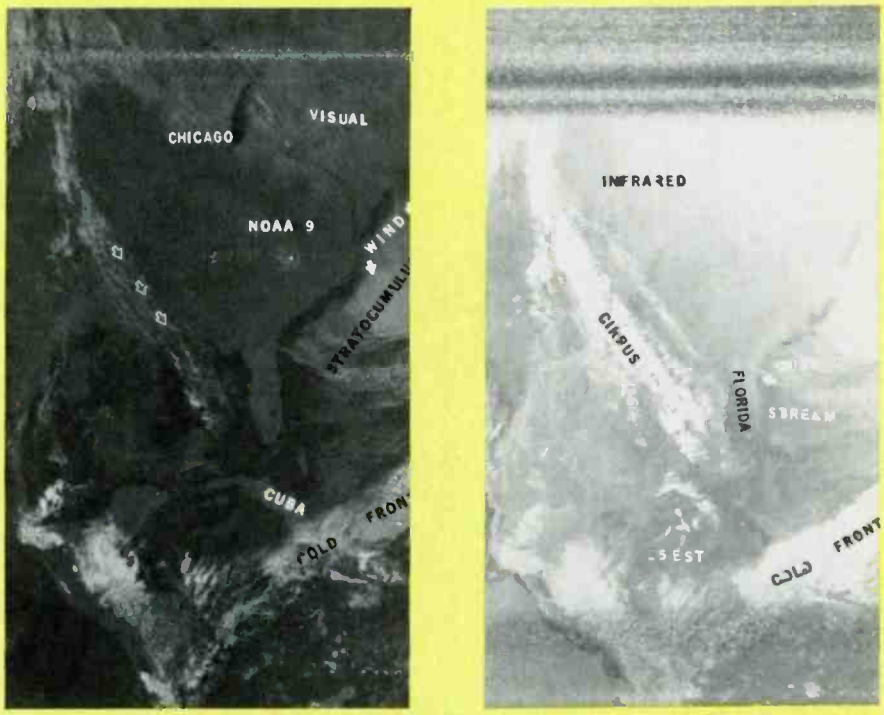
receiver. He had a 12-volt power supply that he purchased from a government-surplus outlet (The name had been scratched off, but that is not important. Almost any bench-top regulated +12-volt power supply will do the job). He connected the supply with clip leads to the receiver and plugged it into an outlet in the garage. He ran 30 feet of speaker wire along the roof and into the Laserfax (inside the house). 50 feet of speaker wire costs approximately $4.00. We had the computer ephemeris and knew approximately what time one of the satellites would be going over us. Sure enough, we started to get a "beep-beep-beep" signal. Not a strong one, but definitely a signal. Holly adjusted the antenna to try to optimize it and, we could see that by orienting the welding-rod dipole configuration in various ways, the signal strength would improve. Just for the fun of it, I turned the fax machine on and *voila*! I got a very, very small, but noisy picture. Holly then suggested that we needed to have a more stable setup than that on the lawn. So he took a ladder and went back to the rooftop and with a couple pair of old dungaree legs, full of sand from the backyard, tied at both ends to form sandbags, he anchored the antenna to the chicken wire onto the roof of the house. To run the cable, of which he had plenty, he decided to cut a small hole in the window screen at the side of the garage, hook up the back of the receiver that way and left the antenna on the roof.



The author, Hank Brandli, is a recognized satellite meteorologist who resides in sunny Florida. Here he is at his receiving station with the latest photograph in his hand.

Message from Space

We then waited for the next satellite pass overhead. Lo and behold! "Beep, beep," came from the speaker on the Laserfax. Sure enough, the signal was stronger. Holly adjusted the antenna for optimum reception and the signal was very strong. The picture, however, still had a lot of noise in it and was still weak. I made another call to Andre of Vanguard Labs and he suggested a newer preamp with a special filter. He mailed that on to me in about a week. Being in the wheelchair, I couldn't accomplish the adjustment myself, so Holly again came to my aid. We hooked up the new preamp to the power supply, which sits on top of a file cabinet in the garage, attached to the receiver. He plugged it in, hooked up the wires and waited patiently. At approximately 3:00 PM, the NOAA-9 bird came over. The signal was extremely strong. After another trip to the roof to make a few more adjustments to the antenna, the signal was very loud. Eight minutes later a beautiful photo pair from Southern Canada to South America came. One picture was infrared showing temperatures of water, land, and cloud tops. Then "thump, thump," was heard followed by a picture from the Russian Meteor satellite. It was a large 10-inch picture. Each photo is worth a thousand words. To a satellite meteorologist, it is worth much more.



These two photos came from an American weather satellite on January 15, 1986. The one on the left is taken by a visible-light camera and the right one is taken by an infrared camera. Each photograph has details that the other does not show. The warmer Gulf Stream current mass can be detected in the infrared photograph.

Since that time, the only changes I've made was when I replaced the power supply. I got a more up-to-date model, a Transpac, for only a few dollars at a government supply sale at Patrick Air Force Base. Since then, everything's been functioning A-okay.

TABLE 2—EQUIPMENT/EQUIPMENT SOURCES (For APT Satellite Receiving)

Receivers	
Type	Source
Vanguard Model FMR-260-PL	Vanguard Labs 196-23 Jamaica Avenue Hollis, N.Y. 11412 (718) 468-2720
YAESU 9600 Uniden Bearcat 175XL Scanner	Fair Radio Sales Company Post Office Box 1105 1016 E. Eureka Street Lima, Ohio 45802 (419) 223-2196
Preamps	
Vanguard Low Noise R.F. Model 102-W	196-23 Jamaica Avenue Hollis, N.Y. 11412 (718) 468-2720
Hamtronics LNA-144	Hamtronics, Inc. 650 Moule Road Hilton, N.Y. 14468 (716) 392-9438
Cable	
RG62B coaxial cable (two 21.5-in lengths)	Any electronic-supply store
RG58 coaxial cable (select length required for lead-in run)	Any electronic-supply store
Facsimile Equipment:	
Economical surplus facsimile equipment	Atlantic Surplus Sales 3738 Nautilus Avenue Brooklyn, N.Y. 11224 (212) 372-0349
	Universal Shortwave Radio 1280 Aida Drive Reynoldsburg, OH 43068 (614) 866-4267
Home Computer Information	
PC cards, software, cables, monitors, etc.	Jack Berman WIBGW West Roxbury, MA 02131
IBM	Elmer W. Schwitteck, W2LAF 429 N. Country Club Drive Atlantis, FL 33462
Apple	Jim MacLean 2112 S. Parsons Avenue Melbourne, FL 32901 (305) 727-3646
Video Printer	
The newest video printer for capturing images directly from a CRT screen can be purchased for $900.00 It is Seikosha Model VP-115, Seikosha Company, Cupertino, CA; Telephone: Phil Strong 408/446-5820.	

Shopping Makes It So

A surplus facsimile machine can be purchased from surplus for a few hundred or few thousand dollars (see Table 2). I have a Harris Laserfax...or you can display the images on a home-computer monitor. High-quality prints for hard copy can be achieved at a fraction of the cost of what it used to be and, with that same computer, you can program the satellite acquisition times and locations exactly (ephemeris).

You may want to leave your receiver on, and just wait for the beeping beacon signals. But to determine exactly when a satellite is to pass overhead, get the daily APT prediction message transmitted over worldwide communications circuits under the heading TBUS-1 for North-to-South orbits in daylight hours, or TBUS-2 for South-to-North swings. They tell the exact location and times of successive passes each day. The APT Coordination, Direct Readout Services, U.S. Department of Commerce, NOAA/NESS, Washington, D.C., 20233, is a good source for any satellite status, or Electronic Bulletin Board Information.

Reading the Photos

Visual satellite photos are very easy to understand because clouds are white and land masses are usually seen and can be outlined by either computers or hand.

Infrared photos, however, are somewhat harder to comprehend without an explanation. Infrared film records thermal properties or temperatures—hot temperatures appear black and cold temperatures appear white. Since high clouds, for example, are colder than low clouds, the former appear much whiter. Infrared cameras are used exclusively at nighttime to detect clouds and thermal properties. Land and water temperatures can be distinguished with no clouds.

The ability to differentiate between clouds is important because cold fronts are very easy to detect on photos and can be tracked to determine speed of movement. In that way, an exact time for arrival of a front with its inevitable rain and wind can be ascertained.

Since infrared photos can also forecast freezing weather, farmers can be forewarned of frost.

Further developments in infrared photography can be used on home computers to devise a technique whereby nighttime black-and-white thermal pictures can be converted to color. Each color in a photo corresponds to a different temperature.

Due to advances in color digitized photography, observers now have a choice of colors which can be spread in any temperature range. Hence, any color can be assigned any temperature value for a specific photo.

In addition, hurricanes can also be spotted by both day and night weather satellites. When monitored every three hours, satellite photos indicate quite accurately the path and severity of those tropical storms. Tracing storm movement is like the puzzle, "follow the dots."

Thus, it is within the realm of possibility to utilize satellite weather photos for close monitoring of agricultural conditions, as well as fire control or hurricane warnings.

Today, I get as many as a dozen photos or photo pairs day and night, visual or infrared. Strange as it may seem, twenty years ago in Saigon, I got less reception for more than ten times the cost. I've come a long way and have made a lot of personal and technological progress.

So, how about it? Some money, a little electronics knowledge, and initiative are all you need to become the first in your area to receive satellite images of impending weather. ■

THE DIRTY LITTLE FM SNOOPER

By Ricky Shea

This snooper used as a fun gadget can bring many hours of enjoyment to the listeners and *listeners!*

NO, IT'S NOT JUST FOR SECRET AGENTS AND *BOUDOIR bandits*! The *Dirty Little FM Snooper* was designed for the amateur broadcaster, for weak-voiced stage singers, as a baby-sitter replacement, and countless other people with ethical applications. But, let's be honest: Wouldn't you like to know what the team is saying about you in the locker room? How's this party stopper: Broadcasting the gals comments in the powder room? What, the Devil you say? Exactly!

The Dirty Little FM Snooper is an FM transmitter that consists of a simple condenser microphone, which is used to modulate the output of a small, one-stage, FM transmitter. The transmitter radiates a continuous wave whose frequency is altered in sympathy with the sound waves striking the microphone. You need only an ordinary FM-broadcast receiver (88-108 MHz tuning range) to detect its output carrier. A pocket FM receiver with an earphone plug will do the job.

When you tune across the FM dial in your town, you will find one or more wide gaps where there are no broadcast signals. Your Dirty Little FM Snooper should be tuned to one of those gaps in the band so that you will pick up its minuscule signal loud and clear, and you won't cause any annoying interference to your neighbors. Don't worry too much about your neighbors. The power output of the transmitter is very low as specified by the FCC, so the Dirty Little FM Snooper's output should not get too far. If you do irritate the big guy next door, just tune to another gap in the band. If he's a beer drinker, tune to the lower educational portion of the dial—88–90 MHz.

Voice to FM Carrier

The Dirty Little FM Snooper's circuit is basically an RF oscillator that operates at around 100 MHz. Refer to Fig. 1. The most important parts of the oscillator are transistor Q1 and the tuned circuit, which embraces the inductor L1 and the variable capacitor C5.

When the 9-volt transistor-radio battery, B1, is connected, a brief surge of current flows from the collector to the emitter of Q1, causing an alternating current (shock oscillation in the resonant LC circuit) to flow back and forth between L1 and C5. An oscillating voltage, therefore, appears at the junction of L1 and C5. The frequency of the oscillation depends on the

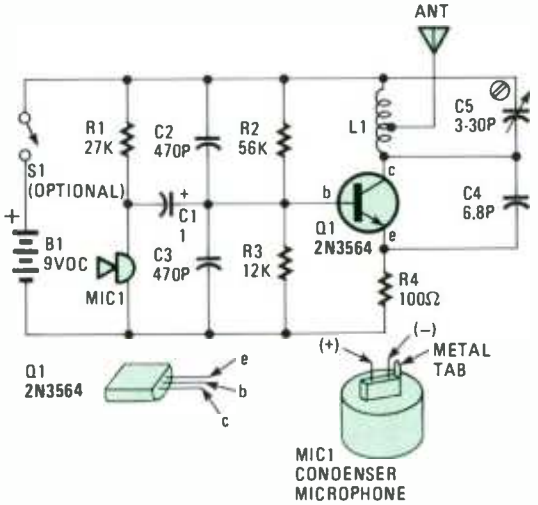


Fig. 1—The Dirty Little FM Snooper circuit is a one-stage, FM transmitter. The condenser microphone, MIC1, couples audio to transistor Q1 whose internal *junction capacitance* provides a variable capacitance to the LC-tuned circuit, thereby frequency modulating the output carrier.

values of L1 and C5, so that varying the value of C5 tunes the oscillations to the exact frequency desired.

The oscillating current in L1 and C1 would rapidly decay to nothing, but for the fact that the oscillating voltage is fed back via C4 to the emitter of Q1. That action makes the base-emitter current of transistor Q1 vary at the oscillation (resonant) frequency. That causes the emitter-collector current to vary at the same frequency, keeping the current flowing in the tuned circuit and continuing the oscillations. Some of the energy in the oscillating electric and magnetic fields of the tuned circuit is radiated as radio waves, partially by the circuit itself and mainly by the antenna.

Modulation Made Easy

But why do sound waves arriving at the microphone vary the frequency of those waves? They can do that because the frequency of the oscillations depends on the total capacitance in the oscillator circuit. Although tuning capacitor C5 accounts for the major part of the tuning capacitance, other parts of the circuit also make minor contributions. In particular, the capacitance between the base and the collector of Q1 has a small, but noticeable, effect on the oscillation frequency. That capacitance, which is known as the *junction capacitance*, is not a fixed value, but instead varies when the voltage on the base of the transistor varies. Sound waves striking the microphone induce a voltage that varies in time with the sound and that voltage is applied via C1 to the base of Q1, thereby frequency modulating the transmitter.

Solderman of the Board

It's unequivocally vital to use the printed-circuit board detailed in Fig. 2, because one of the indispensable components, the RF-inductor L1, is actually part of the board itself. You can make your own printed-circuit board from the template we supply or purchase one—details a bit later.

Begin by soldering the resistors onto the board, referring to Fig. 3 for their locations. Next, mount the fixed capacitors (C1, C2, C3, and C4), taking care that C1, the electrolytic or tantalum capacitor, is inserted with the correct polarity.

That leaves only two components to be mounted on the printed-circuit board: The variable capacitor, C5, shouldn't present any problems, because it can be installed without fear of polarity problems. However, there are three holes for two terminals; That's a problem you can solve quickly. Look at the flip (foil) side of the board and notice that two holes are electrically connected together. Once-upon-a-time C5 had three mounting terminals, now it has two! Be absolutely positive that one terminal of C5 connects to the lonesome solder pad on the printed-circuit board, and that the other terminal of C5 connects to one of the duo pads. The holes for C5's terminals may be a bit tight, so ream them out gently; only a millimeter may be required.

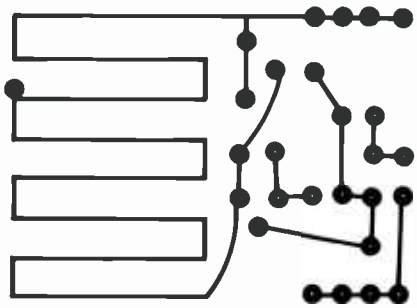
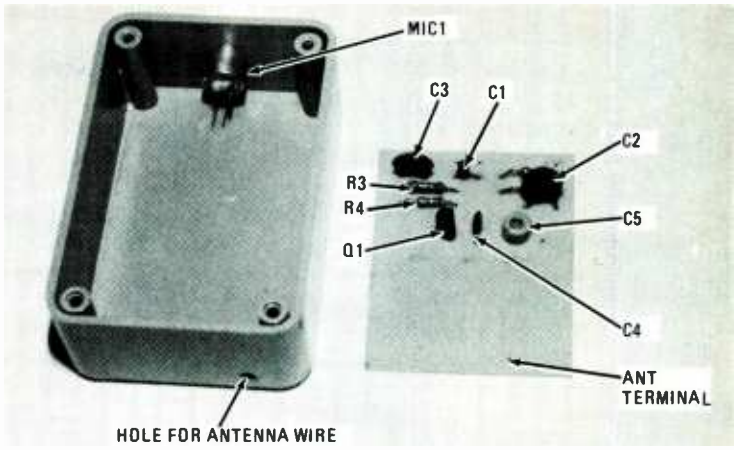


Fig. 2—The template for the Dirty Little FM Snooper's printed-circuit board also includes one part in the resonant circuit—tuning coil L1. The template is shown here same size.



The printed-circuit board is shown here completely wired, except for battery and microphone connections. The time required to assemble the components onto the board was only 20 minutes. You will spend much more time preparing the plastic box and installing the microphone and printed-circuit board.

The other component, transistor Q1, must be oriented correctly before it is soldered to the printed-circuit board. Refer to the transistor terminal-identification drawing in Fig. 1. Seat the transistor in the board and solder in place.

Stop now and carefully inspect the board at this time. All the leads should be clipped close to the board, solder connections should be shiny and bright, and the parts in their correct locations as indicated in Fig. 3.

The Antenna

Since the Dirty Little FM Snooper is intended to be a short-range transmitter, only a small antenna is necessary. Excellent results were obtained with an antenna about 5-inches long, made from a piece of stiff wire soldered onto the printed-circuit board at point A on Fig. 3. Longer antennas will increase the range considerably, with the best range being achieved with an antenna about 24-inches long. However, apart from being unwieldy, such an efficient antenna is unwise—if the Dirty Little FM Snooper transmission is too powerful it will begin to interfere with other listeners of the FM band and thus it may actually corrupt the purpose for which it is being used.

Once all the parts are mounted on the PC board, you can connect the battery-clip leads now (for B1), and the microphone (MIC1) connections will follow.

You may decide to add a SPST, on/off switch (S1 in Fig. 1) in series with one leg of the battery's leads. That can be done any time after the project is completed.

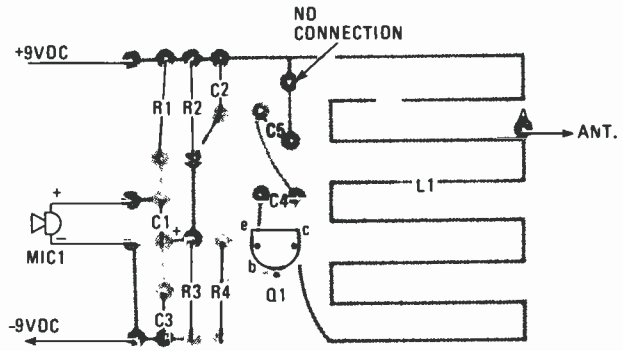


Fig. 3—The board layout for the Dirty Little FM Snooper is hassle free. Solder all—the parts to the board, then connect the external leads. Use the battery clip as a power switch.

Boxing the Snooper

If you are going to house the wired Dirty Little FM Snooper in a box, do not use a metal one. The box used by the author is a small experimenters box made of plastic and it came with an aluminum cover. Only two holes were drilled in the box; one for the condenser microphone, MIC1, and the other hole for the antenna wire to protrude. The hole for the microphone was hand reamed to an exact size so that the microphone slipped in easily and held in place. A drop of clear nail polish holds it in place. Do not force-fit the delicate microphone into the hole—it can be damaged.

Solder two uninsulated, solid, copper wires to the microphone terminals on the printed-circuit board and clip the length to one inch. Slip the board into the box as shown in the photo. With the microphone in place, the two added wires will be along side the terminals of the microphone. The wire that connects to ground (negative terminal of B1) connects to the metal tab and negative terminal of MIC1. The other wire connects to the positive terminal of MIC1. Refer to Figs. 1 and 3 for additional details.

Slip a ½-inch to 1-inch square of ⅛-inch foam that has self-adhesive *stick'um* on both surfaces under the printed-circuit board, and press down gently, securing the board to the box. Attach the battery clip to B1 and try to fit it into the box sideways—it just doesn't make it. Snip off the plastic vinyl covering on the clip and now the battery will fit snugly without need for any mounting arrangement.

Setting Up

Tune your Dirty Little FM Snooper to a point on the FM dial where there are no broadcast stations near by. With the radio microphone fairly close to your receiver and turned on, use a small non-metalic screwdriver to adjust the variable capacitor, C5. At some point you should hear a terrible "howl" through the receiver. The Dirty Little FM Snooper is now transmitting on the same frequency that your FM receiver is tuned to. That condition sets up acoustic feedback, because the Dirty Little FM Snooper is too close to the FM receiver's loudspeaker. Turn the receiver off, leave C5 set in the same position, and move the receiver away from the Dirty Little FM Snooper. Now turn your FM receiver on again and get a friend to speak at the microphone. For complete clarity, you may need to alter the tuning of your receiver slightly.

If you do not own a non-metalic screwdriver, fabricate one from an old solid plastic stirrer used to make bar drinks. You can carve or file a blade that will turn the rotor of C1.

PARTS LIST FOR THE DIRTY LITTLE FM SNOOPER

CAPACITORS

C1—1-μF, 16-WVDC, electrolytic (or tantalum)
C2, C3—470-pF, ceramic
C4—6-pF, ceramic
C5—1-30-pF, trimmer

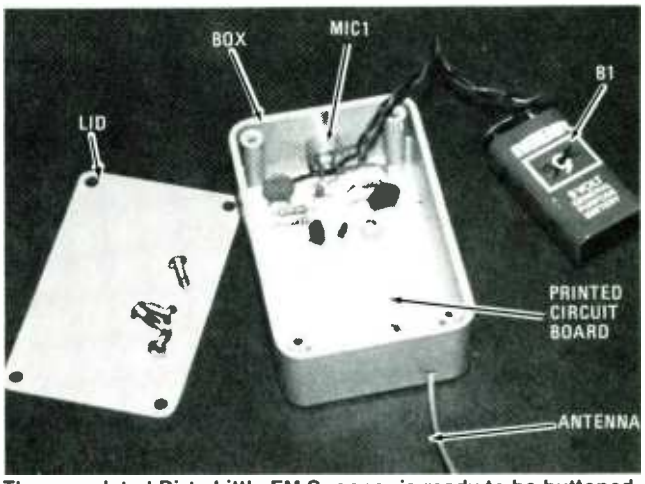
RESISTORS

(All resistors are ½-watt, 5% units)
R1—27,000-ohm
R2—56,000-ohm
R3—12,000-ohm
R4—100-ohm

ADDITIONAL PARTS AND MATERIALS

B1—9-volt, transistor-radio battery
L1—Center-tapped coil (part of printed-circuit board)
MIC1—Condenser microphone
Q1—2N3564 transistor
S1—SPST slide switch (optional)
Printed-circuit board, 3-¼ × 2⅛ × 1⅛-in., experimenters box (Radio Shack 270-230), battery-connector clip, clear nail polish, foam spacer, solid hookup wire, stiff antenna wire, solder, etc.

The printed-circuit board, parts mounted on it, and the microphone are available in kit form for $9.50 plus $2.00 for shipping and handling costs from Imtronics Industries, Inc., 11930 31st Court N., St. Petersburg, FL 33702. Please allow 6-8 weeks for delivery.



The completed Dirty Little FM Snooper is ready to be buttoned-up and put to respectable use. Never use the project in an application that you would not want used in a similar way on yourself, your friends, or family. Be certain that everyone will laugh when what you have done has been revealed to them.

Power Consumption

The Dirty Little FM Snooper consumes power all the time it is on, whether there is any sound being transmitted or not, so batteries don't last too long. You can expect a 9-volt, transistor-radio battery to last about ten hours. Use a bigger battery or a 9-volt power supply (wall-plug module power supply) if you want continuous use for longer periods. The battery clip is used as an on-off switch.

Radio FM microphones like the Dirty Little FM Snooper are used extensively by stage performers and by professional eavesdroppers, but they do have more mundane uses as well. The Dirty Little FM Snooper can be used for any kind of remote monitoring of sounds. For example, you can use one to hear your phone or doorbell ringing when you're sitting out in the backyard, or to make sure you don't miss a word of your favorite TV program while you're in the kitchen. It makes for an excellent baby alarm, too, because the Dirty Little FM Snooper can go anywhere that baby goes. Just don't forget to bring an FM receiver with you. ■

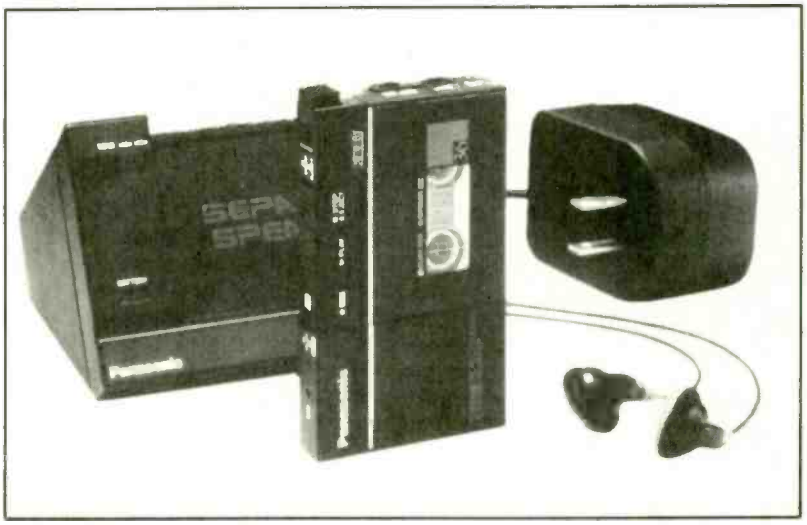
The Dirty Little FM Snooper is shown here buttoned up with the battery inside and attached. It's ready to go!

NUMBER 141

GADGET ©

NOVEMBER 1987 THE NEWSLETTER FOR GROWN-UP KIDS VOLUME XII/NUMBER IX

What's Inside . . .



Small Wonder

TWO SPEED MICROCASSETTE RECORDER (RN-36). Manufactured by: Panasonic Co., One Panasonic Way, Secaucus, NJ 07094. Price: $219.95.

In consumer electronics, there appears to be an inverse relationship between an item's size and its retail price: the smaller the product, the heftier its cost. If you were told of a relatively unremarkable tape recorder which carries out its functions more than adequately but which is priced at the upper end of the portable market, chances are you wouldn't be much interested.

But if you learned the recorder in question, *Panasonic's RN-36 Microcassette Recorder* was about the size of a standard audio cassette (2⅛" x 3⅛" x ⅝"), your interest might be piqued. The *RN-36*, even with its separate "power booster speaker system" is no marvel of high fidelity, and it doesn't do much of anything faster or better or more smoothly than conventional tape recorders with a lower price tag. But it surely is small.

The *RN-36* is diminutive and, in our use of the device, very thoughtfully designed. *Panasonic* has packed lots of information onto the palm-size case and all (and then some) of the standard recorder functions inside.

The system's tiny cassettes are roughly the size and dimensions of a matchbox (of the sort given out in stylish restaurants and bars) and come in either 60-or 90-minute lengths. The *RN-36* offers two speeds, via a control on the bottom of the recorder, with "long play" significantly extending recording time.

Starting from the recorder's top left corner, the mite includes a microphone jack; play, record, rewind, fast forward and stop/eject controls; a built-in mic (which slips out so a supplied remote microphone, complete with pause control, can be connected); a three-digit tape counter; a record/battery indicator lamp; mic sensitivity adjustment; volume control and a jack for either the supplied earphones or the connector for the unit's separate speaker stand.

The left end of the recorder is taken up by a compartment for a single "AAA" battery, above which is a jack for the supplied AC adapter. The arrangement of controls and connectors covers a great deal of functional ground in a very small space.

(Continued on page 2)

MICRO RECORDER

(Cont. from p. 1)

The separate speaker acts as a stand for the *RN-36* during playback, with the palm-size recorder sitting at a slight rake on the front of the system. The stand itself includes a tone control ("high," "low"), a battery indicator lamp and a compartment in its bottom for two "AA" batteries.

When not in use, the cord connecting recorder to speakers also stores in the same space. A minor flaw seems to be that it's impossible to open the compartment without taking its plastic door off, which means a certain amount of fumbling everytime you stow or use the speaker connection.

In a variety of audio situations, the *RN-36* proved itself a dependable, if not extraordinary recorder. We appreciated *Panasonic*'s inclusion of a mic sensitivity control after trying to record an interview in a room filled with background noises.

The unit's cassette mechanism gave us pause in two respects. Twice, in loading a cassette, the *RN-36* began eating the tape, possibly a result of our haste but something that should be noted. In both instances, we were able to retrieve the tape and its contents, so the damage wasn't serious.

A second shortcoming was the *RN-36*'s performance in transcription. Slippage between where the tape was when "stop" was engaged and where it was when play began again was enough that much manipulation of the stop-rewind-play controls was necessary to get the recorded words onto paper.

With its supplied carry pouch, the *RN-36* fits easily into a shirt or coat pocket. Even given its diminutive size, the recorder appears to be a sturdy enough unit. Our publisher has used an *RN-36* for some time in all sorts of places and situations and has found its performance unvarying.

Panasonic has managed to pack real utility into a very small package. Maximum value in a micro-size is no small feat, even in this split-second age.—G.A.

Radio Cool

COOL SOUNDS COOLER/RADIO. Manufactured by: Sun Hill Industries, Glendale Commerce Park, 48 Union St., Stamford, CT 06906. Price: $34.95.

Usefully enough, our test of the *Cool Sounds Cooler/Radio* coincided with the height of New York's oppressive mid-summer heat. Unhappily, however, management at GADGET was not convinced that a proper test of this combination beverage cooler-AM/FM radio demanded a day at the beach, to be financed out of our research budget.

Manhattan's acres of concrete "beach" allowed us to put the cooler end of this combo through its hot-weather paces, even if the crowded city sky made use of its built-in radio, at least, problematical.

At about 10 o'clock in the morning, we filled the *Cool Sounds* with ice. Although the simple directions didn't suggest this, they didn't caution against it. About three hours later, we left the air-conditioned confines of GADGET's testing grounds with *Cool Sounds* slung over our shoulder via its carrying straps and its supplied earphones in place. Even in intense heat there's something about carrying beach gear around in an urban setting that made us feel and (as our co-workers confirmed) look more than slightly foolish.

After an hour in the blazing sun (since we were testing *Cool Sounds* we made it a point of honor to avoid the shade), we returned to the office and examined the remaining ice. Despite heavy condensation on the bottom of the pack, meltage was minimal considering the 90-plus degree heat through which the *Cool Sounds* had been carried. Its insulation certainly seems enough for a day at the beach.

Its water-resistant radio, however, meets somewhat more marginal standards. An AM/FM unit powered by four "AA" batteries, it includes both a built-in speaker and headphone jack. Given the sophisticated audio performance available in portable music systems (in a wide range of price levels), the *Cool Sounds* receiver is minimal in its performance. Tuning, via a single, crowded knob, is only functional.

Still, how many boom boxes or portable audio systems will keep a six pack chilled and ready for refreshment? Although given the dimensions of the *Cool Sounds* bag, its capacity isn't much beyond a single six pack.—G.A.

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GADGET is published by A.G. Consultants, Inc., 116 W. 14th Street, New York, NY 10011, (212) 989-8001. GADGET is published 12 times a year and appears as an Insert in Hands-On Electronics, published by Gernsback Publications, Inc., Farmingdale, NY 11735. For information on subscriptions to Hands-On Electronics, please see the magazine's editorial page. Letters intended for GADGET's editorial staff should be sent to the newsletter's address as shown here.

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Dada Machine

HANDY COPIER (Z-HC1). Manufactured by: Sharp Electronics Corp., Sharp Plaza, Mahwah, NJ 07430. Price: $189.95.

The hand-held copier is undoubtedly the outstanding electronic novelty of this past year. "Novelty," of course, is a label the manufacturers of these devices would object to. Advertising and marketing copy for the products tend to boost their utility as study aides or in the handling of paper work.

There's little doubt that the hand-held copier has its specialized uses. But as gadget fans, we're near positive that potential utility, at this point, isn't the main attraction. Instead, the twin fascinations of miniaturization and portability give these diminutive copiers their consumer appeal.

In May we reported our tests of the Silver Reed Porta Copy (p. 3), even though *Sharp's Z-HC1 Handy Copier* had reached retail outlets first (April, p. 12). Before examining the *Sharp* version, we were inclined to minimize differences with its counterparts.

But hands-on experience with the device demonstrated that the *Z-HC1* represents a significantly different approach to a portable, small-size text and graphics copier. At first glance, there's something almost archaic in the *Handy Copier*'s appearance, a throwback to an earlier era of consumer design.

Roughly the size of a hardbound book, copy scanning is performed with a separate pen-style "wand." The copier itself includes a built-in, rechargeable 6-volt battery, a storage compartment for the unit's single roll of thermal copying paper and the device's seven controls.

Besides the power switch with light, these include the paper feed, a repeat function (which makes multiple copies of materials given only a single scanning), "clear" button and three specialized *Handy Copier* features.

One switch sets the machine for graphic or word scanning. A feature labeled "zoom" will double the size of any letters or text lines scanned, while "layout," according to *Sharp*, can "take information from two sources and print them side-by-side for easy reference."

The copy wand has a single control, a button marked "read," and it scans text or graphics with what *Sharp* identifies as an "amorphous silicon head," capable of reading text line-by-line at the rate of "110 millimeters per second."

As we discovered in familiarizing ourselves with the *Handy Copier,* the device's wand reads like humans in the West do, from left to right. If the "read" button is not kept on the left during scanning, or if the wand is moved from the end of a line to its beginning, the copied text will appear as mirror image of the original.

Given the copy paper's width, 3⅛", the *Z-HC1* also makes numerous decisions regarding arrangement of longer lines in this narrow space. Both of these aspects suggest the *Handy Copier* is a good deal more complex than its Silver Reed counterpart.

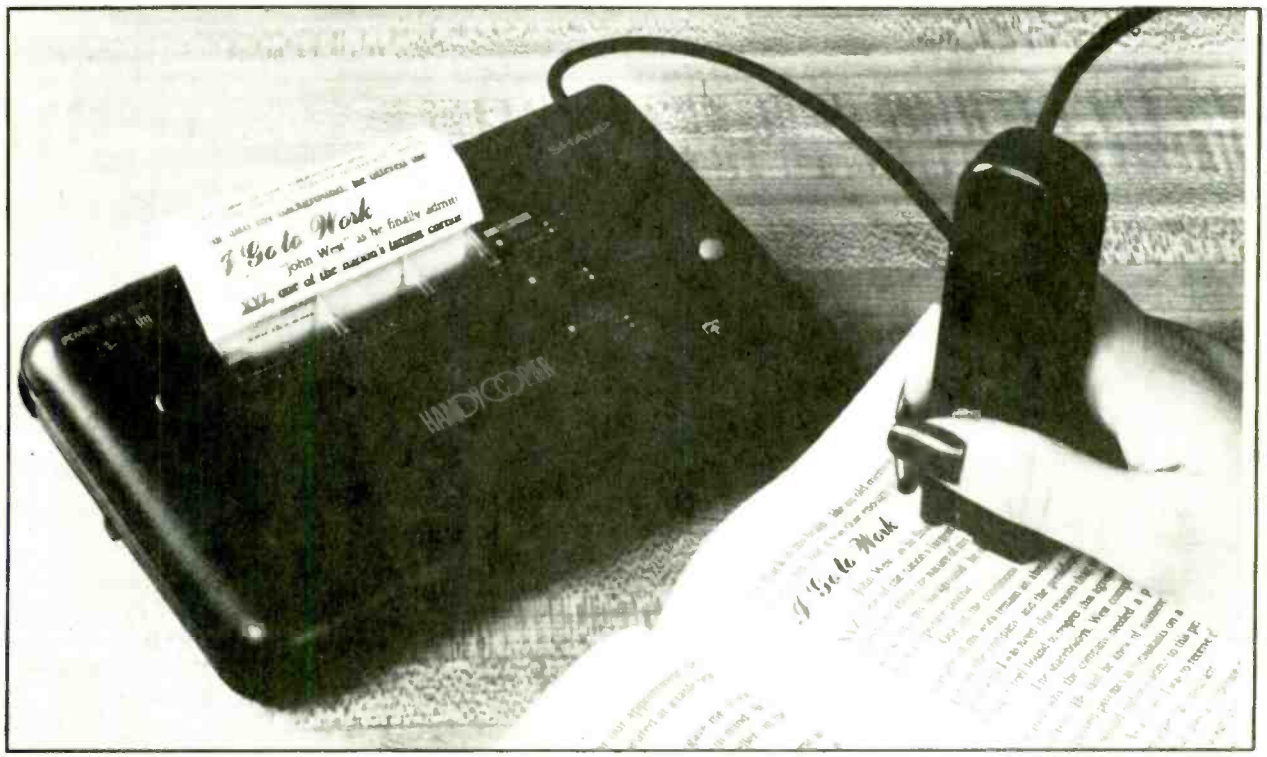
The paper roll included with the *Handy Copier* was used up in just getting the hang of the device. Accurately and legibly copying material is not the effortless line scanning indicated in *Sharp* promotional material. The wand's small "reading window" makes it easy to wander off a line. The scanner's copy guide markings, at least for a left-handed person, are awkward to use and tough to keep an eye on.

Perhaps in recognition of this, the *Z-HC1* is sold with a plastic copying guide frame, primarily for use with graphics, but also helpful in scanning text. Using it keeps the scanning wand on a steady path and assures that each pass neither overlaps nor creates gaps in the copied image or words.

Steady pressure and an even surface are also important in successful *Handy Copier* manipulation. A switch on the side of the copy wand adjusts the unit for duplication of either light or dark originals. In carrying out a basically simple process, the *Z-HC1* demands that its user keep a number of factors in mind. Practice won't necessarily produce perfection.

