HOBBY ELECTRONICS

48784

$2.50 U.S.
$2.95 CANADA
JUNE
1988

Hands-on Electronics®

THE MAGAZINE FOR THE ELECTRONICS ACTIVIST!

THE GADGETEER'S GIZMO BUYER'S GUIDE

Special

SUPERCONDUCTIVITY
Putting the chill on heat loss

FROST INDICATOR
Be forewarned of icy roads ahead

AMATEUR RECEIVER
World's simplest rig you can assemble

COLOR CODE DRILL
You are programmed to learn fast!

HOME SECURITY
Design a system that's best for your home

BUILD A TUNABLE FSM
Tune your antenna system as the pros do

Plus—Computer-aided design program info, antenna-tuner theory, antique radio news, analyzing sinewaves, motor speed-control circuits, shortwave listening, plus more!

0 71896 48784 8 06

A GERNSBACK PUBLICATION

INCLUDING 10-PAGE GIZMO

Hands-on Electronics®

Volume 5, No. 6

JUNE 1988

CONSTRUCTION

FEATURES

HANDS-ON REPORTS

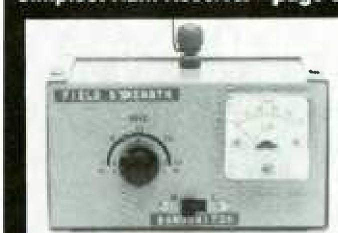
SPECIAL COLUMNS

DEPARTMENTS

CompuSound—page 41

Security System—page 58

Simplest Ham Receiver—page 63



Build the Tunable FSM—page 66

Ellis on Antique Radio—page 84

Saxon on Scanners—page 94

Hands-on Electronics®

The Magazine for the Electronics Activist!

Which way did they go?

Every so often a new product category hits the marketplace and—BAMM—it takes off like a cat on a hot tin roof. Unfortunately, some of those products hit the sidewalk below and *spatter*!

And so, here is a sad tale: It was only last year that almost the entire editorial world flipped its collective lid to herald the coming of the laptop computer. So much type was expended expounding the virtues of the laptops that the obvious drawbacks were ignored. After all, the public will find those out—after they bought the product.

My personal experiences with several laptop models that I was able to borrow and use did not impress me. Once they were loaded with batteries, their weight discouraged long term laptop use. In fact, lug one of those jobs about for a day and one arm will be an inch longer than the other. What really bothered me was that the screens looked great in photos—in real life situations, the screen images were difficult to read and bordered on the migraine level, should constant reading be required.

Two incidents told me to give up the laptop. On a trip to the deep south, one laptop I used dropped its diskette somewhere (I know not where) when I accidentally brushed the unit against my leg and hit a diskette-release button. Not only did I lose two days notes, I lost the system's boot disk. I had to get home before I could use the computer again. On another trip I had a laptop with a built-in modem. All I had to do was dial the office modem and transmit my story. Easy, sure. But I couldn't do it in my hotel room. Hotel people lock the telephone cables in place so that guests don't steal telephones.

So why am I dumping on laptop computers? Today, two different laptop products announced that they are reducing their list prices by $300. One model in question was selling for about $1300 and dropped to $1000. Before the price drop it was selling for $679 in the New York Times. I can see why the list price was cut. Consumers realized that the hype printed was worthless, the products were not that good, and the manufacturers were zonking 'em on the bucks. The consumers took a walk instead of a bath.

The manufacturers are wondering, "Which way did they go?"

Julian S. Martin, KA2GUN
Editor

STAFF

BUSINESS AND EDITORIAL OFFICES

Gernsback Publications, Inc.
500-B Bi-County Boulevard
Farmingdale, NY 11735.
516/293-3000
President: Larry Steckler
Vice-president: Cathy Steckler

NATIONAL ADVERTISING SALES
(For Advertising Inquiries Only)
Joe Shere **MIDWEST/PACIFIC**
1507 Bonnie Doone Terrace
Corona Del Mar, CA 92625
714/760-8697

Larry Steckler, Publisher
500-B Bi-County Boulevard
Farmingdale, NY 11735
516-293-3000

Composition by Mates Graphics

Cover photography by Diversified Photo Services

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.

LETTER BOX

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

Sound Off!

I built the Sound Switch in the April 1987 issue. The project works great. I use it in the basement near the washer and dryer to turn on the lights automatically. There are just a few minor corrections: Resistor R21 is listed in the parts list as 2700Ω. It should be 2.7Ω as shown on the diagram. I found that for the timed mode to work properly, I had to use a Tantalum capacitor for C6. Resistor R8 in the schematic diagram in Fig. 1 is .1Ω, but I used a 1K as written in the parts list and it works fine.

I have enjoyed your E-Z Math features in the last few issues. It helps sharpen my skills because I am a student of CIE. I started with CIE in December 1987 and am doing the math problems that you have in your articles. Thanks for the help.
—D.S., Kansas City, MO

We're glad you have a good use for the project. The nicest part of our hobby is you get useful devices out of a few hours tinkering, not to mention experience and skill. Especially in troubleshooting. Thanks for the corrections.

Immediate Service

Talk about the left hand not knowing what the right is doing, consider the following in the March 1988 issue on page 7: "I too am interested in a voice recognition system, but, much to my dismay, simply cannot afford such a high-priced toy..." On page 15, of the same issue "If Voice Master Junior (voice recognition system) itself isn't amazing enough, then its suggested retail price of $39.95 should be...."

Go figure.
—H.A., Sewanee, TN

Wow, talk about synchronicity! Your letter has made both a reader and an editor very happy. It just goes to show you that even if you work on this magazine, you could learn a lot by reading it cover to cover.

It's one thing to tell the readers the New Products column is important, and another to learn from experience. Thanks for the letter the company will have two more customers.

Hounded Down

Regarding my article in March 1988 issue called The Rad Hound.

Whoever tries to build the Rad Hound must make these corrections to typographical errors in article:

In the schematic: Change transformer T2 to read T1. Change R5 to read 4.7 megohms. Relocate the wire for pin six of U1 (the audio amp chip) to the center-tap point on the primary of T1 (not to the +6 volts of B1).

In the parts list: chance R5 to read 4.7 megohms. For the G-M tube in the note on the bottom of parts list, change the PO box to read H17, not H16. (My error).
—Peter Campione

Thanks for the corrections. With the radon gas scare going around we're sure there are lots of readers interested in getting the Hound off the ground.

Dating Frequently

I have been a subscriber since before the name was changed to **Hands-On Electronics**. I have enjoyed the publication immensely.

However, in the February 1988 issue on page 33 there is a short computer program entitled Date Calculation Software. The author states that although written for the IBM PC, the program is easily modifiable to run on any machine that has the Basic language.

As written in the article, I don't think this program will run on any computer. It appears that you simply downsized the author's program and printed it. The type is so small that it is difficult to read and it is especially hard to distinguish the $ from the usual S.

Nevertheless, my son finally got it to run on my Amiga 1000. It does exactly what the author said. I will gladly send you or any readers the correct format for the Amiga computer if an SASE is supplied.
—Harold E. Ratcliffe
5731 Bradley Blvd.
Bethesda, MD 20814-1033

That's an offer our Amiga fans certainly can't refuse. If anyone wishes to distribute software or hardcopies of any of the programs appearing in the magazine please get in touch with us. It is a great service to provide to the other readers.

"Like I told you, Nancy has decided to major in computer games."

Wrapping Up

I recently constructed a circuit for my car, using a wire-wrap tool and 30 AWG wire which I purchased from Radio Shack. The parts were mounted on a PC Board, but used wire wrap around the leads of resistors and transistors in the circuit. The circuit works just fine, with almost all of the components connected together with the 30 AWG wire. Would it be possible to use the wire wrap method in a project that included the use of an AC outlet? Maybe someday, could you do an article on wire wrapping? I'd really like to know how I could expand on this method that I've just discovered. Thank you.
—B.U., Pittsburg, CA

Wire wrap can be used on any circuit not carrying too much current. Do not use it on the powerline side of a transformer in an AC circuit, but if your project is not spewing out mega doses of electrons, you can use it elsewhere. It turns most etch-till-you-drop *projects into one evening affairs.*

You'll be happy to know there's a

rumor going around here that a wire-wrap article is upcoming.*

Hi-Tech Veggies

The article Chemical Polarity Experiment appearing in the March 1988 issue is of the "Pentagon" variety—making a simple thing complicated.

Some 65 years ago I was proud to have among my test measuring equipment a pocket-watch type AC voltmeter and an ammeter from an automobile. In fooling around with Borax solutions to rectify the household 60Hz to get power for some 201 A's and one tube I remember as the "peanut" tube. There was a problem in determining the polarity—assuming rectification, which was not always attained, was successful. With the lack of resources for the then crude VOM's and as no DMM's were around, I used a polchromometer polarity tester.

What is such an instrument? Quite simply it is a piece of potato with two copper wires stuck into it. If DC is passed into the wires the positive one's adjacent area in the potato will turn a light bluish green.

The March writeup refers to a "neutral chloride gas." The gas formed is highly poisonous and corrosive chlorine gas, Cl^0. As Cl^0 (like Cl^-) has a high solubility in water, the solution would need to be saturated before noxious chlorine would escape.

The process is basically

$$NaCl + \tfrac{1}{2}H_20 \rightarrow NaOH + \tfrac{1}{2}H_2 + \tfrac{1}{2}Cl_2$$

The Chlorine gas is at the anode, the lye and hydrogen collect at the cathode. All three products are dangerous.

Therefore, a potato, that can be borrowed from the kitchen is a much safer and more basic polarity tester.
—D.S., Memphis, TN

Well, that puts an end to the lethargic image that vegetables have had since a time immemorial. Perhaps there are more stories about the vital role that vegetables (or fruits, even) can play in electronics. If you know of any such story (especially in regards to superconductivity), or perhaps a more outlandish one (give me strength) then write us right away. It could turn into a cute story, or a side dish.

A Lesson to Learn

I am writing regarding the Foxhole Radio on page 27 in your January 1988 issue. I am a sixth grade science teacher. My class has been building your Foxhole Radio. It is a great project and the students really enjoy it.
—J.H., Minco, OK

We're glad you enjoyed the article. Please send use a few pictures of the class. If anyone has some interesting

LETTERBOX

uses for the project let us know it could make an interesting pictorial.

Uncoiled

In the Letter Box March 1988 issue of Hands-On Electronics there is a reply letter to D.K., Waldorf, MD from G.W.T. of Peoria IL about building shortwave receivers. I have two books sold by Electronic Technology Today "Solid State SW Receivers for Beginners" and "How to Build Advanced SW Receivers".

I haven't been able to build any of the sets so far because of the Denco coils sold by a company in England, I wrote to and received a price list from the Company that has the coils, but it is priced in English currency.

I need help, could you or anyone tell me how to change English currency to U.S. dollars and cents?

If I could find substitutes for the Denco Coil that would be even better.
—C.A., Hackensack, NJ

The solution is quite simple: Have the company tell you what the coils are worth to them in American currency, or visit your local bank and have them work out the rate of exchange and issue a check for the proper amount. Ta da!

Chipped Item

I am writing to you in reference to an article published in February 1988 issue called Choosing the Right Logic Chip, by W. Schopp. I noticed several discrepancies that could cause some problems. (Ref: Texas Instruments ALS/AS Logic Data Book, 1986). In the fourth paragraph the specified operating temperatures for the 5400 type and the 7400 type chips are reversed. For the 7400 type, the operating temperature range is 0 degrees to 80 degrees centigrade and the 5400 type operating temperature range is –55 degrees to 125 degrees centigrade. That could be a major factor if the device being built is to be used outside where the temperature drops below freezing.

Another problem was with Table 2 in which it lists the Frequency Range for the Advanced Low-Power Schottky as being less then the older Low-Power Schottky. The operating frequency should be 70 MHz not 30 MHz. I hope this information can be of some use to you and other hobbyists.
—D.M., Almogordo, NM

That's it, keep the authors on their toes. By the way, I know the line of books that TI has produced over the years, and as an editor (former student, and an information fanatic) have found them very informative, well written, and quite accurate. Thanks for the information

Gripes of Wrath

In the E-Z Math article of the March issue of your magazine, there are several mis-labeled and misplaced diagrams. Anyway, it is very distracting when you are trying to learn something and the text doesn't match the diagrams referred to. Let your proofreaders know that the math in the March issue in the answers section slipped by them too.

I've only been one of your readers since the last two issues and I really like your magazine. Thanks for listening to my small gripes.
—R.U., Toby, AK

No gripes are ever too small to listen to, and we appreciate your advice. The first group of errors R.U. is speaking of is the placement of Fig. 11 in the spot for Fig. 18, Fig. 15 was placed in the spot for Fig. 11, and Fig. 18 was positioned where Fig. 15 should be.

The second one occurs on the third line of math for problem 7 which should read:

$$Z = \sqrt{1000^2 + (4000-2268)^2}$$

Sorry for the confusion.

Dazeled

I have just completed the Dazer project in your November issue. It does not work because I bought the wrong RF power transformer. The article does not say whether the 8 to 1200 ohms is impedance or internal resistance. The only RF transformers I could get was the impedance value.

The article did not give any ideas on obtaining the parts. I hope you can tell me where I can get this transformer. I would really like this thing to work. I am also having trouble getting the small .1 polyester caps. All I could get were Spragues. They are long and have to be stood on end to fit on the board. Maybe you can help me with that too.
—W.B., Brooklyn NY

Transformers of this type are almost always listed by impedance, so you probably have the right transformer. One thing that confuses me is that you say the article gave no parts suppliers, but the entire kit (two kits actually) is given in the parts list.

Also, the the .1–µF capacitor is not listed as polyester, but as monolythic. The best advice I could give anyone just starting out in electronics is to buy a complete kit of parts and assembly it step by step. It really pays off because of the money you'll save by not making acquisition errors.