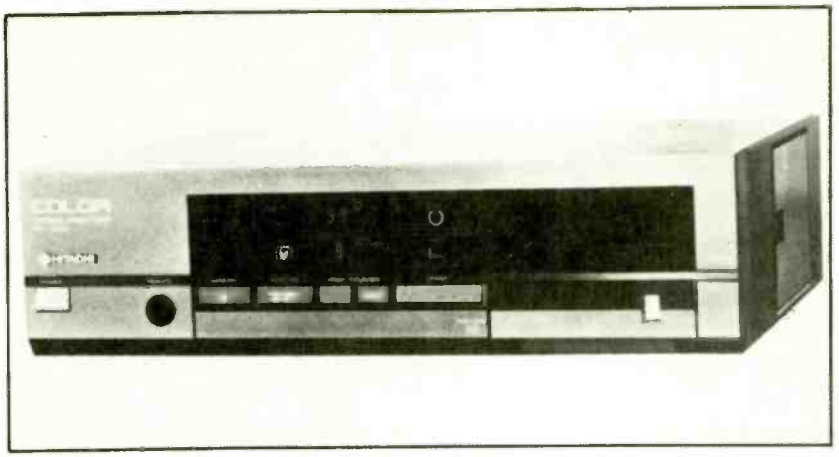
As a portable machine, the *Handy Copier* is sold with a fabric carry case. Its recharger does not function as an adapter, so the unit's built-in battery is its

(Continued on page 8)



Freeze Frame

COLOR VIDEO PRINTER (VY-100A). Manufactured by: Hitachi Sales Corp. of America, 1290 Wall St. W., Lyndhurst, NJ 07071. Price: $3,995.



We have to admit we're slightly befuddled by the *VY-100A Color Video Printer* from *Hitachi,* but we don't mind confessing to our confusion. Judging from the device's instruction booklet and the marketing of the unit, *Hitachi* is equally unsure of just what the future holds for this impressive piece of electronic engineering.

It's certainly clear what the *VY-100A* does. In something like a minute plus 20 seconds, the *Video Printer* can take an image off a monitor or television screen and reproduce it as a 3" by 4" bordered snapshot with exceptionally good color and detail.

The *Hitachi* press release says the *VY-100A* "offers 525 lines of resolution," making for near 35mm image quality. The printer draws on an electronic palette of "64 tones of color," in order to produce "near-photographic quality pictures."

In printing, the *VY-100A*'s "thermal transfer step-up unit," uses a "dye transfer process with ink cartridge and dye transfer thin film." Promised for the near future is a film format which will enable *Hitachi*'s color video printers to produce color transparencies.

Besides capturing images more or less directly from the screen, the *VY-100A* has a memory function (*Hitachi* rates it at 460-kbytes) which allows images to be stored for later reproduction. There's also a function which allows the date and the time to be superimposed in the print's lower right corner. GADGET was able to do all of this with the *Color Video Printer,* so where did our confusion arise?

Its source is an all-too-familiar one, the instruction manual which accompanies the *VY-100A*. Frankly, between confusing nomenclature and badly constructed sentences, we found the manual less than helpful in guiding us in use of the unit.

Although the printer clearly has a memory (the first picture out of it when we turned it on was an image stored from an earlier demonstration of the device), the manual's description of how to use it is terribly convoluted. The "Memory select" control on the front of the *Printer* has three buttons—"frame," "field A" and "field B."

A section at the bottom of the page devoted to memory select explains: "A TV set displays one picture for 1/30 seconds. If all 525 lines were scanned at a time, light and shade would occur in the TV picture resulting in flickering. To prevent this, the field of view is scanned twice to compose one picture." The section goes on to explain that "a picture displayed only by one scanning (lines 1 to 263 or 263 to 525) is called a field picture, and a picture formed by two scannings (line 1 to 263 and 263 to 525) are [sic] called a frame picture."

The scanning, in use, is obvious. When the *Video Printer* is engaged, the image on the TV or monitor screen is suddenly frozen, then a wipe slowly moves across the screen leaving behind it a blank. When the process is complete, the live image (not the one selected for video printing) reappears.

What's not clear from either use of the machine or from the instruction manual is which of the two printer pictures (frame or field) should be selected for use in which situations.

The detailed charts proporting to outline use of the memory select buttons is equally obscure. Step-by-step diagrams show which buttons (frame or fields A and B) put the picture into memory circuit A or B. The instructions go on to outline which frame or field buttons to use for "slow picture," "rapidly moving picture," "still picture from VTR" or "picture from MSX personal computer."

It seems clear enough, but in our tests we were never able to select an image, press a memory button, then bring the image out of the device as a picture. We were missing something, no doubt, but no section of the manual (including a page-and-a-half "Problem Guide") told us either what we did wrong or what we weren't doing. A phone discussion with a *Hitachi* technician, whom we called for further guidance in connecting the device to a Proton 625 monitor/receiver, left us as confused as ever.

The confusion carries over into the *VY-100A*'s controls. There are two "memory" buttons which, although they carry out different functions, are both imprinted with the same symbol. A third control is labeled "memory/source." But none of these complaints touches on the device's impressive functioning.

Prints are sharp and well-focused and the prospect of being able to capture images off of a TV screen adds yet another dimension to contemporary video. Imagine, for example, using a camcorder to capture some moments of family life, then loading the cassette into your VCR and running off a few snapshots to send to some out-of-town relatives.

Or consider its applications in newsgathering. Images from overseas TV broadcasts could be captured and, without the intervention of a camera or photographer taking a picture from a screen, reproduced in magazine or newspaper coverage.

Unfortunately, widespread consumer access to this *Color Video Printer* seems a distant possibility. This is where we discern some confusion on *Hitachi*'s part. Although initially we read of plans to offer this in a consumer model, that idea has apparently been put on the shelf. Aside from the high cost of the *VY-100A* itself, its ink-and-paper cartridges retail for $99.95. With 20 pre-cut sheets of paper in each cartridge, that makes for a per-picture cost of a little under $5. There is a less expensive companion model to the *VY-100A*, the VY-50A which uses half the colors (32) and retails for a mere $2,495.

Still, the *Hitachi Color Video Printer* is a harbinger of video applications yet to be explored or exploited. From GADGET's vantage point, it's a marvelous extension of media. An exciting indication of potential and of changes in visual media just beginning to show themselves. We only wish that the *VY-100A*'s print support, that is its instruction manual, was as clear as the pictures the device produces.—G.A.

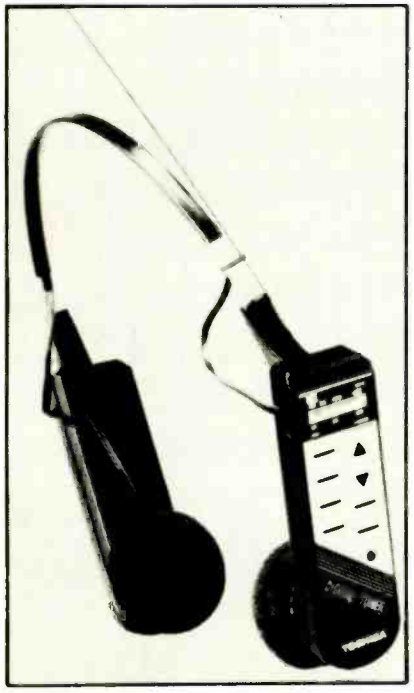
Head Trip

AM/FM STEREO SYNTHESIZER HEADPHONE RECEIVER (RP-2066). Manufactured by: Toshiba America, Inc., 82 Totowa Rd., Wayne, NJ 07470. Price: $79.95.

Personal stereos come in a variety of "flavors," from monster boom boxes to Walkman-style cassette recorders. One style favored by those people who want to be freed of wires, battery packs or anything that would distract them or occupy their hands is the all-in-one stereo receiver, with the whole unit packed into a single lightweight headset.

Toshiba's newest entry into this product category, the *RP-2066*, is on the whole disappointing. We don't want to seem to enlist ourselves in the wholesale *Toshiba*-bashing that's become endemic in the wake of the company's controversial dealings with the U.S.S.R., but this particular product exhibited several shortcomings. While some of the difficulties encountered in the GADGET field test of the *RP-2066* may be attributable to the conditions themselves (Manhattan is a notoriously fickle arena for radio reception), these may be taken into account, with the tally still weighing against a recommendation.

To begin with, the complete title for the small, unassuming gadget is actually quite a mouthful: "AM/FM Stereo Synthesizer Headphone Receiver with Digital Tuner." We were initially quite pleased with that "digital," since our preference is for digital tuners, with their station signal so reassuringly displayed numerically. An analog tuner at times smacks of approximation: is the tuner cued exactly, or would a shade of adjustment "true in" the signal to the final degree?



Toshiba's *RP-2066* does indeed have a digital tuner. It lacks, however, a digital display, which leaves one in essentially the same quandry as with an analog model—the feeling of "where am I?" on the radio band. The *RP-2066* steps through the frequencies a signal at a time, so it does manage to totally blanket the band. But the user's sense of control is limited by the lack of a digital readout.

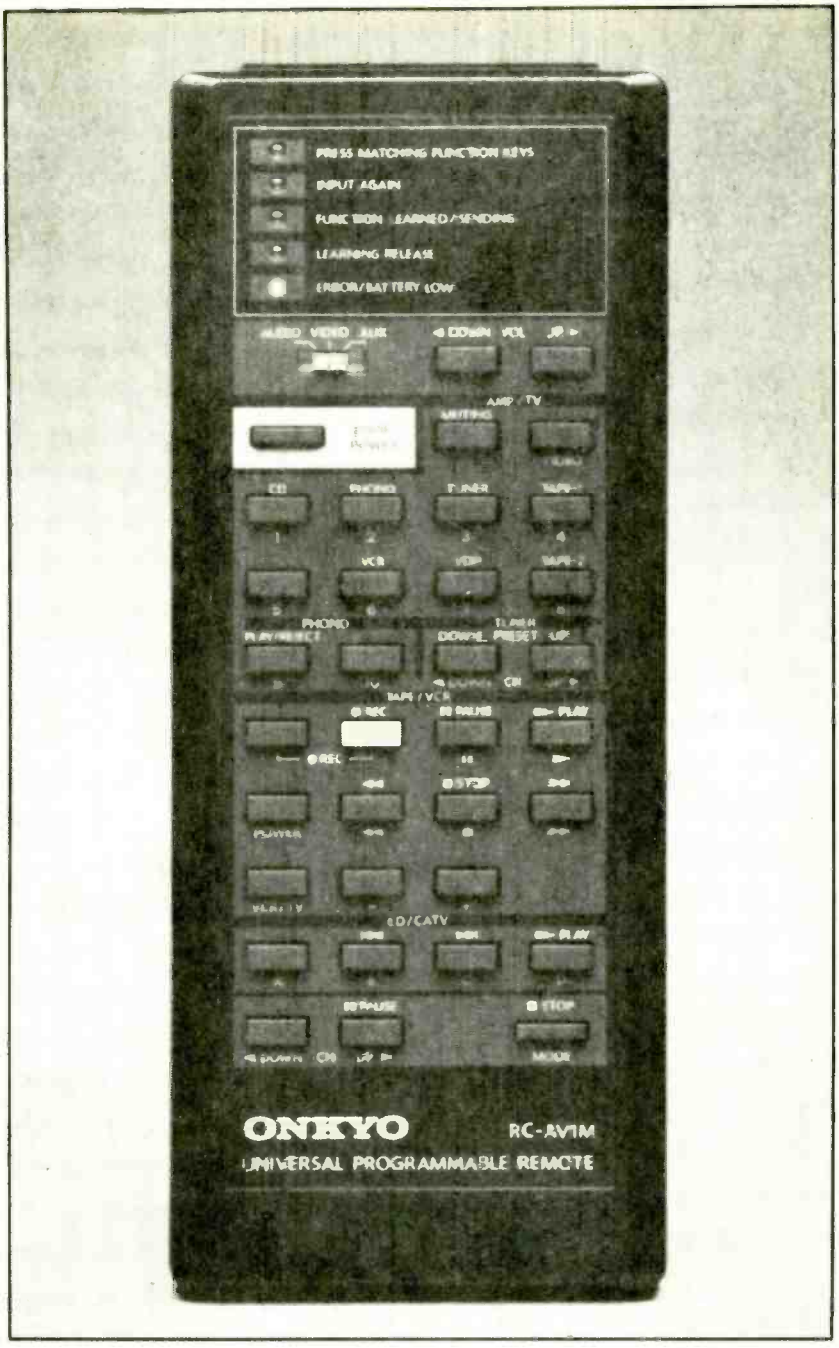
The unit is light (10 oz.) and designed so that the battery pack (in the left side) balances with the tuner control (on the right). There is a small LCD readout which displays incremental bands of black to indicate the wavelength to which the unit is tuned. The on/off button is a small round bump at the bottom of the control panel; the tuner buttons are larger and triangular, and these are differentiated from the five memory buttons by making the latter rectangular. The other controls are volume—a wheel-style adjustment at the bottom of one headphone—and frequency mode, a three-setting AM/FM/FM Stereo switch at the top side of the other headphone.

The *RP-2066* has a search mode which scans the wavelength and automatically stops at signals it considers strong enough. The problem we had with the unit repeatedly was one of reception. Again, Manhattan is not the ideal locale to test a small, free-antenna radio, but when we took the *RP-2066* to the country, in upstate New York, we experienced the same difficulties. Another fault is that the unit sits far too loosely upon the head, making it unsuitable for jogging without some additional method of securing it, such as a headband or bandana.

Compared to other units of this type, we'd rate the *RP-2066* near the bottom end of the spectrum instead of the top. When you are unable to locate enough station signals to fill a radio tuner's five-entry memory, you have to believe something is wrong.—G.R.

Telepathic Control

UNIVERSAL PROGRAMMABLE REMOTE CONTROL (RC-AV1M). Manufactured by: Onkyo U.S.A. Corp., 200 Williams Dr., Ramsey, NJ 07446. Price: $119.95



Unchecked electronic home entertainment proliferation no longer means a tangled mess of wires and unsightly connections. In this age of the infrared remote control, it means, rather, a coffee table clutter of up to a half dozen small black rectangles, each beaming its commands to its designated device, oblivious to its brother remotes.

A way to streamline and organize this mess is to put all your remotes into one package, using *Onkyo's Programmable Remote*. A sort of zoning ordinance for technological sprawl, the *RC-AV1M* accepts the infrared commands of virtually any remote control on the market, learns to mimic them, and is thus able to reproduce a whole host of signals, from the one which tells your compact disc player to skip a song to the one which shuts your VCR off for the night.

The key to all this—the key to so much of the audio/video revolution—is computer electronics. At the heart of the *RC-AV1M* is an 8-bit microchip. Using all the variables supplied on the 34-key control, the user can program over 50 separate commands, each using a specific "learned" infrared frequency. In addition, there are another two dozen commands lodged in the unit's memory for use with *Onkyo* products exclusively, but these may be reprogrammed to control other products. Actually, the grand total of possible learned commands for the *RC-AV1M* is over 90!

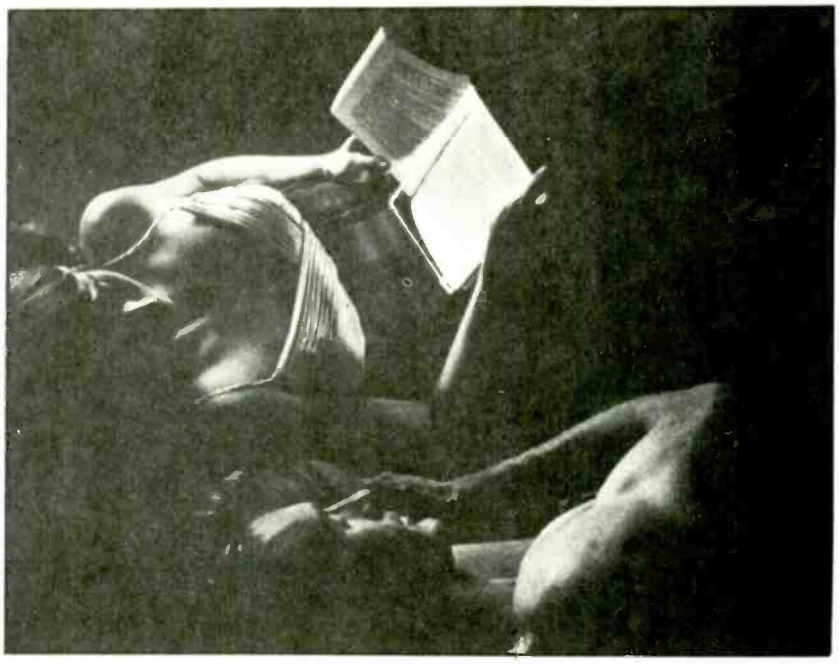
Now, it would take quite the consummate gadget freak to utilize 90 different commands, but it is comforting to know the capability is there. The functions are packed into a sleek 1¼" x 2⅞" x 7" control, with a small protruding battery cavity that allows the unit to sit at a slightly raised angle. The top face is taken up by five LCD status signals, four of which walk the user through the signal-learning programming process and one of which is an error light that doubles as a low-battery warning.

Programming is a fairly direct process. The whole unit is converted to a learning/programming mode by a small, recessed switch set into the rear of the casing. A three-setting master switch allows the programmer to choose from three modes: an "Audio" mode which is preprogrammed for *Onkyo* video products, a video mode for VCR and television controls, and an auxiliary mode for stereo or CD programming. As was indicated before, the "Audio" mode may also be reprogrammed for non-*Onkyo* products.

The heads of the original remote and the *RC-AV1M* are brought together, corresponding buttons are pushed, and the *Onkyo* unit "learns" the signal from its progenitor. In our GADGET test, we found that a widely varying time was necessary for the programming to be accomplished. A Sony Betamax remote control command was transferred within a few seconds, while a rather ancient Zenith television remote was more problematic, and took several tries and a bit of experimenting.

Compared to several other programmable remotes on the market, the *Onkyo* stands up well, primarily because of its compact design. The programming process was easy and effective, taking about 30 minutes to transfer three separate video and audio remotes into one. An erasable template is provided in case you want to note your own command sequences, and there is a reset switch in order to provide for updates and additions. All in all, the *RC-AV1M* impressed us as a streamlined bit of technological wizardry, essential for the dedicated control freak.—G.R.

Deluxe Lux



GLO-PAGE READ 'N WRITE NIGHT LITE (model 20). Distributed by: International Marketing Concepts, Inc., 800 W. Central Rd., Mt. Prospect, IL 60056. Price: $20.

Here's a wonderful example of the "why didn't someone think of this before" style of gadget. Personal reading lights have been marketed in a multitude of tiny, portable, flexible, adjustable and unusual forms for years.

They've been designed to clip to the edge of a page or fasten to a variety of surfaces at all different angles. Although we haven't seen it, we're sure there's got to be one which is a bedtime variation on the miner's lamp, to be worn on the forehead and directed at a page.

Along comes the *Glo-Page* and, it would seem from our test, its designers have a better idea. It's a simple device, a tapered slab of lucite (5¼" x 7¾") with a black plastic bar at the top.

Inside this bar, at the center and mounted vertically, is a tiny 4.8 V clear light bulb. The model 20, the most basic of the *Glo-Page Read 'n Write Night Lites*, comes equipped with a case for four "C" batteries and a connecting cord.

In an ordinarily lighted room, it's difficult to tell whether the *Glo-Page* is on, but in a darkened room, it glows with a pleasing, soft illumination. To use, the reader merely puts the transparent surface over the page and reads through the glowing lucite. In order to write, a single piece of paper is positioned on top of the *Glo-Page*, with the illumination coming through the sheet.

While in our tests, the *Glo-Page* seemed comfortable to read with, we wish it came equipped with the okay of some lighting expert or other. Anything designed to let you read or write in the dark, conjures up the sound of a mother warning, "you'll ruin your eyes."

We were also somewhat concerned about scratches marring the *Glo-Page*'s lucite surface. But in use, they turned out to be immaterial, certainly not distracting or otherwise a detriment to comfortable reading.

Not so easily dismissed was the heat factor. That tiny bulb in the *Glo-Page* raises the temperature of the device's top to an uncomfortable degree. Not dangerous, but still alarming when you accidentally brush an arm or wrist across it. We'd feel a tad apprehensive about falling asleep with the *Glo-Page* glowing on through the night.

Besides the battery case and connecting cord, the *Glo-Page* model 20 comes equipped with a fabric travel pouch, a replacement bulb and a tablet and pen. The more elaborate models 30 and 50 include the above, plus a 110V AC adapter and a 12V vehicle adapter. The model 50 also includes a rechargeable battery pack, available for use with other *Glo-Page* models as a separate accessory (for about $19.95).

We were interested to discover that the *Glo-Page* instruction sheet suggests cleaning its lucite surface with toothpaste. With *International Marketing Concepts, Inc.*'s emphasis on accessories and extras for this handy night light, we're a bit surprised the firm isn't selling a special "*Glo-Page* cleaning paste." But, there's always next year's model.... —G.A.

SHARP HANDY COPIER

(Cont. from p. 3)

only power source. The 12' long copy paper rolls are sold in packs of five at a suggested retail price of $3.95.

Although sold as a study and paperwork tool, we predict that fine and graphic artists will be among the *Handy Copier*'s first fans. As we discovered in our tests, not following the rules for successful copying can produce fascinating oddities and startling variations of familiar images. In its text applications, the *Z-HC1* might also become an artistic tool.

Novelist William Burroughs, for example, first came to literary notice with a technique referred to as "cut-up" composition. The author would slice up some selected or created text, then randomly rearrange the words into something new.

With a *Sharp Handy Copier,* Burroughs could have eliminated the cut-and-paste stage of the creative process, instead merely scanning material, then printing out his "cut-up" composition.

Participants in the First World War era's "dada" movement would have hailed the *Sharp Handy Copier* as technology designed for literary and artistic rebellion.

While we have a few doubts about the utility of the *Z-HC1,* we admit to being fascinated by it. Its copied text and image capabilities are crude, at least judged by full-size copy devices. But in taking a different tack in the design of this product, *Sharp* has created something the capabilities of which await exploration. —G.A.

Handy Copier-produced imagery

Neatnik Beardo

PANASONIC RECHARGEABLE BEARD/HAIR TRIMMER (ER-388). Manufactured by: Matsushita Appliance Co., One Panasonic Way, Secaucus, NJ 07094. Price: $27.95.

In testing this compact beard/hair trimmer, GADGET received proof positive that the device delivers a smooth, close, comfortable trim. Sending it home on Friday with a staffer who was bearded, Monday it returned to the office with the tester, clean-shaven for the first time since coming to work here.

"I got a little carried away," was his explanation, but to us this was a solid indication that the *ER-388* is a worthy entry into a crowded consumer field.

Although we'd not seen the *ER-388* before, it probably isn't a new product. To our untrained eyes, its design and especially its cutting blades resemble nothing so much as an old-fashioned barber's electric hair clipper, slimmed down and made rechargeable.

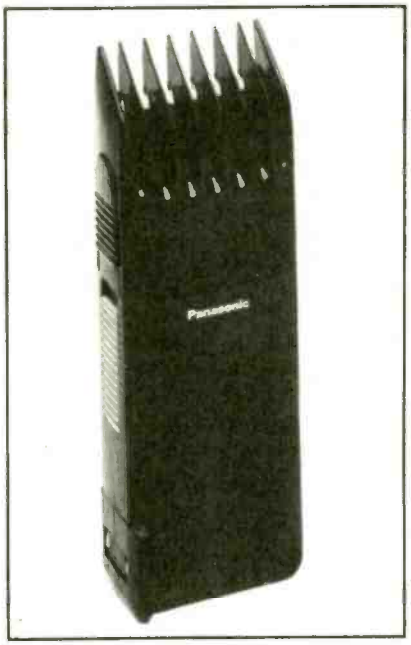
Downright austere in appearance, the *Beard/Hair Trimmer* has just two parts —the appliance itself and a slip-on plastic comb attachment. This fits over the cutting head in one of three clearly marked positions for "long," "short" and "medium" trims.

The unit's recharger is built into the *Trimmer*'s base. A switch on the bottom extends a pair of prongs for insertion into a standard outlet, with eight hours of charge providing 45 minutes of trimming. A note in the directions says that the unit's battery, based on twice-monthly charging, has a life of roughly four years. Presumably it can be replaced as in somewhat fractured English the directions advise, "When the life has been reached, consult *Panasonic* service center."

Included with the device is a cleaning brush and a small container of lubricant for application to the metal blades which also have a specified life. Although this varies depending on "frequency and length of usage," *Panasonic* says, "if cutting efficiency is reduced substantially despite correct maintenance, the blades have exceeded the life time and should be changed."

Our test subject reported that a curly beard renders the *ER-388*'s plastic comb attachment unusable. While it might work for the straight-haired among the bearded, after struggling with it for a few strokes, our tester merely shaved sans plastic comb.

But the *ER-388* does correct a defect of many other trimmers. In doing sideburns or touching up facial hair, other trimming devices often obscure the view, making it difficult to see what you're doing and just what, or how much, you're cutting. In contrast, the simple cutting head of this *Panasonic* product makes visual guidance easy.



Besides its main use, the *Panasonic ER-388* can be used to cut hair with its comb attachment removed. Cautiously the instructions merely state, "fringe cut and outline cut can be done."

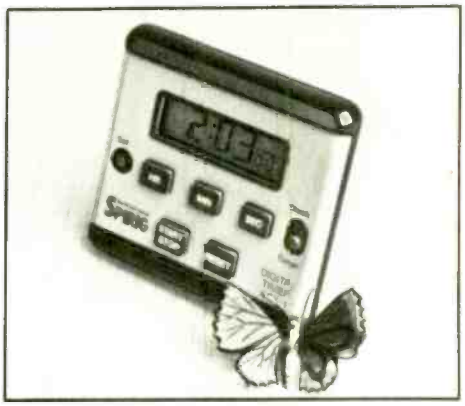
For the hirsute, this *Panasonic Beard/Hair Trimmer* may well establish itself as a necessity. Although if our GADGET tester's experience is any guide, it might render itself obsolete in just one session.—G.A.

Bits & Pieces

We're tempted to label this, "the boom box that ate North Palm Beach" and we offer it to readers who may have wondered, will the trend to larger and larger portable audio systems ever end? The **Giant Boom Box** comes from *Electronic Media Consultants, Inc. (1208 U.S. Highway One, N. Palm Beach, FL 33408)* and it's described as "a giant fiberglass box that looks, acts and sounds like a radio and plugs in anywhere a radio station or sponsor wants to draw a crowd." Designed for radio promotional activity and the like, this live-in boom box is some 20 feet long, features "studio quality" wiring and is even on wheels for use in parades. By last March, Electronic Media Consultants had sold some 60 of these to U.S. radio stations with orders and projected sales of an additional 60 Giant Boom Boxes by year's end. If you move now, you can be the first on your block to actually live inside your audio system. Price: $29,995.

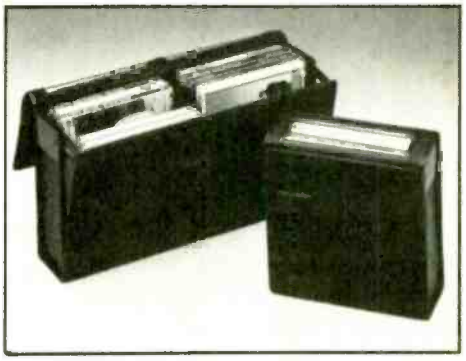
Giant Boom Box

Up in New England, cradle of the American timepiece industry, *Solder Absorbing Technology, Inc. (144 Oakland St., Springfield, MA 01108)* is pretty excited about its new battery-operated **Electronic Timer** (ECT-1). The unit incorporates a stopwatch, countdown, alarm, count-up timer as well as a clock. The timer is equipped with a memory and "does not need to be keyed in again for repetitive identical timer settings." It's fitted with a multi-purpose clip to fit "almost any attachment needs." How excited is Solder Absorbing Technology, Inc. about this new product? Well, from now until the end of November, the company is cutting the ECT-1's regular price of $24.50 to introduce it to buyers. Payment in advance also means Solder pays postage. Price: $19.90 (through Nov. 1).



Electronic Timer

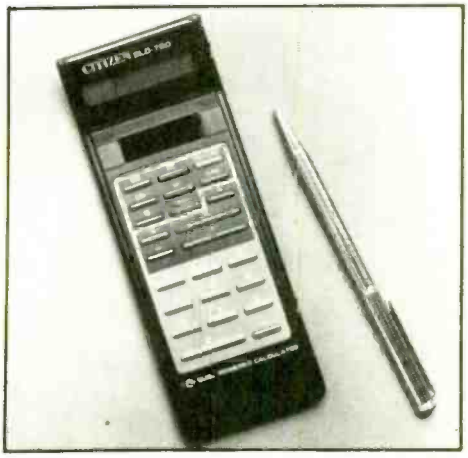
Here's a subtle touch for the energy-conserving home. With this device, householders can quickly warm up a room, for a period of from 30 minutes to 12 hours, with a touch of a button. Then the **Clark Automatic Vacancy Setback Thermostat** automatically returns the temperature to the lower, energy-conserving level. Available from *Free Market (1001 Connecticut Ave., N.W., Suite 638, Washington, DC 20036)*, the unit includes an indicator light which operates during the "comfort cycle." The product carries a one-year warranty and is available in three different models, corresponding to gas, oil or solar heating systems (model C-2), electric heat (C-1) and non-heat-pump heating/cooling systems (C-4). Price: $100.75-$141.75.



CD Storage Cases

Compact discs, of course, are supposed to be handier to store and transport than the 12" LP, so how come accessory manufacturers expend so much effort coming up with systems to store and transport this newest in audio convenience? Take *Discwasher (4309 Transworld Rd., Schiller Park, IL 60176)*, the same firm that came up with a cleaning system for those "maintenance-free" CDs. The latest from Discwasher are new **CD Storage Cases**, in ten-disc and five-disc sizes, which also hold a portable CD player. Lightweight and featuring rugged water-resistant construction, their design allows a user to flip through the stored discs, while windows allow visual inspection of individual disc jewelbox edge labels. Price: $8.95 (5-CD unit); $12.95 (10-CD unit).

This product could put a little excitement into contemporary electronic lifestyles via some electronic cultural confusion. *Citizen Consumer Products (CBM America Corp., 2999 Overland Ave., Los Angeles, CA 90064)* promises "new excitement" with a **Calculator** "styled like TV remote control devices." The model SLD-780 is a slimline, desktop model, featuring "sleek contoured lines, 8-digit LCD display, repeat functions, percentage capability, chain calculations, reciprocal and mark-up features, plus three-key memory." Best of all, at least in Citizen's corporate eye, it looks just like a TV remote control device. Imagine if this trend spreads to other electronic products—refrigerators that look like TVs, VCRs that appear to be copying machines, tape recorders tricked out as CRT units, the potential for creative camouflage is limitless. The next move for Citizen Consumer Products? How about a combination calculator/TV remote control unit? Price: $11.95.

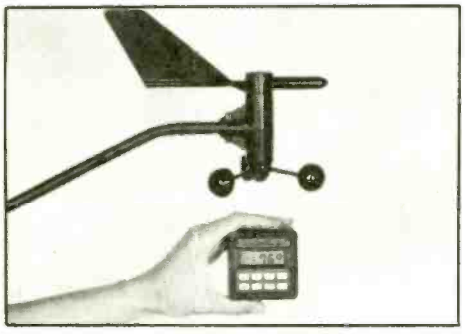


Citizen Calculator

Bits & Pieces

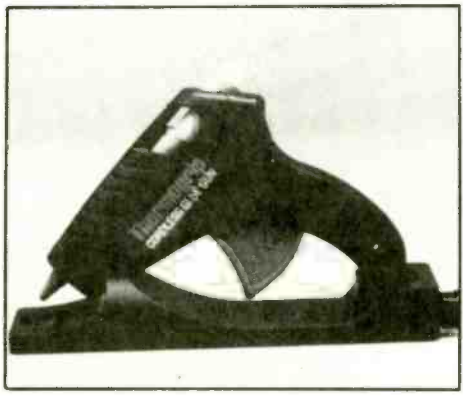
Bob Hope Golfer

Talk about your Bob Hope Classic, this item puts us in mind of a period in our youth when Bob and Bing (Crosby) used to appear on TV screens driving specially designed golf carts on behalf of an orange juice brand. Bing's sported a pipe and golf hat, while Bob's was outfitted with a replica of the Hope proboscis. This item, before we got carried away with nostalgia, refers to the **Bob Hope Golfer**, a radio-controlled miniature cart with a Bob figure swinging his club at the buggy's front. According to *The Synchronics Catalog (Unique Merchandise Mart, Bldg. 42, Hanover, PA 17333)*, "Bob responds to fingertip radio commands that allow him complete freedom of movement, he will drive, chip and putt." The rig comes with three golf clubs, four tees, four balls, two golf bags and a trio of magnetic flags/holes. Synchronics gives the distinct impression that this radio-controlled replica is a better golfer than its flesh-and-blood inspiration. It's also said to be a "real test" of the user's skills. Fore! Price: $100.



Micro Weather Station

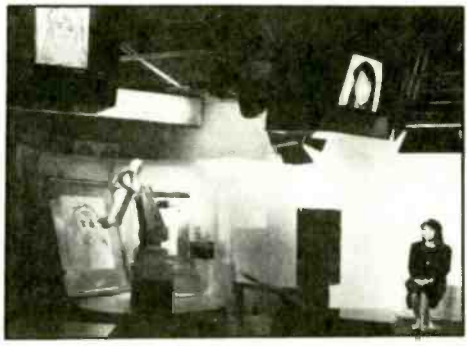
We're suckers here at GADGET for the world's "smallest" anything, which is probably why *Magnaphase Industries, Inc. (1502 Pike St. N.W., Auburn, WA 98001)* sent us its announcement of the **Micro Weather Station**, at 2.7" square, "the world's smallest digital weather station." Designed for the amateur weather forecaster or hobbyist, the Micro features an LCD display with 4" numerals and monitors wind speed, wind gust, temperature, highest and lowest temperature recorded and wind direction. Power is supplied by 12V direct current, 120V alternating current or the station's own internal batteries. The Micro Weather Station is sold with a one-year warranty. Price: $140.



Cordless Glue Gun

For survivalists, solar energy buffs and the just plain curious, now there's a **Portable Solar Box Cooker** that pre-heats in 30 to 45 minutes and is capable of cooking temperatures of 250 to 300 degrees Fahrenheit. The unit uses a "heat trap" system which, in contrast to magnifying systems, "won't burn food." Offered by the *Free Market Catalog (1001 Connecticut Ave., N.W., Suite 638, Washington, DC 20036)* in kit form, its distributors say it "cooks vegetables without water" and food "tastes better, too." The kit comes with everything needed to assemble your own 2½' square, 1' high solar box cooker. Price: $55.75.

A small step for humankind, but a gigantic advance for the glue gun field as *Thermogrip (Emhart Consumer Group, P.O. Box 13716, Reading, PA 19612)* announces its first **Cordless Glue Gun System**. The new product combines "the efficiency of hot melt gluing's quick bonding properties" with the "ease of free movement, unencumbered by electrical cords." The Thermogrip Cordless can be adjusted for plug-in use using the unit's recharger/adapter. The gun is also sold with a charge stand, storage tray, dust cover, six clear and six all-purpose glue sticks. It sounds as if this might be a handy tool in any number of sticky situations. Price: $29.95.



Portrait-Drawing Robot

Forget what robots and robotics are achieving on the world's assembly lines. *Matsushita Electric Corp. of America (One Panasonic Way, Secaucus, NJ 07094)* reports that its Japanese parent company, Matsushita Electric Co., Litd. of Osaka has unveiled a prototype **Portrait-Drawing Robot**. In order to come up with a likeness, this computerized artist utilizes a video camera to record a still of the subject's face. The picture's details are then analyzed by a 16-bit microcomputer. Next, a line drawing is produced on the video monitor, with particular attention paid to features like eyes, hair and facial characteristics. The drawing itself utilizes brush-stroked paint on paper. The robot is programmed to move in three dimensions and can control length, direction and thickness of each line used in the finished portrait. But can it be programmed to remove an auditory sensor in artistic frustration? Price: Not for sale.

Bits & Pieces

Which audio manufacturer is going to be the first to market a portable sound system with its own set of wheels? That possibility suggested itself with the introduction of a new *General Electric (Consumer Electronics, Portsmouth, VA 23705)* system, the **Watch Out** (model 7-7400). It's an integrated portable audio visual system featuring a black-and-white TV with a 4.5" screen. The mini-tube is surrounded by an AM/FM tuner, stereo cassette recorder and a three-band graphic equalizer. Its four-speaker system is detachable and there's an auxiliary speaker for the TV. In portable use, the Watch Out is powered by 10 "D" alkaline batteries or the GE Power Stick recharge-capable battery pack. The unit can also be plugged into a standard electrical outlet or into a vehicle cigarette lighter. Price: $194.95.

Watch Out Audio-Video System

There are a lot of credit-card-size data management gadgets floating around the electronic marketplace, including the new **Directory-Mate** from *Executive Communications Systems (2622 Quaker Ridge Pl., Ontario, CA 91761)*. This 1.06 oz. mite includes a daily alarm reminder, one-year message alarm reminder, automatic daily message scrolling, a 200-listing telephone-address directory, two-line, 20-character display, security lock, five-function calculator and metric conversion capability. Executive Communications says the device's "instant recall" completes in a quarter-of-a-second, while its battery lasts up to two full years. Dimensions are a petite 3.3" x 2.1" x .13". Price: $39.95.