"Now that's what I call linearity."

Sound Cable/Cable Sound

Having been introduced to your magazine via Gadget, I've liked what I've found. Your construction projects are closer to the sort I putter with, as opposed to the more ambitious projects in other magazines.

I should mention that Sams puts out a book on the 555 Timer, which had a raft-and-a-half of circuits in it. Too bad I can't find my copy anymore: lots of fun hookups for the breadboard, some even useful!

I'm writing as I have two cable-related questions perturbing me. I've written an advertiser, but they only sent me a list of available cable boxes.

Our cable company mentions that stereo audio for several channels is available on FM. As I can't pick it up by hooking my FM tuner to the cable, there must be something I've missed. Any suggestions?

Thanks again for keeping a sense of fun in your magazine. Mr. Wels' column comes to mind, though all are interesting. I for one can forgive the occasional error in a schematic when considering the overall editorial spirit.
—J.T., Chicago, IL

Thanks for the book advice. Those 555's are the most versatile chips around.

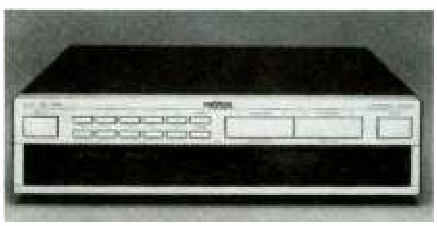
About your cable difficulty, it has been my experience that you can hook your cable up to your FM stereo receiver. Connect it using an impedance matcher if necessary. Your cable company should have a listing of frequencies it uses for the stations in question. Check it out with your cable company first in case their system is different. They're usually glad to help people use their service. You are paying for their services, aren't you? ■

NEW PRODUCTS

Programmable Tuner

Revox of Switzerland has introduced a programmable tuner engineered for optimum performance in high density reception areas. The new Revox B260 Tuner features 60 FM presets with six subgroups, calibration tone, auto tune, two programmable (front panel selectable) antenna outputs, florescent display, and low profile design just 4[1]/3" high.

The Revox B260 Tuner is extremely adaptable and offers a variety of programming options. The 60 FM presets can be divided into six subgroups or "P" program types. For example P1 could consist of only rock stations, P2—all jazz stations, P3—all classical, etc. Users need only access and scan their selected group of station presets. The fluorescent display shows both frequency and alphanumeric characters.



CIRCLE 57 ON FREE INFORMATION CARD

Auto tune is another major feature for easy, one-touch preset programming. Just tune in the station, touch AUTO STORE, and the next available preset location is automatically assigned.

Operation of the B260 can be tailored precisely to the users's needs and preferences. The output level of each station can be programmed to provide uniform volume settings for each station. The memory can be programmed for optimum antenna setting for each station. Two levels of blend and mono can also be programmed. All programming controls are placed behind a glass door to completely separate them from the operating controls and offers protection from children's prying fingers.

Superb performance in high-density reception areas includes excellent stereo separation and imaging. The demodulation system incorporates extra filters in the IF circuitry (six filters instead of one or two normally used), to improve selectivity. Coward filters are used to filter out unwanted sidebands and extraneous frequencies to provide a clear signal.

The B260 Tuner and the companion B250 Integrated Amplifier are fully remote controllable from the new B208 Infrared Remote Controller.

The B260 matches the low profile design of Revox's new B250 Integrated Amplifier, which has been introduced simultaneously. Each of these components can be used together or integrated separately into any high-quality stereo system.

Suggested list price of the Revox B260 Tuner is $2,000. It can be auditioned at authorized Revox dealers throughout the U.S. For further information contact Revox Division, Studer Revox America, Inc., 1425 Elm Hill Pike, Nashville, TN 37210.

Serial/Parallel Breakout Box

M-Test Equipment is now offering their Model 250. Priced at $299, it is a full-featured, high-quality RS-232C serial breakout box that includes parallel-interface test, a pulse trap for storing short-duration pulses, and a cable test. Model 250 has 102 LED's which give 4-state signal indication. 26 in-line switches and 52 sockets allow breaking

"I asked my Mom to get me some wire and alligator clips...So she gets me jumper cables."

CIRCLE 59 ON FREE INFORMATION CARD

and re-directing of all 25 lines plus one unassigned line. A 9-volt battery simulates high or low signals.

Features include: 102 LED's to give 4-state signal indication on both DTE and DCE; 26 in-line switches and 52 sockets for breaking and re-directing all lines; one unassigned line for testing open lines and ground potential differences; parallel interface test indicating standard TTL signals; a pulse-trap/current-loop test makes it possible to store short-duration pulses and test short-haul modems; a battery simulates high or low signals; a cable test; jumper cables and 2 attached ribbon cables with dual gender connectors; durable ABS plastic case; gold-plated connectors.

For further information, contact: M-Test Equipment, PO Box 146008, San Francisco, CA 94114-6008; Tel. 415/861-2382.

Pocket Megohm Meter

A battery-powered, hand-held megohm meter that measures surface resistivity and path to ground per NFPA 99A and ASTM D-257 on all ESD control materials is on the market.

The U MEG Pocket Megohm Meter-CP925 is capable of testing static dissipative and conductive materials over a $<10^5$ to $<10^{9.5}$ sensitivity range. Simple to use, just place its bi-electrode sensors on the surface being tested, press a button and a series of six colored LEDs will illuminate indicating whether the

Train for Fastest Growing Job Skill in America

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

NEW! Training now includes 20 meg hard disk drive!

Your NRI total systems training includes all this: NRI Discovery Lab to design and modify circuits • Four-function digital multimeter with walk-you-through instruction on audio tape • Digital logic probe for visual examination of computer circuits • Sanyo 880 Series computer with "intelligent" keyboard and 360K, 5¼" floppy disk drive • 20 megabyte hard disk drive you install internally • High-resolution monochrome monitor • 8K ROM, 256K RAM • Bundled software including GW-BASIC, MS-DOS, WordStar, CalcStar • Reference manuals, schematics, and bite-sized les...

With more and more new applications being developed for every facet of business, education, and personal computer use, the demand for trained computer service technicians surges forward. The Department of Labor ranks computer service high on its list of top growth fields, with accelerated demand creating more than 30,000 *new* jobs within the next 10 years.

Total systems training

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

You'll assemble the Sanyo's "intelligent" keyboard, install the power supply and 5¼" floppy disk drive, and interface the high-resolution monitor. Plus now you also install a powerful 20 megabyte hard disk drive—today's most-wanted peripheral—to dramatically increase your computer's data storage capacity while at the same time giving you lightning-quick data access. You get more confidence-building, real-world experience as you go on to master programming, circuit design, and peripheral maintenance.

No experience necessary—NRI builds it in

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

Send for 100-page free catalog

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

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

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

. . . then install the power supply, checking all connections with your digital multimeter. From there, you go on to install the floppy disk drive, monitor, and new 20 megabyte hard disk drive.

NRI SCHOOLS

McGraw-Hill Continuing Education Center
3939 Wisconsin Avenue, NW
Washington, DC 20016

We'll Give You Tomorrow.

IBM is a Registered Trademark of International Business Machines Corporation.

NEW PRODUCTS

material is antistatic, static dissipative, or conductive.

Designed for testing static dissipative floor wax and laminates, portable work surfaces, transparent shielding bags, foam, wrist, grounding and heel straps, the U MEG Pocket Megohm Meter-CP925 is supplied with a rechargable NiCad battery and performs 1,000 tests per charge. It measures $3^3/_8'' \times 2^1/_2'' \times 1^1/_4''$, weighs 6 oz. and there are no wires, cables, or electrical hazards.

CIRCLE 56 ON FREE INFORMATION CARD

The U MEG Pocket Megohm Meter-CP925 sells for $249 (list). A brochure describing instruments for the measurement and control of static electricity is available on request. For more information contact: Charleswater Products, Inc., 93 Border St., West Newton, MA 02165; Tel. 617/964-8370.

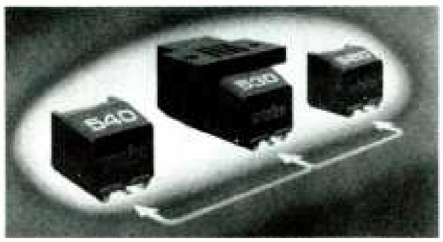
500-Series Phono Cartridges

Ortofon's three new 500 Series phonograph cartridges use an entirely new lightweight advanced-technology moving magnet transducer system and wide contact-area stylii, including the radical Fritz Gyger II. Those enable the cartridge to achieve outstanding sound quality and tracking ability, with exceptional reproduction of sonic detail.

The three models, the Ortofon 540, 530 and 520 (P-Mount versions designated 540P, 530P and 520P), are identical except for their stylii. The top-of-the-line 540 features the new Fritz Gyger II stylus for incredibly accurate reproduction of subtle musical details, more focused imaging, and improved tracking ability. Models 530 and 520 are respectively available with Fine Line and nude-mounted elliptical stylii.

Previous Ortofon designs have employed either moving coil or variable inductance-transducer systems. But now, Ortofon's engineers have found a new way to couple the magnetic field from a low-mass moving magnet to fixed coils while overcoming the inherent disadvantages of moving magnet systems.

In the development of those cartridges, a major goal was to achieve a low equivalent stylus tip mass. That factor, together with the use of advanced diamond geometry delivers a high frequency response that is flat to 27,000 Hz.



CIRCLE 58 ON FREE INFORMATION CARD

However, such an extension in frequency response is practical only if the coil and magnetic system are also engineered to reduce so-called "eddy current" losses at rising frequencies. Ortofon developed a new type of split-pole pin which reduces eddy-current losses, thus preventing the output from being reduced in connection with the extended frequency range.

The cartridge body is made from a composite of Noryl-Fiber Plastic and pure melted glass, which produces a body that is extremely inert and rigid. By the use of advanced computer aided design programs it has also been possible to define the natural pivot point of the cantilever system with unprecedented accuracy and thus achieve optimum oscillation balance. These factors translate into improved linearity and reduced distortion.

The front face (side facing the oncoming groove) of the Fritz Gyger stylus is flat, while three rear facets are angled for maximum strength. The wide contact area and narrow radius are highly polished for low drag and the highest degree of contact ever achieved by a playback stylus—surpassed only be the cutting stylus itself. The geometry of the Fritz Gyger II is as close as possible to that of a record cutting stylus without running the risk of damaging an LP.

The Ortofon 530 uses a nude-mounted fine-line stylus with a response flat to 25 kHz and the 520 has an elliptical stylus and a response flat to 23 kHz. The stylii are replaceable and owners can easily upgrade by installing a Fine Line or Fritz Gyger II at a later date.

A unique, world-patented stylus guard functions as a three-position stylus lock. One position is for normal play, one for locking the stylus in a position to prevent damage during installation and shipping, and a third allows for easy removal of the stylus from the cartridge body. The 500-series stylii are completely interchangeable, allowing owners to upgrade their cartridge by replacing the stylus.

The cartridges are available now. Suggested retail prices: Model 520, $150; Model 530, $225; and Model 540, $300. For more information contact Ortofon Inc., 122 Dupont St., Plainview, NY 11803; Tel. 516/349-9180.

Parallel Extender

Want to put distance between IBM PCs and printers? The Black Box PC Parallel Extender package costing $225 includes two units, one for the computer end and the other for the printer end, two pieces of RJ-11 cable—6 ft. and a 50 ft. respectively, all you need to part a PC from a printer. The Extender's total transmission distance is 1000 ft.

CIRCLE 60 ON FREE INFORMATION CARD

Used in conjunction with other Black Box interface devices, such as print buffers and multi-port spoolers, the PC Parallel Extender lets a lot of PCs share high speed printers and that can save a lot on equipment costs. Black Box technical-support people will discuss your particular situation and help you determine which device can make your network even more efficient.

The PC Parallel Extender and dozens of new products are detailed in the latest Black Box Catalog, along with hundreds of other quality data communications and computer devices. For a free copy write: Black Box Catalog, PO Box 12800, Pittsburgh, PA 15241; Tel. 412/746-5500.

Super Scanner

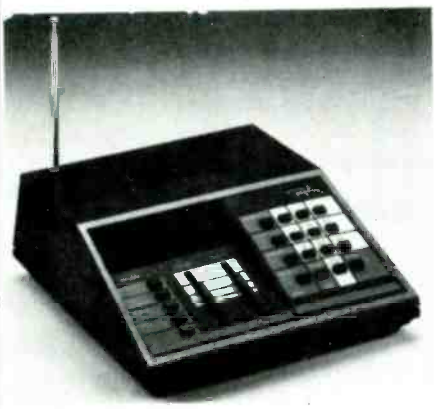
Regency's patented "Turbo Scan" tops the list of R2060 features. "Turbo Scan" allows the R2060 to scan at a rate of up to 50 channels-per-second. A special WEATHER ALERT key provides instant awareness of severe weather. At the touch of a button, the R2060 silently monitors the weather frequencies, broadcasting severe weather alerts in plenty of time to take safety precautions.

The R2060 incorporates seven of the most popular bands, including: VHF Low Band, 30-50 MHz; VHF Amateur, 144-148 MHz; VHF High band, 148-174 MHz; UHF Low Band, 406-440 MHz; UHF Amateur, 440-450 MHz; UHF Standard, 450-470 MHz; UHF Extended, 470-522 MHz.

Its 60-channel programmability provides instant access to favorite frequencies either directly or in the scan mode. Bank scanning provides easy access to four groups of consecutive channels. A separate set of non-programmable channels provides exclusive scanning of NOAA weather frequencies in the U.S. and Canada. Additional features include Priority, Lockout, Delay and Hold.

The R2060 also sports a newly designed keypad with soft-touch controls that are easy to read and simple to operate. Both the volume and squelch are operated with sliding controls. A dual-intensity vacuum flourescent display provides all necessary information.

The R2060 has a suggested retail price of $249.95. For more information about the home scanner, contact Regency Electronics, 7707 Records St., Indianapolis, IN 46226.



CIRCLE 61 ON FREE INFORMATION CARD

"Everytime they simplify the software they complicate my life."

NEW PRODUCTS

Super VHS Camcorder

Hitachi Sales Corporation's first super-VHS camcorder has been added to the company's line-up of camcorders.

The VM-6000A joins Hitachi's VM-3000A and VMC-30AR, full-size and C-format camcorders already in the 1987 line, both priced at $1199.95.

The VM-6000A is a full-size, full-featured camcorder with a MID IVe MOS 2/3-inch image sensor, 400,000 pixels, an F1.2×8 lens, HQ circuitry, record/play, auto focus, and a power-zoom/macro lens. Along with the new Super VHS circuitry, it has 450 lines of horizontal resolution and an S-output. The camera also features audio/video inputs and outputs, auto/manual focus, auto/manual white balance, time remaining, date coding and 10 lux.

CIRCLE 62 ON FREE INFORMATION CARD

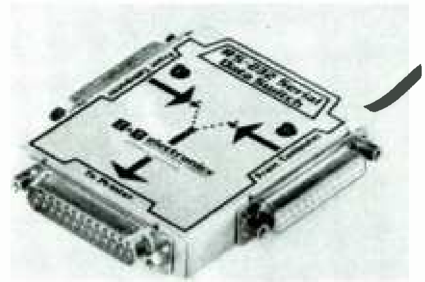
A unique feature of the VM-3000A and the VMC-30AR is Hitachi's self-timer, which allows the photographer the opportunity to join the action being shot. By pushing the timer button once, it delays the recording for 10 seconds while the user joins the scene, and then tapes 30 seconds. By pushing the button twice, after the 10 second delay, the unit will tape until it is shut off.

Suggested list price for the VM-6000A is $1,700. For further information contact Hitachi Sales Corporation of America, 401 W. Artesia Blvd., Compton, CA 90220; Tel. 800/262-1502.

Computers Share A Printer

Here's a most-needed serial scanning switch (Model 232SSS) that automatically scans two RS-232C Serial ports waiting for data to be sent. Upon the receipt of the data from either PD (pin 3) port, the switch then selects that port, and passes all RS-232 data on pins 2-7, 8, and 20. Approximately 15 seconds after the data has stopped flowing on pin 3, the Switch resumes scanning.

During the time that the Switch is locked on one port, the other port outputs (pins 2, 4, & 20) will be low which should prevent the computer from outputting data. To clarify further, that



CIRCLE 63 ON FREE INFORMATION CARD

means that if the Switch is connected to one computer and the other computer tries to output, it will be kept in a busy state until the first computer is done and then it can output its data.

This innovative and practical Serial Scanning Switch comes complete with a 110-volt AC power supply. The two input-port connectors are female and the main connector is a male DB25p. The Scanning Switch Model 232PSS sells for $119.95.

For more information contact B&B Electronics, 1500P Boyce Memorial Drive, PO Box 10400, Ottawa, IL 61350; Tel. 815/434-0846.

Miniature Cordless Phone

For convenience and mobility, Panasonic has introduced the miniature KX-T3000, a cordless phone with a handset so small that it fits easily into many shirt and jacket pockets. The unit, which features a sleek, black design, is wall-mountable and offers intercom, two-way paging, speakerphone and digital security codes.

CIRCLE 64 ON FREE INFORMATION CARD

The KX-T3000 handset features special flip-open styling. It folds on hinges, and when the unit rings, users can simply open it to talk. The ear-piece and all dialing buttons are located in the upper section of the handset, while the operating controls—such as pause, flash, and page—and the mouthpiece are in the lower portion.

In the intercom mode, users can actually carry on a conversation between the handset and the base, which has a built-in condenser mic and speaker.

The KX-T3000 miniature cordless two-way paging feature allows users to page from the base to the portable or from the handset to the base. A call button is located on both the portable and the base.

With the speakerphone feature, miniature-cordless users can conduct a "hands free" conversation. The built-in mic and speaker make over-the-phone discussion possible from almost anywhere in the room.

To protect the privacy of KX-T3000 users from cordless phone users who may be operating on the same frequency, the KX-T3000 features digital security codes. The unit is designed not to function unless codes on the base and portable match.

Extra security is provided by an Auto Security System, which is designed to prevent any outward dialing when the handset is attached to the base of the unit.

The miniature cordless is also equipped with a 10-number automatic dialer. Other features include high/low receiving volume, re-dial, and flash.

The suggested Retail Price is $179.95 and the unit is available from Panasonic Company, One Panasonic Way, Secaucus, New Jersey 07094.

"Around here, time is money and nanoseconds are big bucks."

Ultra-Fast Logic Probe

Capable of capturing pulses as short as 5 nanoseconds and pulse trains as fast as 100 MHz, the LP-5 incorporates both pulse and memory modes, switch-selectable TTL/CMOS thresholds, and three different color LED's for no mix-up troubleshooting. Performance credentials that make it a good choice for the professional circuit designer or computer troubleshooter.

Like all Global logic probes the LP-5's signal inputs are protected against overvoltages and its power leads are protected from over and reverse voltages.

CIRCLE 65 ON FREE INFORMATION CARD

The LP-5 and all Global instruments and solderless breadboarding products can be purchased direct from the manufacturer and are included in Global's 1988 Electronic Testing and Prototyping Equipment catalog. For further information contact Global Specialties, PO Box 1405, New Haven, CT 06505; Tel. 800/345-6251, or 800/445-6250 in Connecticut.

Car Cassette/Receiver

Priced at a suggested retail of $169.95, the RX-222 is designed to provide maximum performance at minimal price.

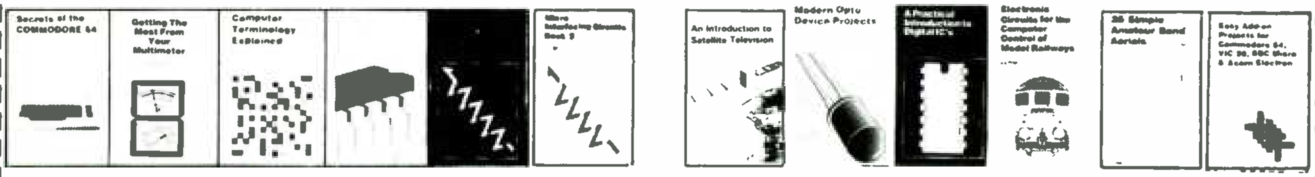
The ultra stable Quartz PLL synthesizer AM/FM stereo tuner uses a dual-gate FET and balanced mixer for maximum performance. It offers Auto Scan and Manual tuning. There are 12 presets (6 FM, 6 AM) and a stereo/mono switch.

Specifications are: Sensitivity, 15.2dBf; Signal-to-Noise Ratio, 55dB; Stereo Separation, 30dB (at 65dBf/1kHz).

The tape deck features a hard permalloy head, sturdy construction, and a highly reliable, quick auto-reverse

Electronics Paperback Books

GREAT ELECTRONICS PAPERBACKS FROM ETT



☐ **BP195—INTRODUCTION TO SATELLITE TV.....$8.00.** A definitive introduction to the subject written for the professional engineer, electronics enthusiast, or others who want to know more before they buy. 8 × 10 in.

☐ **BP128—20 PROGRAMS FOR THE ZX SPECTRUM AND 16K ZX82.....$5.75.** Included with each program is a flow chart and a description of what happens. Notes for converting programs for use on other computers are also included.

☐ **BP235—POWER SELECTOR GUIDE.....$10.00.** Complete guide to semiconductor power devices. More than 1000 power handling devices are included. They are tabulated in alpha-numeric sequency, by technical specs. Includes power diodes, Thyristors, Triacs, Power Transistors and FET's.

☐ **BP234—TRANSISTOR SELECTOR GUIDE.....$10.00.** Companion volume to BP235. Book covers more than 1400 JEDEC, JIS, and brand-specific devices. Also contains listing by case type, and electronic parameters. Includes Darlington transistors, high-voltage devices, high-current devices, high power devices.

☐ **BP99—MINI-MATRIX BOARD PROJECTS.....$5.00.** Here are 20 useful circuits that can be built on a mini-matrix board that is just 24 holes by ten copper-foil strips

☐ **BP157—HOW TO WRITE ZX SPECTRUM AND SPECTRUM + GAMES PROGRAMS.....$5.95.** A crystal-clear step-by-step guide to writing your own graphics games programs.

☐ **BP117—PRACTICAL ELECTRONIC BUILDING BLOCKS—Book 1.....$5.75.** Oscillators, Timers, Noise Generators, Rectifiers, Comparators, Triggers and more.

☐ **BP184—INTRO TO 68000 ASSEMBLY LANGUAGE.....$6.50.** The 68000 is a great new breed of microprocessor. Programming in assembly language increases the running speed of your programs. Here's what you need to know.

☐ **BP179—ELECTRONIC CIRCUITS FOR THE COMPUTER CONTROL OF ROBOTS ..... $5.00.** Data and circuits for interfcing the computer to the robot's motors and sensors.

☐ **BP126—BASIC & PASCAL IN PARALLEL.....$4.95.** Takes these two programming languages and develops programs in both languages simultaneously

☐ **BP198—AN INTRODUCTION TO ANTENNA THEORY...$6.95** Basic concepts relevant to receiving and transmitting antennas.

☐ **225—A PRACTICAL INTRODUCTION TO DIGITAL IC'S.....$4.95.** Mainly concerned with TTL devices. Includes several simple projects plus a logic circuit test set and a digital counter timer.

☐ **BP170—INTRODUCTION TO COMPUTER PERIPHERALS.....$5.95.** Shows how to use a variety of co computer add-ons in as non-technical a way as possible.

☐ **227—BEGINNERS GUIDE TO BUILDING ELECTRONIC PROJECTS.....$5.00.** How to tackle the practical side of electronics so you can successfully build electronic projects.

☐ **BP169—HOW TO GET YOUR COMPUTER PROGRAMS RUNNING.....$5.95.** Shows how to identify error in program and what to do about them.

☐ **BP194—MODERN OPTO DEVICE PROJECTS.....$6.25.** Crammed with great projects for the experimenter. Includes sections on Fiber optics, passive Infra-Red detectors, plus an assortment of miscellaneous projects.

☐ **BP180—ELECTRONIC CIRCUITS FOR THE COMPUTER CONTROL OF MODEL RAILROADS.....$6.25.** It's easy to interface home computers to model railroad control. The main problem is in interfacing the computer to the system.

☐ **BP110—HOW TO GET YOUR ELECTRONIC PROJECTS WORKING.....$5.00.** How to find and solve the common problems that can occur when building projects.

☐ **BP239—GETTING THE MOST FROM YOUR MUTLIMETER..... $5.00.** Covers basics of analog and digital meters. Methods of component testing (includes transistors, thyristors, resistors, capacitors and other active and passive devices.

☐ **BP36—50 CIRCUITS USING GERMANIUM, SILICON & ZENER DIODES.....$5.00.** A collection of useful circuits you'll want in your library.

☐ **BP37—50 PROJECTS USING RELAYS, SCR'S & TRIACS.....$5.00.** Build priority indicators, light modulators, warning devices, light dimmers and more.

☐ **BP39—50 FET TRANSISTOR PROJECTS.....$5.50.** RF amplifiers, test equipment, tuners, receivers, tone controls, etc.

☐ **BP42—SIMPLE LED CIRCUITS.....$5.00.** A large selection of simple applications for this simple electronic component.

☐ **BP127—HOW TO DESIGN ELECTRONIC PROJECTS.....$5.75.** Helps the reader to put projects together from standard circuit blocks with a minimum of trial and error.

☐ **BP122—AUDIO AMPLIFIER CONSTRUCTION.....$5.75.** Construction details for preamps and power amplifiers up through a 100-watt DC-coupled FED amplifier.

☐ **BP92—CRYSTAL SET CONSTRUCTION.....$5.00.** Everything you need to know about building crystal radio receivers.

☐ **BP45—PROJECTS IN OPTOELECTRONICS.....$5.00.** Includes infra-red detectors, transmitters, modulated light transmission and photographic applications

☐ **BP48—ELECTRONIC PROJECTS FOR BEGINNERS.....$5.00.** A wide range of easily completed projects for the beginner. Includes some no-soldering projects.

☐ **BP49—POPULAR ELECTRONIC PROJECTS.....$5.50.** Radio, audio, household and test equipment projects are all included.

☐ **BP51—ELECTRONIC MUSIC AND CREATIVE TAPE RECORDING.....$5.50.** Shows how you can make electronic music at home with the simplest and most inexpensive equipment.

☐ **BP56—ELECTRONIC SECURITY DEVICES.....$5.00.** Includes both simple and more sophisticated burglar alarm circuits using light, infra-red, and ultrasonics.

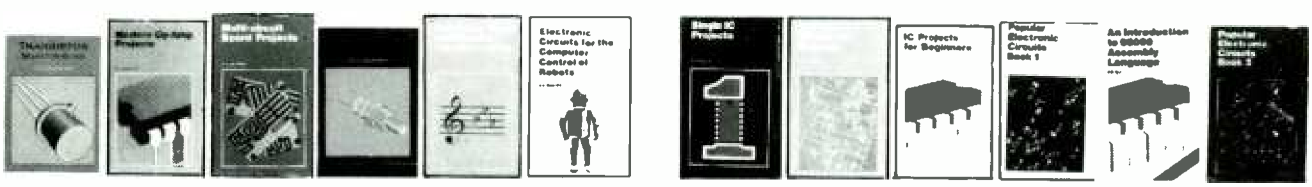
☐ **BP59—SECOND BOOK OF CMOS IC PROJECTS.....$5.00.** More circuits showing CMOS applications. Most are of a fairly simple design.