Here's a gadget for which someone has probably been waiting a lifetime, or at least for the duration of a long trip by car. From *Casco Products Corp. (512 Hancock Ave., Bridgeport, CT 06605)*, it's the new, entirely unprecedented **AromaLyte** combination automotive cigarette lighter and air freshener dispenser. This leaves hanging pine trees and Playboy bunnies in the dust as it "releases an impressive array of spectacular aromas via replaceable air freshener cartridges" (including "Country Air, Mailibu Midnight, Vermont Woods, Oriental Moon, Citrus Grove" and, our favorite, "New Car") even as it lights a cigar, cigarette or pipe. Users can dial the "level of aroma released" and the AromaLyte's cartridges include "a patented ingredient that effectively removes undesirable odors." Caso is a division of Sequa Corp., Scentronic Industries, Inc. The AromaLyte itself is electroplated in 24K gold and features a "high-tech black knob with gold signature." Casco says the device is "compatible with most cars." Replacement aroma cartridges are $1.90 each. Price: $9.95.

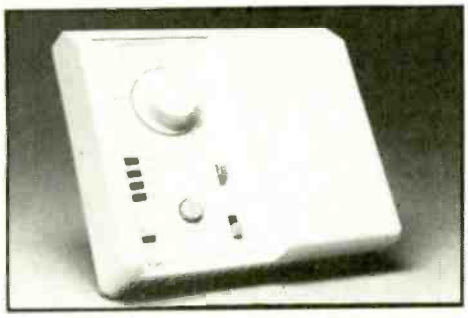
AromaLyte

That dream of every bad speller, the typewriter which corrects its own errors has nearly become a reality. The latest to offer a spelling checker option for its line of popular electronic typewriters is *Olympia USA, Inc. (Box 22, Somerville, NJ 08876-0022)*. The firm recently announced an 80,000 word vocabulary Spell Check option for its **Startype 4K** and **12K Memory Electronic Typewriters**. Besides the dictionary, a "personal" list of up to 1,200 words can also be created and added. The Startype Spell Check can automatically replace an incorrectly spelled word and also can command the machine to "automatically complete a partially typed word." Upgrades of Startype typewriters to take advantage of the Spell Check option can be performed by authorized Olympia USA, Inc. service representatives. Price: $149.

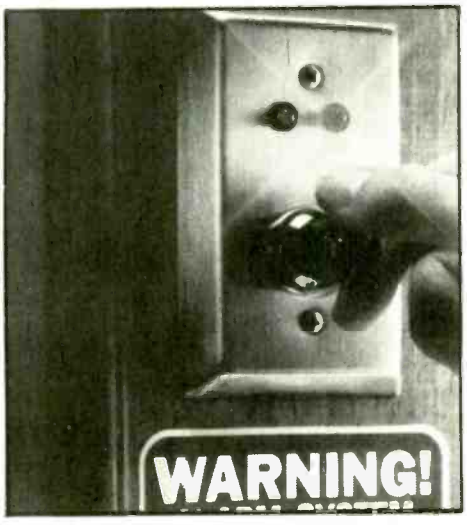
We can only speculate as to why *Owi, Inc. (1160 Mahalo Pl., Compton, CA 90220)* decided to call this gold-colored, pre-assembled robot, **Execu-Bot**, although the company's product description provides some clues. "It hears a sound, following your command it slowly awakens and begins to hobble on its four legs, stopping only at a pre-set time, all at the snap of your finger!" We suspect that "snap of your finger" is the key phrase, suggesting that the Execu-Bot isn't the executive half of the user-robot relationship. This simple robotic item comes in a display case and draws its power from two 1.5V "N" batteries. Its appearance puts us in mind of the giant robotic invaders of H.G. Wells' classic *War of the Worlds*. Price: $79.95.

Execu-Bot

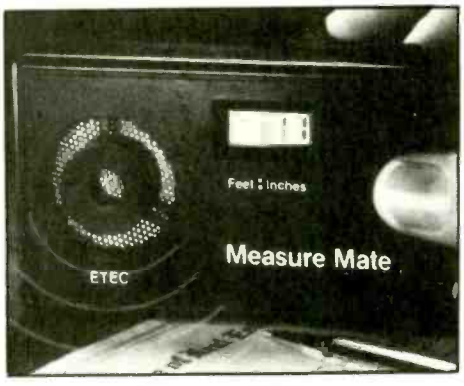
Bits & Pieces



Magic Stat Programmable Thermostat



Fake Alarm



Measure Mate

GADGET has received a torrent of announcements regarding electronic thermostats for home use. The problem is that lack of standardization in both the furnace and thermostat businesses can make buying the right unit a little tricky. Take, by way of example, the new **Magic Stat Programmable Thermostat** (CT2550) from the long-established *Honeywell, Inc. (Retail Business Unit, 3753 Plaza Drive, Ann Arbor, MI 48104)*. With an analog clock dial and simple button control, the Magic Stat is aimed at "consumers not electronically oriented." Its "user-friendly" controls and "comfort-level" programming eliminate "the need to calculate specific temperature settings." In fact, "this 'smart' thermostat does the thinking for the user." Unfortunately, it wasn't smart enough to design itself for furnace control circuits using other than 24V DC. If that sounds like your furnace, this may be a good unit for your home. Price: $58.95.

Some cynics suggest that in the modern world, appearance counts for everything, with substance a very distant second. A product carried by *The Sharper Image (650 Davis St., San Francisco, CA 94111)*, unfortunately makes a pretty compelling argument for that view. It's called a **Fake Alarm** and what it does is simulate the appearance of an expensive home or office alarm system. Stainless steel, Fake Alarm looks like a built-in keyswitch for control of a security system. In reality, however, "no cutouts or wiring required, mounts flush to wall or door frame with two included screws...," comes with security alarm warning sticker and a green LED, as well as two keys to "operate" the Fake Alarm system. This may be a foolproof deterrent to any fake burglars operating in this country. Price: $32 (includes shipping).

The right tool for the right job remains a useful guide even in the electronic era. But when it comes to picking and scraping, the right tool can be hard to find. Which is where **Mr. Tight-Spot** from *Intromark, Inc. (701 Smithfield St., Pittsburgh, PA 15222)* comes in. Made of stainless steel with plastic handles, one end of the tool is a pick and the other is a broad-tipped scraper, much like some dental instruments in widespread use. Mr. Tight-Spot can be used to "clean electrical contacts, remove corrosion from plumbing fixtures or clean ceramic greenware." But wait there's more. Mr. Tight-Spot can also "trim and remove cuticles" and "remove plaque and tartar from teeth," or so Intromark says. We just hope they don't mean that users should wield the same implement for both jobs. Price: $6.50.

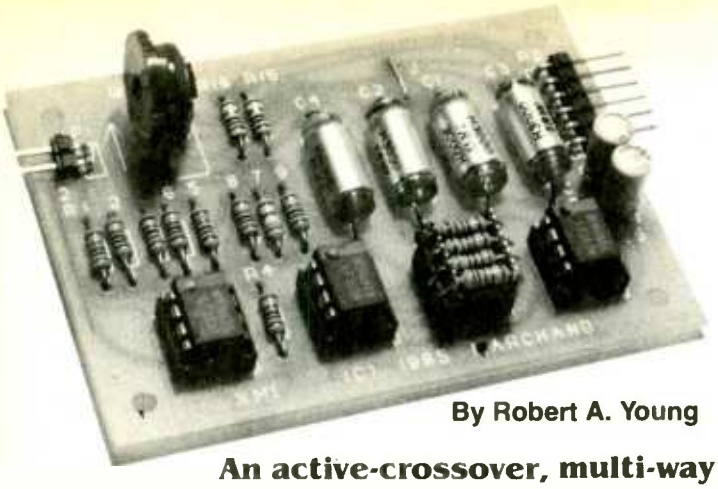
If we'd invented this device, we might have called it the "ultrasonic tape measure," but we didn't so it's dubbed a **Measure Mate** by its manufacturer, Etec. Available from *The Sharper Image (650 Davis St., San Francisco, CA 94111)*, this gizmo used "sophisticated ultrasound technology" to provide "accurate room dimensions instantly." The Measure Mate is held flush to any surface and then activated. The device "gauges the time it takes for a series of ultrasonic waves to echo back to the unit." The LCD readout displays the distance to the opposite surface from 2 to 35 feet. Measure Mate compensates for its own depth and rounds to the nearest half-inch for "99 percent accuracy." Features include a built-in thermometer, low battery indicator and an automatic turn-off function. Power is from a single 9V battery (not included). Price: $102.50 (includes shipping).

Coming in future issues of GADGET newsletter

• Time Management Marches On—A compact plug-in device gives users the electronic edge in beating the clock. GADGET spends some time with TimeTrax.

• Heady Listening—Stereo headphones were a hallmark of audio technology's first great leap forward. We listen to two contemporary pacesetters, Panasonic's Double Drive Digital-Ready mini's, the EAH-Z70 and the full-size Beyerdynamic DT 900.

• All this and CD too—Toshiba's RT-7096, a boom box with the compact disc difference.



XM1 ELECTRONIC CROSSOVER NETWORK

By Robert A. Young

An active-crossover, multi-way speaker system could improve the sound quality of your high-fidelity stereo system!

IN MANY HIGH-PERFORMANCE LOUDSPEAKER SYSTEMS, INDIVIDUAL loudspeakers, which provide high-, mid-, and low-range (tweeter, mid-range, and woofer, respectively) frequencies, are each driven by an individual power amplifier. The amplifiers are, in turn, separated from each other by an electronic crossover network. The advantages of an electronic crossover—such as the *XM1*—are many, including lower intermodulation distortion, better loudspeaker damping, and more precise crossover performance. Specifications for the XM1 Crossover are given in Table 1.

TABLE 1—XM1 CROSSOVER SPECIFICATIONS

Frequency response:	DC to 100 kHz, ±0.2 dB
Cross over frequency:	1 Hz to 20 kHz
Insertion gain:	0 dB (1×)
Filter slope:	24-dB per octave
Output load capability:	2000-ohms, min.
Input impedance:	100,000-ohms
Output impedance:	10-ohms, typ.
Maximum Input voltage:	25-volts, peak-to-peak (rms)
Power supply requirement:	±15V, 15 mA, typ.

Active Crossover Design

The XM1—built around three LF353 dual op-amp chips (U1 to U3, see schematic diagram in Fig. 1) and configured as a fourth-order, constant-voltage, state-variable filter—provides simultaneous highpass and lowpass functions at the two ends of the chain of four integrators. Because the highpass and lowpass functions are derived from the same network, both the highpass and lowpass outputs—using only four capacitors to provide both fourth-order functions—are always in phase with each other, guaranteeing a near-perfect match of the highpass and lowpass responses. Both the highpass and lowpass outputs have a slope of 24 dB/octave.

The XM1 has a square, Butterworth transfer function, which operates like two second-order Butterworth filters connected in series. The transfer functions of the highpass filter is given by:

$$H_p(s) = 5^4/(\omega_c^2 + 1.414 \times f_c \times s + s^2)^2,$$

where ω_c (the cutoff frequency) equals $j \times 2 \times \pi \times f_c$; f_c is the crossover frequency in Hz; s equals $j \times 2\pi \times f$. The lowpass filter transfer function is given by:

$$L_p(s) = 1/(\omega_c^2 + 1.414 \times f_c \times s + s^2)^2,$$

where ω_c equals $j \times 2 \times \pi \times f_c$; f_c equals crossover frequency; s equals $j \times 2\pi \times f$. The amplitude of the transfer functions are given by:

$$f_{hp} = 1/1 + (f_c/f)^4; f_{lp} = 1/1 + (f/f_c)^4,$$

which corresponds to a 24 dB/octave attenuation slope in the stopband. The sum of the highpass and lowpass output signals of the filter is, thus, equal to the input signal ($f_{hp} + f_{lp} = 1$) or unity. Also, because the two output signals are always in phase, the output soundwaves of the loudspeakers at the crossover frequency add up in phase. Note, however, that at the crossover

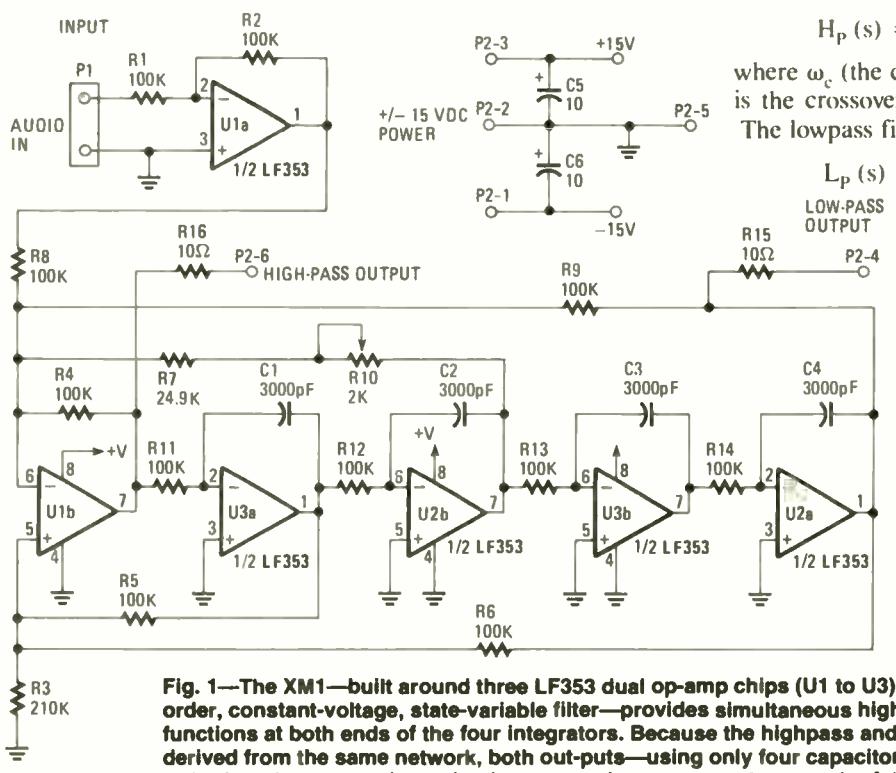


Fig. 1—The XM1—built around three LF353 dual op-amp chips (U1 to U3) configured as a fourth-order, constant-voltage, state-variable filter—provides simultaneous highpass and lotwpass functions at both ends of the four integrators. Because the highpass and lowpass functions are derived from the same network, both out-puts—using only four capacitors to provide both fourth-order functions—are always in phase, assuring a near perfect match of the two responses. For more information on the XM1 circle No.73 on the Free Information cards.

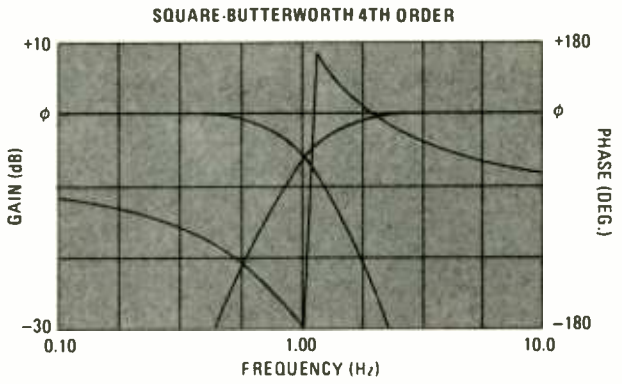


Fig. 2—The frequency response of the transfer functions without adjustment, along with the highpass, lowpass, and sum functions are shown here. The phase function is the same for all three transfer functions.

frequency, the total power output of the two channels equals half the power of the crossover point and is given by:

$$P_f = H_f^2;\ P_{tot} = P_{lp} + P_{hp},$$

and at the crossover frequency:

$$P_{tot}(f_c) = 1/4 + 1/4 = 1/2.$$

In some cases, the total sound pressure at the crossover frequency shows a dip, because the sum of the output powers of the loudspeaker is not unity. To compensate, potentiometer R10 can be used to adjust XM1's frequency response at the crossover point. With R10 set for minimum resistance, the frequency response is a flat constant-voltage function and the sum of the output of the two channels equals the input voltage.

With R10 set for maximum resistance, a 2-dB peaking is released to compensate for a possible dip in the frequency response of the loudspeakers at the crossover frequency, when driven with a constant voltage crossover. Figure 2 shows the frequency response without adjustment, along with the highpass, lowpass, and sum functions. The phase function is the same for all three transfer functions. Figure 3 shows the same transfer functions, but with the correction potentiometer (R10) at maximum.

Crossover Frequency

The crossover frequency of the XM1 is easily changed by changing the value of the components in the frequency module, an 8-pin DIP header that holds 4 resistors, R11 to R14 (which determine the crossover point). Those resistors should have a tolerance of 1%, and be of equal value. The value of the resistors needed for the desired crossover point is given by:

$$R = 1/6.283 \times f \times C,$$

where f is the crossover frequency in Hz; R is the resistance of R11 to R14 in ohms; C is the capacitance of C1 to C4 in Farads.

With a typical capacity of 3000pF for C1 to C4, and a targeted crossover point of 530.5 Hz, the value of R is:

$$R = 53.05/f = 100{,}000 \text{ ohms},$$

where f is the crossover frequency in kHz and R is the resistance of R11 through R14 in kilohms (K). Figure 4 shows the relationship between the crossover frequency and R11 through R14 for three different values of C1 through C4.

The value of resistance for resistors R11 to R14 should not exceed 1-megohm, nor should it be less than 10,000 ohms. That gives a range of 53 Hz to 5.3 kHz for the crossover frequency with a value of C1 to C4 set at 3000 pF. The minimum value of capacitance required for C1 to C4 is 1000 pF; there is no maximum allowed value. Outside that range, the value of C1 to C4 should be adjusted.

Power Supply

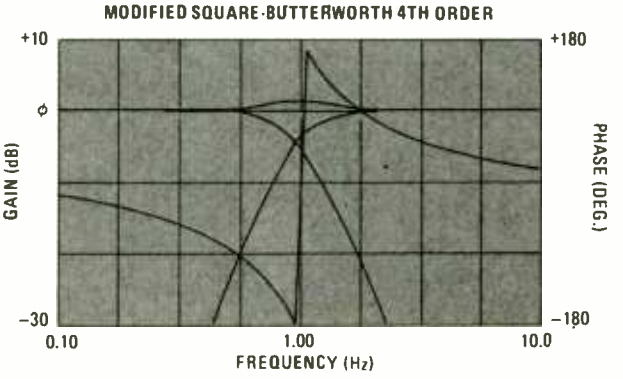
Because the XM1 is an active filter, it must have a power source to operate. A dual, regulated power supply (providing ±15 volts at 1A), like the one in Fig. 5, can power several crossover networks. Transformer T1 steps down the AC line voltage to 15 volts at either side of the center-tap, and feeds it to a fullwave bridge rectifier (consisting of D1 through D4) for rectification.

The output of the rectifier—a pulsating DC voltage—is then filtered by capacitors C5 and C6, and regulated to ±15 volts by U4 and U5 (LM7815 positive and 7915 negative three-terminal voltage regulators, respectively). Such an arrangement is inexpensive and very simple to put together.

Assembly Instructions

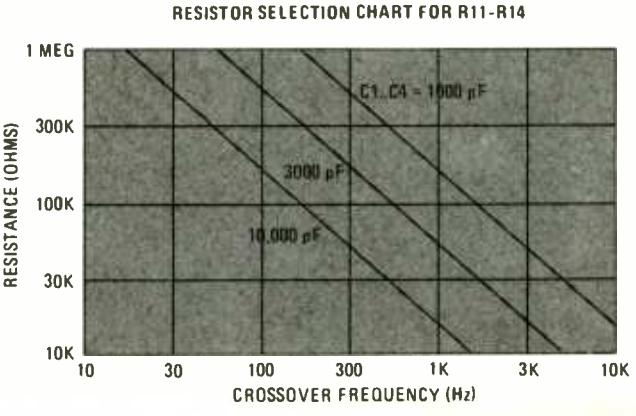
The XM1 is built on a single-sided printed-circuit board, measuring 2 by 3 inches. If you are fairly experienced in making printed-circuit board layouts, and you have a well-stocked junkbox, you can put the circuit together for next to nothing.

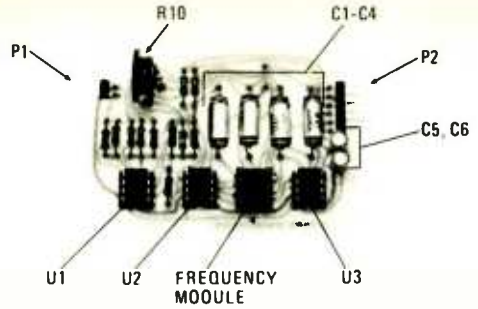
Fig. 3—The transfer functions in Fig. 2 are shown here with the correction potentiometer (R10) at maximum.



B

Fig. 4—The relationship between the crossover frequency and R11 through R14 for three different values of C1 through C4 is shown. The value of resistance of R11 through R14 should not exceed 1-megohm, nor should they be less than 10,000 ohms. The minimum value of capacitance required for C1 to C4 is 1000pF; there is no maximum allowed value. Outside that range, the value of C1 to C4 should be adjusted.





The Frequency module— four 1% tolerance resistors (R11–R14) set in an 8-pin DIP header— determines XM1's crossover point.

As to the parts, it is recommended that 1% metal-film resistors be used for R11 to R14, and that 1% matched, polystyrene film capacitors be used for C1 to C4. (Caution: Never use electrolytic capacitors for C1 to C4!) Polypropylene film capacitors match polystyrene in performance. Other types of film capacitors are inadequate because they have much higher absorption coefficients.

For those of you who prefer to purchase rather than *roll your own* printed-circuit board, a complete kit of parts is available from the supplier listed in the Parts List. The assembly of the XM1 Crossover Kit is made easy by the silk-screen guide on the board. All components should be installed on the side of the board that has the silk screen, called the component side. The parts are then soldered in place on the foil side of the board.

Begin by installing a jumper—using tinned blank wire—at all points labeled J on the circuit board. Insert both ends through the board from the component side, solder in place, and trim the leads.

Once the jumpers have been installed, move on to the passive circuit components. Start with the resistors, installing each 100,000-ohm unit at the points indicated. Each resistor's value is given by the multi-color (color-code) bands on the body. All you need do is look up the color-coded value in the table provide in the assembly manual. For instance, a 100,000-ohm unit would be coded *brown-black-black-orange-brown*: brown being the first digit in the value, black the second and third, and orange being the multiplier. The last band, *brown*, indicates resistor tolerance (which in this case, is 1%).

Note that for 1% resistors, the value is given in four bands, instead of three as with 5 and 10% units. The orientation of the fixed resistors is not important. Install R10, a 2000-ohm

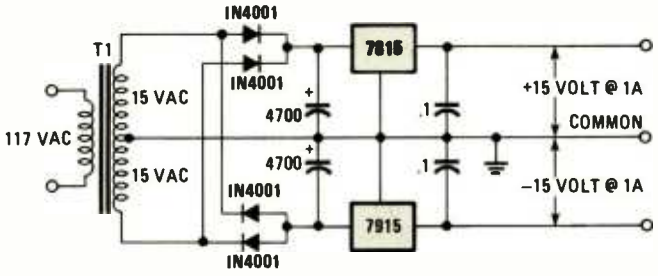


Fig. 5—Being an active crossover filter, the XM1 requires a power supply (like this one, which can power several crossover networks) for operation. Transformer T1 steps down the AC line voltage to 15 volts, and is feeds it to a fullwave bridge (consisting of D1 through D4) for rectification. The output of the rectifier (pulsating DC) is then filtered by capacitors C5 and C6, and regulated to ± 15 volts by U4 and U5 (LM7815 positive and 7915 negative three-terminal voltage regulators).

PARTS LIST FOR THE XM1 ELECTRONIC CROSSOVER

(All resistors 1/4-watt, 1% metal-film units unless otherwise noted.)
C1–C4—3000-pF, 160-WVDC, 1% polystyrene
C5, C6—10-μF, 50-WVDC, electrolytic
R1–R6, R8, R9, R11–14—100,000-ohm
R7—24,900-ohm
R10—2000-ohm, trimmer potentiometer
R15, R16—10-ohm
P1—2-pin male header
P2—6-pin male header
U1–U3—LF353 dual, Bi-FET op-amp
Printed-circuit board (2-inch × 3-inch), 8-pin DIP sockets (5), 8-pin DIP header, 2-pin female connector, 6-pin female connector, terminal pins (8).

Note: The following is available from Marchand Electronics Inc., 1334 Robin Hood Lane, Webster, NY 14580; Tel. 716/872-5578. A complete kit of parts (with manual) for the XM1 Crossover (Part No. XM1-K) is available at $17.95: the bare board (Part No. XM1-B) at $6.95: assembled and tested kit at $21.95. Please allow 6-8 weeks for delivery.

trimmer potentiometer. The unit will go in only one way.

Install capacitors C1 – C4, according to the crossover-frequency chosen. Each capacitor should be installed with the red band marking facing away from the IC sockets. When soldering the leads of the capacitors, be sure not to overheat the leads—the capacitors are easily damaged by excessive heat. All you need is sufficient heat to melt the solder enough to make a good solder joint.

Install C5, a 10-μF, 50-WVDC, radial-leads, electrolytic capacitor. The capacitor must be mounted with negative terminal lead as indicated on the board. The negative lead is indicated on the capacitor with a minus (–) sign. If correctly installed, the minus sign on the capacitor will be facing the outside of the circuit board. Install C6, a 10-μF, 50-WVDC, with C6 facing in the same direction as C5.

Next install the 8-pin DIP sockets at the points indicated by a chip outline, making sure that all 8 pins go through the holes in the board, and that they are properly oriented by checking that board markings (a half-circle at one side of the silk-screened rectangle) correspond to those on the socket. Finally, install an 8-pin DIP socket at the points labeled R11–R14. That block is the circuit's frequency-determining component (known as the *frequency module*).

Install a right-angle 2-pin male header connector at P1 and a 6-pin male-header at P2, which are mounted in a plastic support strip. When installed, the plastic strip should rest on the printed-circuit board, the long ends of the contacts should face outward of the board with the short, angled sides of the pins inserted through the board holes. Solder in place, the long pins must be parallel with the board.

Assemble the frequency module, which is made up of the four resistors (R11–R14, mounted in an 8-pin DIP header) that set the crossover frequency. The value of the resistors depend on the crossover frequency chosen, typically 100,000-ohms. Solder and trim the leads; and insert the module into the 8-pin DIP socket at the positions marked R11–R14.

Install the three LM353 chips at positions U1–U3, observ-

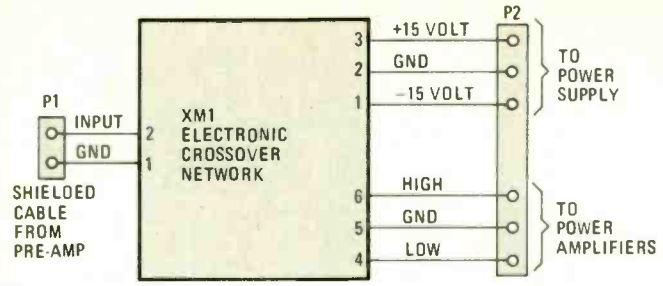


Fig. 6—Hookup and installation of the XM1 is made truly simple when this illustration and Table 2 are used in conjunction with each other. Audio from the preamp is fed to the crossover at P1, and output at pins 4, 5, and 6 of P2. The crossover feeds two power amplifiers, which drive individual loudspeakers.

ing the proper orientation. The pin-1 side of the chip is indicated by a dot, a notch, a band, or some combination thereof on the pin-1 end of the chip. Make sure all 8 leads are properly seated in the DIP socket.

Double check orientation of U1, U2, U3, C5, C6. The operation of those components with reverse power voltage applied will result in the destruction of the parts.

Finally, assemble female connectors that will mate with P1 and P2. The connectors are assembled by soldering the

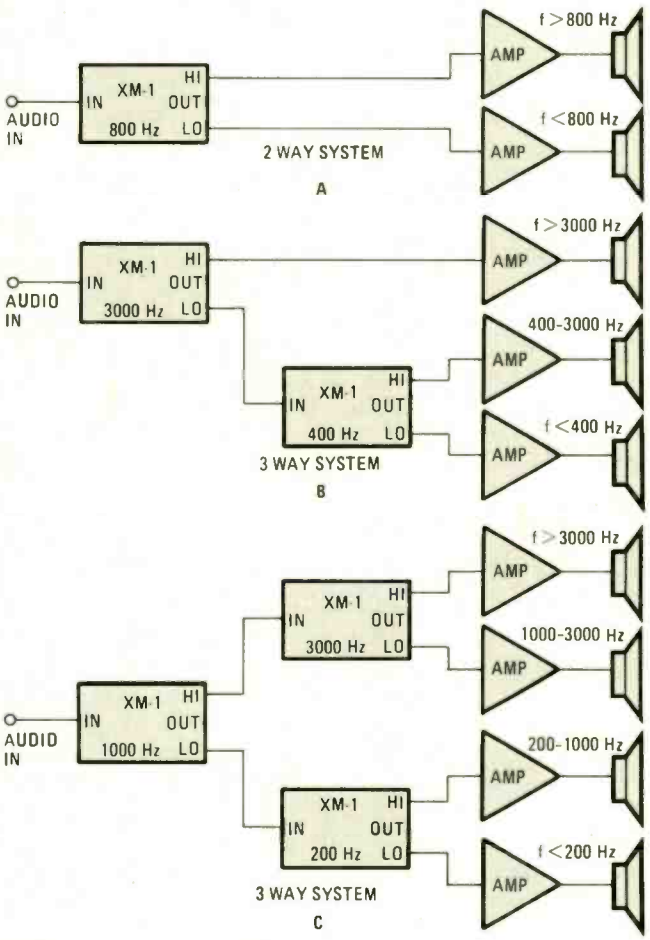


Fig. 7—In 2-way installations, one crossover network and two power amplifiers (one each for the high and low frequencies, as shown in A) are needed for each channel of the system. A 3-way system (B) needs two networks (one to separate the high frequencies from the mid/low frequencies, and the other to separate the low and mid-range frequencies) along with three individual amplifiers. A quad system (C) needs 3 crossover networks (plus the appropriate number of amplifiers), etc.

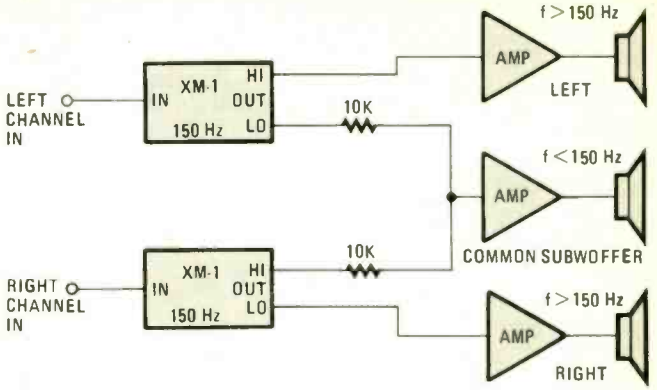


Fig 8—The XM1 can also be used to drive a common subwoofer, where the subwoofer is fed by both channels of a stereo system, by adding the outputs together through a summing network.

terminal pins to the connection wires and then inserting each pin into the housing. The connector pin number is indicated on the connector housing with a mark at pin 1. The circuit board silk screen has indications for pin 1 and pin 2 for P1, and pin 1 and pin 6 for P2. The connectors should always be plugged in so that the narrow side of the housing fits between the circuit board and the header pins. Thus, when the connector is on properly, it slips all the way down to the plastic part of the header.

Installation and Use

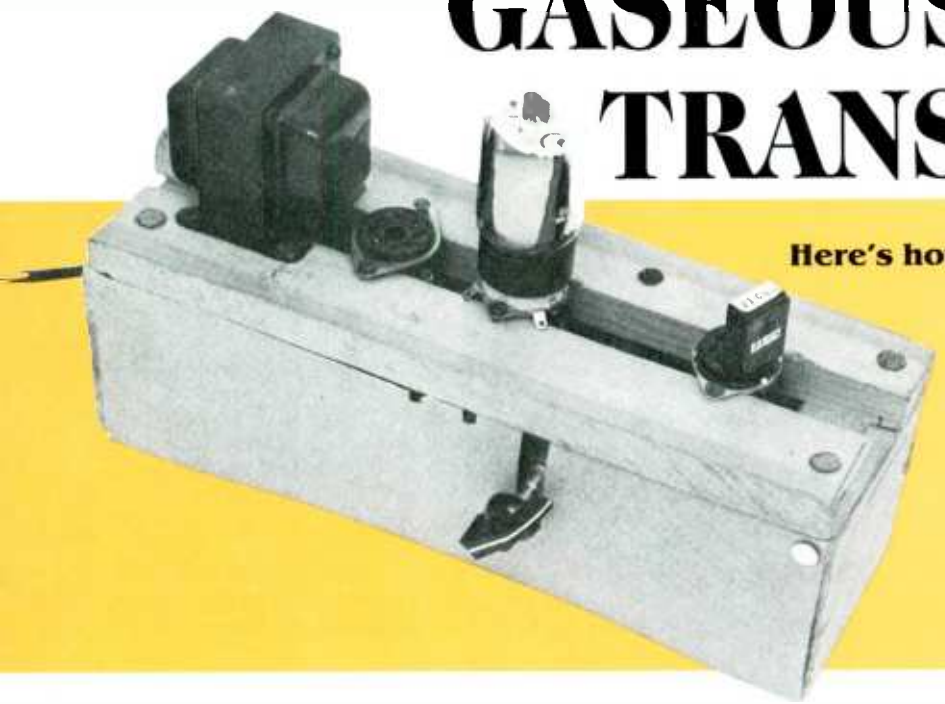
Refer to Fig. 6 and Table 2. The signal output of the preamp is fed to the crossover at P1, and output at pins 4, 5, and 6 (the low frequency, ground, and high frequency outputs, respectively) of P2. The crossover feeds the inputs of two power amplifiers, which then drive the individual loudspeakers. The typical application for the XM1 electronic-crossover filter is to separate the frequency bands in a multi-way audio system. Figure 7 shows some typical arrangements for 2-way, 3-way and 4-way installations. One crossover network and two power amplifiers (one for the low frequencies, and one for the high's) are needed for each channel of a bi-amplified system.

A tri-amplified system needs two networks (one to separate the high frequencies from the mid/low frequencies, and another to separate the low and mid-range frequencies, along with three individual amplifiers. A quad system needs 3 crossover networks (plus the appropriate number of amplifiers), and so on. The XM1 can also be used to drive a subwoofer, where the subwoofer is shared by the two channels of the stereo system, by adding the outputs together with a simple resistive summing network as shown in Fig. 8. For driving long—up to about 50 feet of shielded cable—a line driver/buffer amplifier may be needed. ■

TABLE-2—CONNECTOR PIN ASSIGNMENTS

Connector	Pin	Signal Description
P1	1	Input signal ground
P1	2	Input signal
P2	1	–15-volt, 15 mA power-supply input
P2	2	Power-supply ground
P2	3	+ 15-volt, 15 mA power-supply input
P2	4	Low-pass output
P2	5	Output signal ground
P2	6	High-pass output

GASEOUS-STATE TRANSMITTER



Here's how Dad did it! Now you can do it in an hour's time!

By Larry Lisle, K9KZT

WHO SAYS A HAM TRANSMITTER HAS TO BE COMPLICATED, or expensive, or use hard-to-get parts! Here's a little RF rig that will really do the job on the 40-meter band, and won't strain your Visa Card or project-building abilities. I call it the *Gaseous-State Transmitter* for far out reasons. First, it's not solid state! Second, there's always some gas in any vacuum made on Earth. Third, and last reason, the electron flow in a vacuum tube is based on the gas equations of Poisson. If you didn't look at the photographs in this article, and still can't guess what it's all about, let me tell you. The Gaseous State Transmitter uses a vacuum tube—the famous 6L6 type. And, if you need a fourth reason, every so often I tire of solid-state gadgets and long for the old days.

I built the the Gaseous-state Transmitter shown in the photographs in an hour's time and have had many enjoyable amateur contacts in 42 states using Morse code—good, solid contacts too!

Designer's Thoughts

Although I've never seen a transmitter exactly like the Gaseous-state Transmitter, the device isn't exactly on the cutting edge of modern, electronic technology. The RF portion is housed in the time tested 6L6/GC vacuum tube used in a simple, crystal-oscillator circuit. It loafs along at a mere 25-watts input for the sake of good keying characteristics. The super-simple power supply was inspired by the *Economy Forty* of Fred Sutter who wrote a popular series of articles on simple transmitters back in the thirties.

The wooden "chassis" is also a child of the thirties and the cardboard panel (skirt) came to mind when looking at the back of an old AC-DC radio.

Most of the parts can be scrounged from an old 1950's or '60's TV set, or purchased new for about thirty dollars. Availability of parts was a major consideration in designing the transmitter and all parts, but the variable capacitor and crystals, should be easy to get. The variable capacitor and crystals can be obtained at hamfests or by mail from advertisements in the back of the various ham magazines.

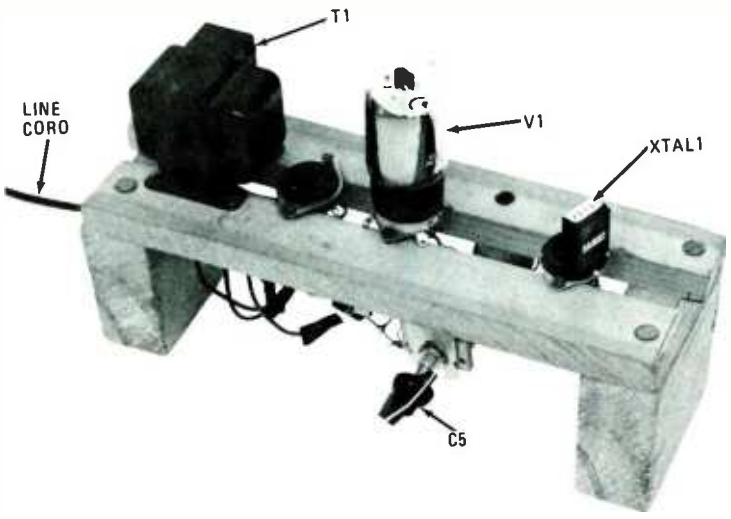
Some builders may question whether television interference (TVI) may be a problem without shielding and that is a valid consideration if you live in an apartment house centered in a weak, TV-signal area for instance. In that case I suggest you build the rig on an aluminum chassis and use the usual shielding and filtering procedure. For most people though, with the low frequency and low power used by this transmitter, TVI won't be a problem—it wasn't for me.