☐ **BP72—A MICROPROCESSOR PRIMER.....$5.00.** We start by designing a small computer and show how we can overcome its shortcomings.

☐ **BP74—ELECTRONIC MUSIC PROJECTS.....$5.95.** Provides the experimenter with a variety of practical circuits including a Fuzz Box, Sustain Unit, Reverberation Unit, Tremelo Generator and more.

☐ **BP91—AN INTRODUCTION TO RADIO DXING.....$5.00.** How you can tune in on those amateur and commercial broadcasts from around the world in the comfort of your home.

☐ **BP94—ELECTRONIC PROJECTS FOR CARS AND BOATS.....$5.00.** Fifteen simple projects that you can use with your car or boat. All are designed to operate from 12-volt DC supplies.



ELECTRONIC TECHNOLOGY TODAY INC.
P.O. Box 240, Massapequa Park, NY 11762-0240

Name ____________________

Address ____________________

City ________ State ________ Zip ________

H688

SHIPPING CHARGES IN USA & CANADA

$0.01 to $5.00....	$1.00
$5.01 to $10.00...	$1.75
$10.01 to 20.00...	$2.75
$20.01 to 30.00...	$3.75
$30.01 to 40.00..	$4.75
$40.01 to 50.00..	$5.75
$50.01 and above.	$7.00

SORRY No orders accepted outside of USA & Canada

Number of books ordered ☐

Total price of merchandise .... $ ________
Sales Tax (New York State Residents only) .... $ ________
Shipping (see chart) .... $ ________

All payments must be in U.S. funds

Total Enclosed . . $ ________

mechanism. Its Frequency Response is (metal) 40-15,000Hz, and Signal-to-Noise Ratio is 50dB.

The RX-222 has a maximum power output of 7 watts + 7 watts, a Frequency Response of 20-20,000Hz, and a THD of less than 0.1%. Features include a power fader for 4-speaker operation and separate bass, treble, and balance controls.

CIRCLE 66 ON FREE INFORMATION CARD

For more information about Sansui's car-audio components, please contact; Sansui Electronics Corp., 1250 Valley Brook Ave., Lyndhurst, NJ 07071; Tel. 201/4600-9710.

Multiport Protocol Converter

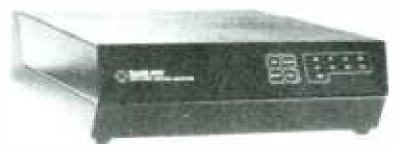
The Black Box Multiport Protocol Converter (PQ-MP) will support up to seven parallel and serial devices at one time, making it a versatile device for System 3X users.

The base unit PQ-MP ($2749) comes equipped with four RS-232 serial ports. Additional ports (with a maximum of three Centronics parallel or serial ports) can be added at the buyer's request for an additional $335/port.

File-transfer software is available for the PQ-MP that will allow data-file transfer between the 3X host and IBM compatible or Macintosh PCs.

Serial ports can be configured for data rates from 110bps to 19.2Kbps, for one or two stop bits, seven or eight data bits with even or odd parity.

The protocol converter will allow most ASCII printers to emulate IBM 5256 printers and others to emulate costly IBM 5225/5225 printers. It lets ASCII terminals or PCs with terminal emulation software emulate IBM 5291 and 5251. The PQ-MP is locally attached to the CPU with twin-axial cables.



CIRCLE 94 ON FREE INFORMATION CARD

For more information on this and other unique devices that can enhance the 3X environment, write for a free subscription to the: System 3X Catalog, PO Box 12800, Pittsburgh, PA 15241; Tel. 412/746-5530.

Math Formatting Program

Exact 3.0, an advanced RAM-resident mathematical typesetting program that cooperates with all PC-based word processors has been released by Technical Support Software, Inc.

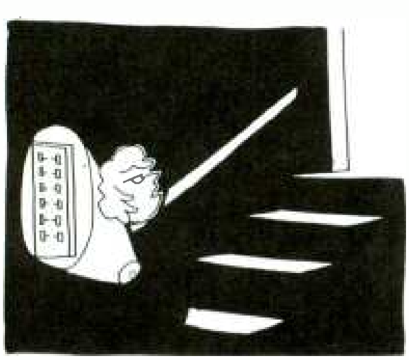
The software maker says Exact is the only PC mathematical typesetting which combines WYSIWYG on screen interactive editing with the ability to continue to use your existing word processor.

A major new feature of the program is the ability to typeset one or more mathematical symbols in the middle of a line of the printer's normal text. Previous versions of Exact running on dot matrix printers had to print all the text and math on a single line in graphics.

In addition to improving the appearance of dot matrix printout, Exact 3.0 now supports all printers which can use IBM Graphics or Epson emulation modes including QMS, AST, and IBM laser printers. "Previously users could print on these machines buy they got less than laser quality," says Gale, "Now, we utilize the on-board fonts to provide high quality printed characters plus the graphics math symbols."

The program loads into RAM before the word processor. At any time during the creation of a document in

(Continued on page 102)



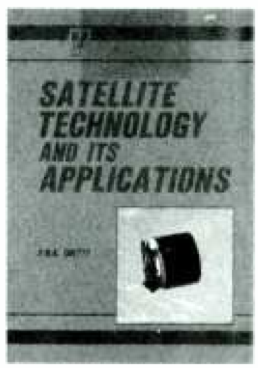
"You'd better re-program that remote control. It turned everything on at once and tripped all the circuit breakers."

BOOKSHELF

Satellite Technology and its Applications
By P.R.K. Chetty

Satellites play a key role in today's world—fascinating low-cost global communications, providing accurate predictions of weather and crop yields, collecting valuable information on the stars and planets, and much more. And as the costs of satellites drop, potential applications grow. Satellite designers need a good, all-purpose reference to this important technology. The text Satellite Technology and its Applications is such a book.

Satellite design engineers, systems engineers, and managers will find this book to be completely up-to-date, comprehensive, and accurate. The author's extensive experience in the U.S., European, and Indian space programs gives him a broad perspective on this increasingly international scientific effort.



CIRCLE 81 ON FREE INFORMATION CARD

Chetty begins by exploring the evolution of satellites and then looks at current technology, with complete discussions of the various satellite building blocks. Finally, Chetty examines in detail the benefits derived from satellite technology and the many present and possible future applications in communications, navigation, meteorology, prediction of crop yields, mineral exploration, land and forest surveys, and the growth of ultra-pure crystals.

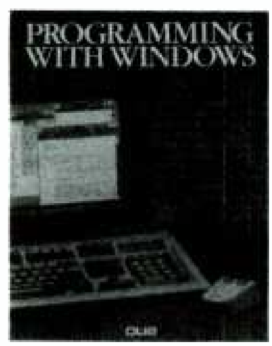
The book includes more than 300 illustrations, an appendix, a selected bibliography, and an index; as well as important design details, calculations, examples, and formulas.

Satellite Technology and Its Applications, Order No. 2931, costs $39.95. It contains 432 pages available from TAB Professional and Reference Books, A Division of TAB Books Inc., PO Box 40, Blue Ridge Summit, PA 17214; Tel. 717/794-2191.

Programming With Windows
By Tim Farrell

Programming with Windows, is a complete guide to creating applications programs with Windows, the versatile operating environment from Microsoft. This authoritative text promises to cut down the time it takes programmers to create Windows applications—whether the reader is programming with Windows 2.0 or Windows 386.

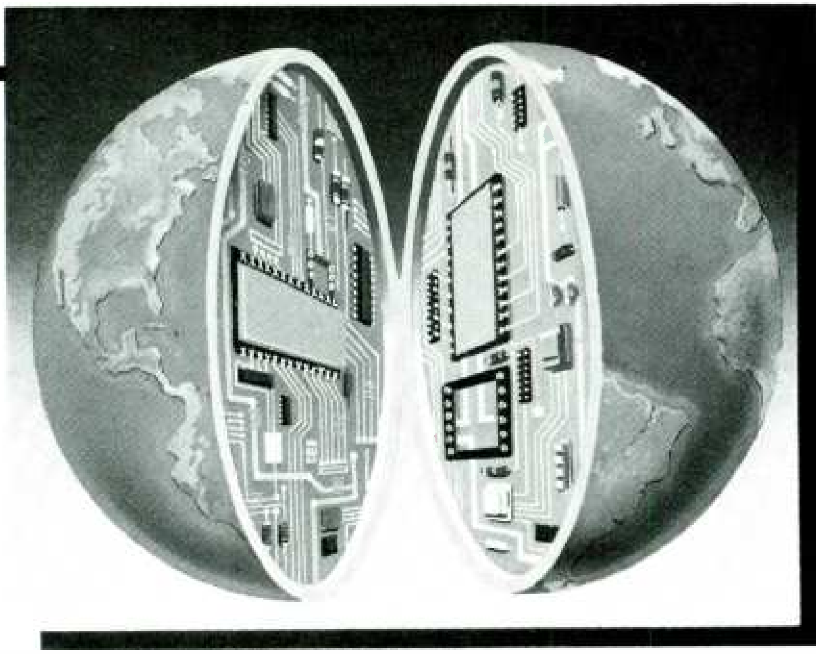
Building on the reader's knowledge of the C programming language, Programming with Windows moves from basic Windows programming concepts



CIRCLE 84 ON FREE INFORMATION CARD

to advanced applications topics. Programming with Windows includes basics not discussed in the Microsoft Windows Developers kit. The book will show readers how to: efficiently use the Windows Development Tools, create dialog boxes and applications, display text and graphics with the Graphics Device interface, manage main and child windows, incorporate assembly language routines, and debug Windows applications.

(Continued on page 22)



BOOKSHELF

(Continued from page 18)

Readers can also save valuable time by purchasing Que's companion software for Programming with Windows. That IBM-format software, sold separately, contains numerous sample applications, including the EDIT program editor.

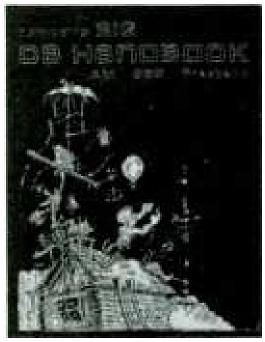
Programming with Windows is $22.95. Order #99, it contains about 450 pages. The software disk for Programming With Windows costs $39.95. Que books can be found in book and computer stores worldwide. To order directly from Que, call 800/428-5331 and ask for a sales representative.

Tom Cat's Big CB Handbook By Tom Kneitel

The nation's most popular CB author has written the largest and most unique CB handbook yet published! Tomcat's BIG CB Handbook, is 221 large-sized pages of information and opinions on AM, SSB and "Freeband" 27 MHz operations—legal and otherwise. It's a giant book with instant appeal to the newcomer as well as the experienced oldtimer, written in Kneitel's famous irreverent and easy-to-read style that has been a mainstay of CB radio since the earliest days of the service in 1959.

The book has it all, from a *warts included* uncensored history of CB to everything you'd ever want to know about buying, installing and using 27-MHz equipment for maximum enjoyment and efficiency. It contains an updated CB jargon dictionary, a state-by-state highway channel directory, anti-theft info, emergency-use info, shooting skip, using QSL cards, CB freqs in other nations, FCC enforcement info, all CB codes/signals, operating tricks/techniques/taboos, DX antenna projects, and lots of kicks in the rumps of many 27-MHz sacred cows—plus a very candid look at an assortment of topics that other authors have always avoided discussing, like out-of-band activities, illegal equipment, etc. All this and more—all of the fun, excitement, mystique, and off-the-wall humor that is unique to 27-MHz activities—in a book written by someone who has been long one of the driving forces behind 27-MHz communications.

Tommcat's BIG CB Handbook is illustrated with numerous photos, rare QSL cards, diagrams, line drawings, and clever cartoons. In all, it's everything



CIRCLE 86 ON FREE INFORMATION CARD

they never told you, written by an active 27-MHz operator for other members of this dynamic fraternity.

Tomcat's BIG CB Handbook, by Tom Kneitel, is available from leading CB dealers. It may be ordered by mail directly from its publisher, CRB Research Books, Inc., at $13.95 per copy, plus $2 postage/handling to addresses in the USA/Canada/APO/FPO. N.Y. State residents add sales tax. Order from CRB Research Books, Inc., PO Box 56, Commack, NY 11725.

Electronic Display Devices By Richard A. Perez

Electronic devices are an ever-present part of today's technologically developed society. There are few people who do not receive information daily from some sort of electronic display device: the LCD on a wristwatch, the CRT in a personal computer, the digital display on a car's dashboard, or the ubiquitous television screen.

The purpose of the book is to provide a comprehensive technical overview of the electronic-display field—to compare basic information on a wide variety of display types.

CIRCLE 83 ON FREE INFORMATION CARD

Three hundred manufacturers of electronic displays have provided input for the book. Every kind of display is included: incandescent lamps, analog meters, CRTs (cathode ray tubes), LEDs (light-emitting diodes), LCDs (liquid-crystal displays), vacuum flourescent displays, electroluminescent displays, and plasma displays.

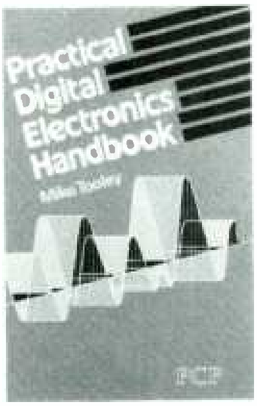
In every chapter, Perez describes the way each display works, how it is made, its operating characteristics, its strong and weak points, and provides a number of sample applications for each.

One final chapter offers an extensive comparison of the devices surveyed, and summarizes the entire field in a nutshell. Throughout, Perez emphasizes the practical concern of finding the right display for a particular purpose. The technical data and specific applications examples are precise enough to be extremely valuable to electronics professionals. A glossary of terms and an alphabetical index are included for reference.

Electronic Display Devices, Order No. 2957; retails for $39.95 and contains 416 pages. It is available from TAB Professional and Reference Books, Division of TAB Books, Inc., PO Box 40, Blue Ridge Summit, PA 17214; Tel. 717/794-2191.

Practical Digital Electronics Handbook
By Mike Tooley

The vast majority of modern electronic systems rely heavily on the application of digital electronics, and the Practical Digital Electronics Handbook aims to provide readers with a practically based introduction to this subject. The book will prove invaluable to anyone involved with the design, manufacture or servicing of digital circuitry, as well as to those wishing to update



CIRCLE 82 ON FREE INFORMATION CARD

their knowledge of modern digital devices and techniques.

The book introduces digital circuits, logic gates, bistables and timers, as well as microprocessors, memory and input/output devices, before looking at the RS-232C interface and the IEEE-488 and IEEE-1000 microprocessor buses.

A special feature of the book is the section on digital test gear projects, and the practical emphasis is continued with appendices on test equipment and useful reference data.

The book, costing $8.95 plus shipping and handling, contains 190 pages, and is available from Electronics Technology Today, POB. 240, Massapequa, NY 11762.

Electronic Test Equipment and Applications
By T.J. Byers

Electronic Test Equipment Principles and Applications is written for the modern professional engineer or technician who must deal with complex electronic measurements and the procedures required by contemporary electronic instruments. Its blend of instrument theory and application gives the reader insight into the equipment's inherent capabilities and limitations.

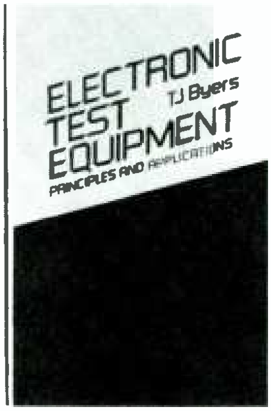
Electronic Test Equipment discusses analog instruments and procedures, emphasizing the analog instrument's role in the laboratory and field, and its limitations; digital instruments and procedures, including frequency counters and digital voltage/current meters; signal generators and waveform sources; oscilloscopes—the operation and application of analog, digital, and storage oscillo

"There's your trouble. You're going to laugh when you see all the mistakes you made assembling that unit."

BOOKSHELF

scopes; computer-based test equipment—the use of integrated PC-based instruments and the new GPIB bus.

Clearly written and authoritative, Electronic Test Equipment features exhaustive illustrations of test equipment theory and applications. Central to the book is a comprehensive analysis of measurement errors, their cause and correction. And, a detailed discussion of the



CIRCLE 97 ON FREE INFORMATION CARD

new breed of computer-based oscilloscopes and test instruments includes software routines as well as hardware operations.

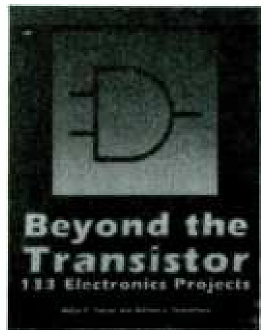
The book contains 317 pages and costs $39.95. It's available from McGraw-Hill Book Company, 11 West 19th Street, New York, NY 10011.

Beyond the Transistor: 133 Electronics Projects By Rufus P. Turner and Brinton L. Rutherford

Powerful integrated circuits, both digital and analog, are now readily available to the electronics hobbyist and experimenter. This new second edition of a popular book presents many of those devices in practical circuits readers can build at home—no experience required.

Many exciting new projects are included: a dual LED flasher, an audible continuity checker, a proximity detector, a photocell-activated night light, an electronic noise maker, a siren, a pendulum clock, a metronome, and a music box, just to name a few. The book also contains information for the novice on soldering, wiring, breadboarding, and troubleshooting electronics projects, as well as where to find and how to buy electronics parts.

With the book, readers will learn to use several of the special-purpose ICs, increase their understanding of solid-state devices, strengthen their technical



CIRCLE 88 ON FREE INFORMATION CARD

knowledge base, and above all have fun. By studying the book and building the projects, any student of electronics—whether formally enrolled in a course of study or experimenting at home—can expand his or her horizons and reach beyond the simple bipolar transistor.

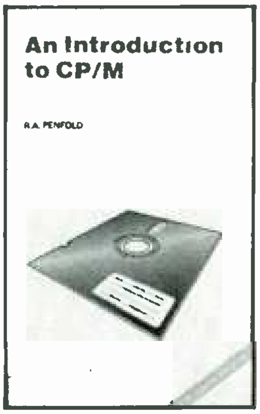
Beyond the Transistor: 133 Electronic Projects, Order No. 2887, costs $9.70 with 240 pages, from TAB Books, Inc., PO Box 40, Blue Ridge Summit, PA 17214; Tel. 717/794-2191.

An Introduction to CP/M By R.A. Penfold

For the newcomer to computing, or even for someone who has experience with computers, it can be a little difficult at first to understand the basic function of an operating system such as CP/M.

The primary purpose of an operating system is to enable the various parts, that make up a complete computer, work together in an orderly and co-ordinated way, and thus enable the computer to carry out its tasks efficiently and without crashing.

"That's strange...When I asked him if he still had a malfunction with his receiver, he didn't answer."



CIRCLE 87 ON FREE INFORMATION CARD

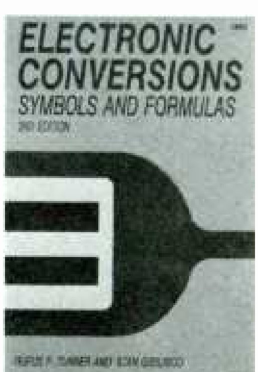
CP/M is often called a *disc operating system* which has led to the popular misconception that it is only concerned with the control and operation of disc drives. That is not the case, and while it is true that disc drives are very much at the center of things, a full rage of peripherals are controlled by CP/M.

In order to run and use programs operating under CP/M it is not essential to have an understanding of the system, but a reasonable knowledge of the subject can certainly be of immense help when minor problems occur, and also in fully exploiting the possible potential of the system. This book tells the story.

An Introduction to CP/M contains 83 pages costing $5.75, and is available from Electronics Technology Today, PO Box 240, Massapequa, NY 11762.

Electronic Conversions, Symbols and Formulas
By Rufus P. Turner & Stan Gibson

Any engineer, technician, student, or electronics hobbyist will appreciate this easy-to-use guide. Accurate, thorough, and concise, it covers all the most-needed mathematical relations, functions, tables, symbols, formulas, and conversion factors, without the fluff—



CIRCLE 85 ON FREE INFORMATION CARD

little-used and obscure facts—which clutter up other books.

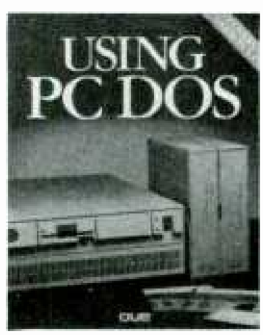
Readers have ready access to fundamental information on impedence, imaginary numbers, vectors, longwire antennas and feedlines, line and standing-wave-ratio losses, polar coordinates, the use of significant digits, and much more. The book also covers the mathematics used in electronics and explains complex numbers.

Everyone involved in any phase of electronics needs ready access to the facts found in this guide. It should prove to be a valuable addition to the library of every serious electronics enthusiast.

Electronic Conversions, Symbols and Formulas, sells for $14.60, contains 280 pages, and is available from TAB Books, Inc., PO Box 40, Blue Ridge Summit, PA 17214; Tel. 717/794-2191.

Using PC DOS, 2nd Edition
By Chris Devoney

Using PC DOS, 2nd Edition, is the newest version of the Que classic. Building on the popular first edition, Using PC, DOS, 2nd Edition, features close to 400 all-new pages, including details of PC DOS version 3.3, advice on how to cope with 3½ inch disks, information on IBM's new PS/2 equipment, and a comprehensive DOS Command Reference.



CIRCLE 98 ON FREE INFORMATION CARD

Using PC DOS, 2nd Edition, is a comprehensive tutorial and lasting reference for all DOS users, regardless of their expertise. DOS novices will learn to prepare diskettes, create, copy, rename, and erase files, manage DOS directories. More experienced users will learn to customize DOS, manipulate hierarchial directories, create batch files and internationalize DOS.

Using PC DOS, 2nd Edition costs $22.95, contains 896 pages and is available from Que Corporation, 11711 N. College Ave., Carmel, IN 46032; Tel. 800/428-5331. ■

CIRCLE 13 ON FREE INFORMATION CARD

CIRCLE 14 ON FREE INFORMATION CARD

STAR

Build an infrared and visible-delight in music from light...

By Timothy A. Riggs

The *Starlight Synth* with its wide range of sounds will amaze and entertain all who hear it. It's a sure winner with the kids (if they ever get it away from you). The wife says it sounds like *rock-n-roll*, I say it sounds *unique*.

The heart of this easy to build project is a 556 timer chip that is used to generate various tones. Unlike an electronic organ with keys or buttons, each note from the Starlight Synth is activated by an infrared (IR) emitting wand or by a photocell. The project requires two batteries, a 9-volt battery for the synthesizer unit and a 1.5-volt dry cell for the IR wand. Its minimal power requirements make the Starlight Synth convenient to operate just about anywhere. Obtaining parts for the project is very easy—all parts can be found at your local electronic-supply store. Parts are mounted on an experimenter's board or can be mounted on standard perfboard.

The values of all resistors and capacitors are not critical. In fact, you are encouraged to experiment with different values as different sounds can be produced.

Toss the Scale

The circuit can be divided up into two parts (see Fig. 1). The first, and simplest, is an astable multivibrator composed of one half of the 556, resistors R1 and R2, and capacitor C1. The pulses it generates are fed from its output pin (pin 5) to the trigger pin of the second timer circuit in the IC (pin 8).

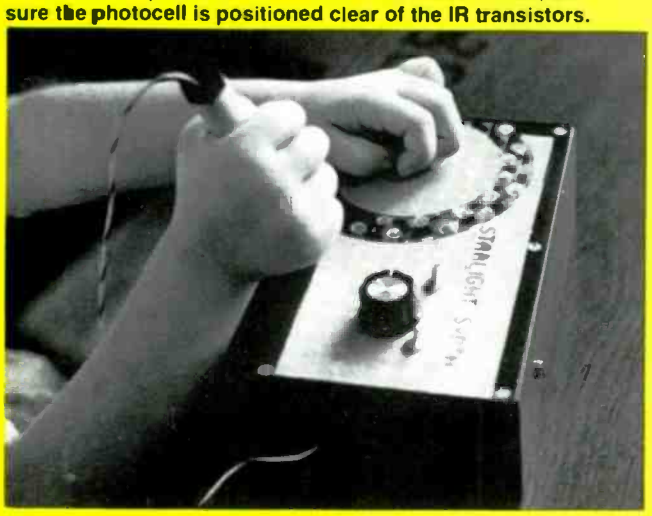
The second timer circuit is connected as a monostable pulse generator triggered by the output of the oscillator. When S2 is closed, the duration of the output pulse is determined by capacitor C2, resistor R3, and the photocell. When S2 is open, the pulse duration is determined by capacitor C2, resistor R3, and the switched resistor network (R4-R17).

Using the dual chip in this way disrupts the normal tone scale which makes for truly inventive improvisational performance. That is because the first circuit programs the time between pulses and the second circuit varies the pulse width. The output is then AC coupled to a speaker.

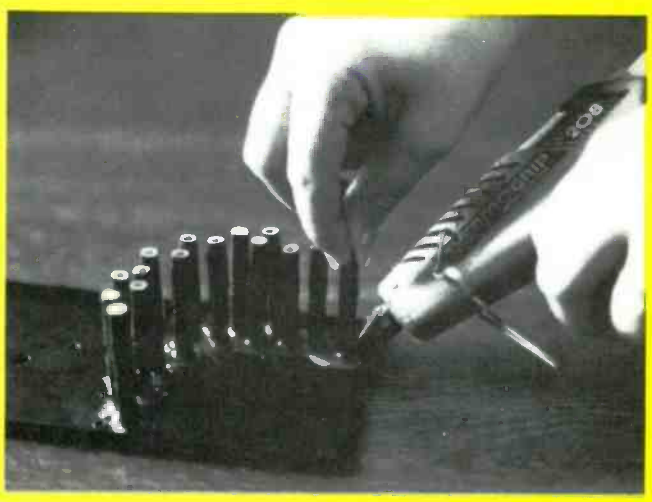
The Switched Resistor Network

Another intriguing part of the circuit is the switched resistor network. With S2 open, the duration is determined by the combined values of whatever resistors are switched into the circuit.

Once the tone range is set, the synthesizer can be played with either one or two hands depending on whether the switch for the photocell is turned on. Because of that, be sure the photocell is positioned clear of the IR transistors.



Ordinary drinking straws covered in black electrical tape are secured in place with a hot-glue gun.



LIGHT SYNTH

light activated synthesizer and take if you can get it away from the kids!

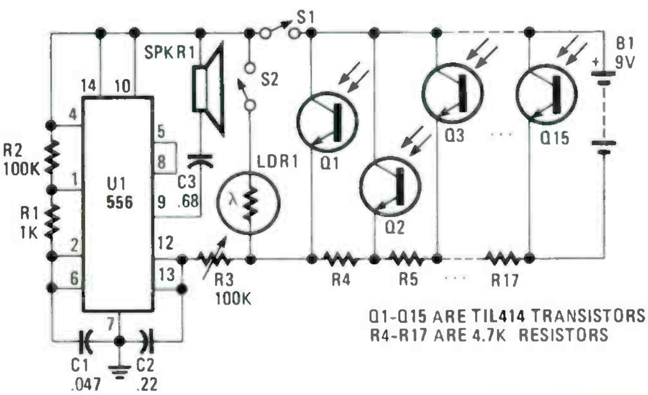
Hands-on Electronics

JUNE 1988

I used 4700-ohm resistors connected with the IR-activated switches (Q1-Q15). When an IR-activated switch goes high, one side of its associated resistor is brought close to nine volts. That makes that resistor and all resistors between it and Pin 12 part of the timing circuit. The first IR-activated switch sees the potentiometer's impedance, as no fixed resistor is connected between the switch and the chip. The second IR-activated switch switches in an additional 4.7K ohms. Activating the third switch instead, connects a further 4.7K ohms, and so on.