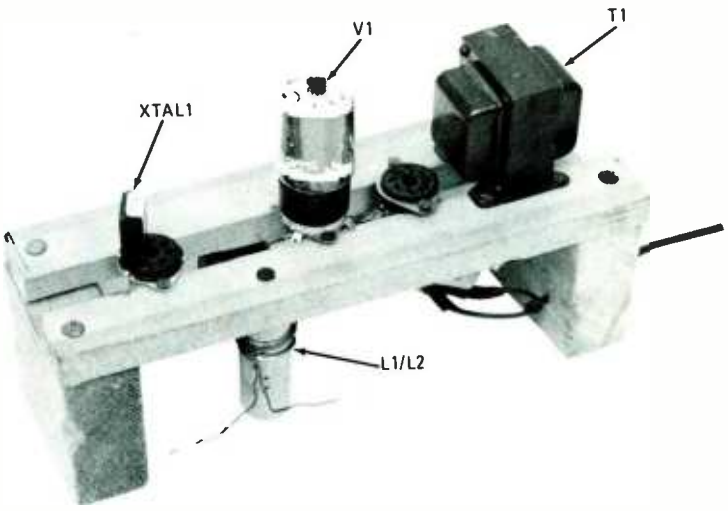
In case you're wondering whether a single capacitor can do an adequate job of filtering the power supply—it can. A 5 percent ripple is considered adequatly low for the high-voltage supply of a CW transmitter—the Gaseous-state Transmitter has less than 1-percent ripple. But, if you want to over build, go ahead.

Finally, how about *chirp* or *drift*. There isn't any in this transmitter. Those problems were taken care of by running only 25-watts input, keeping the screen voltage low, omitting the usual capacitor between the bottom of the plate coil and ground, and not using *chirpy* crystals.

In the old days hams used to run 100-watts or more input to the earlier versions of the 6L6 vacuum tube—*and used a hammer to keep the tubes from jumping out of the sockets*—25-watts only tickles the 6L6/GC. A few crystals you may find will chirp. The solution's simple—don't use them! Surplus crystals are still cheap, especially when buying several at a time, so don't use those few that won't give you a signal of which you can be proud.

The modern, plated crystals don't work as well as the older FT-243 style, so use the latter (they're cheaper too)!





Here's the 25-watt Gaseous-state Transmitter you can build in an hour. It uses a 6L6/GC vacuum tube, a wooden chassis with cardboard side panels, and a power transformer scrounged from an old TV set to put a solid CW signal on the 40-meter band. Front and back views are shown. It's a project transmitter that even a beginner can build!

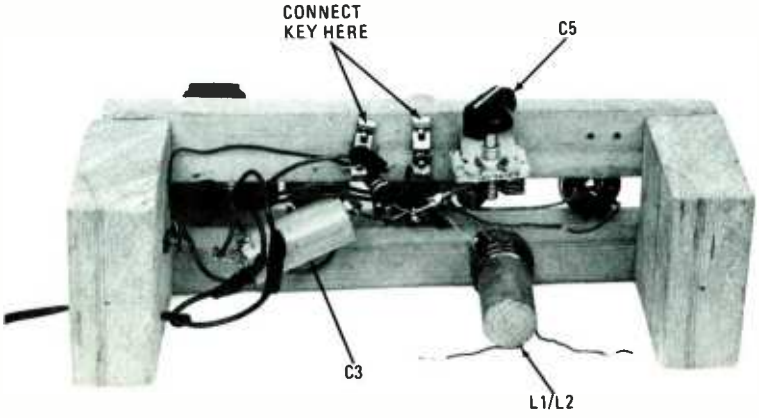
Shop Work Begins

The photographs show how the rig is put together. I used three octal sockets: One for the 6L6/GC vacuum tube, one for the RF crystal, and one as a set of tie points for the power supply.

Glue a 12-inch long firring strip on two 2 × 4 wood legs and hold in place with a nail at each end. Using the octal sockets as a spacing guide, glue and nail the second firring strip in place. You'll probably find it easier to partially wire the sockets before mounting them on the chassis and then connect things together.

Fabricate a small aluminum bracket to hold the variable capacitor, C1, by its shaft hardware. Secure the bracket to the wood chassis using small wood screws. Fasten the variable capacitor to the bracket.

The tank coil, L1, has 15 turns of #22 enameled wire wound on a short piece of a one-inch wooden dowel which is glued at one of the one-inch firring strips—do not nail the dowel rod in place. Use a brass screw—the smallest one that will do the job. The wood dowel has a permeability equal to air and the coil is, in fact, an open-air coil. A near-by iron nail or screw would upset the coils rating and function. If you can't find enameled wire, solid hook-up wire will work with slightly lessened efficiency. One good supply of enameled wire is inside a defective or surplus power transformer. Try to use a wire as close to the #22 size as possible.



Some Old-Timer Tips

Fahnestock clips are used to connect the telegraph key and external muiltimeter. You could used the common multi-way binding posts that are so easy to get, but that would not have been done forty years ago.

The Gaseous-state Transmitter could be built much more compactly than it is shown in the photographs, and the wiring made more direct; but, it won't work any better, and it will be harder to build if you're a beginner.

The leads from the power transformer can be trimmed to the exact length if desired, but leaving them long doesn't hurt anything and you might want to use the transformer or other parts in another rig later.

There's nothing at all critical about assembling the Gaseous-state Transmitter. If you don't have the exact parts called for in the diagram, try using what you do have, or if you have some other ideas about construction, try them and see how they work. You could use a plywood panel and mount the variable capacitor on it, use an aluminum cake pan for a chassis, breadboard the rig, mount the tube upside down—try it and see! That's the advantage and fun of home-brew projects and simple RF transmitters.

Don't Become a Silent Key

Keep safety procedures always in mind! All high voltages should be kept out of reach whenever possible. Cover exposed high-voltage connections. Use a plastic bag over the key for added insulation. The high voltage used in the Gaseous-state Transmitter is dangerous.

About the Circuit

The Gaseous-state Transmitter uses one vacuum-tube, V1, as an electron-coupled oscillator. The crystal, XTAL1, is placed in the control grid-cathode circuit. The turn-on transient current flow within V1 shock oscillates the crystal so that it oscillates. The control grid regulates the current flow

Point-to-point wiring is what the transmitter's rat's nest is politely referred to—but it does the job! Three octal sockets are used; one as a tie point for the power supply, one to mount the vacuum tube, and one to mount the crystal.

in V1 amplifying that oscillation and before it can die out, feeding back, by means of internal capacitances within V1 and external wiring, a small portion of this amplified energy

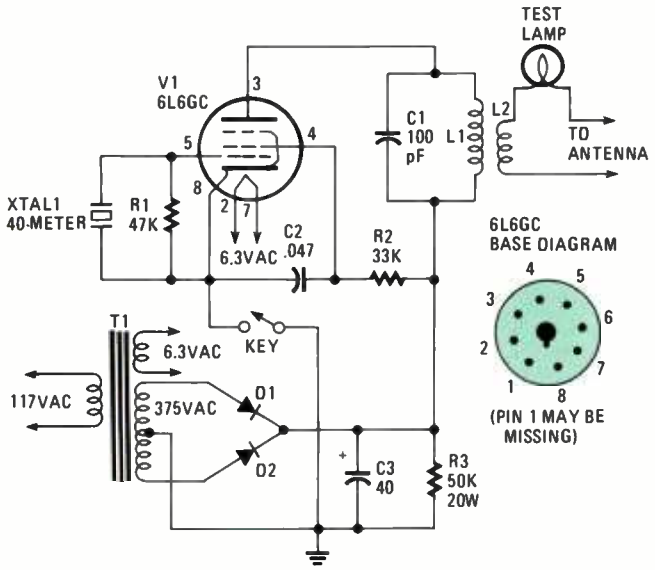


Fig. 1—The schematic diagram for the transmitter is very simple, scarcely having enough parts to rate a Parts List.

to the crystal to sustain a regular oscillation. That part of the circuit uses the first three elements of V1 as a triode amplifier. The second grid (screen grid) serves as the plate in this arrangement.

The parallel-LC plate circuit (consisting of L1 and C1) is tuned to the fundamental frequency or a suitable harmonic of the crystal to place the output frequency within the ham 40-meter Novice band.

Resistor R2 limits current flow in the screen circuit to reduce key chirps. Capacitor C2 locks the screen voltage to RF ground so that load variations in the plate circuit will not cause frequency drift by loading the *triode* section of V1.

The power supply circuit is a simple, full-wave rectifier filtered by capacitor C3. Transformer T1 provides the voltage step-up from the AC line to approximately 375 volts. Resistor R3 provides some voltage regulation by loading down the power supply, and it discharges the energy stored in the filter capacitor, C3, when the AC power is turned off. Keying is achieved by switching in the ground circuit to complete the load circuit for the power supply in the cathode circuit of the vacuum tube. The 6.3-volt AC winding in T1 supplies the filament voltage for V1.

Tuning Up

Adjusting the transmitter is a snap. You can use an analog milliammeter (selected scale of a multimeter) that will indicate at least 100 mA in series with the key lead that goes to the cathode of the vacuum tube and tune the variable capacitor for a dip in plate current, or you can use a pilot light in series with one of the antenna leads and tune the variable capacitor for maximum brilliance.

Three turns is about right for the antenna coil if you're using a dipole fed with 72-ohm twinlead, zip cord, or coax. If you're using 300-ohm twinlead and a folded dipole antenna, you'll need a few more turns. Experiment with various numbers of turns to get the desired current on the meter or the brightest glow from the pilot light. Be certain to unplug the power cord and short the filter capacitor anytime you reach behind the panel!

Power output can be checked by using a 15-watt light bulb as a dummy load in place of the antenna. Remember though, you'll need a different number of turns on the antenna coil to match the impedance of the light bulb if you want to light it to full brilliance. Also, using a light bulb as a dummy antenna can cause the transmitter to chirp as the bulb heats, so don't spend hours trying to find a problem that isn't in the transmitter at all!

When putting the transmitter on the air, check the keying in your receiver. You'll probably find that best results are obtained by tuning the capacitor slightly higher in frequency than the maximum power point. That is normal and the guy at the other end will never notice the slight decrease in power output.

PARTS LIST FOR THE 25-WATT TRANSMITTER

C1—100-pF, variable capacitor (Calectro A1-226 or equivalent)
C2—.047-μF, 600-WVDC, tubular capacitor
C3—40-μF, 450-WVDC, electrolytic capacitor
D1, D2—1000-PIV, 1-A, diode rectifier (Radio Shack 276-1114 or equiv.)
L1—Coil, 15 turns of #22 enameled wire, close wound on 1-in. dia., wooden dowel
L2—Coupling coil, 3 or more turns of hook-up wire wound over L1 (refer to text)
R1—47,000-ohm, 1-watt, 10% resistor
R2—33,000-ohm, 2-watt, 10% resistor
R3—50,000-ohm, 20-watt, 10% resistor
T1—Power Transformer: 120-volt AC, primary winding; 500-to-750-volt secondary winding at 100 mA; 6.3-volt filament winding at 1 A (minimum)
V1—6L6-GC or 6L6 Beam-power Amplifier Tube
XTAL1—40-meter, amateur-band, transmitting crystal

ADDITIONAL PARTS AND MATERIALS

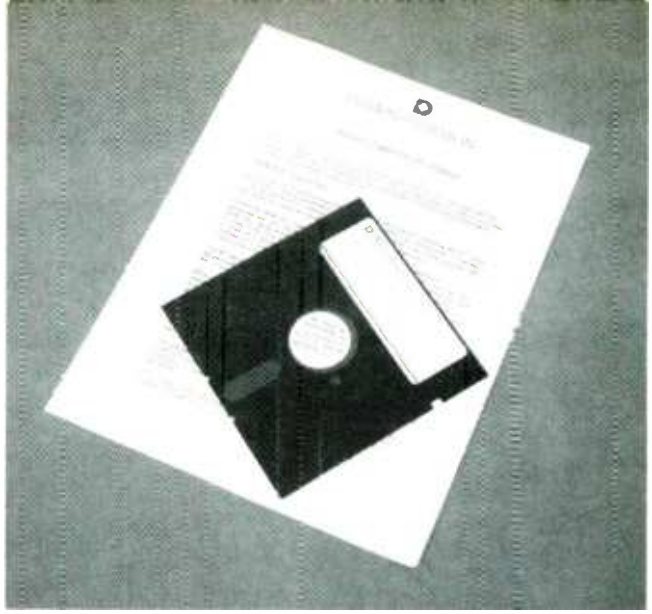
Wooden legs: 2 pieces of 2 × 4 studs, 4-in. long, wood chassis top: 2 pieces of 1 × 1/2-in. board (firring strips), 12-in. long, L1 wood core: 1-in. dowel, 3-in. long, cardboard sides: 2 pieces of cardboard or posterboard cut to size, 3 octal sockets, 5 or more Fahnestock clips, bracket for variable capacitor, hook-up wire, knob for variable capacitor, solder, screws, brass screw, nails, etc. An analog multimeter capable of reading 0-100 mA or pilot lamp No. 44, 46, or equivalent, used to tune the L1/C1 resonant circuit.

One suggestion about ordering crystals. Obtain several crystals at 2 kHz intervals around your favorite frequency such as 7102, 7104, 7106, 7108, 7110 kHz, and set your receiver at the center of the cluster—7106 in the example. When someone calls CQ, you'll be able to answer him within 1 kHz of his own frequency. It's cheaper than a variable frequency oscillator (VFQ) and works almost as well though it requires more patience.

Don't be afraid to try an occasional CQ yourself. Unlike some of the real QRP rigs, the Gaseous-state Transmitter has enough power to make easy QSO's. And if you don't you're missing all the fun. Well, that's it. Listen for me on the low end of the Novice band sometime and I'd appreciate hearing what results you have. ■

HANDS-ON REPORT

HEATHKIT HAM COMPUTER COURSE



While the course covers theory as well as Morse code, just the code practice function alone is worth the price.

BECAUSE THE HISTORY OF LEARNING-by-computers is notable for its failures and not its successes, we were pleasantly surprised by the effectiveness and value of Heath Company's computer-assisted instruction (CAI) software for amateur radio operators, which is intended for IBM PC/XT/AT's, or their "look-alikes." Actually, there are five individual software packages containing both Morse code theory and practice.

The problem with most CAI software is that unless dynamic (moving or changing) graphics is a heavy part of the computer-assisted instruction, the average person is better off reading a book than a computer screen. In fact, when static graphics are involved, a book is better because the graphics can show greater detail. The only thing a book can't do is automatically keep track of what you know and don't know. Heath planners did not fall into the trap of trying to teach you all the knowledge known to mankind on a computer display. Instead, Heath has made their CAI software interesting and effective by making it the means whereby you can easily and quickly determine what you do and don't know *in terms of passing an FCC examination*. It's then up to you to use other references, such as the ARRL handbook, to fill in the gaps in your knowledge.

Code and Theory

The Novice software actually consists of two individual programs—theory and code practice. Both programs are menu-driven. A photograph shows the opening screen display when the theory program first comes up (the main menu). The user can select questions from nine categories, ranging from rules and regulations to antennas and feedlines; can generate a 20-question test from any of the nine sub-elements; or can be questioned on a random basis from the entire database.

A typical question would go like this:

What are the Novice control operator frequencies in the 40-meter band?

A. 3500–4000 kHz
B. 3700–3750 kHz
C. 7100–7150 kHz
D. 7000–7300 kHz

RIGHT ANSWER =

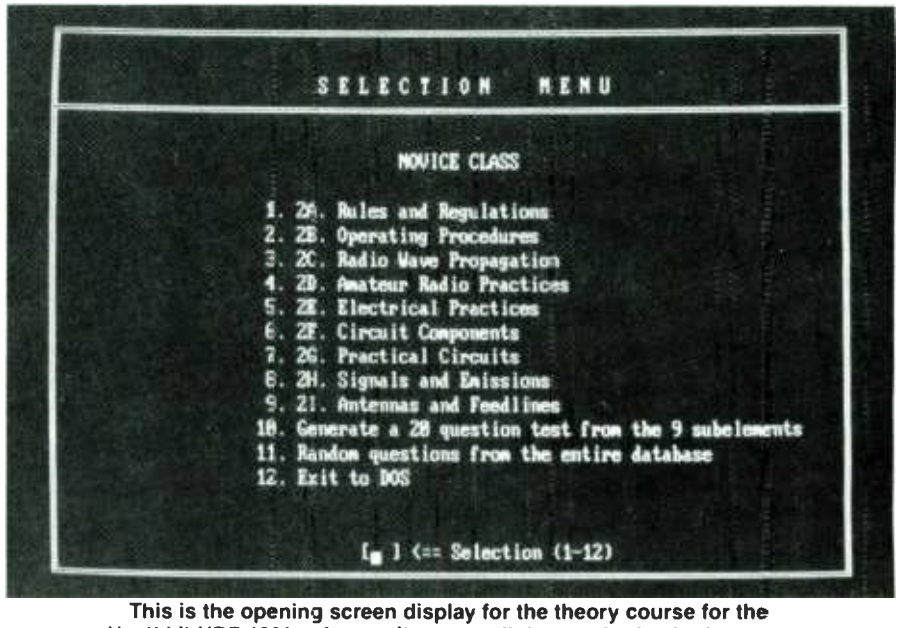
If the user selects the correct answer the screen displays CORRECT. If the user selects the wrong answer the screen displays TRY AGAIN. Those are the only prompts. The computer doesn't attempt to explain a wrong answer. If the screen says that you're wrong, you know that you need more study on that subject.

Schematic Diagrams

Functional-circuit outlines (usually boxes) that are needed for questions are created on the screen. Detailed drawings, such as transmitting-tube elements, component symbols, and even a 3-element beam antenna and its transmission line, are supplied the old-fashioned way—as a drawing on paper. The questions on the screen simply reference the drawings.

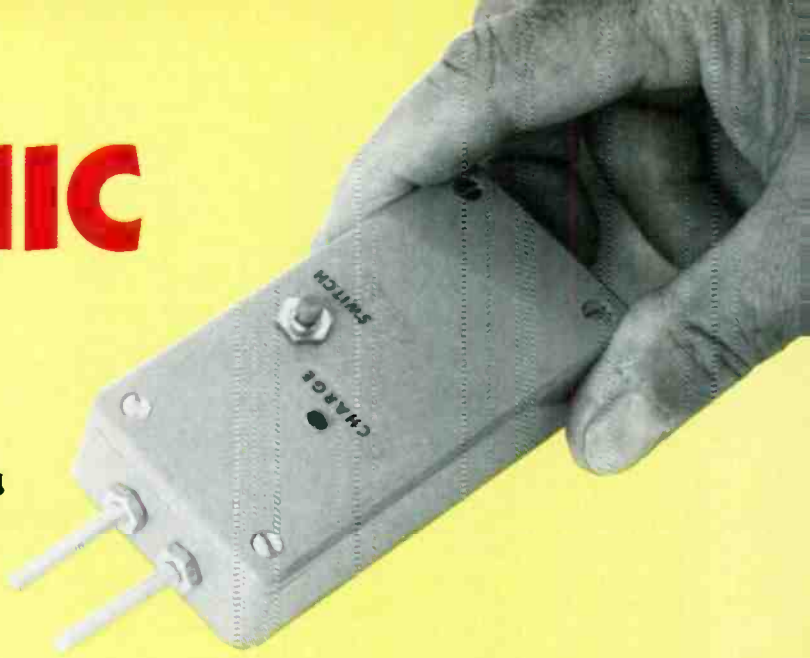
Typical of FCC exams, the answers to the questions are "tricky" in that at least two of five possible choices are very close to being correct—although only one is *absolutely correct all the time*. Although FCC exams are multiple choice—a format not particularly well-regarded by educators—it's the FCC's ability to make two answers appear to be correct at first glance

(Continued on page 101)



This is the opening screen display for the theory course for the Heathkit HDP-1601 software. It covers all the required sub-elements. For more information circle No. 92 on the Free Information Card.

ELECTRONIC DAZER



Never walk in fear with this one-evening project. It won't kill, but it's an effective way to say "Leave me alone!"

By Rick Duker

THE *ELECTRONIC DAZER* IS A MODERN, PORTABLE, PERSONAL-PROTECTION appliance. It generates high potential energy to ward off vicious animals or other attackers. It is an aid to help escape from a potentially dangerous situation. The device develops about 2,000 volts. Higher voltages may be attained by adding additional multiplier stages, but it should be noted that those stages will also increase the overall size of the unit.

The Dazer is very compact, being built into a small plastic case. It is powered a single nine-volt battery, either NiCad or alkaline. The high voltage is applied to two electrodes which require only light contact to be effective. When touched with the Dazer, the victim will receive a stunning, but non-lethal jolt of electricity that will usually discourage any further encounters.

The Electronic Dazer is a power supply which consists of a micro-size regenerative amplifier/oscillator coupled to an energy multiplier section. It should not be confused with cheap induction-type cattle prods. The Dazer is more versatile than other high-voltage stun devices currently being sold. Those devices are basically high-voltage, AC generators which jam the nervous system. However, the Dazer may be used for heating and burning applications, or anywhere a high voltage DC supply is required.

WARNING

THIS DEVICE IS NOT A TOY. We present it for educational and experimental purposes only. The circuit develops about 2000 volts at a respectable amperage. It can cause you pain and even damage if you become careless and touch its output terminals. The unit can also damage property as well so use it wisely.

You should never use the device on another person! It may not be against the law to possess such a device in your area, but if you use it on someone you may be deemed liable in a civil and/or criminal action suit. Don't just follow the golden rule after constructing the project, instead just don't do unto anyone.

Included in the article are a number of instructions on how to build, test, and operate the Dazer; all of them must be followed to the letter. Do not deviate from the procedure.

How It Works

Referring to the schematic diagram in Fig. 1, the two power transistors Q1 and Q2, form a regenerative amplifier operating as a power oscillator. When Q1 turns on, Q2 turns on and that shorts the power supply across the primary of T1. That current pulse induces a high voltage in the secondary of T1. As C1 charges, Q1 turns on again and the cycle repeats itself. Therefore, a rapid series of DC pulses are generated and stepped up by T1 to approximately 300 volts at full battery charge. That voltage is rectified and increased by the voltage multiplier section which consists of C2 and C9, and D1 to D8. The final output is approximately 2000 volts. The neon bulb NE1 is used as a charge indicator and indicates that the unit is charged and operating properly.

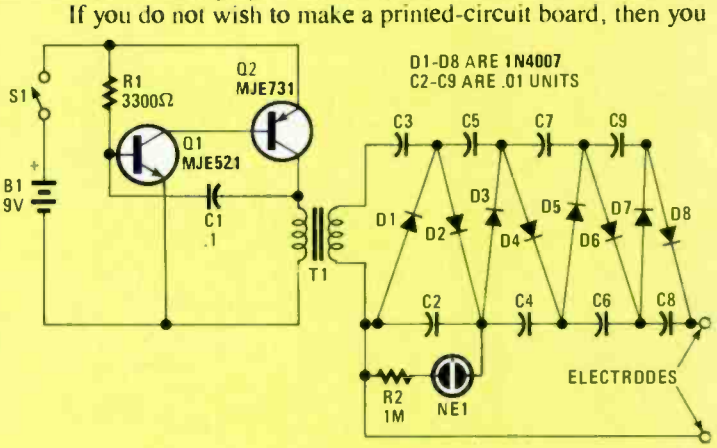


Fig. 1—As you can see, although the Dazer is not complex, it contains enough doubler circuitry to pack quit a punch. The oscillator does nothing more than send sharp current pulses through T1. The back EMF across the secondary winding is then pumped through the multiplier stage to produce the very-high output voltage across the electrodes.

Construction

As with all projects start out by laying out and identifying. If you do not wish to make a printed-circuit board, then you

may use a perf board as long as you remember to keep the leads of all high-voltage components isolated. That is to prevent sparks from arcing across your board. A 4 x 7.5 cm of perfboard is suitable for that purpose.

The first components you should mount are the two transistors Q1, Q2, transformer T1, resistor R1, and neon bulb NE1. Solder them in place (for PC construction) being sure that the transformer and transistors are hooked up correctly. Apply a small amount of adhesive to the base of NE1 to hold it securely in place.

Mount D1 to D8 and C2 to C9 on the board and make all solder connections. Note proper polarity of the diodes. The off-board components come next. Solder in leads for S1, and the output electrodes. Also solder in the battery clip for B1.

Build the enclosure from some nonconductive material such as plastic. Drill holes for S1, NE1, and output electrodes. Be sure that the output electrodes are about a cm or greater apart. Connect the output wires to the electrodes and insert them through holes from inside of case. Thread on the retaining nuts and tighten them securely. Set the circuit board in the case and mount S1, securing with nut. That completes the construction.

PARTS LIST FOR THE ELECTRONIC DAZER

C1—0.1-μF monocapacitor
C2–C9—0.01-μF 400 volt polyester capacitors
D1–D8—1N4007 1-kVolt diode
NE1—Type NE-2 neon bulb
Q1—MJE521 NPN power transistor
Q2—MJE731 PNP power transistor
R1—3,300-ohm ¼-watt resistor
R2—1,000,000-ohm ¼-watt resistor
S1—SPST monetary-contact, pushbutton switch T1—1200 to 8-ohm audio power transformer

ADDITIONAL PARTS AND MATERIALS

9-volt battery clip, 10 × 5 × 2.5-cm plastic case, 7.5 × 4-cm perfboard or PC board, two 6/32 × 1-¼ bolts and nuts for electrodes, adhesive for mounting NE1, circuit board standoffs (optional), hookup wire, solder, etc.

The following are available from Quantum Research, 17919-77th Avenue, Edmonton, Alberta, Canada T5T 2S1:
QV100K1—Complete kit without PCB (includes all above parts except those following the electrodes in the above list) $40.00 (includes postage).
QV100K2—Complete kit with PCB (includes all above parts except those following the electrodes in the above list) $45.00 (includes postage)

Testing

Before inserting the battery and closing the case, a few test measurements should be made to ensure correct operation. With the ground clip connected to the battery, connect a VOM between the positive clip and the positive terminal of the battery. Set the meter for current reading, and press S1. You should measure a current of approximately 300 to 500 mA. NE1 should be glowing.

With a high voltage VOM, you should measure about 2000 volts on the output terminals. Those measurements indicate proper circuit operation. Let the unit run for about one minute. Transistors Q1 and Q2 should be warm, but not hot to the touch. Insert the battery in the holder and close the case. That wraps up the Electronic Dazer.

Good parts layout is the secret to any miniature project. If your layout causes the battery to come too close to the high-voltage components we suggest you insulate it with tape.

Operation and Use

Activate the unit by pressing S1. NE1 will light indicating the dazer is fully charged and ready to use. Notice also that only one pole of NE1 will glow indicating DC voltage present. It is important to remember that the device holds a charge even after S1 is off. To discharge, touch the electrodes to a metal object and note the healthy spark discharge.

The Electronic Dazer was designed as a self-defense weapon for use against vicious dogs or other attacking animals. The device is most effective when the electrodes contact an area of low resistance such as skin or flesh. Those include the snout or mouth since the resistance of those areas are much lower than areas of hair or fur. The electrodes could be pointed to penetrate these areas better. The dazer generates great stopping power. One contact will give a powerful jolt and should discourage any further attacks.

The device can burn and heat materials with low resistance. Those include flesh, moistened paper or wood, etc. That makes the unit potentially hazardous to humans. Remember, the dazer is not a toy but a quality electrical appliance and therefore must be treated accordingly. Use the utmost discretion with this device.

Another use for this device is as a high-voltage DC power supply. It may be constructed as a variable power supply if output taps are taken from various stages of the voltage multiplier section. Remember, always disconnect the battery and fully discharge the capacitors before working with the circuitry. ■

HANDS-ON REPORT

THE MOTRON AUTO-KALL AK-10

Here's a simple way to add Touch-Tone squelch to almost any communications system.

☐THE MOTRON MODEL *AK-10 AUTO-KALL* is an accessory device for receivers that makes it possible to easily add DTMF selective calling to any CB, amateur, VHF/UHF communications system.

One of the problems with any radio communication system is that the greater the number of users, the greater the drone from the speaker with messages, announcements, and conversations having no interest to the average user; they are simply unwanted intrusions. Commercial VHF/UHF communication equipment eliminates the constant "grind" from the speaker through an assortment of tone-activated squelch devices: the speaker isn't opened (unsquelched) if a correct tone doesn't precede or accompany a transmission.

Unfortunately, neither CB nor amateur equipment, nor some VHF/UHF gear, normally make provision for a tone-activated squelch. But if you need it you can have it by simply connecting a Motron AK-10 Auto-Kall to your receiver's remote speaker jack.

Selective Calling

The AK-10 is a three-digit DTMF (*D*ual *T*one *M*ulti *F*requency) selective-calling device that can be used with any FM receiver, transceiver, scanner, etc, to enable the user to receive calls without the need to constantly monitor the frequency.

The device simply plugs into a receiver's external speaker jack, thereby cutting off the receiver's speaker (because most external speaker jacks lift the receiver's internal speaker connections). Instead of feeding its own speaker, the receiver feeds the Auto-Kall, which constantly monitors for three user-programmed DTMF signals that correspond to conventional Touch-Tone keys. When the Auto-Kall senses the proper DTMF sequence, it closes a relay that feeds the receiver's output to a small speaker (see Photo) inside the Auto-Kall, or to an external speaker that is connected to the Auto-Kall.

The relay remains closed for about 10 seconds, at which point it opens and again mutes the speaker even if the received station is still transmitting. To receive a signal for longer than 10 seconds, the user must flip a switch, which we'll explain shortly.

General Description

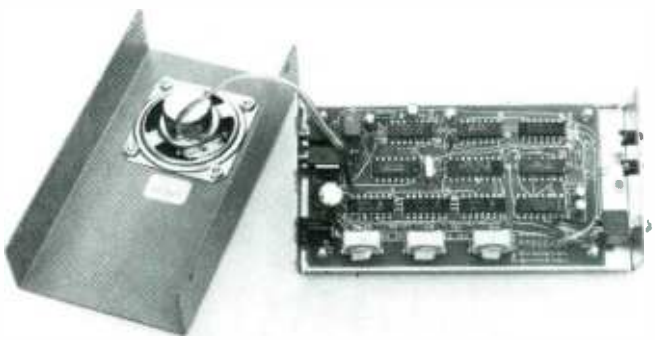
The Auto-Kall can be used with both base station and mobile equipment because it is powered by 8–15-volts DC, which can be provided by either an "AC adapter" or an auto battery. The precise power-source voltage isn't critical because it's regulated by a 5-volt regulator that's built into the Auto-Kall.

The device measures approximately 3 × 5½ × 1⅛-in. As shown in the photo, the rear apron has a coaxial power jack and two miniature audio jacks: one for the receiver output; the other for an external speaker. The Auto-Kall's small internal speaker is automatically disconnected when the external speaker is plugged in. The front panel has a DECODE-OFF switch, a green POWER LED, and a red CALL LED.

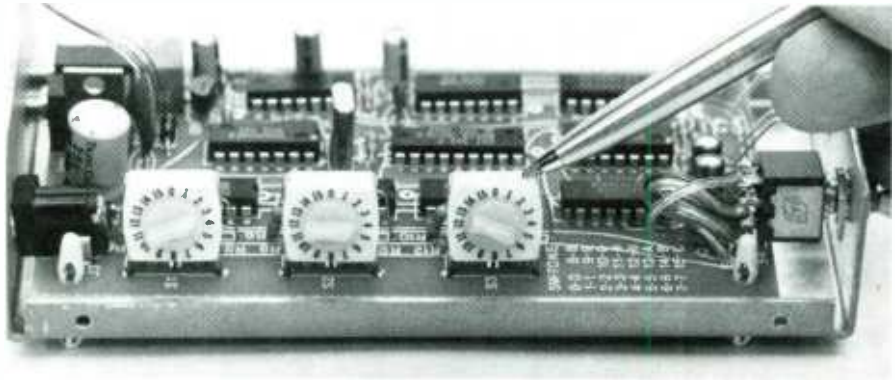
Programming

The three internal rotary switches—which are accessed by removing the cover—allow the user to program any of the 16 Touch-Tone frequencies. Yes, 16 is correct! Although the conventional telephone keypad has only twelve keys, communications keypads have four additional keys that are usually labeled A, B, C, and of course, D.

The DTMF decoder circuit has continuous wrong-number reset. In plain terms that means that the circuit will respond at any time to the sequence of correct tones. For example, if the programmed DTMF code is 345 and the decoder receives 346572 the speaker remains muted. However, if the detector receives the se-



The *Auto-Kall* contains its own internal speaker that substitutes for the receiver's speaker. You can get extra information on the Auto-Kall by circling number 87 on the Free Information Card in the back pages.



The pen points to one of the three switches used to select the three DTMF codes. The switches appear to have "extra" calibrations because they accommodate the 16-key Touch-tone pad, which is often used in communications.

quence 765345127 it will unmute the speaker because the correct sequence of 345 is received. The decoder simply ignores everything that follows 345.

Signal Tone

The Auto-Kall unmutes the speaker almost instantly, and most of the last DTMF tone is clearly heard. The last tone therefore functions as a signal that the correct code number has been received and that the speaker is unmuted. If the user doesn't hear sound it's because someone isn't speaking at the transmitter.

The green LED lights when power is applied by setting the switch to the DECODE position. When the switch is set to OFF the power is off and the receiver is connected directly to the Auto-Kall's internal speaker.

When the switch is set to DECODE, power is applied, the speaker is muted, and the receiver is connected to the DTMF decoder. If the correct DTMF code is received, the speaker unmutes for 10 seconds, and then, as we mentioned earlier, mutes. To keep the speaker unmuted the switch must be set to OFF. As soon as the switch is reset to DECODE the speaker is muted and the DTMF decoder is reset. In a way, the switch functions as the power switch, a speaker unmute, and as the DTMF reset.

The red LED lights when the correct DTMF code has been received and remains lit until the Auto-Kall is reset by the user. Even if the device does an auto-reset after 10 seconds, the LED remains lit to let the user know a correct code was received.

Here's how the red LED might be used. Let's assume you're waiting for a CB call from a family member, but you had to answer the doorbell just when they called, and you never heard their call. On returning to the rig you see the red LED is lit. Aha! You know they've called, so you get on the air and give them a shout.

Generating DTMF

One problem you've probably already foreseen is that of generating the DTMF code. Since the Auto-Kall is only a decoder, how can the tones be generated? Simply by replacing the microphone on your own equipment with one having a DTMF keypad built into the back of the microphone case. Or, if you don't want to go through the trouble and expense of a new microphone, you can have "your people" carry a DTMF *beeper*, a small, battery-powered, acoustic-coupled, DTMF keypad device that people carry in their pocket so they can access Touch-Tone, long-distance services from a rotary telephone. They simply place the beeper's speaker over a telephone or microphone and press the beeper's DTMF keys in the correct sequence, or the beeper can be programmed to generate a DTMF tome sequence at the touch of a single key.

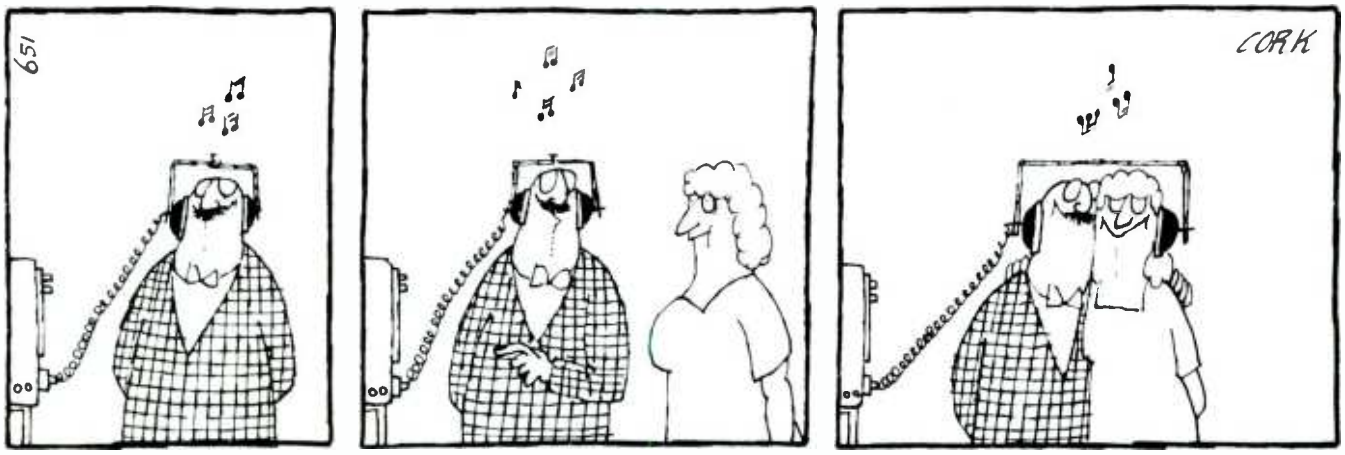
Works Great

The Auto-Kall's performance checkout was first-rate all the way. Most important, it handles a very wide range of both signal input level and distortion. The only thing we could complain about is the "tinny" sound quality, but that's entirely a function of the 1½ inch transistor-radio type speaker built into the case. Using a a larger external restores the receiver's original sound quality (which usually isn't all that good to start with).

The AK-10 Auto-Kall is priced at $89.95, plus $3.00 shipping and handling. It is sold direct by the manufacturer, Motron Electronics Co., 695 West 21st Ave., Eugene, OR 97405. For more information circle number 87 on the Free Information card. ■

The rear has connections for the DC power supply, input from the receiver, and a switched output for a speaker.

MAKING A LOCAL CALL



REPAIRING *HEADPHONE/WALK-A-LONG* RADIOS

Don't toss out that non-operational walk-about radio—you can fix it and learn something in the process!

By Homer L. Davidson

YOUR FAVORITE COLLEGE FOOTBALL TEAM IS BEHIND 6 points, they have the ball down on rival Tech's one-yard line with thirty-seconds to go...and your headphone radio conks out. Do you throw the radio against a cement wall? Do you continue to watch the amateur presentation of Hamlet, or do you feint a sick stomach and drag your wife home to a color TV? Do you end your walkathon and drop into a bar? No, like all us timid souls, you slip the broken radio into your pocket, grit your teeth, and read tomorrow's paper.

The often-used headphone radio rides along while jogging with you listening to your favorite baseball game or to a cross-town rival high school football game. The headphone radios take a licking and keep on beeping, but they do give up the ghost some of the time. Since those small radios cost from $20 to $40, you can either toss them out or take time to see what happened to them. You will be able to restore nine radios out of ten and put them back into operation, because you followed the easy instructions given in this article.

I would have written this article for headphone radios only, except that the "Walkman" types have many of the common problems, so I've mixed them together. If the radio you own can be used while walking about, then this article is what it's all about!

You say you got a few bummers in the shop's junk drawer. OK, let's give it a try.

Check the Batteries

Since just about every electronic gadget operates on dry cells, take out that VOM or DMM, and test each one. Run-down dry cells can cause weak and distorted reception on far-away stations, while one dead dry cell may prevent any reception at all. Sometimes a corroded cell terminal may cause the radio to go dead. Simply rub the ends of the batteries against your pants and give the apparent dud another chance.

It's best to test batteries with a battery tester (which provides a simulated load) or take a voltage measurement

Here is a small AM-FM stereo radio that has a belt clip at the back. Some of those small radios also have a cassette tape player. All are very susceptible to damage and wear.

across the battery with the radio in operation and the volume full on. While under load, one battery may show up weak. Replace the small flashlight or pen-light cells if the voltage drops ½-volt.

Check the battery clip or metal contacts for each dry cell for bright, shiny surfaces. If a dry cell leaked in the radio, it could have corroded one or more of the contacts, causing a high-resistance circuit. If a cell did leak in the battery compartment, you're due for some heavy cleaning. A bit of advice to avoid that problem—take the dry cells out of the radio when putting it away overnight or for longer periods.

Noisy Volume Control

After a few months, just about every one of those small radios ends up with a noisy volume control. That can be very annoying with earphones clamped to your ears. Remove the back cover of the radio to expose the small volume control. Some backs just clip into position, others have a few small screws to hold the back in place.

Squirt cleaning fluid (Carbona—carbontetracloride) or TV-tuner lube inside the volume control. Many such cleaners come with a fine plastic nozzle or thin straw to direct the liquid to where it is needed. Rotate the volume-control knob back and forth several times to clean up the noisy control. Clean the off/on switch contacts if they are exposed. Replace the small volume control if it is broken or worn excessively so that the slight play in the knob will open the sliding contact in the control. You may locate the small control at the local radio/TV parts store or electronics mail-order firm advertised in your favorite electronics magazine.

Check those batteries when the radio becomes weak, dead, or distorted. It's a good idea to check the voltage of each battery while the radio is operating. A battery tester may be used.

Stone Cold Dead—Nothing

The dead radio may result from a broken earphone jack, broken wires, or an open speaker. After testing the batteries, measure the voltage at the on/off switch and the collector terminal of the output transistors or IC component. Inspect the small chassis for broken or loose components. Check the antenna coil for torn away or broken wires if the radio has been dropped.

Take a peek at the small speaker terminals when one stereo channel is dead. Actually, small speakers are used as earphones in radios that clamp over your head. Measure the continuity across the speaker terminals with the low-ohm scale of your multimeter. A normal 8-ohm speaker may have a resistance of 7.5 ohms with the DMM. Flex the wire to the speaker or earphone while the radio is playing. Notice if the music cuts in and out. Usually, when you discover the point where mechanical movement causes cutting in and out of the sound, the repair suggests itself to the tinkerer.

No AM—FM Good!

First thing, take a look at the AM antenna coil. Carefully inspect it for broken wires or a damaged ferrite rod. A broken ferrite rod may cause weak or no reception. The whole coil must be replaced if the rod is broken in two. Double check each wire going to the antenna coil and variable (tuning) capacitor. Those wires are very fine and are apt to break due to heavy usage. Depending on the model you have, your headphone radio may be transistorized or contain some integrated-circuit chips (IC's). Don't let it throw you; in most cases you proceed with troubleshooting in the same way.

Next, go to the AM converter transistor or IC component. You may find one large IC taking care of both the AM and FM converter and oscillator sections. Check the converter transistor for open or leaky conditions with the diode-test function of the DMM. Refer to Fig. 1. Take critical voltage tests on the transistor. Measure the bias voltage between the base and emitter terminals (NPN types, 0.6 volt; PNP, 0.3 volt). Usually, the transistor is normal with correct bias voltage between base and emitter terminals. Bad semiconductors are to be replaced—if you can find them new or surplus.

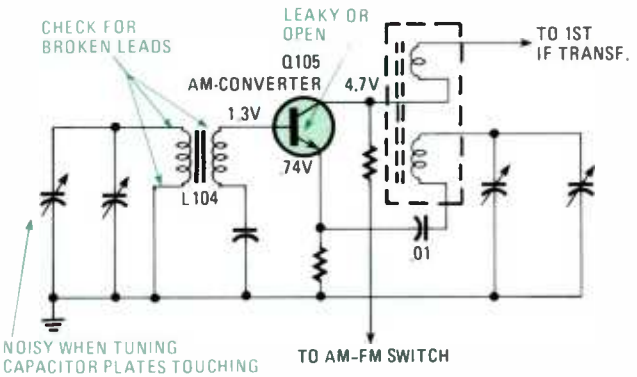


Fig. 1—No AM reception may result from a broken antenna wire or antenna-lead wire, fractured ferrite rod, or defective AM-converter transistor. Check the transistor for open or leakage with the diode- test function of your multimeter. If you have an in-circuit transistor tester, use it! Consider replacing the common front-end IC when both AM and FM stations cannot be tuned in.

Erratic FM—AM Good!

Spray the AM-FM switch with cleaning fluid when the FM is erratic or intermittent. Place the plastic spray tube in the end or on the switch contacts for a good cleanup. Move the switch back and forth to help clean the dirty contacts. Blowing the switch dry really doesn't help, but it sure makes you feel good.

Most FM front-end circuits have two or three separate transistors. You may find one IC component serving as FM-RF oscillator and mixer. Refer to Fig. 2. Take critical voltage

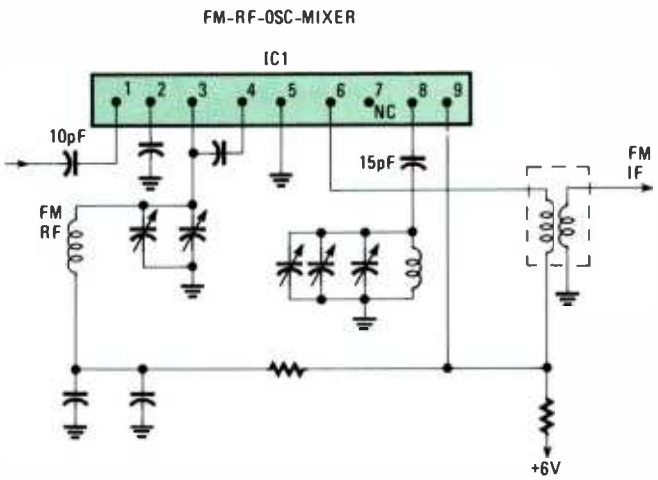


Fig. 2—Test the FM transistors with your multimeter as you would the AM section. Measure for correct voltage on the FM IC if there is one. Oldies still use transistors. Replace the FM front-end IC when the AM stations are normal. IC1 (FM-RF, oscillator, mixer) was replaced in a Sanyo MG-25 headphone radio with a TA-7358P IC with a dead front end. That type of part is available from commercial parts distributors.

measurements on the IC component to determine if it is leaky. Often, when one large FM IC is used, the AM antenna coil ties directly into the IF circuits. Replace the FM IC component if the AM reception is normal with improper voltages on the IC.

Distorted Right Channel

I once put on a set of headphones to test the sound quality of a pocket radio and told the owner of the radio that the left channel was out. He said that the right channel was out and that I had the headphones on backwards. It's important to learn which channel is which when troubleshooting. Go directly to the audio output transistors or IC circuits when a stereo channel is distorted. Take critical voltages on the IC component. Check the output transistors within the circuit for open and leakage conditions with the diode-test setting of the DMM. Often, one of the output transistors may be open or leaky. Remember, with one channel working normally, you do have a comparison channel to compare voltage readings against. Usually the voltages are equal. Keep the radio in the AM mode for pure mono operation and equal performance expectations. Refer to Fig. 3.

Before removing the suspected bad transistor, mark on a piece of paper where each lead goes with the flat side of the transistor, as reference. Check the bias diodes and resistors when the power-output transistors are out of the circuit.

You may find one large IC component combining both audio output channels. Locate the audio-IC component on the printed-circuit board and take voltage measurements. The suspected IC may be located by using an audio-signal tracer.

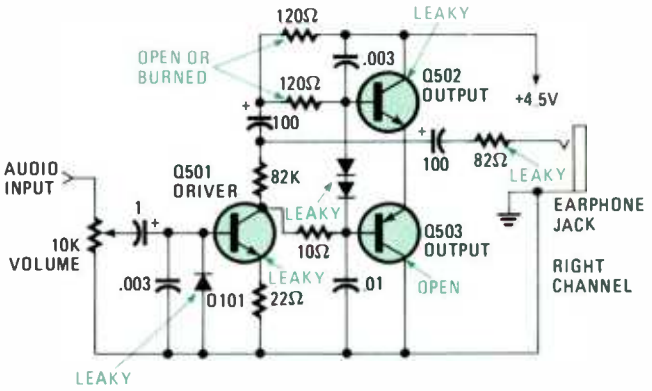


Fig. 3—Besides transistors, suspect leaky bias diodes or open resistors for causes of distorted sound. Take another listening test after the suspected leaky transistor has been removed. Don't overlook possibility of a defective earphone.

No normal sound at the output terminal and normal sound at the input terminal of the IC indicates improperly applied voltage or a defective IC.

Dead Left Channel

Left, right! If you recall the story I gave at the beginning of the previous section, you would expect that the left channel would be checked the same way. Yes, but we split the troubleshooting tactics in two to keep you alert!

Locate the defective stereo channel on the printed-circuit board. Remember, those components are jammed together in the small headphone radio. Most small radios come with a schematic diagram on the back side of the instruction booklet. Sometimes the schematic diagram is pasted on the inside surface of the back cover. In either case, if you are over 30 years old, you'll need a magnifying glass to read it. Trace the defective audio channel back from the earphone jack or small speaker if a schematic diagram is not available. Draw the output circuits on a piece of paper, big enough so you can follow them.

Take voltage measurements on the suspected output transistors or IC. Refer to Fig. 4. Test each transistor with the DMM or transistor tester. A leaky IC component may lower the supply voltage a couple of volts. Check the current by inserting a piece of cardboard between the battery and termi-

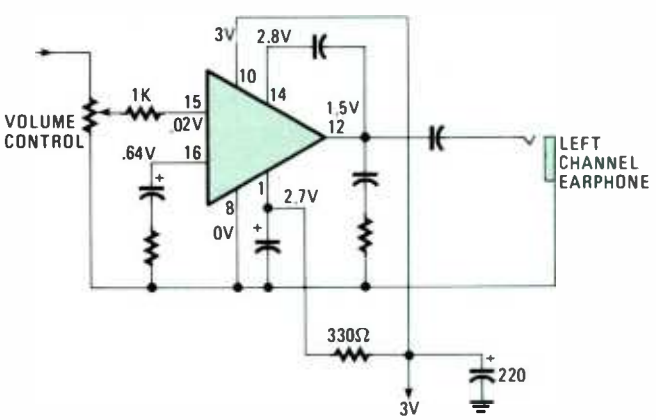
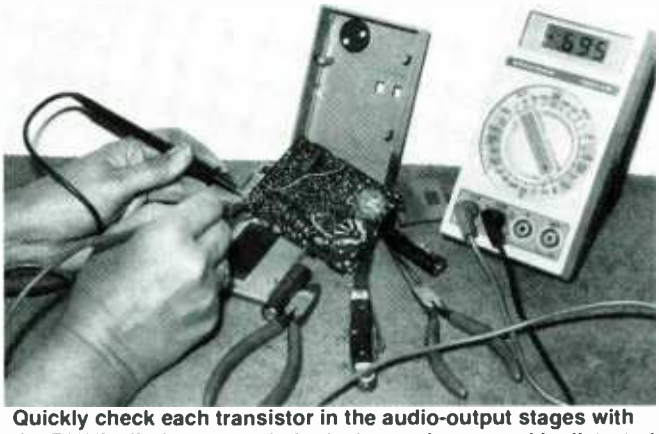


Fig. 4—Check the audio output IC for distorted, weak, or no sound signal. Compare the voltage measurements at the IC or audio transistors with those in the good stereo channel. Remove the operating voltage pin terminal of the suspected IC and measure the resistance from disconnected pin to common ground. A low resistance under 250 ohms indicates a leaky IC.

You may find one- or two-inch PM speakers in the clamp-on headphone radios. Check the speaker voice-coil continuity with the low ohm scale of the DMM or VOM. Those small speakers are easily replaced, providing that you can find new ones.



Quickly check each transistor in the audio-output stages with the DMM's diode-test mode for leakage when sound is distorted. Usually, a couple of small screws hold the radio chassis to the case. Mark each transistor terminal for easy replacement.

nal. Most small AM-FM headphone radios pull less than 25 milliamperes of current. If the current measurement is over 30-milliamperes, suspect a leaky output IC or transistor. Do not overlook a broken earphone jack.

Intermittent Sound

Erratic or intermittent sound may be caused by a broken board, loose battery, loose components on the printed-circuit board, or defective headphone cable and connections. Flex the cable at the top of each earphone for possible wire breakage with the large earphone radio playing. Determine if one speaker or earphone is intermittent or both. Suspect a dirty plug or a male plug with detachable earphones.

Remove the back cover, replace the battery and turn it on for intermittent checks. With a pencil eraser, gently nudge or move each component on the small printed-circuit board. A resistor soldered to the board is not going to move far, so don't push it so that it cracks or damages the board. Remember, do it gently!

Inspect the printed-circuit board for cracks if the radio was dropped or has seen rough (teen-age) duty. Move each component on the board until the radio pops on and off, indicating the break is close at hand. You may locate a cracked resistor or component-terminal that has torn loose from a poorly soldered board connection.

Mushy Sounding Earphone or Speaker

The small headphones have usually an impedance from 8 to 32 ohms. The headphone consists of a foam cover, driver, and a plastic piece that connects to the head band. Each driver usually has a single-conductor cable with a shield. The earphone may have two small 8–10-ohm PM speakers, or inexpensive earplug-types.

The continuity of the earphone driver may be checked at the earphone's male plug. The earphone's speaker cable or driver unit may be an open circuit. Check the driver terminals for open conditions. Each cable wire may be checked from earphone to the male plug for a break with the low-ohm scale of the VOM or DMM. Wire breaks are sometimes very easy to repair and restore the headphone to service.

The mushy or distorted driver sounds may be caused by sharp objects poked through the earphone holes or a hard drop. Perspiration can do a lot of damage to the delicate voice coil. In most cases the driver's voice coil rubs against the center magnet. That's bad news! Replace the small PM speakers in the earphone with correct impedance replacements. Of course, it is easier and cheaper to buy replacement earphones for $5.95.

Speakers built into the small radios (if any) are easy to fix should they go bad; just replace them. If you can't replace them with an exact fit, disconnect them and use headphones only.

You could use outboard speakers through the speaker jacks, but that's a project for another article.

What Else Is There?

Remember, all parts are fitted tightly together in headphone radios. The innards must be handled with extreme care. Most problems are caused by improper operation and rough treatment. Universal transistor and IC components may be used as replacements throughout the small headphone radios. Use a low-wattage soldering iron when replacing the defective component. Above all, I can't cover every possible fault that can occur, so use your head, eyes, ears, nose (sniff), and touch (detect heat) to pinpoint problems. And, don't make a business of repairing those products—their replacement cost is less than your repair bill in many instances. ■

Inspect the printed-circuit board for damage if the radio was dropped. Use the pencil eraser to prod or move the various components. Intermittent reception may be caused with cracked resistors, broken connections, and poor solder connections.

LEARN BY DOING

Learn About Thyristors

By Louis E. Frenzel, Jr.

The most useful power-control devices are thyristors. While some articles gloss over them, we'll show you how they operate!

IN THIS MONTH'S INSTALLMENT, WE ARE GOING TO TAKE A look at a class of semiconductor devices that never seem to get the same amount of attention and respect as other devices, particularly integrated circuits. That class of semiconductors is known as thyristors. While thyristors are widely used in many electrical and electronic applications, they are less visible and might be considered by some as boring compared to the powerful and sophisticated integrated circuits that are available today.

As in previous articles, we start by defining some learning objectives that state specifically what you will know and be able to do when you complete this article.

That is followed by a brief tutorial on thyristor fundamentals. The bulk of the article is devoted to a step-by-step experiment which you can actually follow to study the operation of thyristors and build practical working circuits. Like other kinds of lab experiments, this one will help you to learn by doing.

Learning Objectives

When you complete this experiment, you will be able to:

1. Name three types of thyristors and explain how each operates.
2. List the main specifications of thyristors.
3. Build SCR and triac phase-control light dimmers and motor-control circuits.

Background Tutorial

Thyristors are special semiconductor devices used as switches in power applications. Whenever a thyristor is triggered on, it acts as a closed switch, having a very low resistance and small voltage drop. When the device is off, it acts as an open switch having an extremely high impedance. Thyristors are often called bistable devices because they have two stable states, off and on.

Most thyristors look like transistors because they are packaged in the same housings used by transistors. The most-common packages are the TO-92 and TO-220 plastic packages illustrated in Figs. 1A and 1B. Very-high voltage/high-current thyristors are packaged in the TO-48 stud-mounted package shown in Fig. 1C. Since thyristors are used primarily in power applications, most are capable of withstanding either very high voltages or high currents or both. Thyristors can operate on voltages up to a thousand volts and can switch currents as high as 5000 amperes.

Thyristor Use

Thyristors are used in applications where it is necessary to switch very-high voltages or currents quickly. An example of a high-speed, power-switching application is solid-state relays that use thyristors to replace slower electromechanical relays. Thyristors are also used in applications that require the precise control of power to some device. Some typical power control applications are light dimmers, motor speed controls, and power conversion applications, such as inverters used to produce AC from DC.

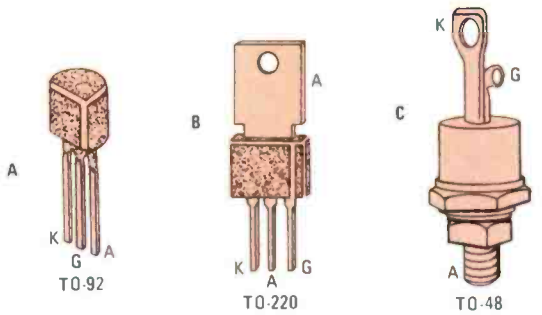


Fig. 1—Thyristor cases come in three-flavors-from left to right the power handling capability of those shown here increases.

There are three basic types of thyristors: silicon controlled rectifiers (SCR), triacs, and diacs. Let's take a look at how each of them operates. Then, we will demonstrate the operation and application using a low-cost, readily available SCR.

Silicon-Controlled Rectifiers

An SCR (silicon-controlled rectifier) is a three-terminal, semiconductor device that acts like a silicon rectifier diode. That means that it blocks current in one direction but allows current to flow freely through it in the opposite direction. The current flows from the cathode through the device to the anode as in any other diode. However, the SCR is unique in that its third terminal, called the gate, is used to turn the forward current on.

Figure 2 shows the schematic symbol ordinarily used to represent an SCR. Sometimes you will see that symbol without a circle around it. The cathode, anode, and gate leads are labelled.

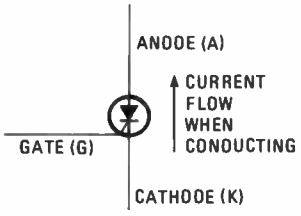


Fig. 2—This is the commonly used symbol for the SCR. Note that current flow is restricted to only one direction.

The SCR can operate with both DC and AC, however, most applications are with AC. We will illustrate the operation with both DC and AC.

Figure 3 shows the basic DC circuit for an SCR. Resistor R_L is the load which is being switched by the SCR. As indicated earlier, the load can be any number of different kinds of devices, including lights, heating elements, or motors. Whenever the SCR turns on, the DC supply voltage is connected to the load.

Ordinarily, the supply voltage in Fig. 3 would cause a standard diode to be forward biased and conduct. However, the SCR will not conduct until current is applied to the gate. The cathode and gate form a PN junction just like the PN base-emitter junction in a transistor. That junction must be forward biased to cause gate current to flow. Once a sufficient amount of gate current is applied between the cathode and gate, the SCR is triggered on. Current will flow through it as in an ordinary diode.

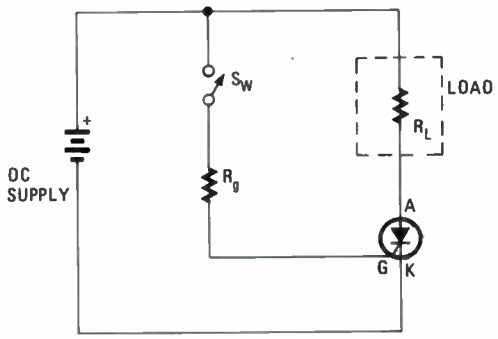


Fig. 3—Once the gate is triggered by closing the switch the SCR will conduct. But opening the gate will not turn the SCR off, so current will continue to flow.

During conduction, an SCR has a small voltage drop across it of approximately 0.7 to 1.8 volts depending upon the size of the SCR and the amount of current flowing through it.

In Fig. 3, a switch (S1) is used to apply DC to the gate through resistor R_g. Closing the switch forces gate current to flow and the SCR conducts. Other triggering methods can also be used.

Gate Current

Gate current need only flow momentarily to turn the SCR on. Once it is on, the SCR will continue to conduct even if gate current is removed. The SCR latches in the on state when gated as shown in Fig. 4. Note that the second gate pulse has no effect on the device current.

Gate current cannot be used to turn the SCR off. That can only be done by decreasing the amount of current flowing

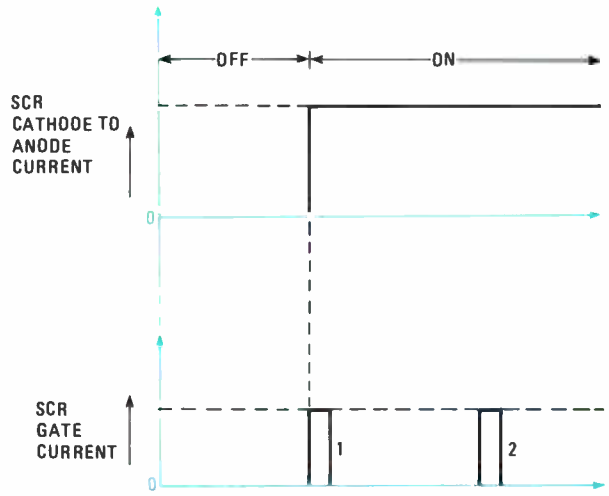


Fig. 4—One tiny blip is all it takes for an SCR to conduct. Afterward it's on its own, with or without blips. Power will have to be removed from it to turn it off.

through the device below a specific level of current known as the holding current. Various circuit arrangements, depending on the application, are used to remove the current in the SCR. A switch may be connected in series with the circuit to momentarily disconnect the supply voltage. Alternately, a manual or transistor switch may be connected in parallel with the SCR and closed momentarily to shunt current around the SCR so that its current drops below the holding-current value. With the SCR off, it can then be triggered on again.

Usefulness

The SCR is more commonly used in control circuits where AC operates the load. A typical connection is shown in Fig. 5. Again, the load may be a light to be dimmed, a motor whose speed is to be controlled, a heating element whose temperature is to be varied, and so on.

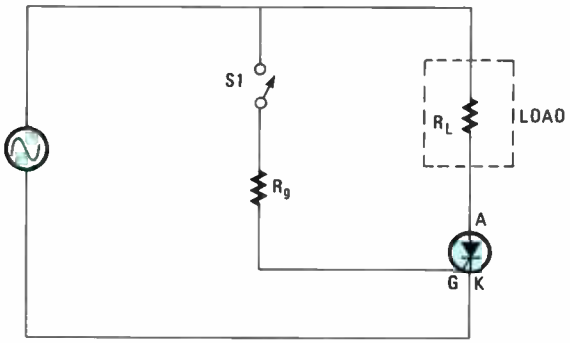


Fig. 5—Under AC conditions the activated SCR acts as a rectifier, allowing current to flow in only one direction. That's okay for half-cycle applications only.

Consider how the circuit would operate if the gate had no effect. The SCR would simply act as a half-wave rectifier allowing current to flow through the load on the positive swings as illustrated in Fig. 6. Pulses of half-sine current would flow in the load. The average current in the load as indicated by the dashed line in Fig. 6B is the same as the average current that would flow in the load of an unfiltered half-wave rectifier power supply. The average current I_{avg} is 31.8% of the peak current I_{peak}.

$$I_{avg} = .318I_{peak}$$

The idea is to provide some convenient means of adjusting

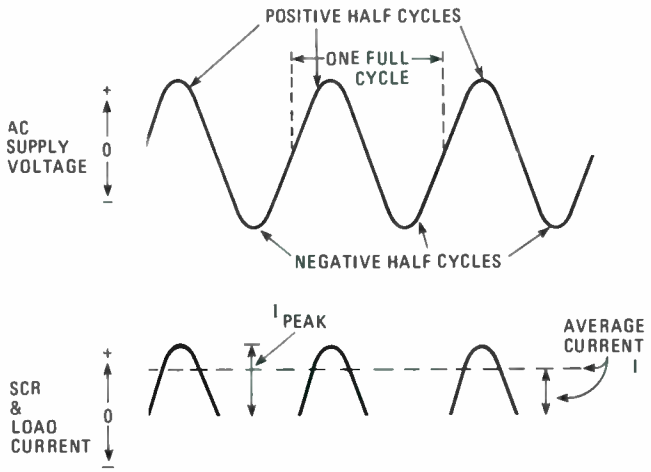


Fig. 6—The average current output from the SCR is not only low, but is always positive. For circuits requiring rectification and power control this feature is very useful.

the level of that average current to vary load power. That is done in an SCR circuit by applying an appropriate signal to the gate.

In Figs. 3 and 5, we used a simple switch in series with the gate resistor R_g to control triggering. If the switch is open, no gate current flows and the SCR remains off. If the switch is closed, gate current will flow turning on the SCR. By controlling the point where the SCR is turned on, the average current through the load can be varied.

Reducing Output Power

Assume that the switch is closed 30 degrees after the positive alternation of the sinewave begins (see Fig. 7A). Gate current flows rapidly, switching on the SCR. The current through the load would then follow the sine curve for the remainder of the positive cycle. As the sinewave voltage drops, the SCR current decreases below the holding current value and the SCR switches off. No current will flow during

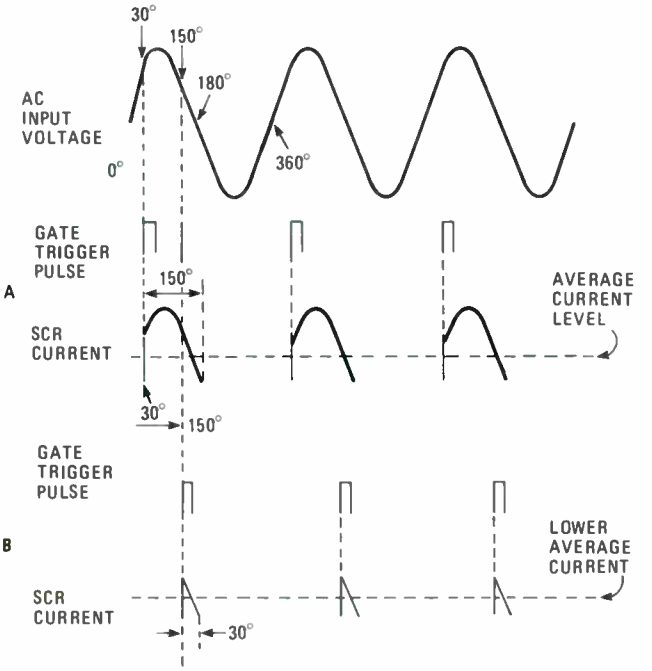


Fig. 7—Timing the trigger pulses to coincide with the same part of the AC waveform, each cycle allows one to adjust the average output current to any desired value.

the negative half-cycle. Instead of current flowing for the entire 180 degrees of the positive half-cycle, the current now only flows for only 150 degrees. For that reason, the average current will now be lower.

Figure 7B shows the effect of turning the SCR on much later in the cycle. The switch is closed at 150 degrees, turning on the SCR. But very quickly the AC voltage drops to zero and the SCR turns off. Only very short, narrow spikes of current flow, thus further reducing the average current through the load.

An independent source of trigger pulses can be used to eliminate the switch in Figs. 3 and 5. The occurrence of the pulses can be controlled, thereby varying the load current.

RC Triggering

A more-common technique for controlling the gate current, however, is shown in Fig. 8. An RC network is used to produce a sinewave delayed in time from the applied voltage. The RC network acts as a phase shifter. In an RC circuit, the current leads the voltage, however, the voltage across the capacitor lags the applied voltage. Also, by making the resistor variable, the amount of delay can be varied. That

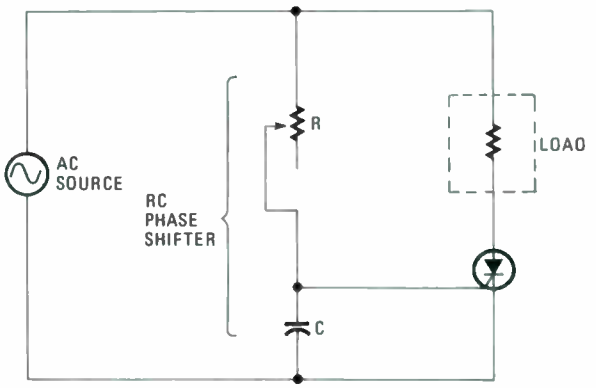


Fig. 8—This circuit allows you to vary the time at which the SCR receives a sufficient trigger pulse. That is accomplished by varying the RC time constant.

simple circuit allows adjustment of the phase of the sinewave applied to the gate to be varied over approximately the 0 to 90 degree range. That permits varying the point where the gate current is high enough to trigger the SCR, thereby providing control of the average current in the load.

Neon-Bulb Triggering

The triggering of the SCR in Fig. 8 is not always precise as it relies upon the gradual rise of a sinewave. As a result, it does not provide as fine a control as is desired in some applications. To overcome that problem, a trigger device such as a neon lamp is often used to improve triggering. Such an arrangement is shown in Fig. 9.

Keep in mind that a neon lamp contains two electrodes in a glass tube filled with the inert gas neon. When a voltage is applied across the neon lamp, no current will flow until a high enough trigger voltage has been reached. That trigger voltage is usually in the 60 to 70 volt range. As soon as the trigger voltage has been reached, the neon lamp conducts. Current through it must be limited by a series resistance. The point of conduction is very sharp and precise providing an accurate turn-on pulse for the SCR.

The main specifications of an SCR are: PIV—Peak inverse voltage. The maximum reverse voltage that can be applied between anode and cathode. I_t—Forward current. Maximum

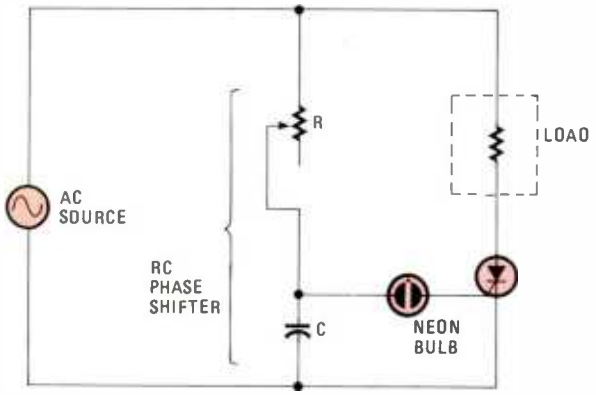


Fig. 9—This circuit delivers accurately timed amounts of current since the trigger pulse is independent of the shape of the sinewave. The lamp delivers very slim blips to the gate, which enhances the timing accuracy.

allowable continuous cathode to anode current. I_g—Maximum gate current. I_gf—Gate current required to turn the SCR on. I_h—Holding current. Value of I_f below which SCR turns off. V_f—Forward voltage. Voltage drop between cathode and anode when the SCR is on.

Triacs

Another popular thyristor is the triac. Like the SCR, it is a three terminal device, however, it can conduct current in either direction. The triac operates as if it were two SCRs connected in parallel but with opposite polarities as shown in Fig. 10. The gates are connected together to form a common

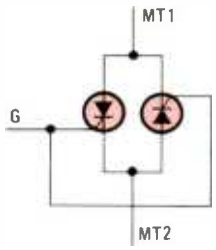
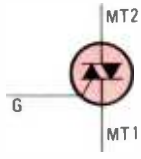


Fig. 10—This is a good (but inaccurate) way of viewing a triac. The jist of the idea is that when one SCR is off due to reverse biasing the other can conduct if triggered.

control element. In reality, two SCRs cannot be connected in that way without some special arrangements for properly controlling the gates. However, a triac provides bidirectional conduction with the gate controlling the turn-on time as it does in an SCR.

Figure 11 shows the schematic symbol used to represent a triac. The two primary connections to the device are called main-terminals 1 and 2 (usually denoted as MT1, MT2). The control element is called the gate as in an SCR.

Fig. 11—Note that the current control terminals of the triac are referred to as MT1 and MT2, The MT's representing main terminals. The unit can operate during any portion of the AC cycle allowing control of output power for AC devices.



Like the SCR, the triac was designed for use in AC power control. Since it conducts in both directions, the full AC supply is available to the load. However, the gate provides a way to control when the triac conducts, again permitting the average current through the load to be controlled on both the positive and negative half-cycles of the sinewave.

Diacs

A diac is another type of thyristor which is used as a triggering device for triacs. It is a two-terminal device that conducts current in both directions but has a specific voltage threshold. Figure 12 shows the schematic symbol used for a diac.

A voltage of either polarity may be applied to a diac. If that voltage is below a point known as the break-over voltage, no current will flow and the diac acts as an open circuit.

Fig. 12—Since a device such as a triac requires trigger signals during either half-cycle the AC waveform the diac was invented to permit a pulse to pass in either direction.

However, once the break-over voltage point has been reached, the diac conducts and acts as an on switch. A resistor must be used in series with the device to maintain the current within limits. Typical diac break-over voltages are in the 25-to 45-volt range.

Keep in mind that the diac will conduct in either direction and that the breakdown voltages for both the forward and reverse directions are approximately equal (at least within 3 volts of one another). The primary application for a diac is as a gate-trigger device for a triac.

A Diac-Based Trigger

Figure 13 shows a basic triac control circuit with diac triggering. The RC network delays the sinewave used, allowing triggering up to 90 degrees. Assume that the RC network is set for a phase shift of 60 degrees. The triac will fire 60

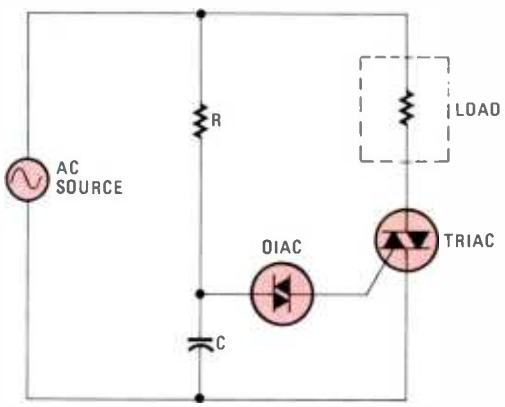


Fig. 13—The diac allows the triac to fire during both portions of the AC sinewave. Making complete AC-power control possible. The load can be a drill or any AC device.

degrees into the positive half. As the positive half-cycle drops to zero, the triac switches off. But at 60 degrees into the negative half-cycle, the triac again conducts. The resulting waveform is shown in Fig. 14A. Note that current flows through the load on both the positive and negative half-cycles but that the duration of conduction has been shortened due to the time at which the gate is triggered.

The waveform in Fig. 14B shows the effect of turning the gate on at the 120 degree point. Again, as before, short spikes of current flow through the load on both the positive and negative half-cycles. The average current through the load, therefore, is much less than in Fig. 14A.