I found this particular resistance array produces a pleasing range of tones. Potentiometer R3 is used to set the tonal range of the resistors and the photocell.

Fig. 1—The circuit revolves around the use of a dual timer chip, the 556. The two timing circuits really work in unison to create the high and low portions of the output.



Using the Photocell

The synthesizer can be played by the IR-activated switches or in combination with the photocell. The photocell is mounted on the outside of the enclosure and produces an amazingly unique sound. The tones are actually varied by placing your hand over the photocell and allowing more or less light to reach it. That varies the amount of current that passes through the photocell which varies the tonal output.

Case Construction

The IR-activated switches must be mounted on the inside of the enclosure at the end of a 2- or 3-inch tube. I used ordinary drinking straws covered in black electrical tape. Spray paint the inside of each tube as effectively as possible to cut down on reflection inside the tube. In that way the IR LED must actually shine down the tube to reach the IR transistors and activate it, which effectively isolates each IR transistor from the others.

After selecting an enclosure and drilling the necessary holes, slip the straws in place and using a hot glue gun secure the straws in place. Next take an IR transistor and bend one leg (collector) and drop it into one end of the straw. Using the glue gun secure it in place. Repeat the procedure with the other transistors. When finished, run a common wire between all of the bent collector pins of the transistors and make sure that all of the emitter pins have no exposed wire. I covered the exposed wire with heat shrink tubing.

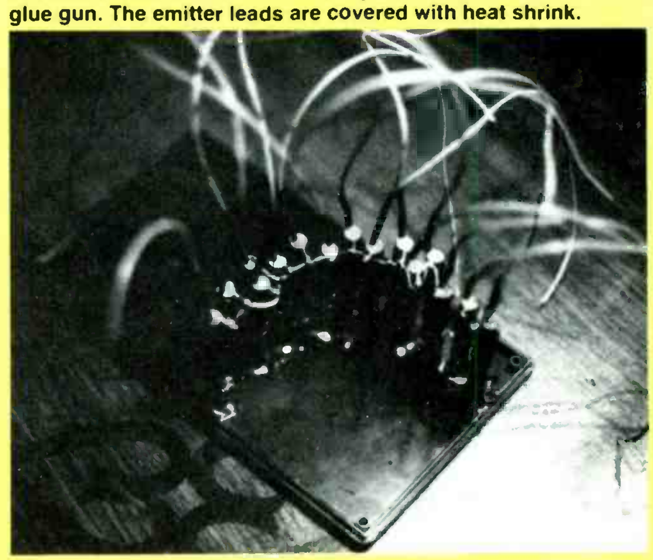
Wand Construction

The IR Wand is actually a large magic marker with the insides removed and an IR LED in its tip (a perfect fit, held

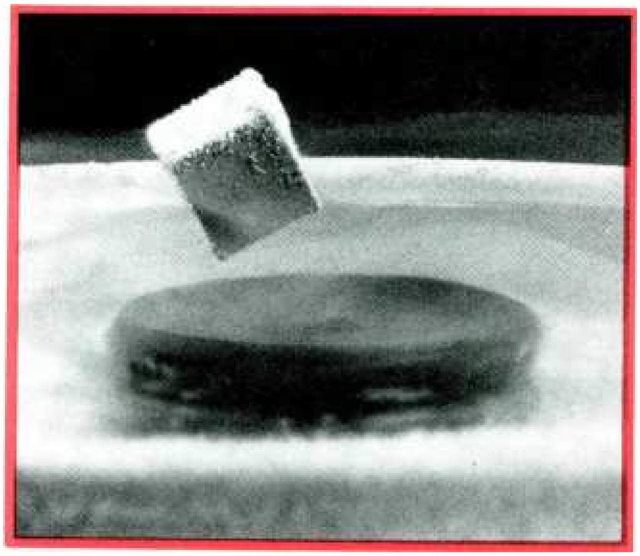
(Continued on page 103)

IR Phototransistors with one lead (collector) bent are placed into end of straws. That makes for easy wiring and lead identification when the collectors are soldered. All bent collector leads are connected with a common wire.

IR Phototransistors are secured in place with a hot melt glue gun. The emitter leads are covered with heat shrink.



SUPERCONDUCTIVITY: THE THIRD AGE OF ELECTRONICS



Now comes the dawn of a new day, a day without resistance to impede the footsteps of our giant technology. Imagine the possibilities of lossless circuits, and you'll imagine a new life!

By Jonathan L. Mayo

THESE DAYS, IT SEEMS IMPOSSIBLE TO READ A NEWSpaper, news magazine, or to watch the television news without running across a story on superconductivity. The field of superconductivity promises to change our lives as few technological advances have. It is probable that the impact of superconductivity will compare with that of the transistor. In fact, many scientists and researchers are referring to superconductivity as the "third age of electronics," following the transistor and integrated circuits.

The field of superconductivity has many aspects. At the root of the field are the many scientists who are actually developing the technology. However, the main thrust of superconductivity will be in the applications. Just as a single transistor is a mere scientific curiosity until many transistors are combined with each other and other components to make a product, such as a portable radio, the full effect of superconductivity will not be felt until it is used in many practical devices. The drive to develop such superconductivity applications is an international effort, with most of the industrialized world competing.

Despite the fact that superconductivity was first discovered in 1911, most people outside of the physics community are hearing about it for the first time. There are already many devices that incorporate superconductivity; however, they are not in widespread use.

Before continuing with any further discussion of the effects of superconductivity, it is necessary to answer the question: "What is superconductivity?" The following section gives a thorough introduction to the field of superconductivity.

The Answer

Superconductivity was first discovered by a Dutch physicist, Heike Kamerlingh Onnes, in 1911. Onnes was doing research on the effects of extremely cold temperatures on the properties of metals. While conducting his experiments, he discovered that mercury lost all resistance to the flow of electricity when cooled to around 4°K (the °K stands for degrees Kelvin, a temperature scale in which 0°K equals –459.4 degrees Fahrenheit and –273 degrees Celsius).

Up to 1911, there was no way to eliminate the resistance inherent in even the most efficient conductors. However, with the discovery of superconductivity, a new breed of conductors was developed—superconductors. Superconductors are materials which conduct electricity with practically no resistance at all. None of the electrical energy is lost when flowing through a superconductor.

A good analogy of superconductivity is a pendulum, such as a swing. No matter how hard you push a swing, it will eventually come to a stop. The energy imparted to the swing from your arms would eventually be lost to forcing the swing through the air and more significantly to friction where the ropes or chains meet the supporting device. Now imagine a swing that would never stop or diminish. Once pushed, it would continue to swing at the same rate forever. The same idea can be applied to superconductivity. In a conductor, a current would quickly diminish due to resistance. However, in a superconductor, a current would continue to flow forever because there is nothing to stop it.

Onnes, the Dutch physicist, went on to discover superconductivity in other metals. In each case, the material had to be cooled to within several degrees Kelvin to absolute zero (0 degrees Kelvin). That cooling was accomplished by bathing the soon-to-be superconductor in liquid helium. Helium, which most people think of as a gas, liquifies at about 4°K. Once the material had cooled to that temperature, it became a superconductor. Onnes once induced a current in a superconductor, formed in the shape of a ring, cooled in liquid helium. One year after removing the source of electricity, the current was still flowing undiminished in the superconductor.

Despite the perceived value of superconductivity, it was not for several decades that any useful applications were developed. One major obstacle to the development of useful superconductivity applications was the extreme cooling required. The equipment necessary to make liquid helium to cool the superconductor to the very cold temperatures was complex and expensive, and that is still true to a great extent today. Another major problem was the superconductor's inability to support a large magnetic field.

Scientists have long used electromagnets to generate magnetic fields. By flowing electric current through a loop of conducting material, a magnetic field is induced. By replacing the normal conductors with superconductors and cooling the loop to the necessary temperature, it should be possible to generate much more powerful magnetic fields than with normal conductors because of the absence of resistance and generated heat in the loop. However, initially that was not the case. Once the magnetic field grew to a certain strength, the superconductor would lose its ability to conduct without resistance and would behave as a normal conductor.

It was not until the 1940s that the magnetic field problems were solved. And it is only very recently that the problems of extreme cooling have been overcome.

Temperatures on the Rise

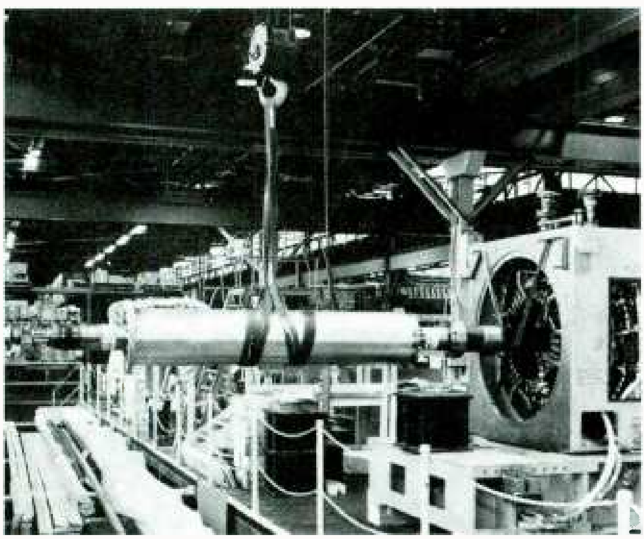
Cooling the superconducting material to temperatures near absolute zero has always been a problem. Liquid helium is used to cool the materials to temperatures around 4°K. Liquid helium is very expensive, and the cooling equipment is sizable. The cooling costs were much greater than the energy savings superconductors offered over conventional conductors, so there was no economic incentive to attempt to replace the conventional conductors with superconductors.

For those reasons, superconductivity has remained in the laboratory and for special uses where conventional conductors are not suitable, such as in extremely powerful electromagnets. If superconductivity was to move out of the laboratory, the cooling problems had to be overcome.

There are two obvious ways to overcome the cooling problems. One way is to find another means to cool the superconductors that is much less expensive and bulky than liquid helium. The second way is to raise the temperatures that are necessary to cause superconductivity in a material. By rais-

Superconducting Generator

In 1983, General Electric scientists and engineers conducted the first full-load test of a superconducting electric generator, exposing the generator to a wide range of operating conditions encountered by conventional generators on electric utility power systems. At full load, the experimental generator produced enough electricity for a community of about 20,000 people. That is approximately twice as much electricity as could be produced by a conventional generator of comparable physical size.



The General Electric experimental superconducting electric generator. The superconducting component of the machine is its 13-foot-long rotor with superconducting coils . (Photo courtesy of G.E. Research and Development Center.)

The generator's thirteen foot long rotor was cooled to close to absolute zero. By using superconductors, the generator can develop a much stronger magnetic field than a conventional generator, permitting the superconducting generator to be physically smaller for the same power output. Another advantage of the superconductors is that the electrical resistance normally associated with the flow of electricity in the rotor windings of a conventional generator is not present. That increase in efficiency could ultimately reduce the operating costs of large generators by millions of dollars.

The windings of a conventional generator are made of a copper-silver alloy. General Electric's superconducting generator has a modular field structure made from hundreds of strands of a niobium-titanium alloy in a copper matrix.

One crucial challenge in the development of the superconducting generator was preventing the rotor windings from moving under the intense mechanical and magnetic forces exerted on them. The rotor rotates at a speed of 3,600 revolutions per minute; a small movement of the components would generate enough heat by friction to degrade the performance of the superconductors.

To overcome that obstacle, the General Electric superconducting generator utilizes a special vacuum epoxy-impregnation process to bond the niobium-titanium superconductors into solid modules. An aluminum support structure is used to provide rigidity for the windings. A special flow system was developed to supply liquid helium to the spinning rotor in order to keep the winding constantly bathed in the super-cold liquid.

During tests of the superconducting generator, the electrical energy it produced was fed to an electric motor that was mechanically coupled to the generator. The electricity generated by the superconducting generator powered the electric motor which provided most of the mechanical energy necessary to spin the superconducting generator during the tests. Throughout the tests, several computers recorded data from the approximately 700 sensors installed in the experimental superconducting generator.

The experimental General Electric superconducting generator proved that the technology exists to produce superconducting generators that work as well as conventional generators. Even though the generator was constructed using older, low-temperature superconductors before the current crop of high-temperature superconductors was discovered, there are no immediate plans among any of the conventional generator manufacturers to build superconducting generators with the new high-temperature superconductors. The high-temperature materials are too new and different from the conventional low-temperature superconductors. Presently, they are difficult to form and cannot carry the required current or generate the necessary powerful magnetic fields. ■

Georg Bednorz and Alex Mueller at IBM's Zurich Research Laboratory provided the spark that ignited the excitement of the world's scientific community by their discovery of high-temperature superconductivity in a class of copper-oxide materials. (Photo courtesy of IBM.)

ing the temperature at which superconductivity occurs (called the critical temperature) in a material, less costly and less complicated cooling systems could be used.

Since liquid helium is already the best known way to cool materials to temperatures close to absolute zero, the field of superconductivity would have to wait for the development of superconductors whose critical temperatures were much higher than near absolute zero before the benefits of superconductors could be felt outside the laboratory environment.

Scientists working with materials similar to those originally used by Onnes managed to raise the critical temperature of their superconductors slightly by combining materials into superconducting alloys. By 1933, the critical temperature had been doubled to around 10°K—still very cold. It was not until 1969 that the critical temperature was doubled again to 20°K. That was a big step since hydrogen liquefies at 20°K. For the first time, another cooling agent could be used.