In the following experiment, you will demonstrate the operation and application of SCRs, triacs, and diacs. First you will learn thyristor operating principles with both DC and AC voltages using an SCR. You will also build a simple

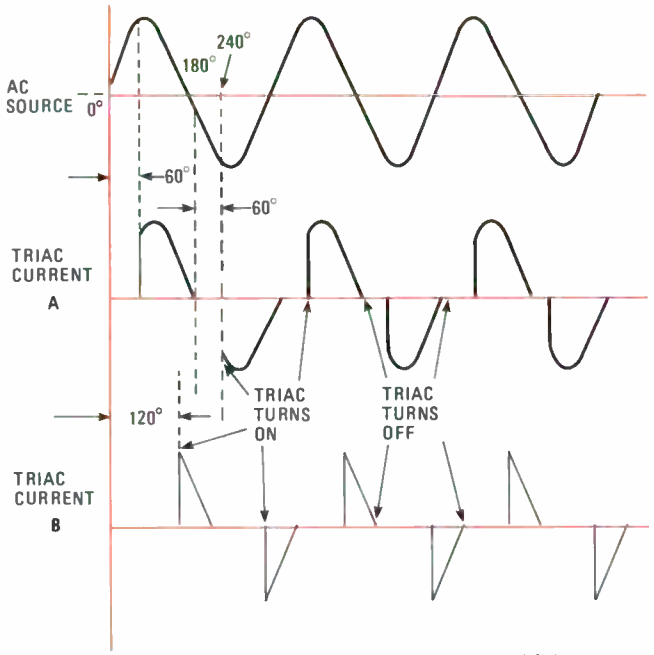


Fig. 14—Just like the SCR, by varying the time at which the triac fires varies the average power delivered to the load. Early timing (A) delivers more than late timing (B).

phase control light dimmer circuit using an SCR. Then finally you will construct a triac phase control circuit which can be used for light dimming and motor control purposes.

Parts Required

The components you will need for these experiments are listed below. You will also need a breadboarding socket and a DC power supply capable of furnishing 6 volts. A multimeter is needed for DC and AC measurements. An oscilloscope is required to view the AC waveforms. You'll also need a 2N5060 SCR; a Q4015L5 triac; and a HT-32-ND diac. Those parts are available by mail from Digi-Key Corp., P. O. Box 677, Thief River Falls, MN 56701. Lastly, get your hands on one LED; a 100-ohm ¼-watt resistor, two 1000-ohm ¼-watt resistors; a 3300-ohm ¼-watt resistor; a .47-μf capacitor; a 500-ohm potentiometer; a 100,000-ohm potentiometer; a power transformer to step down 120V AC to 6.3VAC; an AC line cord; an AC line switch; and an AC receptacle (optional)

Experimental Steps

In the first part of the experimental procedure, you will demonstrate the basic operation of an SCR with a DC supply.

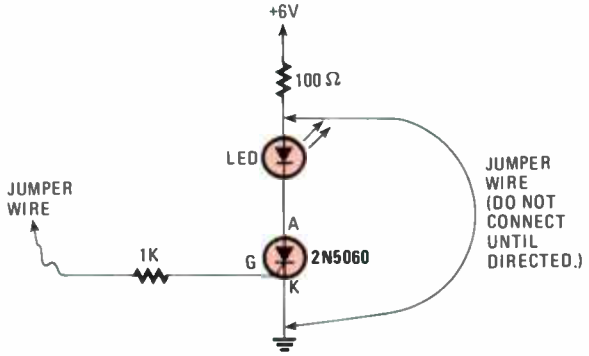


Fig. 15—The LED can be turned on with the small amount of voltage on your body by touching the gate jumper wire. To turn it off however you must short the SCR momentarily.

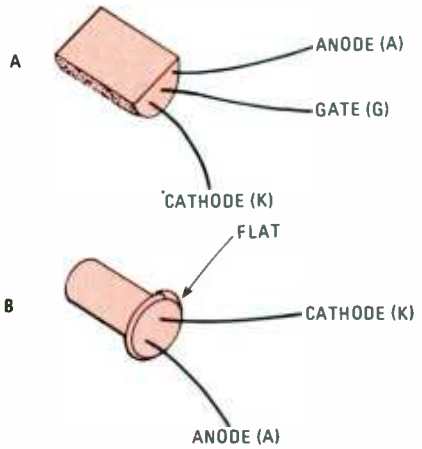


Fig. 16—The lead layout for the SCR (A) and LED (B) are shown here with the lead abbreviations. Why anyone would abbreviate cathode with a K is beyond me.

1 On your breadboard, wire the circuit shown in Fig. 15. The pin connections on the 2N5060 SCR and LED are illustrated in Fig. 16. The DC supply voltage can come from any available electronic supply or can be derived from four flashlight cells connected in series. If a 5-volt logic supply is available, the circuit will operate satisfactorily from it. Do not connect the jumper wires shown in the diagram until told to do so.

2 Apply power to the circuit and note the condition of the LED. It should be off. Momentarily touch the free end of the 1K resistor to the +6-volt supply and again note the LED. Remove the jumper from the free end of the 1K resistor and move it to ground, continuing to observe the LED condition.

3 Disconnect the 6-volt supply from the circuit. The LED should go out. Reconnect the 6 volts, and again note the condition of the LED. Touch your finger to the free end of the 1K resistor and note the LED. Finally, connect the jumper wire between the 100-ohm resistor and ground as shown in Fig. 15. Note what happens to the LED.

4 Trigger the SCR on by touching the 1K resistor to +6 volts. Then connect the 1K resistor lead to ground. Measure the DC voltage across the conducting SCR. Record your value below.

SCR-on voltage drop _____ volts

Review of Steps 1–4

That basic DC circuit illustrates the primary operating characteristics of an SCR. When you first applied power to the circuit, the LED should have been off. In order for the LED to turn on, the SCR must be triggered. To do that, you momentarily touched the 1K resistor from the gate to the supply voltage. That provided sufficient gate current to turn the SCR on. The LED should have turned on. Removing the 1K resistor from the supply voltage should have had no effect on the LED which remained on. That shows that the gate has no effect once the SCR conducts. To turn the SCR off, you had to momentarily disconnect the supply voltage.

You found that it was possible to trigger the SCR by simply touching the end of the 1K gate resistor. Your body picks up a considerable amount of 60 cycle AC floating around the room. Because the gate is very sensitive, even the small amount of voltage picked up by your body is sufficient to provide gate current to turn the SCR on.

In Step 3, you saw that you could turn the SCR off by

momentarily bypassing the SCR with a jumper. The jumper is a short circuit between the 100-ohm resistor and ground and, therefore, the current will flow through it, halting the current through the SCR. The resistance of the jumper wire is much lower than the SCR and, therefore, all current is diverted from the SCR, turning it off. Once you remove the jumper, the LED should remain off until the circuit is retriggered.

In Step 4, you should have found that the voltage drop across the SCR while conducting is approximately 0.8 volt. That voltage drop could be higher depending upon the current through the SCR and may be as high as 1.7 volts.

Experimental Steps (continued)

5 Connect the circuit shown in Fig. 17. You will use that circuit to measure the holding current of the SCR. The 5K potentiometer is connected across the supply voltage to provide a variable voltage source for the SCR.

There are two ways to measure the holding current. One way is to use a milliamp meter connected in series with the 1K anode resistor as shown in Fig. 17. The large X tells where to insert the meter. Remember, to measure current, the ammeter must be in series with the circuit with the proper polarity. Your ammeter should be capable of indicating in the 0- to 5-mA range.

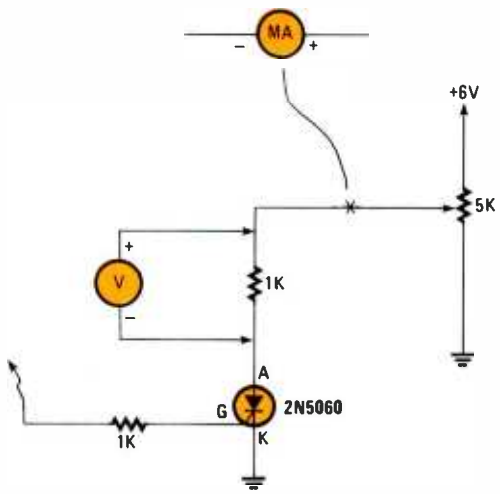


Fig. 17—Measuring the turn-on current can be done with either an ammeter or voltmeter. Using a linear taper potentiometer will improve your accuracy.

If you do not have current-measuring capability on your multimeter, you can determine the current by measuring the voltage across the 1K anode resistor. The voltmeter should be capable of reading up to about 5 volts. Connect it with the polarity shown in Fig. 17.

6 Apply power to the circuit. Adjust the potentiometer so that the full 6-volt supply voltage will be applied to the 1K anode resistor. Then, momentarily touch the 1K gate resistor to the +6 volt supply to trigger the SCR on. You will know when the SCR is triggered on by an indication of current on the milliamp meter or voltage across the 1K anode resistor. Once the SCR is triggered on, connect the free end of the gate resistor to ground.

7 Begin varying the potentiometer to reduce the applied voltage. That will be indicated by a drop in the current or a drop in the voltage across the 1K anode resistor. Continue to reduce the applied voltage slowly while monitoring the current. At some point, the holding current will be reached at which time the SCR will abruptly turn off. Your job is to monitor the current and note its value just prior to its dropping to zero. That is the holding current.

You may want to repeat the process several times in order to more accurately estimate the holding current. Simply increase the voltage and retrigger the SCR. Then again, slowly decrease it until the current ceases.

If you used a milliamp meter to note the current, you can obtain the reading directly from the meter. If you used a voltmeter across the 1K anode resistor, you can compute the current with Ohm's law simply by dividing the voltage reading by 1000 ohms. Since a 1K resistor is being used, the voltage reading across the resistor will actually be equal to the current in milliamperes. Once you determine the holding current for your SCR, record the value in the space provided below.

Holding Current = _____ mA

Review of Steps 5 Through 7

Once the SCR is triggered on, it will remain on until the power supply voltage is interrupted. The current through the SCR will also cease if the current through it is reduced to a low-enough level. The current value where the SCR turns off is known as the holding current. In other words, the current through the SCR must be higher than that value in order to sustain conduction.

To determine the holding current, you used a potentiometer to vary the supply voltage to the SCR. You decreased the supply voltage, thereby lowering the current through the circuit. At some point, the current ceased. The value you measured just prior to the current dropping to zero, of course, is the holding current.

The specifications for the 2N5060 SCR indicate that the holding current will be less than 5 mA. The values vary widely. For the device used in this experiment, a holding current of .75 mA or 750 microamperes was obtained. Your value could be higher or lower than that, but in all cases it will be less than 5 mA.

Experimental Steps 8–10

8 Construct the circuit shown in Fig. 18. That is a phase-control SCR light dimmer circuit. Note that the circuit operates from AC rather than DC. A low voltage transformer T1 steps down the standard 120-volt AC line voltage to 6.3 volts AC. That provides adequate voltage for operating the SCR, but is low enough for safety in working with experimental circuits.

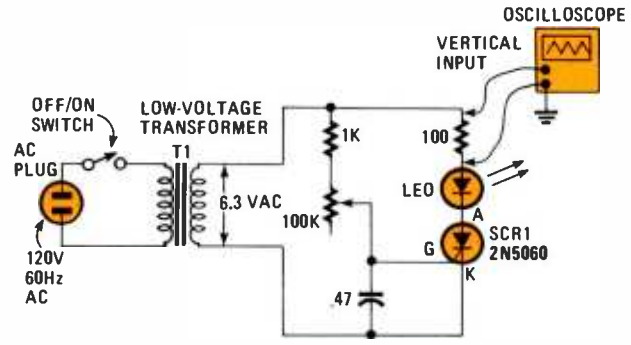


Fig. 18—Viewing the output waveform on an oscilloscope is the best way to get a feel for SCR action. If you don't own one you can still observe the changes in LED output power.

9 Apply power to the circuit by turning on the off/on switch. You should see the LED come on. Vary the 100K potentiometer from one end of the range to the other, noting the brightness of the LED. You should be able to vary the intensity of the LED from full on to full off.

10 If you have an oscilloscope, connect it across the 100-ohm resistor in series with the LED as Fig. 18 shows. The voltage across that resistor is proportional to the current through the LED load and SCR. It should correspond to the SCR current waveforms shown earlier in the tutorial (Fig. 7). While observing the waveform, adjust the 100K potentiometer from one end of its range to the other, noting the effect on the waveform.

Review of Steps 8, 9, and 10

The SCR phase-control, light-dimmer circuit is very widely used in industrial and consumer products. You will find it in light dimmers for homes and in entertainment light dimming circuits for theaters and light shows used by music groups. It is also used in motor control circuits such as mixers or blenders and in sophisticated, motor-driven machine tools.

Varying the resistance with the 100K potentiometer varies the phase shift of the AC signal applied to the gate. With minimum resistance, there is minimum phase shift and therefore, the AC signal applied to the gate is nearly in phase with the AC applied to the anode. Because of this, the SCR triggers on quickly in the positive AC alternation and, therefore, current flows through the LED for nearly the full half-cycle of AC. With the 100K potentiometer set to its maximum resistance value, the phase shift approaches 90 degrees, thereby delaying the turn on of the SCR near the end of the half cycle of AC. The LED will conduct for only a short period of time or not at all, thereby giving a dim glow or no illumination.

The waveforms you observed across the 100-ohm resistor should be similar to those shown earlier in Fig. 7.

Experimental Steps 10–13

The following steps are optional, but should you desire first-hand experience with diacs and triacs, the following will provide it.

Most practical triac circuits are used to control the 120-volt, 60-Hz power line. The circuit to be described here will operate directly from 120 volts AC. It can be used to control the brightness of light bulbs up to 150 watts. Also, AC motors whose currents do not exceed approximately 150 watts can also be used. The most important thing to point out is that working with 120 volts AC on a breadboard is an extremely dangerous proposition. Should you plan to go ahead with the following steps, take extreme precautions to prevent shock as well as damage to components. Never work on a circuit while power is applied.

Refer to Fig. 19. The circuit is similar to that you have studied previously (Fig. 13). The load is connected in series with the triac. The load may be a light bulb or an AC motor. The most convenient method of connecting the load is simply to build-in a standard AC outlet receptacle into which the load, either a lamp or an appliance with a motor, can be plugged.

11 Construct the circuit shown in Fig. 19. Build it on your breadboard, but then connect it to the AC line cord and the AC receptacle into which the load will be plugged. The triac connections are given in Fig. 20. The diac is fully bidirectional so can be connected in either direction.

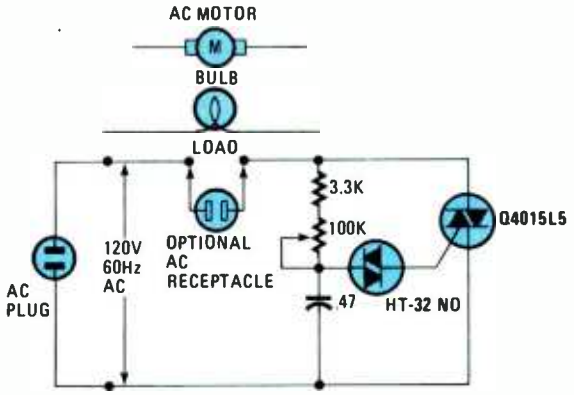


Fig. 19—Now here comes the fun part. You can use this circuit to control any device you wish. Note that when the SCR is off, the load is still going to receive some current.

Fig. 20—Note that MT2 is also the heat sink and should be the lead connected to the ground plane to avoid shorts.

12 Plug a lamp into the load receptacle. Then, connect the AC plug to a standard outlet. By using the 100K potentiometer, you should be able to vary the brightness of the lamp from full off to full on. Vary it several times to get a feel for how it works.

13 Disconnect the AC power cord. Then disconnect the lamp and in its place plug in an electric drill or other small appliance with a motor. A kitchen mixer is an example. Apply power by plugging in the AC cord. Activate the drill or other appliance by turning on its switch. Note the speed at which the motor turns. Vary the 100K potentiometer from one end of its range to the other noting the change in drill or appliance speed. Disconnect the AC plug.

Review of Steps 10–13

That circuit operates as previously described in the tutorial. The RC network provides a varying phase shift for the gate control. The diac provides positive reliable triggering.

The most important thing about a triac circuit is that the device conducts in both direction, thereby providing power to the load on both positive and negative AC swings. Therefore, both lamps and motors can operate as they normally would from the AC power line but with full control.

With a lamp as a load, you should have been able to vary its brilliance from its normal high to completely off. The potentiometer provides a continuous dimming action.

When you used an AC motor as a load, you should have been able to vary its speed from its maximum normal value down to extremely low levels before the motor shuts off completely.

Now you should have thyristors pretty much under your belt. Next month we'll explore the theory and application of the two main forms of modulation: amplitude modulation (what we regular folks call AM) and frequency modulation (you guessed it, FM). Till then, enjoy your knowledge. ■

CIRCUIT CIRCUS

By Charles D. Rakes

Unlock the mystery of voice/remote activation circuits

GETTING THE CIRCUITS WORKED OUT and ready for this month's circus has been a real ball for me, as I have always wanted to put together a few special circuits designed to increase and expand the use of the plentiful and popular portable cassette tape recorder, and best of all be able to share the experience with others. In fact, you can thank one of our fine Circus readers for suggesting a need for a gadget that became our first circuit offered this month.

Extended-Play Circuit

If, more often than not, you tend to come up just a few feet short of having enough tape to complete a recording, then our time-expander circuit (see Fig. 1) should help solve that problem. No, I'm not suggesting taking the tape and stretching it out to increase the recording time, but instead to slow down the rate of tape travel and double, or perhaps even triple, the recording time of your cassette recorder. Sounds difficult? Not at all if you have a recorder your are willing to get into and make a minor modification that will in no way effect the normal operation of the machine.

The trick is to slow the DC-powered, tape-drive motor down without causing it to stall or vary greatly in speed. No, a pot in series, or a reduction in the motor's supply voltage just won't do. To try either of those simple methods, most assuredly, will end in failure with the motor either stalling or wobbling up and down in speed.

If we can keep the motor's supply voltage at it's normal preset value and somehow vary the time that the voltage is applied to the motor, the speed will be reduced and should be fairly constant. The on/off timing interval can not be too slow or the motor will slow when no power is applied and speed up when the voltage is turned on. But if the on/off rate is just fast enough, say about 200 Hz, the motor will not be able to respond in a stop and start operation, and will run smoothly at a slower than normal speed.

A single op-amp (one of four contained in the popular LM324) is operating in a variable pulsewidth, free-running square-wave oscillator circuit, with its timed output driving two transistors that control the on/off cycle of the tape-drive motor.

The oscillator's positive feedback path holds the secret to the successful operation of the variable on/off timing signal. The two diodes and pulsewidth potentiometer R8 allows the setting of the on and off time without effecting the oscillator's operating frequency. One diode allows only the discharge current to flow through it and the section of R8 that its connected to. The other diode, and its portion of R8, sets the charge time for the timing capacitor, C3. Since the recorders speed is controlled by the precise off/on timing of the oscillator, a simple voltage-regulator circuit is included (Q1, R3, and D4).

Connecting the speed control to most cassette recorders is a simple matter of going into the recorder and disconnecting either of the motor's power leads (the ground or common side might be best) and connecting the recorder through a length of small shielded cable to the control circuit. In some recorders a remote input jack is furnished to remotely turn on and off the recorder.

Before going in and modifying a recorder with a remote jack, try connecting the circuit to the remote. Check the polarity at the remote terminals and connect the circuit as Fig. 1 indicates. I found that about half of the recorders with an external remote input work with the circuit, without going into the machine at all.

PARTS LIST FOR THE EXTENDED-PLAY CIRCUIT

C1—220-μF, 24-WVDC electrolytic capacitor
C2—100-μF, 25-WVDC electrolytic capacitor
C3—.1-μF, 100-WVDC Mylar capacitor
D1, D2, D3—1N914 general-purpose signal diode
D4—1N4738, 8-volt, 1-watt Zener diode
U1—LM324 quad op-amp, integrated circuit
Q1, Q2—2N3904 or 2N2222 NPN general-purpose transistor
Q3—2N3055 power NPN transistor
R1, R2, R3—1,000-ohm, ½-watt resistor
R4, R6—4700-ohm, ½-watt resistor
R5—10,000-ohm, ½-watt resistor
R7—470-ohm, ½-watt resistor
R8—50,000-ohm, potentiometer
S1—Single-pole, single-throw (SPST) toggle switch
Perfboard, cabinet cassette recorder, 11- to 15-volt power source, IC socket, etc

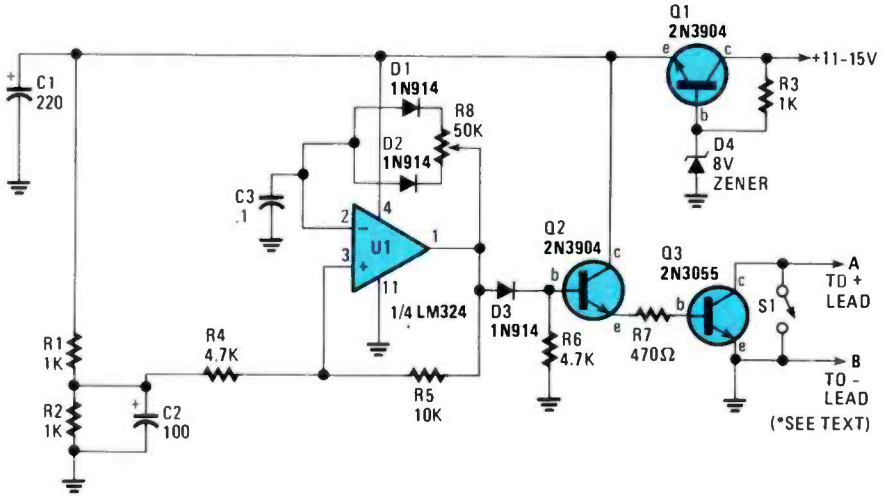


Fig. 1—The Extended-Play Circuit

If the oscillator's positive going portion of the timing pulse is set to close at 25% of the total timing period, the cassette should be operating at about ½ or ⅓ of it's normal speed. Switch, S1 is needed to get the motor started when operating at lower speeds. It can also be used to speed up the rewind and fast forward functions of the recorder.

Even though the circuit won't start the motor at it's lower operating speeds, it will (once started) maintain a reasonably steady motor speed. But don't expect hi-fi reproduction at the lower speeds. To obtain the best results with the circuit and selected cassette recorder, expect to spend some time experimenting with the combination.

Sound-Activated Tape Switch

The next cassette-recorder accessory circuit is one that can serve many fun-time needs. First, the circuit can set up a cassette recorder to automatically turn on when a sound or noise is present and start recording. Another use, which could be the most-valuable application for the circuit, is when the sound activated switch is used to turn on a cassette player especially set up so that it turns the combination into a burglar-alarm detector and sounder.

The heart of our multifaceted audio switch (as shown in Fig. 2) is the LM324 quad op-amp. Op-amps U1a and U1b are connected in tandem to amplify the sounds picked up by the detector's mike. The amplified audio voltage, output at pin 7 of U1b, is fed to a voltage-doubler circuit, consisting of D1 and D2.

The elevated voltage from the doubler circuit is input to the positive input of op-amp U1c (which is operating as a simple comparator circuit). The other input of U1c is connected to a voltage divider that sets the switching point for the DC signal voltage, to turn on when the signal level is greater than about 1.5 volts.

As the comparator switches on, its output at pin 8 goes positive and supplies a forward bias to turn on D3 and Q1, which in turn, starts the recorder. The RC combination of C4 and R9 sets the cassette's run time after the input sound has ceased, preventing the recorder from chopping up or turning off between closely-spaced sounds or words picked up by the mike. The delay time is roughly 6 to 8 seconds. R11 sets the circuit's gain.

Using the circuit is simple. Connect a low-impedance cassette mike to the amplifier's input, and connect the output of Q1 to the cassette's remote input, or internally as in the first circuit. Supply 9 or 12-volts DC to the circuit (either a battery or AC-operated supply) and set the recorder to record. Talk to the circuit and adjust the amplifier's gain with R11 for the desired sensitivity.

Now to use the circuit and recorder as a burglar alarm, a specially-recorded tape is required, which you can make yourself. One scheme in making the special tape is to use the sound of a vicious barking dog to run on the tape for a minute or so with a silent time period between each barking session for about 15-seconds.

The silent gap will allow the circuit to shut down the cassette and be ready for another intruder to make noise, starting the barking again. The complete tape should be filled with a time period of the dog barking and the 15-second spacing and dog barking, etc. With a little imagination the circuit can be used with a cassette and a specially-recorded tape to automatically scare tricksters on Halloween.

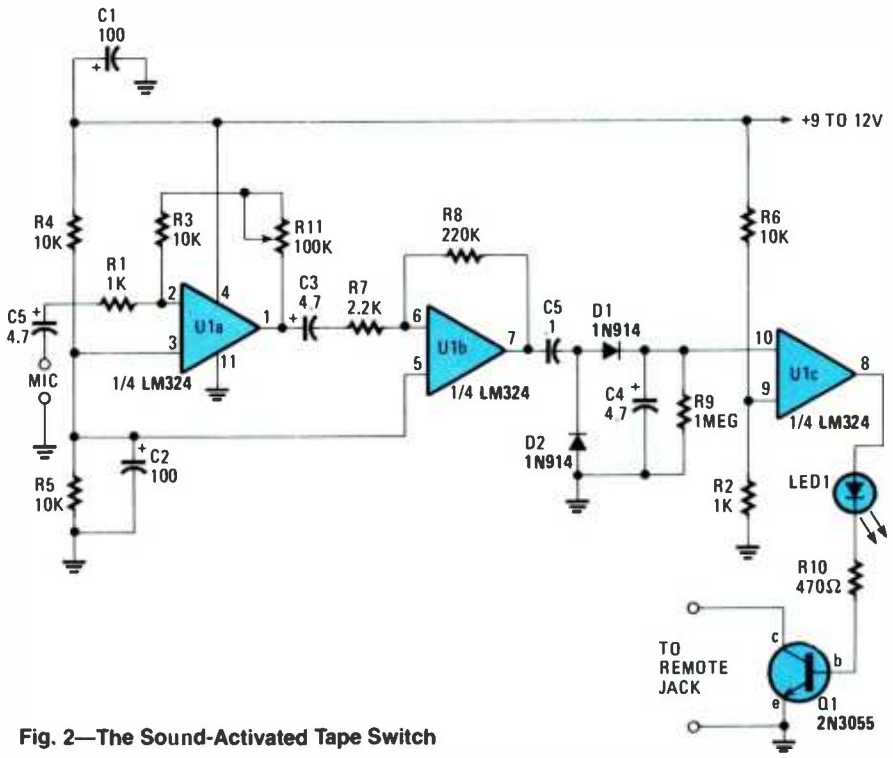


Fig. 2—The Sound-Activated Tape Switch

PARTS LIST FOR THE SOUND-ACTIVATED TAPE SWITCH

C1, C2—100-μF, 16-WVDC electrolytic capacitor
C3, C4, C5—4.7-μF, 25-WVDC electrolytic capacitor
C6—.1-μF, 100-WVDC Mylar capacitor
D1, D2—1N914 general-purpose signal diode
D3—Light-emitting diode
U1—LM324 quad op-amp, integrated circuit
Q1—2N3055 (or similar) NPN power transistor
R1, R2—1,000-ohm, ½-watt resistor
R3, R4, R5, R6—10,000-ohm, ½-watt resistor
R7—2200-ohm, ½-watt resistor
R8—220,000-ohm, ½-watt resistor
R9—1-Megohm, ½-watt resistor
R10—470-ohm, ½-watt resistor
R11—100,000-ohm, potentiometer, IC socket, perfboard, terminals, microphone, etc.

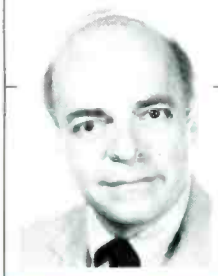
Telephone Auto-Record Circuit

The circuit in Fig. 3 turns the cassette recorder into a poor man's secretary—keeping perfect notes of all telephone

(Continued on page 106)

PARTS LIST FOR THE TELEPHONE AUTO-RECORD CIRCUIT

C1—.05-μF, 100-WVDC Mylar capacitor
C2—.01-μF, 100-WVDC Mylar capacitor
Q1—2N4360 (or similar) P-channel field-effect transistor (FET)
Q2—2N2222 or 2N3904 general-purpose NPN transistor
Q3—2N2102 or 2N3725 NPN silicon transistor
R1, R2—10-Megohm, ½-watt resistor
R3—22-Megohm, ½-watt resistor
R4—39,000-ohm, ½-watt resistor
T1—2,000-ohm, to 10,000-ohm, mini audio transformer
Perfboard, mike and remote plug to match cassette recorder used, etc.



By Marc Ellis

ELLIS ON ANTIQUE RADIO

The Echophone is back on-line!

The Start-Up Console (outlined in the August 1987 column) was used to gradually raise EC-1's AC supply voltage during the initial start up. A multimeter was used to monitor the set's plate voltages.

DURING THE LAST COUPLE OF COLUMNS, I've enjoyed having you look over my shoulder as I carried out the restoration work on the Echophone EC-1. For those who have just joined us, the EC-1 was a low-priced, but nicely made, BC/SW receiver of the early 1940's.

Unlike most inexpensive all-wave sets of the time, it was styled and designed primarily with the SWL in mind. Housed in a business-like, commercial-looking metal cabinet, it sports a bandspread control, CW oscillator, earphone jacks, and a "standby" switch.

Those who've been following this *radio revival* project will recall that the restoration work consisted mostly of partial disassembly for deep cleaning. In fact, the set was so dirty that I decided it would be best to get rid of the grime on the chassis and in the controls even before applying power for the first time. As the work for this month's column began, the set stood cleaned and reassembled—with a set of checked tubes installed—waiting to be tested.

The Initial Start-up

Following my own earlier recommendation for turning on an AC set after a long period of disuse, I brought up the EC-1's line voltage very slowly. That was done with the help of a tapped-primary, isolation transformer (see the *Start-Up Console* described in the August 1987 issue of this column).

Slowly increasing the line voltage lessens the chance of marginal electrolytic capacitors (within the set's power supply) shorting out before they've had an opportunity to "heal" themselves by forming a new dielectric, or insulating layer. For a complete discussion of the healing, or reforming, process, see the May, 1987 column.

As the set warmed up, my ears told me that the strategy had been only partly successful. The hum level from the speaker was a little too loud to be tolerated, and the electrolytics definitely needed to be replaced. A voltmeter connected across the power-supply output showed normal voltages, indicating that the capacitors weren't shorting out. They could be left in place for some of the early testing procedures.

Using a short test antenna, I tuned through each of the Echophones's three bands without hearing a signal. Then I took the radio into my ham shack and connected it to the lead-in from my 130-foot long-wire antenna. There was still no reception on the shortwave bands; but on the BC band, I noted an extremely odd effect. I was picking up a jumble of voices at each of three different spots on the dial. It sounded like the same group of stations at each spot, though it was very hard to distinguish the individual programs.

Temporarily Baffled

I'd never run into a symptom like that before, and I theorized that maybe an uninitiated (and over-enthusiastic) would-be repairman had gotten hold of the set and botched up several critical adjustments. Getting out the surplus Navy "LM" frequency meter that I use as a signal generator for simple alignment work, I checked the tuning of the IF transformers and found them very close to correct.

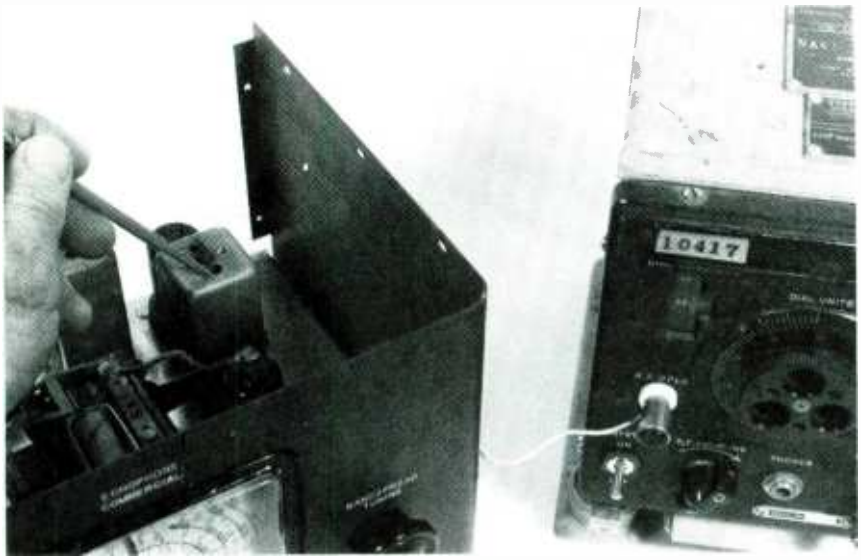
However, no amount of tweaking of the RF and oscillator circuit trimmers resulted in a response from the set. So I found myself forced to admit that the basic problem had probably not been caused by misadjustment.

Further trouble-shooting localized the problem in the set's oscillator stage. It just wasn't working, and the reasons weren't too clear—the voltages were generally correct and I knew that the tube was good. Probing further, I found that a few of the paper bypass capacitors in the circuit were somewhat leaky (showing a resistance of two megohms or so). While I didn't really feel that that was a serious problem, I tried replacing all five of the paper capacitors associated with the oscillator. I also replaced the bad electrolytics, but still the set was inoperative.

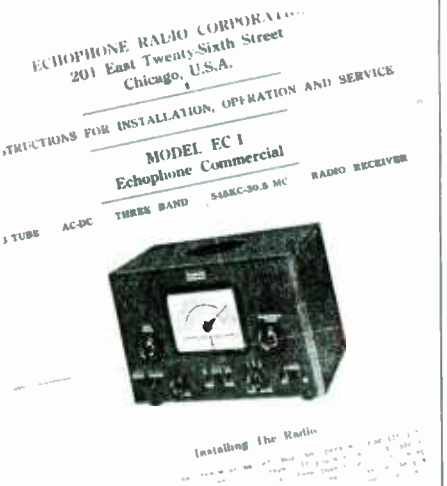
Having ruled out almost everything else, I now began to wonder if one of the oscillator coils had opened. If it had, it would greatly reduce my chances of ever getting the set to work again. An open coil isn't an easy item to fix, and I certainly wouldn't be able to write Echophone for a replacement!

A Dumb Cause For A Dumb Problem

It was while tracing the circuit to identify the coil connections that I found the real cause of the problem. And I had nobody to blame for it but myself! While reinstalling the tuning capacitor after cleaning it, I'd connected a small mica capacitor to the wrong terminal—effectively wiring the oscillator tube to the tuned circuits for the receiver's RF input stage, instead of the oscillator tuned circuits. No wonder I was getting those crazy symptoms!



This surplus Navy "LM" frequency meter was used as a signal generator during alignment checks on the Echophone EC-1.



Reader Dan Scheer, bless him, supplied me with a copy of the original EC-1 instruction manual. Thanks a bunch, Dan!

I don't mind telling you how dumb I felt. And there's something to be learned from my experience: You can never keep too many records when dismantling sets for repair. Readers who have followed the earlier columns covering the EC-1 restoration know that I'm a great believer in making reference sketches of anything that must be temporarily disassembled or disconnected. But I didn't make a sketch in this case because I thought the connection point for the free end of the capacitor would be quite obvious during reassembly. Well, I was wrong. That mistake cost me a few hours of troubleshooting time.

The Set Comes Back to Life

Reconnecting the mica capacitor to the correct terminal of the main tuning capacitor—and realigning the RF and oscillator adjustment I had upset during my earlier fruitless tweaking—brought the set back to life. Even with a six-foot temporary antenna strung in my basement workshop, it brings in stations from all over the world.

So many stations can be "captured" that moving through some frequency ranges, using the main tuning control, produces a noise somewhat like machine-gun fire—and the stations are very hard to separate no matter how carefully you turn the knob. Considering that the entire broadcast and shortwave spectrum (545 kHz to 30.5 MHz) is covered in just three bands, it's no wonder that the dial is a little crowded.

However, the bandspread circuit works wonders in untangling crowded spots on the dial. Tightly-packed groups of stations can be separated easily, with the signals smoothly tuning in and out as the bandspread control is turned.

The tone quality is surprisingly good, too. Unlike many small radios of its era, the set is pleasant to listen to when tuned to broadcast-band music. All in all, the little Echophone EC-1 packs a lot of performance into a very small package. Now that mine is running, I think I'll give it a permanent spot on the bedside table—where it will be ready for an occasional impromptu late-night listening session.

Memory Lane

Readers of the October column will remember the stories sent in by George Pearson and Dan Scheer. Both shared their World War II experiences with the Echophone EC-1, and both reported that they've hung on to their sets over the years. In fact, Dan sent me a copy of the original EC-1 instruction manual, and I'm running a photo or part of the cover page with this column.

Recently, I received yet another Echophone story—this one from George Kasdorf, Sr. of Lewiston, PA. George acquired his set from a Navy radioman, trading a Vibroplex "bug" (automatic key) for it. The set remained in his possession until some time after World War II. A few years ago, George responded to an advertisement and purchased another EC-1.

Moving shortly thereafter, he stored the set, and it remained in the attic until he noticed the first of our restoration articles. Now George is cleaning up his EC-1 and plans to put it back into use.

He goes on to report that, just after the war, Hallicrafters (which, by then, had purchased the Echophone Company) brought out a model almost identical to the EC-1. He believes it was called the S-41. George bought one for his bride-to-be as part of a campaign to make her a licensed ham. It didn't "take" at the time, but a few years later she came through and got her ticket!