Four years later, in 1973, the critical temperature was raised a few more degrees to 23°K. For over a decade, scientists tried to raise the critical temperature higher. They experimented with different compounds and alloys without any appreciable success.

Then, in 1986, two IBM researchers in Zurich reported achieving superconductivity at 30°K in a totally new material. The IBM researchers, Alex Muller and Georg Bednorz, had constructed a complex ceramic material that was superconducting at 30°K. That exciting discovery prompted many superconductivity researchers to work with similar types of ceramic materials.

Later in 1986, the critical temperature was increased to 39°K. In February of 1987, Ching-Wu (Paul) Chu and his research team at the University of Houston reported developing a superconductor with a critical temperature of 98°K. The discovery excited the entire physics community because a significant barrier had been broken. Nitrogen liquefies at 77°K, well below the critical temperature of Chu's superconductor. Liquid nitrogen is relatively inexpensive and can be easily carried about in an insulated thermos. Liquid nitrogen costs less than fifty cents a liter, while liquid helium costs several dollars a liter. Now viable, it was truly possible to develop practical, efficient, and cost-effective superconductive devices.

However, the race to raise the critical temperatures is not over yet. Scientists have set their sights on a room temperature superconductor that would not require any cooling. Room temperature is about 293°K, and some laboratories have already reported obtaining superconductivity at temperatures in excess of 230°K.

There are many problems still to be resolved with the new superconductors. While their critical temperatures are much higher than those of the older superconductor materials, the new materials cannot support the flow of as much electrical current, have problems generating equally powerful magnetic fields, and are much more difficult to form into wires, loops, and other shapes. However, most researchers believe those problems will be overcome.

The Meissner Effect

If a superconductor is cooled below its critical temperature while in a magnetic field, the magnetic field is retained by the superconductor. That property is known as the Meissner effect and was first discovered in 1933. If the magnetic field is too strong, the superconductor will return to its normal state even though it is cooled below its critical temperature. One of the photos shows a magnet floating above a superconductor because of the Meissner effect.

Using a superconductor's ability to maintain a magnetic field (or flux) as a criteria, it is possible to divide superconductors into two types. The first type of superconductor (called Type I superconductors) are pure simple metals such as lead and tin. Type I superconductors will retain a magnetic field until the field reaches a certain strength. That strength is called the critical field, and the critical field varies for each superconductor. Once the magnetic field exceeds the value of the critical field, the superconductor will return to its normal state and lose its superconducting properties.

A team of scientists at AT&T Bell Laboratories has succeeded in developing superconducting wires that can easily be formed into coils. Shown here, the superconducting wire is being immersed in liquid nitrogen. The wire is clad in a metal coating for electrical, thermal, mechanical, and environmental protection. (Photo courtesy of AT&T Bell Laboratories.)

Type II superconductors behave in a slightly different manner. Type II superconductors are more complicated materials, often transition-metal alloys (transition-metals are a group of related elements in the periodic table). In a Type II superconductor, there is a second critical field which is higher in value than the first critical field. Once the magnetic field exceeds the value of the first critical field, the superconductor will no longer emit the entire field; however, the superconductor will continue to conduct without resistance until the magnetic field exceeds the value of the second critical field. Most of the superconductors of current interest are of Type II.

Current Density

Applying a large magnetic field is not the only way to destroy superconductivity once a superconductor has been cooled below its critical temperature. The passing of a large current through the material may also cause the superconductor to return to its normal state. The amount of current that a superconductor can conduct while remaining superconducting is called the current density. The current density is measured in amperes per area. For example, a typical value for the current density of a superconducting wire might be 100,000 amperes per square centimeter. Should a larger current be passed through the superconductor, the superconductor would lose its superconducting properties.

Most normal conductors, such as copper and silver, are isotropic, meaning they conduct current equally well in all directions. With an isotropic wire conductor/superconductor, it does not matter which ends of the wire are connected to the positive and negative terminals of an electrical source. However, many of the new high-temperature superconductors are anisotropic, meaning they conduct better in only one direction. Some high-temperature superconductors will carry current thirty-times more readily in one direction than in another direction.

The Josephson Effect

Another interesting property of superconductors is the Josephson effect, discovered by a British physicist. The Josephson effect is based on a phenomenon called tunneling. Tunneling occurs when a thin oxide barrier is sandwiched

Superconducting Electronics

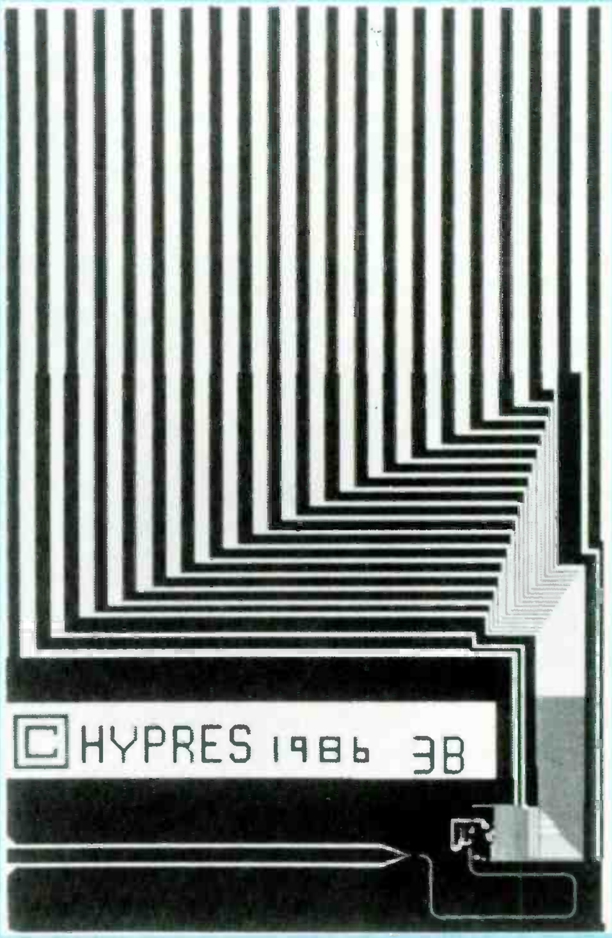
HYPRES is a corporation founded by Dr. Sadeg Faris, an ex-IBM superconductivity researcher. HYPRES was started with the intention of developing small-scale superconducting devices.

HYPRES' first commercial product, the PSP-1000, appears to be a success. The PSP-1000 is a signal-processing workstation—an advanced oscilloscope. It is capable of operating in the picosecond range and can receive five times the range of electrical signals as any competing device. The PSP in PSP-1000 stands for Picosecond Signal Processor.

Here's HYPRES' PSP-1000 Picosecond Signal Processor. It can actually handle picosecond signals, unheard of in transistor technology. (Photo courtesy of HYPRES, Inc.)

The extraordinary capabilities of the PSP-1000 are possible because of the use of superconducting electronics. To produce the PSP-1000, HYPRES had to develop many novel superconducting devices. A special integrated-circuit architecture was developed in which one corner is kept at 4.2°K (to achieve superconductivity) while the rest of the circuit is at room temperature. A cooling system in which liquid helium is sprayed on the corner of the circuit that needs to be cooled eliminated many of the cooling problems encountered by other methods such as bathing the circuit in a liquid helium bath. The spray method conserves coolant and eliminates bulk. A helium reservoir mounted inside the machine will give up to 12 continuous hours of operation.

The Josephson Junction portion of the device is constructed from a niobium alloy formed on a silica substrate. It is specially designed to take the punishment of changing temperature extremes from room temperature to near absolute zero. The PSP-1000 itself is a transportable digital instrument with a built-in 13 inch color monitor. ■



HYPRES' superconducting IC chip will work with less power drain and at higher speeds then ever before possible. CMOS's move over. (Photo courtesy of HYPRES, Inc.)

IBM scientists are measuring a superconducting material. The graph on the upper monitor shows the sudden drop in electrical resistance of the material as its temperature drops below the superconductivity transition temperature after immersion in liquid nitrogen. (Photo courtesy of IBM.)

between two superconductors. The two superconductors are coupled together and the current flowing through them is measured. When the superconductors are exposed to various magnetic fields and radiation, the current flow is changed because some electrons will jump through the oxide barrier (that is tunneling). The effect can be used to detect very faint magnetic fields and in computer circuits.

Recent studies have shown that the Josephson effect may occur at temperatures much higher than the critical temperature of the superconducting material.

Theories

Since the discovery of superconductivity in 1911, scientists have attempted to explain why superconductors act as they do. Developing a theory that explains the various properties of superconductivity would allow scientists to develop new and better superconductors as well as learn more about the behavior of the materials. In 1957, three researchers, John Bardeen, Leon Cooper, and J.R. Schrieffer, published a theory attempting to explain how superconductors work. The theory has become known as the BCS theory, and the three researchers received the Nobel prize for its development.

Keep in mind that in 1957, high-temperature superconductors under development today did not exist. The BCS theory attempts to explain superconductivity at temperatures close to absolute zero. When materials are cooled close to absolute zero, their atomic motion slows down dramatically.

The BCS theory states that as electrons flow through the superconductor, they join up in pairs (called Cooper Pairs). The electron pairs are coupled together by phonons, which create a kind of subatomic glue. As an electron flows through the lattice structure of the superconductor, it leaves behind a wake which serves as a path for the electron behind it. The wake serves as a pathway through the lattice obstacle course for other electrons to follow, thus avoiding collisions with other particles that would disrupt the flow and generate chaos within the lattice (as happens in normal conductors).

The BCS theory takes the reduced molecular activity of the atoms in the superconductor's lattice structure into account when explaining how the electrons can flow through the lattice without interference from other particles. The BCS theory explains how a superconductor loses its ability to conduct without resistance when its temperature is greater than its critical temperature. According to the theory, as the temperature of the superconducting material increases above its critical temperature, the atomic vibrations within the material increases to the point where the lattice structure begins to vibrate too much. The increased vibration causes the electron pairs to break apart and disrupt the phonon wake, causing a loss of superconductivity.

The magnitude of lattice vibrations is directly related to temperature. Absolute zero (0°K) is the starting point where all atomic vibrations have stopped. It is impossible to lower the temperature any further, hence the name "absolute zero." As the temperature rises above absolute zero, the magnitude of the atomic vibrations increase. The temperature of a material is just a measure of its atomic motion.

The melting point of a material (such as ice) is simply the transition temperature where the atomic vibrations have become so great that the lattice forces are no longer strong enough to hold the atoms in their lattice positions, and the atoms are free to move around. The result being that the rigid solid (ice—in the case of water) has turned into a liquid. As the temperature continues to rise, there comes another transition temperature where the atomic motion is so great that the atomic attractions in the liquid can no longer hold the atoms together, so the material becomes a gas.

Since the new high-temperature superconductors have critical temperatures well above absolute zero, the BCS theory seems to no longer explain why superconductivity occurs in these new materials. The high-temperature superconductor's critical temperatures are much too high for the expected reduced atomic vibrations to take place as with the older superconductors. However, most theorists still believe the electrons flowing through a high-temperature superconductor must pair up.

More Particles

Finding a reason for the pairing of electrons in the high-temperature superconductors has proven difficult. Experimental physicists are coming up with new, even higher-temperature superconducting materials faster than the theorists can explain them. Current theories contribute the electron pairing to an atomic mechanism much stronger than the phonons of the BCS theory. The exciton is such a mechanism.

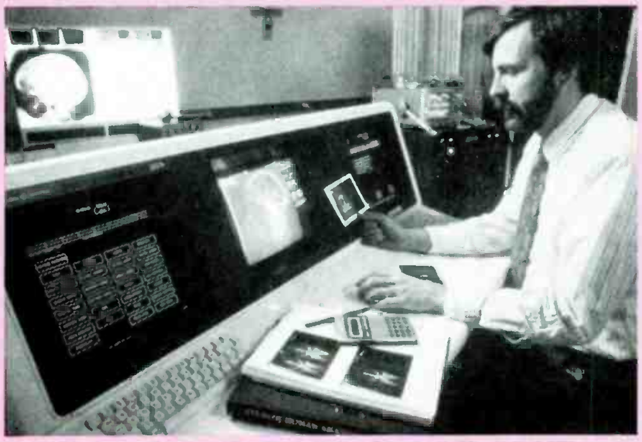
The exciton (called such for electronic excitation) is a much stronger medium than phonons and can continue to operate at high temperatures. When the new high-temperature superconductors are cooled to their critical temperature, the vibrations of the lattice structure are synchronized in such a way that the electrons are guided through the lattice. Other theories advance various mechanisms for pairing the electrons at the higher temperatures.

One theory uses plasmons (the collective motions of electrons) as the pairing mechanism. Another uses magnons which are spin fluctuations travelling through the lattice, a kind of path that the electrons can follow to avoid obstructions. The RVB (Resonating Valence Bond) theory is based on electron-electron repulsion; since electrons are of like charge, they repel each other causing the electrons to push their way through the lattice.

Superconducting in Medicine

MRI is an acronym for *M*agnetic *R*esonance *I*maging. MRI is the medical term for a scientific system known as Nuclear Magnetic Resonance (denoted NMR) Spectroscopy. Put simply, MRI is a method for viewing the inside of the human body by noninvasive means.

MRI images are similar in many respects to a CAT scan. Computerized Axial Tomography (CAT for short) scanning is a system in which X-ray data are recorded from many angles. The X-ray data are mathematically reconstructed to give cross-sectional anatomical views of the body. However, CAT is not sensitive to soft tissue and exposes the patient to radiation. MRI is much more sensitive to soft tissue and does not expose the patient to X-ray radiation.



Shown here is the control panel of a General Electric MRI system. On the computer screen is an image of the major blood vessels in the head and neck. (Photo courtesy of General Electric Research and Development Center.)