That completes our series on the Echophone restoration. We'll start with a brand new topic next month. Until then, I'll be looking forward to hearing from *you!* Write to Marc Ellis, *Ellis On Antique Radio*, **Hands-On Electronics**, 500-B Bi-County Blvd., Farmingdale, NY 11735. ■

This booth belongs to one of the friendliest people you'll find in the antique radio business. I snapped it at the Dayton Hamvention a few months ago. The proprietor is Bill Rolf, 30131 Center Ridge, Westlake, OH 44145. Bill sells at many of the major hamfests and antique-radio flea markets—and he also responds to mail inquiries. He has a large stock of radios, tubes, parts, books, and magazines: also does repair work.

By Don Jensen

JENSEN ON DX'ING

Would you believe shortwave sports coverage?

☐SPORTS ON SW? THOUGH YOU MAY NOT think of shortwave as a sports medium, there is really quite a lot of coverage of worldwide sporting events. Right now there's pro football, for example. If it's America's NFL you favor, try the New Orleans Saints live, Sunday afternoons, on WRNO Worldwide. Since this is being written before the fall schedules have been finalized, I can suggest only some probable frequencies to tune: 9,650, 11,705, 15,420 kHz. A bit later, you can also find Louisiana State University college basketball play-by-play on WRNO too.

For Canadian pro football—a bit of a different thing for Yankee sports fans, with its three downs and scoring "rouges"—there's CFCX on 6,070 kHz with its coverage of the Toronto Argonauts. You can hear Canadians' NHL hockey and Expo's baseball, in season, via Montreal's shortwave voice, CFCX on 6,005 kHz. Both of those domestic and commercial Canadian SW outlets may be heard in eastern North America during the prime sports-events hours.

The single best source for live sports coverage on shortwave, though, is the American Forces Radio and Television Service. AFRTS shortwave has a dual role. Primarily, those transmissions serve the crews aboard Navy and Coast Guard vessels at sea. AFRTS landbased AM and FM stations, at American military posts and installations around the globe generally get their program feeds via satellite or landlines, but shortwave does serve as a backup for those other programming sources.

You can be reasonably sure that if there is a major sporting event "back home"—be it baseball, football, basketball, hockey (professional and college) boxing, auto and horse racing, and more—it will be broadcast on AFRTS shortwave.

AFRTS programs are aired by Voice of America transmitters, in the US and, by relay, in West Germany and the Philippines. Check VOA frequencies, including 6,030, 9,700, 11,790, 11,805, 11,890, 15,330, 15,345, 15,430 and 17,765 kHz.

The British Broadcasting Corporation's World Service can usually be counted on to cover major international sporting events. For instance, though many shortwave stations provide live play of soccer's quadrennial World Cup competition, most of that coverage is in Spanish or Portuguese. The BBC is the best way for English speaking SW listeners to follow what's happening in what is undoubtedly the premiere global sports event in terms of numbers of fans.

Most major, and some not-so-major shortwave stations offer regular sports news broadcasts, with spotlights and insights on some meets, matches, and competitions that you might otherwise have missed.

This attractive sticker is sent by Radio Universo in Curitiba (ZYJ219), Brazil to SWL's, who receive its signals.

Fred Waterer, writing in *DX Ontario*, the monthly bulletin of the Ontario DX Association, suggests some of these off-the-beaten-track sports shows that you may find interesting:

Argentina—RAE, the Argentine foreign service from Buenos Aires, has a Sports Bulletin on Tuesdays; Sports in Argentina on Wednesdays. This one broadcasts in English at 0100 and 0400 UTC on 9,690 and 11,710 kHz.

Austria—*Radio Austria International*'s Sports Review is also on Mondays. The station broadcasts to North America at 0130, 0330 and 0430 UTC on 6,155 kHz at the time of this writing.

Brazil—*Radio Nacional do Brasil* broadcasts Sports along with Brazil news during the 0200 UTC English transmission on Saturdays, on 11,745 kHz.

Bulgaria—*Radio Sofia* features sports highlights during its Monday transmissions. Try between 0100 and 0400 UTC on 6,070 or 11,720 kHz.

Kuwait—*Radio Kuwait* has "The World of Sports" in its English language service at 1900 UTC Sundays, 11,675 kHz.

South Korea—*Radio Korea*'s sports news is heard during its "Seoul Calling" magazine show, Mondays through Fridays, at 0000 UTC on 15,575 kHz, 0600 UTC on 7,275 and 9,570 kHz and 1400 on 9,750 and 15,575 kHz.

Spain—*Spanish Foreign Radio* has a sports feature on Saturdays at 0016 and 0116 UTC on 6,125 and 9,630 kHz, and at 0516 on the latter frequency.

Now if you are looking for something completely different, consider this tip that I received not long ago from San Francisco DX'er, Bill Sparks. On the west coast, Bill sometimes gets reasonably good reception from the Japanese-lan-

(Continued on page 106)

ABBREVIATIONS

AFRTS	American Forces Radio and Television Service
AM	amplitude modulation (modulated)
ANARC	Association of North American Radio Clubs
BBC	British Broadcasting Corporation
CKFX	C is prefix for Canadian SW station call signs (CKWX, CKVP, CFRB, CFCX, etc.)
DX	long distance (over 1000 miles)
DX'er	listener to shortwave broadcasts
DX'ing	listening to shortwave broadcasts
FM	frequency modulation (modulated)
kHz	kiloHertz (1000 Hertz or cycles)
RAI	Radio Austria International
SW	shortwave
SWL('s)	shortwave listener('s)
TV	television
UTC/GMT	Universal Time Code/ Greenwich Mean Time
VOA	Voice of America
VHF	very-high frequency

By Joseph J. Carr, K4IPV

CARR ON HAM RADIO

Radiowaves propagate over greater distances under certain conditions

LAST MONTH WE HAD A GENERAL OVERview of the radiowave-propagation phenomena. This month we will get down to *brass tacks* about the details. The groundwave, naturally enough, travels along the ground (or at least in close proximity to the Earth's surface). There are two forms of groundwave: *space* and *surface*. The spacewave does not actually touch the ground. As a result, spacewave attenuation with respect distance in clear weather is about the same as in free space.

Of course, above the VHF region weather conditions add attenuation not found in outerspace. The surfacewave is subject to the same attenuation factors as the spacewave, but also suffers ground losses. Those losses are due to resistive loss in the conductive Earth. In other words, the signal heats up the ground!

Surface wave attenuation is a function of frequency, and increases rapidly as frequency increases. In the 75/80-meter band (3.5–4.0 MHz) the surface wave operates out to about 100 miles or so. At 10-meters (29-MHz), however, attenuation is so great that communications is often limited to less than 20 miles. It is common in the upper HF region to be able to hear stations across the continent, or internationally, while "local" stations—only 25–30 miles distant—remain unheard, or are very weak.

For both forms of groundwave, communications is affected by wavelength, height of both receive and transmit antennas, distance between antennas, terrain, and weather along the transmission path.

Groundwave communications also suffers another difficulty, especially at VHF and above. As we discussed last month, the spacewave is made up of two components: direct and reflected waves. If both components arrive at the receive antenna, they'll add algebraically to either increase or decrease signal strength. There is always a phase shift between the two components because the two signal paths have different lengths.

In addition, there may be a 180-degree phase reversal at the point of reflection (especially if the incident signal is horizontally polarized), as in Fig. 1. The following general rules apply in such situations: A phase-shift of an odd number of half wavelengths causes the components to add, increasing signal strength; A phase-shift of an even number of half wavelengths causes the components to subtract (e.g., Fig. 1), reducing signal strength; Phase-shifts other than half wavelength add or subtract according to relative polarity and amplitude.

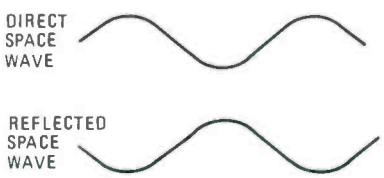


Fig. 1—The space wave is made up of two components: direct and reflected waves. There is always a phase shift—up to 180-degree phase reversal at the point of reflection (especially with a horizontally-polarized incident signal)—between the two components because the two signals have different path lengths.

At VHF and above, the spacewave is limited to so-called *line-of-sight* distances. The horizon is theoretically the limit of communications distance. But as any radio user will testify, the radio horizon is about 60-percent farther than the optical horizon. That phenomena is due to bending in the atmosphere. Although more sophisticated models are available today, we can still make use of the traditional model of the radio horizon shown in Fig. 2.

The actual situation is shown in Fig. 2A. Distance "D" is a curved path along the surface of the Earth. But because the Earth's radius "R" is about 4000-miles, and is, thus, very much larger than practical antenna height "H." We can simplify the model to that shown in Fig. 2B. The underlying assumption for trigonometry buffs is that the Earth has a radio radius equal to about 4/3 its physical radius. The distance "D" is found from the expression:

$$D = 1.42\ (H^{1/2})$$

where "D" is the distance to the radio horizon in statute miles; "H" is the antenna height in feet.

A radio tower has a 2-meter radio antenna mounted 150-feet above the surface of the Earth. Calculate the radio horizon (in miles) for such a system.

$$D = 1.42\ (H^{1/2})$$

$$D = (1.42)(150\ FT^{1/2})$$

$$D = (1.42)(12.25),$$

$$D = 17.4 \text{ miles.}$$

Tropospheric Propagation

The troposphere is the portion of the atmosphere between the surface of the Earth and the stratosphere, or about 4 to 7 miles above the surface. Refraction is the mechanism for most tropospheric-propagation phenomena. Recall from our earlier discussion that refraction occurs in both lightwave or radiowave systems when the wave passes between mediums of differing density. Under that situation the wave path bends in an amount proportional to the difference in density.

Two general situations are typically found, especially at VHF and above. First, because air density normally decreases with altitude, the top of a beam of radiowaves typically travels slightly faster than the lower end of the beam. As a result, those signals refract a small

(Continued on page 102)

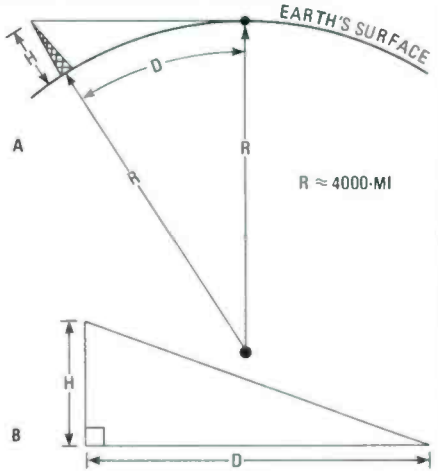


Fig. 2—The horizon is (theoretically) the limit of communications at VHF and above. However, the radio horizon is about 60-percent farther than the optical horizon, due to beam bending in the atmosphere.

WELS' THINK TANK

By Byron G. Wels

Did you get your copy of the Mohammed Ulysses Fips book yet?

FOR THOSE OF YOU WHO MAY HAVE JUST joined us, we're giving away free copies of the Mohammed Ulysses Fips book. What's that? You must have *really* just joined us! Wake up and smell the coffee. Back in the days when radios used vacuum tubes, the founder of many electronics magazines, Hugo Gernsback, used to write a story for each April issue. His stories were hysterically funny to people who understood electronics, and seemed perfectly logical to those with a mere smattering of electronics knowledge. Recently, we assembled all of those April Fool stories into a single book.

How do you get your free copy? Simple: All you have to do is send us a schematic diagram of your favorite circuit. Keep it simple (two or three transistors or IC's at the most); make it legible and readable, and write up a complete description. Be sure to include your return address. To say thanks, we'll send you a free copy of the Fips Book (a $12.95 value). We'll publish your schematic diagram, along with your name.

OK, let's start opening envelopes and see what this month's mail has brought us, and how many copies of the Fips Book are going out!

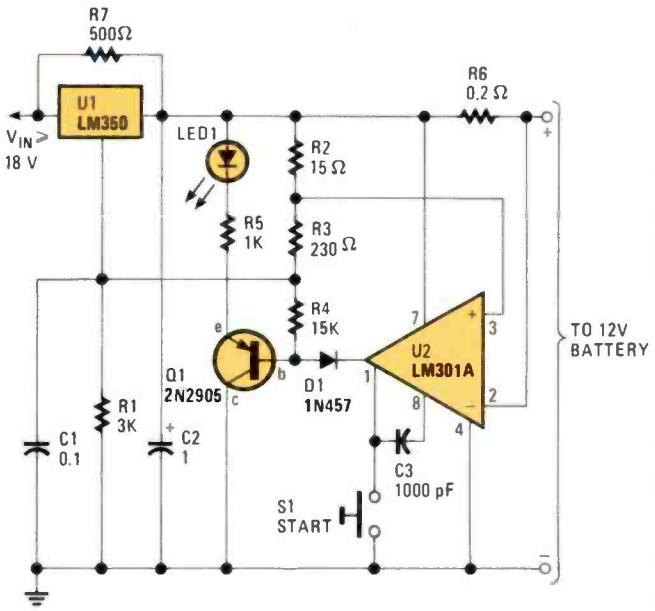


Fig. 1—This high-performance charger quickly charges gelled lead-acid batteries, and turns off at full charge. At first, the charge current is held at two amperes. But, as battery voltage rises, current decreases. When current falls to 150 milliamps, the charger automatically switches to a lower float voltage to keep from overcharging. When you hit full charge, transistor Q1 lights the LED to indicate that status.

Car Battery Charger

My garage is not heated, and one cold, snowy morning, I bundled up and went out to the garage to start the car. Nothing. *Nada. Niente*. Since I couldn't get out, I spent the morning in my basement workshop putting this charger together. I mounted a socket on the car's engine block that the charger plugs into, and now when I get home at night, I open the hood and plug the car in.

I still might have to shovel the driveway to get out, but I can tell you that if I *do* get stuck it won't be because of a dead battery!—Ernest Balbo, Sioux Falls, SD.

Take a look at Ernie's circuit, in Fig. 1. That high-performance charger will quickly charge gelled lead-acid batteries and then turn off at full charge. At the start, the current is limited to two amperes. As battery voltage rises, current decreases. When current falls to 150 milliamps, the charger automatically switches to a lower float voltage to keep from overcharging. When you hit full charge, transistor Q1 lights the LED to indicate the charge status.

Good circuit Ernie! Now keep an eye on the mail, because I just sent out your copy of the Fips Book, and you're in for some happy reading!

Fuzz Box

I'm not sure I understand the kids today, and I guess that means that I'm getting old. Any way, my son plays guitar. I, too, played guitar when I was his age, and when my guitar developed a crack in the back, it made the same kind of sound that he calls *fuzz*. I quickly had it repaired so it sounded good again.

Being an electronics hobbyist, I put together an amplifier for the kid, but he wasn't satisfied. He wanted fuzz, too. First I offered to rap him over the skull with his guitar. That would make it sound fuzzy, too. I finally gave in and threw together this circuit. I would urge that all my brother electronics hobbyists understand that this will *not* make the amplifier (or the music) sound any better. Not to my ears—But then come to think of it, I haven't heard any decent music since Glen Miller died.—Fred Calabrese, Scrannton, PA.

Look at Fig. 2. The 741's maximum gain of 20,000 is pushed to nearly 3 million and therefore distorts the output. It is that distortion that provides the fuzz sound. The level is dropped by the clipping of the two diodes. You can easily put the circuit together on perfboard and tuck it into a corner of the amplifier. But you'll

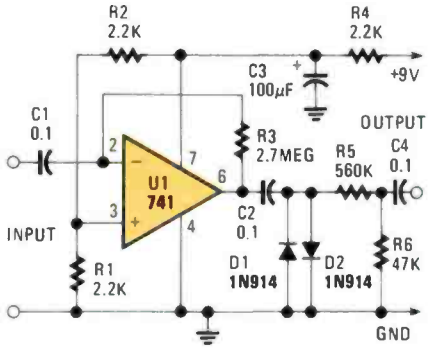


Fig. 2—The 741's maximum gain of 20,000 is pushed to nearly 3 million, distorting the output, providing the fuzz sound. The circuit can be easily built on a perfboard and tucked into a corner of the amplifier, with an on/off switch on the 9-volt bus to cut the circuit in and out.

need a switch on the 9-volt bus to cut the circuit in and out. That switch should be mounted on the body of the guitar so that the player can control it. And while we're on the subject Fred, I just put your copy of the Fips book into an envelope and it will be heading out your way this afternoon. I hope you'll enjoy it.

Light Detector

Byron, I've used this circuit in so many applications, I can't begin to tell you! I've used it to automatically open my garage doors using my headlights; it's been used, along with a simple flashlight, as a TV remote control, and I've even used it to turn lights on at dusk, off at dawn, when the wife and I are away on vacation. In fact, I call it my universal circuit.—Mark Jefferson, Reno, NV.

Thanks Mark. Looking at Fig. 3, note that circuit threshold is set by resistor R2. When the intensity of the light falling on the *L*ight *D*ependant *R*esistor (LDR1) is lowered, the LDR's resistance increases. That lowers the voltage at the inverting input of U1 (a 741 op-amp). Adjust the reference voltage at the noninverting input with R2 and the comparator switches from low to high when the LDR gets darker. That activates transistor Q1, which pulls in the relay.

Take your mounting procedure into consideration with this circuit. If you're going to use it to open a garage door with your headlights, mount the LDR at the end of a long, black tube. If you don't, you'll have the sun opening and closing the doors! Also, be sure that you take into account the power that you're going to draw through those relay contacts! You might want to set up a master/slave system using an additional relay with heavier contacts to operate a motor (for example).

Thanks for the schematic Mark. Your copy of the Fips Book is in the mail, and I do hope you'll enjoy it.

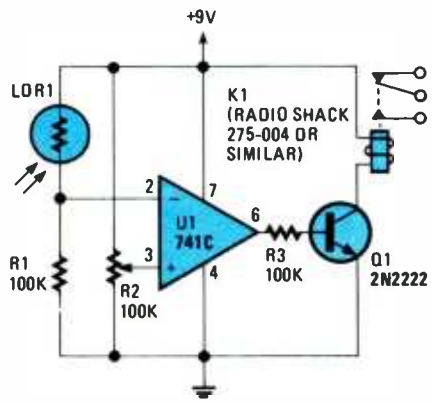


Fig. 3—The circuit's threshold is set by resistor R2. When the intensity of the light falling on the LDR is lowered, resistance of that unit increases, lowering the voltage applied to the inverting input of the 741. The reference voltage at the noninverting input of the 741 is set (via R2) so that the comparator switches from low to high when the light falling on the LDR is reduced. That high activates transistor Q1, which causes the relay contacts to close.

Light Dimmer

Every once in a while, we come up with something that our families hail as *near-genius*. I built this one for myself, however, and I use it every morning. Until you try it, you won't believe the difference it has made in my life!

In order to get to work on time, during the winter months, I wake while it's still dark out. I'd get up, snap on the bedside lamp, and flood the room with light. All that light in all the dark was a traumatic shock to my system. I hated it. After I put this dimmer together, I was able to wake, put the light on just enough to heat the filament, and then when my eyes adjust a bit more, I crank it up a little, then turn the TV set on to catch the morning news, turn the light up a little more, and—in a civilized fashion—prepare myself to meet the day.—Frank Skinner, Madison, WI.

Look at the schematic diagram in Fig. 4. Using no heatsink, the Triac (TR1) can handle up to 350 watts. The neon lamp, I1, won't trip the gate until after it conducts and using R1, you can set the lighting wherever you want it. Our only recommendation, for additional convenience, would be an on-off switch mounted to the back of R1 and wired in series with the line cord.

Frank, we really appreciate the circuit you sent in, and we're saying thank you in a way that you'll appreciate, too. Your copy of the Fips book is now on the way.

Old Timer

Hey Wels! Looking at your picture at the head of the column, I figure you've *got* to be as old as I am, and maybe you'll remember my favorite circuit. It's my favorite, because it's the first one I ever built, and served as my introduction to a hobby that I've followed all my life.—Enos Franklin, Milwaukee, WI.

If you'll look at Fig. 5, you'll see what Enos is talking about. It's a Hartley Oscillator built around a type 30 triode. I built one too, Enos, when I was a rag-tag nine-year-old, and I built mine on the top of one of my dad's cigar boxes, using a surface-mounted receptacle as a tube socket and plug-in coils. Remember those? The unit boasts a tickler coil, and the earphones are connected in series with the B+.

If I remember correctly (don't quote me), the filament voltage was three volts, and the positive B voltage was a 45-volt battery. The grid leak resistor/capacitor eliminated the need for a C battery!

I also remember that (with a high, long-wire antenna) the thing really was a signal sucker, and pulled in stations so well that even my dad was impressed! In fact, that was the first thing I had ever done in my life that *really* made an impression on him, and I heard him asking mom "Where did he learn the stuff?"

Thanks for the trip down memory lane Enos, and your copy of the Fips book is in the mail.

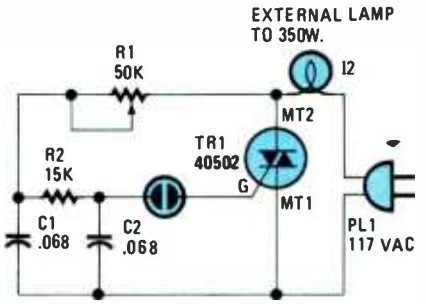


Fig. 4—Using no heatsink, the Triac can handle up to 350 watts. Lamp I2 won't trip the gate until after it conducts. Using R1, you can set the lighting wherever you want it.

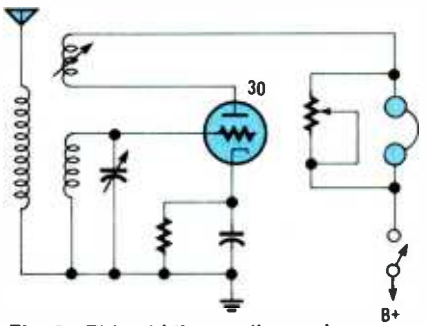


Fig. 5—This old time radio receiver, consisting of a Hartley Oscillator (built around a type 30 triode), a tickler coil, and earphones connected in series with the B+ voltage, used a simple long-wire antenna to pull in RF signals.

Battery Monitor

Byron, this one is (See Fig. 6) quick and easy to put together and install, and tells you when battery voltage falls below the set limit as established by R1 (a 10,000-ohm potentiometer), and can indicate, via LED1, that the battery may be defective or in need of change if operating the starter causes the battery voltage to drop below the present limit. Now is that worth a copy of your Fips book?—Paul Standish, Sioux City, IA.

Sure is Paul! I remember working on an electronics magazine many, many years ago, and we got a story in about how this guy had drilled out the breather holes in his battery caps, and inserted the carbon rods from D-size batteries, which he connected to using grid caps. He then used three small pilot lights to ground, and could tell battery cell condition by look-

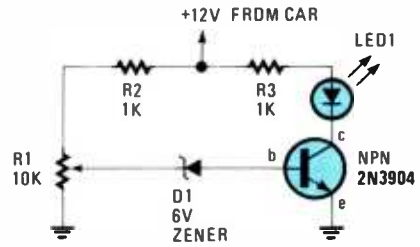


Fig. 6—The Battery Monitor lets you know when battery voltage falls below the set limit, as determined by the setting of R1, a 10,000-ohm potentiometer, indicating that a new battery may be defective, or a used battery is in need of replacement.

ing at the lights. If the light was on, all was OK. If a light went out, it meant the electrolyte level had fallen so the circuit broke. Right? Wrong! Lead-acid cells produce hydrogen as a bi-product when they work, and the little spark when the electrolyte sloshed around was all that was needed. It just shows to go you: Bobbie Burns was right. The best-laid plans of mice and men are aft gang aglee!

Paul, your copy of the Fips book is on the way, and thanks.

Flashing LED Pilot Lamp

OK Wels, pack up a copy of the Fips book with my name and address on it and sent it on out. Also, take a gander at my circuit, which is a—get this—flashing LED for use as a pilot lamp. Until now, we couldn't use pilot lamps except on AC-operated circuits, as the current drain would deplete a battery supply in no time. My LED pilot light uses far less in the way of current drain, and the flashing not only reduces the drain by quite a bit, it's more attention getting.—Jerry Matheison, Ft. Worth, TX.

Now do what Jerry says! Look at Fig. 7. The circuit is built around a conventional astable multivibrator, consisting of Q1 and Q2. R2 serves as bias for Q1 with R1 as collector-load resistor. R3 serves as base-bias for Q2, with D1 and R4 the collector load. C1 and C2 are cross-coupling capacitors whose values are selected to produce 1 Hz oscillation. As a result, the LED (D1) is pulsed on at about one-second intervals.

R1's high value produces a low current consumption when Q1 is on and Q2 is off. The average current consumption of the unit is in the order of 1.25Ma. C1 offers power-supply decoupling and helps suppress transients that might be applied to your circuit through supply lines.

So OK Jerry, to paraphrase George M. Cohan, I thank you, my readers thank you, and Mohammed Ullyses Fips thanks you—Your copy is now in the mail.

Auto Fade

Byron, my slide shows have tape recorded narration along with sound effects and background music. They're really quite spectacular, if I do say so myself. I've built a little theater in my basement, and friends and family consider it a real delight to be invited to one of my travelogues. But when it came to adjusting the level of the background music so the narration could be heard, it took some really-fancy juggling, and I got as busy as one-armed paper hanger with the seven-year itch!

I put together this automatic fader, that—all by itself—drops the level of the background music when the narration comes up. It adds a bit of professionalism to the shows.—Joe Ryan, Dyersburg, TN.

Take a look at Joe's circuit, Fig. 8. The control input goes through R10, a preset audio level control, to the input of an emitter-follower buffer stage (Q1). The buffer offers a high input impedance and makes sure that the source impedance is low enough drive the rectifier and smoothing circuit, which consist of D1, D2 and C5. The smoothed output drives a simple LED circuit. R8 and LDR1 form an input attenuator across which the output is fed via C6 and C7 to the output jack. The output at the emitter of Q1 couples to this socket through C4 and R5. R5 and R7 are a passive mixer.

When you've got 200 mV or less at the input, there isn't sufficient voltage across C5 to make Q2 turn on. Over 200 mV, Q2 does turn on to a limit, and the LED gets power. That makes the LDR's resistance fall, and signal loss through the attenuator increases. Increase the input to 350 mV RMS, and you get a signal reduction of better than 20 dB.

OK Joe, You earned it. Your Fips Book is on the way, and hey! Thanks.

Portable Amp

Dear By, I'm a member of a fraternal group, and we travel all over the state visiting other groups, and we do lectures. The problem, was that often the members haven't seen each other in awhile, and tend to talk through the lectures. It's disconcerting to the lecturer, and something had to be done. I solved the problem with this eight-watt amplifier built into an attache case. Batteries and speaker are all in the case also, and the only outboard device is the microphone that plugs into a jack near the case's handle. My next project is going to be a dual-nine-volt supply so we can use AC where it's available.

By, I used to renew my subscription to *Radio-Electronics* in January of each year so I wouldn't miss the great April Issue with Hugo's "FIPS" articles! I hope that this can get me a copy of the Fips book. I'm sure looking forward to it.—John Chattick, West Palm Beach, FL.

You got it, John! It's in the mail right now. Take a look at Fig. 9. U1, an FET op-amp needs a bipolar voltage at pins 4 and 7 with a common ground for optimum gain. You can calculate the gain by divid-

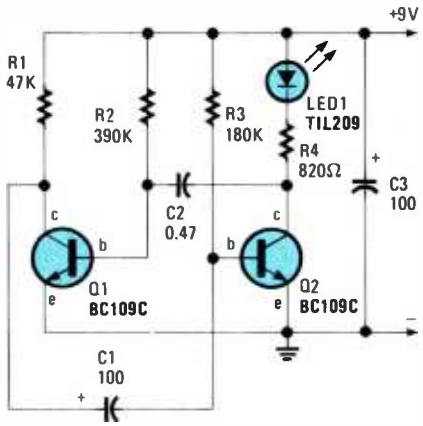


Fig. 7—The Pilot Lamp circuit, built around a conventional astable multivibrator (consisting of Q1 and Q2), has an average current consumption of the unit is in the order of 1.25 mA.

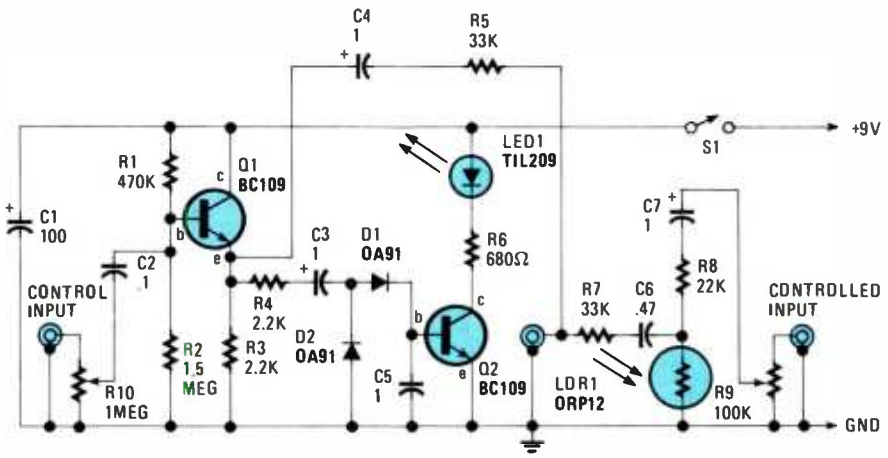


Fig. 8—The control input is fed through R10 to the base of Q1. Q1, (which is configured as an emitter-follower/buffer stage) offers a high input impedance. The output of the buffer is fed via D1 to the base of Q2.

ing R2 by R1. Zero-set balance can be had through pins 1 and 5 through R3. Put a voltmeter between pin 6 and ground and adjust R3 for a zero voltage. Once you've established that, you can measure the ohmic resistance at each side of R3's center tap and replace the potentiometer with fixed resistors. R6, R7, R8 and C3 form a tone control that will give you added bass boost if needed.

Sounds like a handy device John. Thanks a whole, big bunch!

Shadow Knows

My family operates a small retail business, and sometimes when only one of us is on the sales floor, or taking care of a customer, somebody else can come in and we're totally unaware of it. Well, people will wait around only so long and then they'll walk out. Other times, not knowing that somebody came in, they can walk out just as easily with merchandise. That's called shrinkage. Not being a huge operation, our staff meetings are usually held around the dinner table and I became aware of dad's concern about this. That's when I put this circuit together, and its unobtrusive warning isn't noticed except by those of us who know about it. It has saved the day for us.—Max Holland, Long Island City, NY.

Max, we appreciate both the problem and the solution. See Fig. 10. The circuit is sensitive to the least change of light. A direct light need not fall on the light-sensitive area of the optoelectronic switch for the alarm to be activated. U1, an LM386 low-voltage amplifier, is hooked up as an oscillator. It is disabled by a reference voltage from U2.

Now U2, a ULN3330Y, is an optoelectronic switch whose output pin 1 is kept to 6.87 volts by incident light on the sensor element. This gives pin 3 of U1 a reference voltage that keeps U1 from oscillating. But if the slightest shadow hits the sensor element, pin 1 goes low to about less than half a volt, and current through R1, D1 and R3 goes to pin 5 to set up a reference voltage. At the same time, capacitor C1 charges by way of R2 to get above this reference voltage, making pin 5 (the output) go low. If C1 is .01μF, the repetition rate is about 1 kHz. The output is coupled to the speaker by C2. We recommend a three-inch, 8-ohm speaker, but if you need more volume, try a larger speaker.

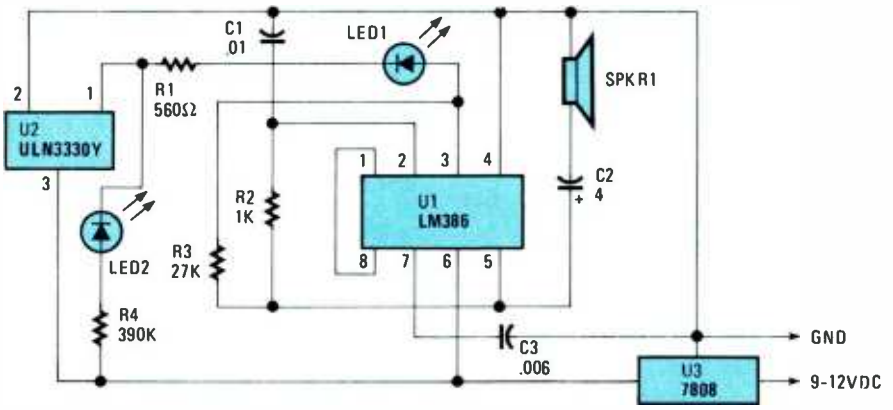


Fig. 10—The Light-sensitive Alarm circuit is built around U1 (an LM386 low-voltage amplifier, configured as an oscillator) and U2 (a ULN3330Y optoelectronic switch), which is used to trigger the audio alert.

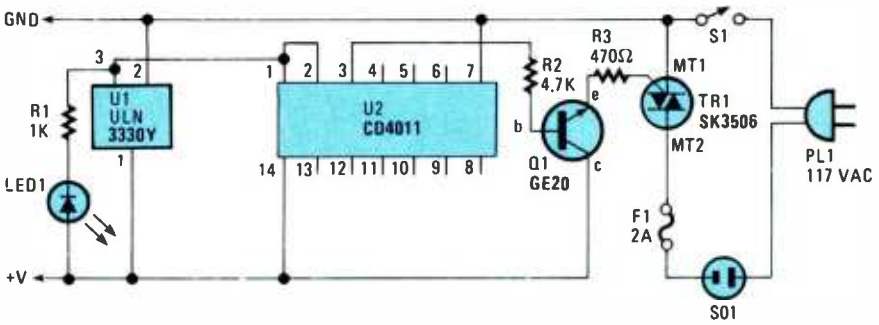


Fig. 11—When light hits the light-sensitive area of U1, opening the ground path, pin 3 goes high, feeding one of the gates (set up as inverter) contained in U2, forcing its output to go low, turning Q1 off.

Night Light

Few people are aware why youngsters are afraid of the dark, or how a night light works. The fact of the matter is that when they waken at night they are totally disoriented and that glowing night light which is usually plugged into a convenience outlet helps them to re-orient rapidly.

What I particularly like about this circuit is that while night lights do not ordinarily use a lot of electricity, this one turns itself off when outside (or even inside) light floods the room.—Tom Landry, Enid, OK.

Tom, I've got two things to tell you. First of all, yes, we *did* like the circuit; and second, start watching the mails. Your copy is on the way.

Take a look at Tom's schematic, Fig. 11. When light hits the flat side of U1, the optoelectronic switch, it is off and opens the path to ground, pin 2. Output pin 3 goes high, and D2 is out of the circuit. Pin 3 is connected to U2's NAND gate, pins 1 and 2. When both inputs are high, the output must go low, and the transistor is off.

When no light is falling on the IC, pin 3 goes low and the LED comes on. At the same time, inputs 1 and 2 go low, forcing output pin 3 to go high. Q1 biases on, applying gate current to the triac, so it conducts.

That's a wrap! Gonna pull the big switch now, and I'll see you again next month. Send those diagrams to Byron G. Wels, *Wels' Think Tank*, **Hands-on Electronics Magazine**, 500-B Bi-County Blvd., Farmingdale, NY 11735. ■

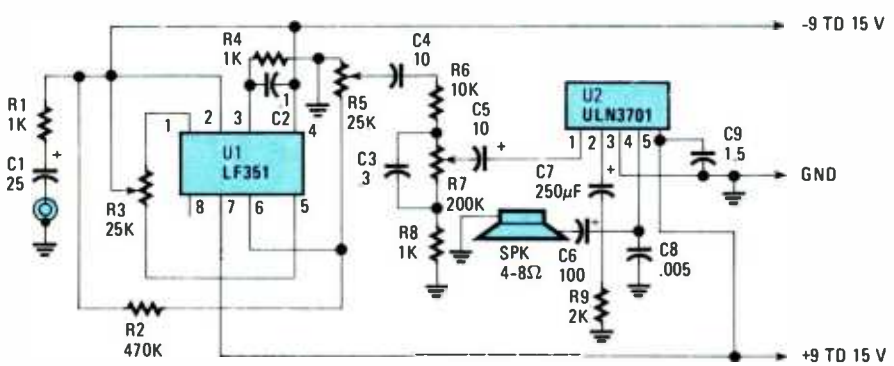


Fig. 9—The Portable Amplifier is built around U1 (an LF351 FET op-amp, requiring a bipolar power supply) and provides 8-watts of output power.

By Marc Saxon

SAXON ON SCANNERS

Full-spectrum capabilities come to scanners!

A TERM THAT'S BEGINNING TO CATCH on in hobby monitoring circles is *full-spectrum capabilities*, in the sense that it's something to brag about when you've assembled a station that can monitor all frequencies between 15 kHz (VLF) and the microwave portion of the spectrum.

One of the many barriers to accomplishing that is that even most top-of-the-line scanners have certain gaps in their frequency coverage. As a result, there are frequencies that manage to evade your ears. The missing frequencies could cause you to lose out on things like an active military-aircraft band (225 to 400 MHz), federal communications (400 to 420 MHz), and other vital activities.

The Regency MX-5500 scanner does its share in providing the monitor with all frequencies between 25 and 550 MHz in a complete and unbroken sweep. That includes the standard VHF/UHF public-service bands, four ham bands, CB channels, two aero bands (108 to 136 MHz as well as 225 to 400 MHz), space research (136 to 144 MHz), several federal bands (including 148 to 151 MHz and 406 to 420 MHz). All of that plus FM broadcasters and even the channels used by VHF/UHF TV stations!

What with all that coverage, you'd think that the MX-5500 would be tricky to program, but not so! To enter a frequency, simply touch the numbered, computer-controlled keypad. A *beep* tone confirms that the instructions that you are feeding in are being accepted by the unit. Once you've programmed in your instructions and frequencies, you can lock the keypad so that nothing can be accidentally changed.

The MX-5500 will store and scan twenty frequencies. When placed in SEARCH/SCAN mode, it will explore frequencies in steps of 5, 12.5, or 25 kHz (depending upon the band) in order to locate active channels. When it locates one, you have the option of continuing the search or storing the frequency in the MX-5500's twenty-channel memory bank.

Frequencies are shown on the unit's Liquid-Crystal Display (LCD), which also provides information about the receiving mode (AM, Narrow FM, or Wide FM), the channel number, lockout or delay modes, etc. There's also a built-in 24-hour clock.

The Regency MX-5500 scanner can monitor all frequencies between 25 and 550 MHz in a complete and unbroken sweep, that includes the standard VHF/UHF public-service bands, four Ham bands, CB channels, two aero bands (108 to 136 MHz as well as 225 to 400 MHz), space research (136 to 144 MHz), several federal bands (including 148 to 151 MHz and 406 to 420 MHz); plus, FM broadcasters and channels used by VHF/UHF TV stations! Its suggested retail price is $599.95. For more information contact Regency Electronics, 7707 Records Street, Indianapolis, IN 46226; or circle 56 on the Free Information Card.

The Regency MX-5500 can be used in your home or in a vehicle. The complete package includes a telescoping whip antenna, an AC power supply, a DC power cord and a mobile mounting bracket. The suggested retail price is $599.95, and it's from Regency Electronics, 7707 Records Street, Indianapolis, IN 46226. For more information from Regency circle No. 56 on the Free Information Card.

Novice Enhancement

One of the biggest hobby-radio events in many years has brought many new stations-to-hear within the realms of scanner owners. That event has (among other delights) permitted Novice-Class Hams to use voice on the 220-MHz band. Scanner owners have good reason to tune in that band and hear the increased activity.

That is a band where FM is the predominant mode, with stations communicating through repeaters and also by direct (simplex) methods. The primary simplex frequency is 223.50 MHz, although you can find simplex communications taking place every 20 kHz between 223.42 through 223.90 MHz. Most repeater outputs lie within the range of 223.60 to 223.90 MHz.

Although not available for Novice Class licensees, the Ham band at 50 MHz (the so-called *6-meter band*) is nonetheless exciting to monitor, especially when DX ("skip") conditions are right. The problem is that most communications in that band are via SSB mode, and the vast majority of scanners can't receive SSB. But despair not; there are some FM operations there. If your scanner picks up that band (starting at 50 MHz and going up to 54 MHz) you can try monitoring for FM simplex operations anywhere between 51 and 54 MHZ, with some FM repeaters noted from 52 to 54 MHz.

If your scanner can receive AM-mode transmissions, some die-hard AM'ers can be heard mixed in with the SSB'ers between 50.10 and 50.60 MHz. And while we're on the topic of Ham bands, a good sampler frequency on yet another interest-

(Continued on page 102)

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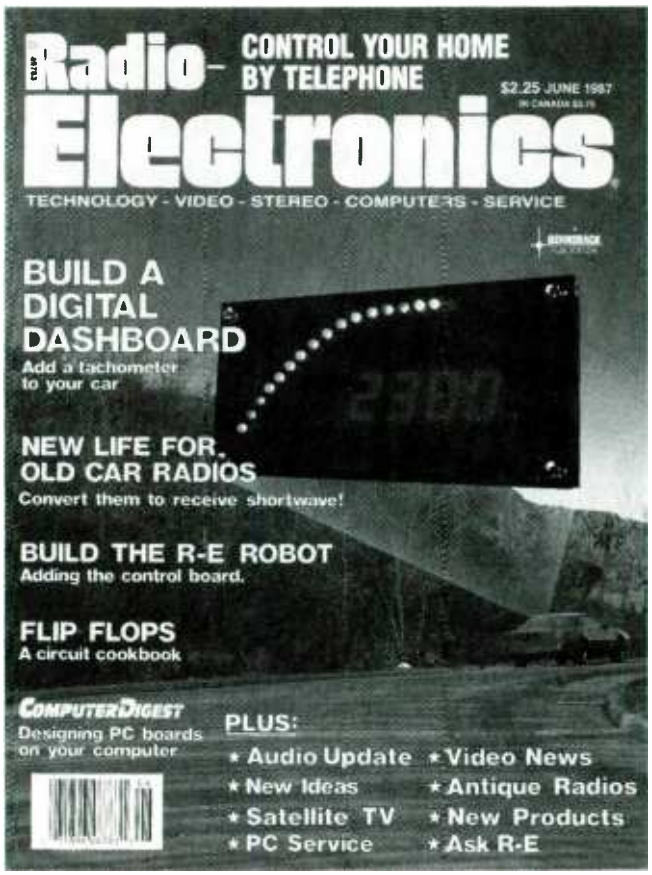

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BOOKSHELF

(Continued from page 30)

Troubleshooting and Repairing the New Personal Computers
By Art Margolis

Here's a practical, hands-on servicing handbook covering all of today's popular 8-bit and 16-bit microcomputers, from the IBM PC/XT/AT and compatibles to the Macintosh, Apple II Series, Amiga, and Commodore 64/128. Whether you're a computer owner who wants to be able to track down and repair

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problems that keep your computer from operating at full capacity, or a service technician who needs up-to-date troubleshooting and repair techniques for today's new 8-and 16-bit computers, this is where you'll find the information.

In this thorough and well-illustrated troubleshooting and repair guide, Margolis includes all-new information on "high pin-count chips" used in newer model computers as well as providing plenty of use-it-now information on older 12-, 14-, and 16-pin chips with both static and dynamic RAM.

The text sells for $17.95 and is available from Tab Books Inc., Blue Ridge Summit, PA 17214; Tel. 717/794-2191.

Power Control with Solid-State Devices
By Irving M. Gottlieb

Whether you're an engineer, technician, advanced experimenter, radio amateur, electronics hobbyist, or involved in any way in today's electronics practice, you'll find you'll find yourself turning to this book again and again as a quick reference and as a source of circuit ideas.

Focusing on specific digital circuits used in power electronics applications, it provides the all-important blend of basic theory and practical guidance that you need to quickly adapt various power-control techniques to your own individual needs. By employing descriptive analysis and guidance wherever possible and the mathematical approach only where relevant, it provides an overview of the

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basic principles of solid-state power electronics that is neither overly theoretical or too simplified.

First a nonmathematical review of the basic principles of solid-state devices is presented, followed by a wide potpourri of practical circuits, each one discussed in terms of operating principles, parts list, circuitry features, and practical ramifications.

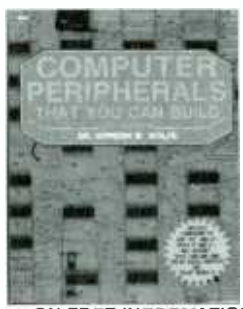
The text sells for $29.95, and is available from Tab Professional Books Inc., PO Box 40, Blue Ridge Summit, PA 17214.

Computer Peripherals That You Can Build—2nd Edition
By Gordon W. Wolfe

If you've got a computer and a hands-on attitude, then peek at this book. In this, the second edition, Dr. Wolfe gives detailed instructions for creating interfaces for the IBM PC and all of its plug-compatibles, all Apple products including the Macintosh, all Tandy/Radio Shack products, and the Commodore 64/128. He also provides full coverage of serial peripherals, digital peripherals with parallel output, parallel digital ports and analog signals, and complete pinout diagrams of all integrated circuits used.

Here's a wide range of peripherals that can be built for a fraction of the cost of comparable commercial units.

All-new projects include an amazingly affordable mouse, a bar-code



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reader, paddle-position readers, a trackball, a z-y plotter for data output, and a drawing tablet. Other peripheral projects range from sense switches, joy sticks, clocks, and interrupt timers, to four different types of analog-to-digital converters.

Techniques are revealed for sending

control signals over household wiring, converting an IBM Selectric typewriter into a letter-quality printer, and two different methods for turning an old TV set into a computer monitor. The reader will also find out how to use stepper motors; how to use a computer to control lights, buzzers, electrical sockets, and counters; how to add a second or third disk drive to a computer; and how to implement tape backup for a hard disk system. Complete instructions, schematic diagrams, and interfacing software given in flowchart form make it easy to put together and effectively use an amazing variety of practical peripherals to expand the versatility and power of a micro!

Computer Peripherals That You Can Build—2nd Edition, contains 304 pages and retails for $16.60 in paperback, and $22.95 hardbound, from Tab Books, PO Box 40, Blue Ridge Summit, PA 17214; Tel. 717/794-2191. ■

NEW PRODUCTS

(Continued from page 23)

DR-MO7 Cassette

Designed to bring Denon technology to a new segment of consumers, the DR-MO7 has quality features with a good price.

The Denon deck uses a full IC logic solenoid transport of unique design. The

CIRCLE 86 ON FREE INFORMATION CARD

transport solenoids are mounted directly onto a circuit board that carries the logic circuitry. That design eliminates loose lead wires, for improved reliability.

The DR-MO7 features Dolby B and C noise reduction systems for up to 20 dB of noise reduction at 2 kHz. the deck also includes a manual bias trim control to assure the lowest distortion and the flattest frequency response on normal- and high-bias tapes.

Other feature of the DR-MO7 include bias trim, LED peak level meters, one-touch record standby, full auto stop, and automatic stop-and eject when the Eject button is pressed during Play, Fast Forward, or Rewind.

The deck carries a suggested retail price of $200. For further information on the DR-MO7 contact Denon America Inc., 27 Law Drive, Fairfield, NJ 07006; tel. 201/575-7810.

Hot Speakers

Boston Acoustics recently announced

CIRCLE 54 ON FREE INFORMATION CARD

improved versions of their popular home loudspeakers. The A70 series II bookshelf speaker and the A150 Series III floor-standing unit.

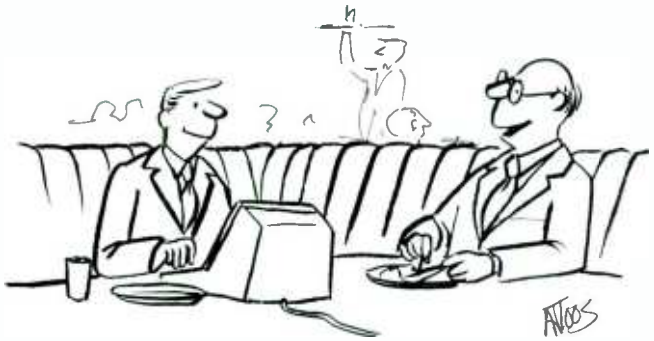
The A-70 Series II is a two-way speaker with woofer, crossover and bookshelf design. The eight-inch woofer uses a polypropylene cone, with more accurate response through the operating range. The tweeter is the B.A. CFT 1-inch dome. Suggested retail price is $300 pair.

The A150 Series III is a floor-standing unit with an all-new driver complement. The three-way system features a ten-inch woofer, 3½ inch midrange, and a CFT 1-inch dome tweeter. Suggested retail is $550.00 per pair.

For additional information, contact Boston Acoustics, 247 Lynnfield Street, Peabody, MA 01960; Tel. 617/532-2111.

Elapsed-Time Meters

Two elapsed-time meters from Simpson Electric come in at a low-price range and offer high accuracy, quartz-clock re-



"OK, what's on the menu for today?"

NEW PRODUCT SHOWCASE

liability and a choice of AC or DC operation. The Model 112 ETM has a 48mm square housing, operates at 120V.A.C. with no adapter and counts to 99,999.99 with 0.01-percent per 24-hours accuracy. It is especially suited for instrumentation, computer, and many business machine applications.

The rainproof Model 110 comes in a compact 60-mm diameter housing and operates from 10 to 80 VDC. It counts to 99,999.9 hours and is designed for machinery which is operated out-of-doors, like welders and construction vehicles.

CIRCLE 72 ON FREE INFORMATION CARD

Both units are housed in plastic cases and come with mounting hardware. Both are available for replacement or OEM (other equipment manufacturers) applications in single to production-run quantities through electronics distributors. Model 112 is priced at $16.80, Model 110 at $26.95. For more info, contact Simpson Electric Co., 853 Dundee Ave., Elgin, IL 60120-3090; Tel. 312/697-2260.

Multi-Driver Speakers

The Kappa Series from Infinity Systems are finished in hand-rubbed, oiled oak. The series consists of three models; The 12-in. three-way Reference Standard 7 *k*, the 12-in., four-way Reference Standard 8 *k*, and the 12-in. five-way, dual woofer Reference Standard 9 *k*. Each speaker uses a newly-developed cast frame woofer with a cone molded from polypropylene and graphite fiber. The increased stiffness-to-mass ratio of the cone improves bass response.

CIRCLE 60 ON FREE INFORMATION CARD

Both the 8 *k* and 9 *k* contain the Polygraph *k*, a five-inch dome-shaped driver optimized for 80 Hz to 500 Hz.

The midrange driver, a three-inch polydome *k* is used in all three speakers. It features flat wire, edgewound voice coils and a polypropylene cone that offers low mass and excellent self damping.

Each model is equipped with the EMIT *k* tweeter. The new tweeter's diaphragm weighs half as much as its predecessor, and is surrounded by exotic, rare-earth neodymium magnets.

For frequencies above 10 kHz, the Reference Standard 9 *k* uses a SEMIT™ supertweeter.

The 7 *k* is priced at $599, retail, the 8 *k* at $899., and the 9 *k* at $1199. For additional data, contact Infinity Systems, Inc., 9409 Owensmouth Ave., Chatsworth, CA 91311; Tel. 818/709-9400.

High-Performance Marine CB

Midland has a 40-channel, marine CB radio with all the frills for you DX'ing boaters. The Model 77-157 has come ashore with a specially designed, waterproof seal and water resistant speaker for protection in marine environments. The new radio is also equipped with high-performance features like a PLL tuner for pinpoint accuracy, a HIGH/LOW tone switch that adjusts signals for peak reception, and a microphone gain control that adjusts talk power for maximum range and clarity.

CIRCLE 97 ON FREE INFORMATION CARD

Midland's marine CB also offers a Brute noise filter that controls electrical power system noise, a LOCAL/DISTANT control that adjusts dynamic range for zero distortion of close-in signals, an easy-to-read S/RF meter to monitor signal strength RF output, instant emergency channel 9, a Public Address system, and high-intensity green readout.

The Model 77-157 has a suggested retail price of $169.95. For more information, contact Midland International, Consumer Products Division, 1690 N. Topping, Kansas City, MO 64120.

(Continued on page 105)

HEATHKIT COURSE

(Continued from page 66)

that makes their exams a lot tougher than they appear; which is the reason why, for almost the entire history of regulated communications, most employers valued an FCC commercial license above *school learn'n*. Heath's software is very good in that regard; it conditions you to give the answer that is *correct all of the time*. Answers which are correct only *some*, or even *most* of the time, are usually never the correct answer on an FCC exam.

The Code Made Easy

If you've made a previous try at learning the Morse code and have failed, or if you've been at it for months and still can't get your code speed up, you're obviously not using the Heath software. The computerized CW software isn't just good, it's great. If the program takes more than a week to get your speed up to 5 WPM so you can pass the code exam, *you ain't never going to learn the Morse code*. In fact, if you put in as little as 15 minutes a day on the CW software, you should be cruising at 13 WPM in about two weeks.

The CW training software uses the tone generator and the speaker built into the computer. Like the theory software, it is menu driven. The main (opening) menu provides four functions: the type of code generation, the code speed (default 5 WPM), the tone (default 700 Hz), and a print mode. The print mode has your printer display the code groups that were displayed on the screen.

The code generation sub-menu allows selection of random 5-character code groups, random groups 1–10 characters long, creation of a text file to be sent in code (you write it), CW from a disk-stored text file, and keyboard entry of the code character (i.e., press the letter B and *dah dit dit dit* is heard in the speaker). The screen always displays the characters after they are heard. The printer mode prints an exact copy of the screen display.

The tone generation sub-menu allows you to set the speed in WPM, the tone frequency, the time unit between letters, and the time unit between words.

A group-type sub-menu allows you to select the alphabet (A–Z), numbers (0–9), alphabet and numbers, and alphabet, numbers, and punctuation. In that way you can learn the code one module at a time (which is not the way to do it), or you can plunge in and learn everything at the same time, with equal practice to the alphabet, numbers, and punctuation (which is the best way to learn the code).

The spacebar is used to control the CW function: The ESC key interrupts the CW session

Summing Up

Over the years we've seen a lot of theory and code training materials. Some were good, others were abysmal, but until the Heathkit CAI software for the beginner, none were great. Heathkit's is great! Of course, you will need an IBM PC/XT/AT or clone computer in order to run the software. Fortunately, many school and public libraries now have PC's available for general use, so even if you don't have your own PC, but would like to use the Heath software, check with your library. They might have a computer you can use. In fact, they might even be interested in stocking the software, after all, most libraries do have books on how to become a ham. They might also go for the best computer course.

The prices for the five courses are: Novice ($39.95), Technician ($34.95), General ($34.95), Advanced ($49.95), and Extra ($49.95). We took a close look at the Novice package, HDP-1601, because the Novice License is a convenient entry level into amateur radio. For more information on the Heathkit HDP-1601 software, write to Heath Company, Benton Harbor, MI 40922. If you wish, circle Free Information Card number 92 and we will do the contacting for you. ■

SAXON ON SCANNERS

(Continued from page 96)

ing band is 1294.5 MHz (FM mode). Several of the newer scanners tune up to that band, which has also just been opened to Novice Class licensees.

Weather or Not

Most areas of the nation are within range of an NOAA weather broadcast station in the 162 MHz band. Unfortunately, scanner owners tend to check out those frequencies only for weather forecasts.

The fact is, there are several frequencies available for such transmissions; and few people ever bother to see what's on any of them other than the one used for their own local area. Try tuning in those other frequencies—they may bring you all sorts of NOAA weather stations located in distant cities!

The complete list of weather broadcast channels is 162.40, 162.425, 162.45, 162.475, 162.50, 162.525 and 162.55 MHz. Since stations on those frequencies are intended to have wide area coverage, they usually use antennas located atop tall buildings. Reception from 150 miles or more isn't at all uncommon.

If you tune around 410 to 411 MHz, you may hear similar weather forecasts. Those are the frequencies used for point-to-point links between the NOAA offices and the remote 162-MHz transmitter sites.

Latest Federal Station Listings

The new 6th Edition of the well-known *"Top Secret" Registry of US Government Radio Frequencies* has just been issued. Covering (primarily) the 25- to 470-MHz frequency range, the huge 192-page directory provides more than 150,000 listings, including frequencies, callsigns, locations, tactical ID's, codes and codewords, ship/aircraft rosters, etc. A revised and expanded edition, it covers more than 80 agencies, including all military forces, the FBI, Secret Service, DEA, Treasury, ATF, Customs Service, Boarder Patrol, Immigration, FCC, all National Forests, CIA, NSA, GSA, State Dept., Dept. of Labor, US Marshall, Federal Prisons, NORAD, FEMA, and others. A newly added section provides many Canadian federal frequencies.

The new 6th Edition is the largest one yet compiled. It is available at $17.95 (plus $2 postage/handling to North American addresses) from CRB Research, PO Box 56-GP, Commack, NY 11725.

Before we go, just a reminder that we invite your questions, comments, ideas, news clippings, shack photos, and anything else relating to scanners that you'd care to send us. Write to Marc Saxon, *Saxon On Scanners*, **Hands-on Electronics**, 500-B Bi-County Blvd., Farmingdale, NY 11735. ■

CARR ON HAM RADIO

(Continued from page 91)

amount. Such propagation provides slightly-longer surface distances than might be expected from calculating the distance to the radio horizon. The phenomenon is called *simple refraction*.

A special case of refraction called *super refraction* occurs in areas of the world where warmed land air goes out over a cooler sea. Examples of such areas have deserts adjacent to a large body of water: the Gulf of Aden, the southern Mediterranean, and the Pacific Ocean off the coast of Baja, California. VHF/UHF/microwave communications to 200-miles are reported in such areas.

The second form of refraction is weather related. Known as *ducting*, this form of propagation (Fig. 3) is actually a special case of super refraction. Evaporation of sea water causes *temperature-inversion regions* to form in the atmosphere. That is, layered air masses in which air temperature of the upper layer is greater than that of the layers below. (Note: air temperature normally decreases with altitude, but at the boundary with an inversion region it increases.)

The inversion layer forms a "duct" that acts similar to a microwave waveguide. In Fig. 3, the distance D1 is the normal *radio-horizon* distance, while D2 is the distance over which duct communications can occur. Ducting allows long distance communications at VHF through microwave frequencies, with 50-MHz being a lower practical limit and 10-GHz being an ill-defined upper limit. Airborne operators of radar and other microwave equipment can sometimes note ducting at even higher frequencies, but it is uncommon.

Antenna placement is critical for ducting propagation. Both receive and transmit antennas must be either inside the duct physically (as in airborne cases); or able to propagate at such an angle that the signal gets trapped inside the duct (the usual situation when amateur stations use duct communications). The latter is a function of antenna-radiation angle.

Distances up to 2500-miles or so are possible through ducting. Certain paths where ducting occurs frequently have been identified: the Great Lakes to the Atlantic seaboard; Newfoundland to the Canary Islands; across the Gulf of Mexico from Florida to Texas; Newfoundland to the Carolinas; California to Hawaii; and Ascension Island to Brazil.

Another condition is noted in the polar regions where colder air from the land mass flows out over warmer seas. Called *subrefraction*, this phenomena bends EM waves away from the earth's surface; thereby, reducing the radio horizon by about 30 to 40 percent.

All tropospheric propagation that depends upon air-mass temperatures and humidity shows diurnal (i.e., over the course of the day) variation due to the local rising and setting of the sun. Distant signals may vary 20-dB in strength over a 24-hour period. Those phenomena explain how TV, FM broadcasts, and other VHF signals can (under certain conditions) propagate over great distances—especially along seacoast paths—while under others be weak or nonexistent.

Next Month

Be with us next time around when we'll get into the DX'ers delight: *skip communications*. Until then, if you have any comments and suggestions for this column, write to: Joe Carr, K4IPV, PO Box 1099, Falls Church, VA 22041. ■

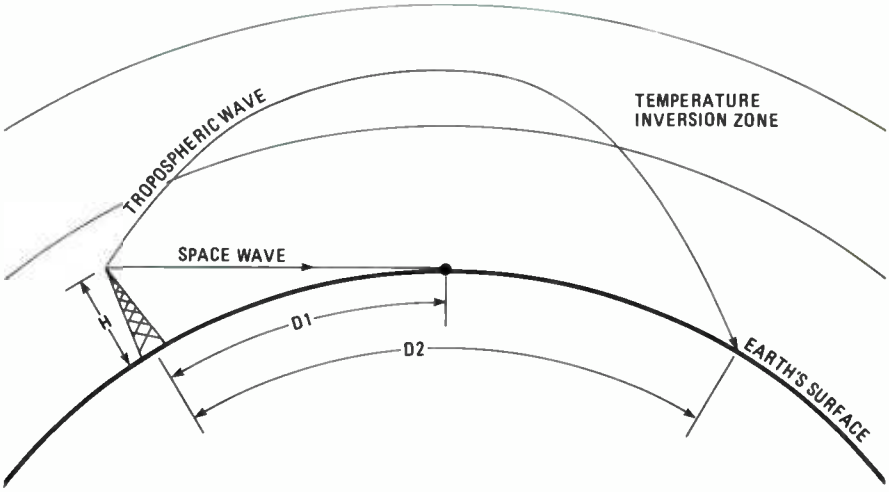


Fig. 3—The troposphere is the portion of the atmosphere between the Earth's surface and the stratosphere (about 4 to 7 miles up). Refraction, the mechanism for most tropospheric propagation, occurs when the wave passes between mediums of differing density. The level of refraction is proportional to the density of the mediums.

SEEING THE LIGHT WITH FLASHMATE

(Continued from page 34)

meter faceplate to give you an indication of the dry cell's *health* in the future. Your calibration of Flashmate is now complete: However, you may want to repeat what you have done—practice makes perfect!

Putting It in Use

In use, Flashmate will sit where your model sits, facing the camera and lights. You set off the flash, or flashes (simultaneously or separately), then read the *f*-stop directly from the meter. You could set Flashmate in a chair or on a tripod at the location your model will occupy. Fiddle with lights and reflectors, take readings, wash away shadows with multiple bursts from your flash, use any combination of situations and lights, making notes on the Flashmate's readings. When your model arrives, you need only duplicate the setups read earlier from the meter and appear very professional without constantly taking readings. You can concentrate on creativity instead of hassling over those inscrutable little wheels on the back of your strobes. You can also throw away the old tape measure and forget guide numbers; let Flashmate do the computations.

The chief advantage of Flashmate is that it will allow you to start making full use of your electronic flash. The computer wheels on the back of the flash unit are for full light, shot directly at your subject for the distances indicated by the settings. If you want to soften that harsh light and erase hard shadows on your subject by bouncing the light off the ceiling or a wall (or more professionally, off an umbrella reflector). The light must travel farther and be scattered, so that at the model it appears that many small spots were shot off at the same time, rather than just one large one. Therefore, less of that light reaches the model (because some is misdirected away from the model and some is absorbed by the walls, floor, and ceiling) and the direct-flash setting is no longer valid.

Except in rare instances for special effect, more than one light is used in studio photography. At least two, usually three or four, lights are used whether the subject is a gorgeous model or a bowl of bananas. To use more than one flash unit or strobelight, you can use a multiple-flash adaptor which is a small p.c. (nothing to do with computers) connector with more than one synch cord socket on it. That adaptor can connect your camera to as many as four flash-unit synch cords.

More often in studios, the pro will use one main flash unit connected to the camera and several other flash units fitted with slave units. A slave unit is provided with an optical switch (some kind of solar cell) which sees the main flash go off and triggers the slave unit(s) to fire at the same time. In all those multiple flash situations, you need to measure the combined result at the point of focus: your model. Just the first few applications of Flashmate will save you enough cash (by not wasting film) to repay you for your Flashmate's parts. Good shooting, and may the Flashmate be with you! ■

"We are a well informed family. Dad has BBC, Voice of America, Radio Moscow, Kas Israel, Radio Japan, and Radio France International. Mom has AT&T."

HANDS-ON MARKETPLACE

PLANS/KITS

STRANGE stuff. Plans, kits, items. Build satellite dish $69.00. Descramblers, bugs, adult toys. Informational photo package $3.00, refundable. **DIRIJO CORPORATION**, Box 212-H, Lowell, NC 28098.

AMPLIFIER breakthrough—The current amplifier drives loads push-pull without voltage gain. Op amps now drive speakers. Amplifiers are quieter, freer from distortion, easier to construct. Plans for audio amps, all wattages, $10. **AMPLIFIERS UNLIMITED**, Rt 2, Box 139, Highmore, SD 57345.

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CATALOG: Hobby circuits, licensed/unlicensed broadcasting, transmitters, antennas, books, scramblers, bugging devices, science projects, more! **PANAXIS,** Box 130-HO11, Paradise, CA. 95967.

DETECTIVE Equipment micro (voice) transmitter. UHF band (highly sensitive and tunable). Will fit inside an aspirin box, including battery, 1 inch antenna. Micro (telephone) transmitter FM/VHF band (tunable). Powerful, clip-on type. All parts available at local Radio Shack store. Detail plans $10.00 ea. or $15.00 for both when purchased together. Free catalog listing many other devices of this nature with order. Catalog only, $5.00 (refundable). **WILSON,** P.O. Box 5264, Augusta, GA 30906.

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2716 Eprom programmer—plans, plus two additional projects—plus—free bonus! $2.50 plus $1.00 S/H. **GALLIUM JUNCTION,** 540-C N.E. Northgate Way, Suite 542, Seattle, WA 98125.

ELECTRONIC house. Bimonthly magazine covering, smart houses, integrated electronics, security, energy, sensors, more. Send $14.95 for one year subscription to: **ELECTRONIC HOUSE,** Dept. HO, 524 East McKinley, Mishawaka, IN 46545, (219) 256-2060.

FM transmitter kit, matchbox size, super sound sensitivity, adjustable frequency/gain. Board, parts, educational instructions, $14.95. **PTS,** Box 1951, Fort Worth, TX 76101.

COMMODORE 64/128 owners. Design your own custom circuits, oscillators, amplifiers, layouts, and more! Just enter specifications and the computer designs the circuit. Free information or send $5.00 for complete line catalog and demonstration disk/tape. Refundable with $20.00 purchase. **WEASELGRAPHISC,** Dept. H9, 606 Thomasville, Pocahontas, AR 72455.

BUILD this five-digit panel meter and square wave generator including an ohms, capacitance and frequency meter. Detailed instructions $2.50. **BAGNALL ELECTRONICS,** 179 May, Fairfield, CT 06430.

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LASERS: Surplus parts, and units, "the source for laser surplus!" Free catalog, **MEREDITH INSTRUMENTS,** P.O. Box 1724, Glendale, AZ 85311.

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PICTURE flyer lists quality surplus electronics at low prices. Since 1970. Send for the last 3 issues. **STAR-TRONICS,** Box 683, McMinnville, OR 97128.

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ADVERTISING INDEX

HANDS-ON ELECTRONICS magazine does not assume any responsibility for errors that may appear in the index below.

NEW PRODUCT SHOWCASE

(Continued from page 100)

Gang Programmer for Intel's

A new module for the PP40 series of programmers from Stag Microsystems, Inc. allows gang programming of up to eight Intel (or equivalent) single-chip microcomputers.

Microcomputers from Intel (or other compatible types) packaged as 40-pin DIP's can be gang and set programmed quickly and efficiently, using the new 41M200 module from Stag. Up to eight

CIRCLE 94 ON FREE INFORMATION CARD

devices can be inserted and programmed simultaneously, either from data held in the programmer's RAM, or from a master EPROM or microcomputer.

Like the earlier M100 and M101 modules for EPROM's, the 41M200 mounted on a PP40 series programmer uses fast programming algorithms to reduce programming time. Other features of the system include recognition of Electronic Identifiers of the devices inserted, Programming of the security bit to prevent devices being read, a time saving *auto recall* feature of the set parameters, and extensive self-test routines on power-up.

Status LED's in conjunction with the built-in alphanumeric display and key pad operation make the PP40 series of programmers easy to use. The extensive editing capabilities include list, edit, fill, RAM, string search, insert, delete, and block move.

The suggested retail prices for the model 41M200 module and PP41 programmer are $975 and $1555 respectively. For further information contact Stag Microsystems, 1600 Wyatt Dr., Santa Clara, CA 95054; Tel. 408/988-1118. ■

"I just couldn't find the short so I went to a bigger fuse!"

JENSEN ON DX'ING

(Continued from page 88)

guage home-service shortwave stations of the NHK network. Japanese professional baseball is sometimes broadcast around 1100 UTC by NHK stations at Nagoya on 6,005 kHz, and at Kumamoto on 6,130 kHz.

If the signal is clear (says Bill), it is possible to follow the ball/strike count since English baseball terms are commonly used by the Japanese play-by-play announcers.

The Mailman Cometh

George L. Rice of Lexington, KY., writes, "I'm a beginner in shortwave listening. I have a portable Realistic Radio Shack radio with shortwave coverage ranging from 6 to 18 MHz." He goes on to ask which shortwave station broadcasts Spanish language lessons.

It probably won't come as a big surprise, George, but it is the *Spanish Foreign Radio* from Madrid that has a regular Spanish lesson for English-speaking listeners.

The program—called *Learn Spanish, A Language Without Bounds*—is presented each weekday evening during the *Spanish Foreign Radio*'s North American programming. Currently, the lessons, which run about five minutes each, can be heard at about 0050 UTC, with a repeat at approximately 0150 UTC, on 9,630 and 11,880 kHz. Listeners in the western part of the US and Canada may find that a later repeat at about 0550 UTC, on 6,125 kHz, comes in better.

If you're serious about learning the language, I'd suggest that you write to *Spanish Foreign Radio, Broadcasts in English for North America*, PO Box 156202, Madrid 28080, Spain, about text material for the continuing course of lessons.

George and another regular reader, Bob Morris, who is returning to shortwave listening after an absence of about 20 years, had another question. Both would like to know of various books or newsletters about SWL'ing.

Two small books that can serve as an introduction to SWL'ing for beginners are *The World Is Yours; Enjoy Listening to International Radio* by Samuel R. Alcorn, and *So You Bought A Shortwave Radio* by Gerry L. Dexter. The former is available for $2.95 (plus postage and handling) from the publisher, Gilfer Shortwave, PO Box 239, Park Ridge, NJ 07656. The Dexter book is brand new and is available for $6.95 (plus postage and handling) from Tiare Publications, PO Box 493, Lake Geneva, WI 53147.

Newsletters? There are a number of listeners' clubs in the US and Canada that publish monthly—some even more frequently—bulletins for SWL's and those who tune in other segments of the RF spectrum, AM MV radio, VHF–UHF scanner bands, FM, TV, etc.

Nearly 20 of the best such clubs are linked together by the *Association of North American Radio Clubs*. ANARC will send you its club list, which gives information about its affiliated clubs, what they offer, and how to join. The club list is yours for a self-addressed stamped envelope and 25-cents in US, or 60 cents in mint stamps in Canada. Write to ANARC Newsletter, PO Box 462, Northfield, MN 55057.

If you have questions, or SW logging information to share in our "Down the Dial" segment, or if you'd like to send in your photo, with your listening equipment, to appear in these pages, the address is *Jensen On Dx'ing*, **Hands-on Electronics, 500-B Bi-County Blvd., Farmingdale, NY 11735.**

Down The Dial

Here are some shortwave loggings being noted in North America recently. The listings are in Universal Coordinated Time (UTC), which old timers like *ye ed*, still like to think of as Greenwich Mean Time (GMT). Frequencies are in kilohertz (kHz).

Albania—6,080, *Radio Tirana* is known to SWL's for its heavy propaganda broadcasts and programming that is *dull, dull, dull*. Still, when it features Albanian folk music, there's some good listening to be had. Look for this one prior to its 0200 sign off.

Dominican Republic—15,045, *Radio Discovery* in Santo Domingo is operated by Jeff White, an Illinois SWL turned broadcaster. This one has programs in English and Spanish, and can be heard in the afternoons, say, around 2030.

Iran—9,022, *Voice-of the Islamic Republic of Iran* has English news at 1945.

Iraq—9,875, *Radio Baghdad* can be heard with its version of the Iran-Iraq war news less than an hour later, 2025, in another corner of this 31-meter band.

New Zealand—17,705, *Radio New Zealand* is another station sports fans should check out periodically. Recently it was heard at 0030, broadcasting a live cricket match.

Venezuela—3,275, *Radio Mara*. Some years back, it seems there were Venezuelan stations all over the lower shortwave frequencies, the so-called *tropical bands*. Today their numbers have dwindled for some reason. One of the more reliable of those Spanish-language outlets is this one located in the city of Maracaibo. Try during the early evening hours. ■

Credits: Sheryl Paszkiewicz, WI; Christos Rigas, IL; Michael Hawk, VA; Cathy Turner, NY; Rufus Jordan, PA; Gladys Martin, Brooklyn, NY; North American SW Association, 45 Wildflower Road, Levittown, PA 19057; Ontario DX Association, PO Box 161, Station A, Willowdale, Ontario, Canada, M2N 5S8).

CIRCUIT CIRCUS

(Continued from page 85)

calls coming in and going out from the same phone or phone line. And to top it off, the circuit requires neither a battery or AC supply to make it work. A really cheap circuit indeed.

Two voltmeter readings are necessary before the circuit can be placed in service. First the polarity of the phone lines must be determined and then connected to the circuit as shown in the schematic diagram. The polarity of the remote input leads on the cassette recorder must be checked out and connected to the circuit as shown. Set the recorder to the record position and when the telephone is taken off hook the recorder starts to record all.

The circuit's operation is simple: When the phone is on hook, in most cases, the voltage across the phone lines is about 48-volts DC; when taken off-hook, the line voltage drops below 10 volts. When the line voltage is near 48-volts, the FET is biased off and no current can flow through Q2 and Q3, but when the receiver is off hook the voltage drops, allowing Q1 to conduct turning on Q2, Q3, and the cassette recorder. Try one or more of the cassette control circuits and have fun until next time. ■

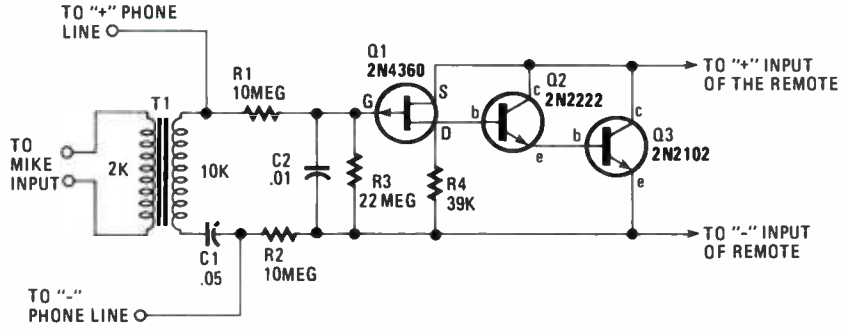

Fig. 3—The Telephone Auto-Record Circuit

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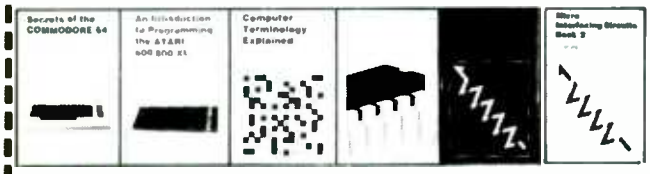

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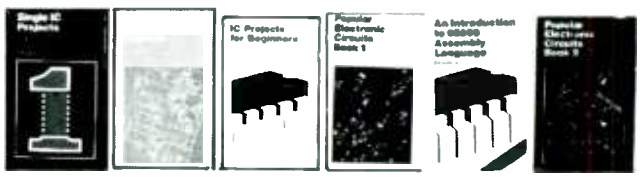

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