The process of MRI works by exposing a human body to a strong magnetic field generated by a superconducting electromagnetic coil. When the human body is exposed to a magnetic field, the protons in the water and other molecules align themselves relative to the magnetic field. A burst of radio frequency energy having the correct resonant frequency is applied, causing the protons to become excited. When the burst decays, the protons return to their former state with a release of energy. The energy is detected and used to create an image. By altering the magnetic field, images of the body representing different anatomical sections can be obtained.

There is no widely accepted theory to explain how high-temperature superconductivity occurs. For the older generation of superconductors with critical temperatures near absolute zero, the BCS theory suffices. However, a new theory must be found for the newer high-temperature superconductors that takes their increased atomic activity into account. Since new superconducting materials with even higher critical temperatures are now being developed, it is doubtful that an all-inclusive theory of superconductivity will be advanced and widely accepted for some time to come.

Ceramic Superconductors

The recent crop of high-temperature superconductors have been developed in research laboratories around the world. Most researchers felt that they had done all that was possible to raise the critical temperature of the older, low-temperature superconductors. Some decided to look for other materials and compounds that might become superconducting at higher temperatures.

Several European researchers began to experiment with a type of crystal, called perovskites. In 1986, Alex Muller and Georg Bednorz, IBM researchers, performed superconductivity experiments with a perovskite and were shocked to discover that the compound became superconducting at a temperature higher than previously recorded. They eventually published their discovery, which was met with some skepticism until their experiments were repeated at other laboratories. In September 1987, Muller and Bednorz were awarded a Nobel Prize for their discovery.

Soon, laboratories and research facilities of universities and corporations around the world were conducting superconductivity research using the perovskite ceramic-like compounds. By changing some of the atomic ingredients of the compound and varying the manufacturing process, researchers were able to increase the critical temperature at which the material became superconducting.

Manufacturing the new ceramic perovskite superconductors is relatively easy; they could be made in most any moderately equipped laboratory. The first step in the process is mixing and heating the ingredients. Oxides of the metals Yttrium (Y), Barium (Ba), and Copper (Cu) are combined with citric acid and ethylene glycol. The mixture is heated to around 100 degrees Fahrenheit.

Then the heated mixture is place in a furnace where it is heated to over 1,500 degrees Fahrenheit, vaporizing the liquid components and causing the remaining material to crystallize into a black powder. The powder is compressed in a special furnace that generates about 2,000 pounds of pressure per square inch. The resulting block of material is gradually cooled over several hours.

Once cooled, the material is placed in a bath of liquid nitrogen to test for superconductivity, as shown in the photo. A resistance meter is connected to the cooled material to measure its electrical resistance. If the meter registers no resistance, it indicates that superconductivity has probably been obtained. If the material also exhibits the Meissner effect, the material is a true superconductor. Researchers may also conduct other experiments with the material to determine its other superconducting characteristics such as current density and critical field.

Manufacturing Superconductors

Now that new, high-temperature superconducting materials have been developed and tested, the laboratories are attempting to create useful forms out of the material. A chunk of superconducting material is not of much practical use beyond testing. To construct practical superconducting devices using the high-temperature superconductors, it is necessary to fabricate the material into wires, tapes, and other forms.

Scientists at the Argonne National Laboratory in Argonne, Illinois were the first American researchers to have formed the new superconductors into the shape of a wire. The ability to shape the material into a wire is an important step towards someday using it in electrical motors and other electronic and magnetic devices. The wire produced at Argonne is about one-hundredth of an inch in diameter. By making the wire so thin, the brittle ceramic material usually remains relatively flexible.

IBM researchers have found a way to "spray paint" large and complex surfaces with high-temperature superconductor material (see Figs. 5 and 6). That raises the prospect of inexpensive, easy-to-apply magnetic shielding, computer wiring, and other applications. Using a common industrial technique called plasma spraying, the superconducting material is quickly heated to thousands of degrees and instantly deposited on a surface where it resolidifies. After the coating, the object is annealed (heated), after which the coating becomes superconducting after cooling.

It is a safe assumption that most of the firms which currently manufacture commercial superconducting materials are conducting research into commercial fabrication of the new, high-temperature superconductors. There are still many problems to be solved before the new superconductors will stand a chance of replacing the older, established low-temperature superconducting materials. The new superconductors are not as flexible, do not generate equally powerful magnetic fields, and have lower current densities. However, most researchers believe that it is only a matter of time before the performance of the new materials will equal or exceed those of the older superconductors.

The Applications

Superconductors offer four main benefits over normal conductors that might be exploited in applications. Superconductors conduct electricity without energy loss, so they might be used in place of conventional conductors to save energy. Because superconductors have no electrical resistance, they do not give off any heat. In a conventional conductor, the energy lost due to resistance is given off as heat. That heat has limited the degree to which electrical circuits can be packed together. Using superconductors, electrical circuits can be packed tightly together with no concern for heat build-up.

The third advantage to superconductors is their ability to generate powerful magnetic fields. Very powerful fields can be generated from relatively small superconducting electromagnets. Finally, superconductors can be used to create Josephson Junctions.

Josephson Junctions, named after the British scientist who developed them, are superconducting switches based on the Josephson effect. They are much like transistors; however, Josephson Junctions are capable of switching 100 times faster. And when two Josephson Junctions are connected together in a certain way, they are capable of detecting minute magnetic fields. Those very sensitive magnetic-field detectors (or magnetometers) are commonly called *SQUIDs* for *S*uperconducting *Q*uantum *I*nterference *D*evices.

The capabilities of superconductors open the doors for a wide variety of new applications. Current conventional applications can be made more efficient, sensitive, and faster. In addition, superconductivity has been used to develop a number of unique applications that have not been possible before.

Power Systems

One benefactor of superconductivity might be power systems. Power systems encompass all the systems used to produce and distribute electricity. Starting with the generators at power plants, and continuing through the distribution network to individual consumers, superconductivity could save much energy and money compared with conventional systems.

Generators wound with superconductors rather than conventional copper wire could generate the same amount of

By adapting a technique called plasma spraying, IBM scientists were able to coat a variety of large and smaller objects with high-temperature superconducting material. Superconductive circuitry can thus be made. (Photo from IBM.)

electricity with smaller equipment and less work. Once the electricity is generated, it can be distributed through a network of superconductors. Conventional conducting systems waste up to twenty percent of the electricity put into them because of resistance.

Once the electricity reaches the consumer, it can be used more efficiently in some appliances because they would contain electric motors wound with superconductors and superconductive electronic circuits.

Electronics

Of all the areas to be impacted by the new high-temperature superconductors, electronics will probably be the first. Electronic devices are typically small scale and self contained, an advantage over large scale applications that combine many technologies. Work developing superconductive electronics has been going on for the past few decades using the older, low temperature superconductors with some success.

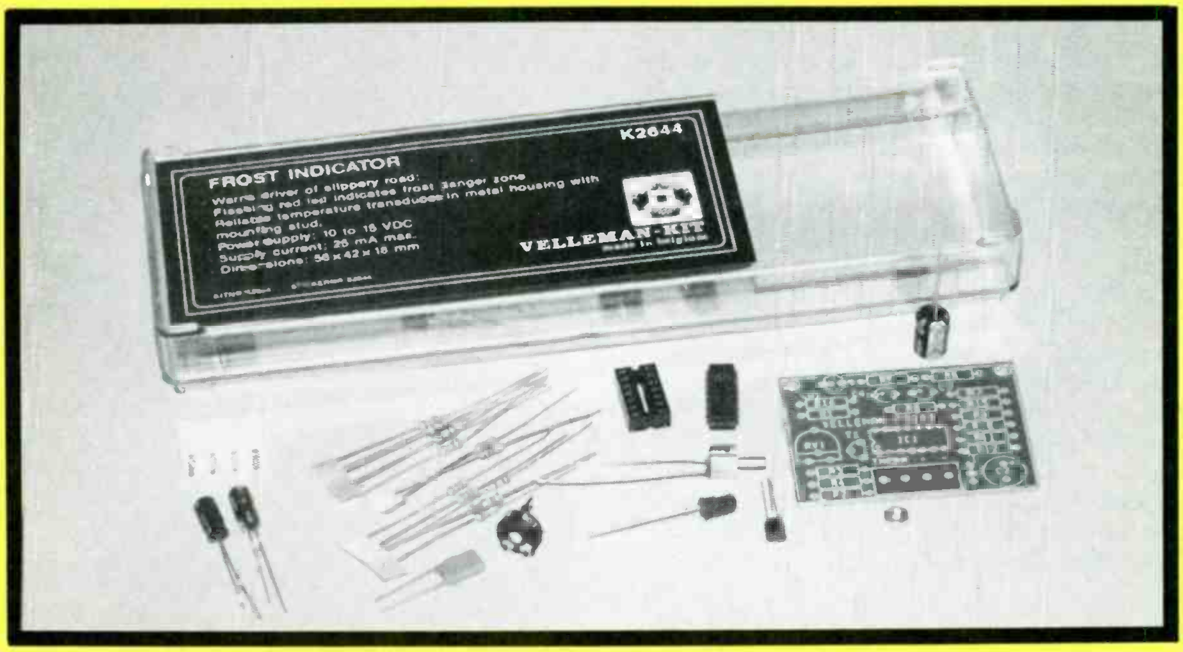
A major anticipated application of superconductivity in electronics is in the area of high-speed; high-density integrated circuits. Integrated circuits have truly revolutionized electronics over the past two decades. Without ICs, it is safe to assume that most of the electronic devices we have today would not have been developed.

Superconductivity allows for the design and construction of a new breed of integrated circuits with tremendous capabilities. Heat is an enemy of integrated circuits. Integrated circuits will quickly fail if they operate at temperatures exceeding their design specifications. Designers of electronic equipment take care to design and space integrated circuits so that the heat is able to dissipate.

By replacing the electric circuits with superconductors, there will be no heat generated. Thus, the circuits can be packed closer together, reducing the time required for the electric signals to travel from one area of the circuit to another. That will allow more complex and faster circuits to

(Continued on page 95)

ASSEMBLE THE FROST INDICATOR



Don't let the highway give you the cold shoulder. Let the frost indicator warn you of ice before a chilling accident occurs

By Damon Frund

MY DAUGHTER CALLED TO TELL ME THAT EVERYTHING was all right. She said that she was driving home from a skiing trip on an interstate highway for over two hours when suddenly what was thought was a patch of water turned out to be slick ice. The car was banged up as it spun off the road, but luckily she and the children, all wearing passenger restraints, were uninjured. Unknown to her, the late-afternoon air temperature had dropped below the freezing mark. Frost and thaw are very difficult for a driver to sense while driving in a heated car.

What she, and every driver who experiences freezing weather, needs in their car is a Frost Indicator. The device, which can be built in one evening, has an easy-to-spot warning indication. A red light-emitting diode (LED) starts to flicker when a temperature sensor outside the car detects a drop in temperature to +3°C (37°F). The LED's flickering gets longer when the outside temperature gets lower; and, the LED remains continuously on when –3°C is reached.

Although we are coming into the summer season, don't let last winter's disastrous events go forgotten, and next winter you are heard to say, "Why didn't I build that Frost Indicator when I had the time?"

How It Works

The integrated circuit chip LM324 (U1) is a quad opamp with all four sections used in the Frost Indicator circuit.

U1-a is used to supply a constant current to thermistor which is used as the temperature sensor, SR1. That is done by regulating the voltage drop across resistor R4. Potentiometer R15 allows calibration of sensor SR1 by adjusting the current applied to it. Both sensor SR1 and resistor R2 share the collector load of transistor Q1.

Current passing through transistor Q1 is regulated by U1-a. As SR1's resistance is increased by a dropping temperature (it has a negative temperature coefficient), less current will flow through Q1 and the voltage drop across R4 will drop. U1-a senses that slight voltage decrease across R4 and increases the current through Q1. That causes a decrease in voltage at the junction of the collector of Q1, SR1, and R2. U1-b buffers and amplifies the temperature-dependent voltage. The voltage from U1-b decreases when temperature lowers.

Opamp U1-d is wired as a slow-running oscillator. It's sawtooth output is compared with the temperature-dependent voltage by comparator U1-c. If the temperature exceeds 3°C (37°F), then the temperature-dependent voltage won't exceed the oscillator voltage, thus keeping the comparator's output high and LED1 turned off. If the temperature is between –3°C and +3°C, then periodically the oscillator output will exceed the temperature-dependent voltage, thus causing the comparator output to go low and switching on LED1 once each sawtooth cycle. The LED's flashing frequency is the same as the oscillator frequency.

The flashing period for each on-off cycle gets longer when temperature goes lower. Light-emitting diode LED1 stays on continuously when the temperature is lower than $-3°C$, as the oscillator voltage is then always higher than temperature-dependent voltage.

The supply voltage should be between 10- to 15-volts DC. The Frost Indicator draws only 25 mA when LED1 is on. You may want to consider adding a filter circuit in front of the Frost Indicator with some series resistance and/or diode protection to overcome the possible high negative-voltage spikes caused by the starter motor and other appliances in the car. You can get real fancy and include a Zener voltage regulator at 10- or 11-volts DC. Thus, when the battery voltage drops somewhat when appliances are turned on or when the battery is weak, the Frost Indicator will operate accurately for sure.

Construction

Before you build, you must obtain the parts which are itemized in the Parts List. Most of the parts (printed-circuit board, parts mounted on the board, and the NTC thermistor sensor) are available from Tapto Corporation in kit form. See the Parts List for additional information.

Begin assembly by mounting all the parts onto the pre-drilled, tinned, printed-circuit board. Silk-screen information helps you get the parts into the correct place. If you want to do it your way, you can use perfboard construction and point-to-point wiring. Once the parts are all in place, inspect your work carefully.

Mount the light-emitting diode LED1 on the printed-circuit board. It can be relocated later.

Prepare the sensor for installation in the car. The sensor has a metal housing with mounting stud. After a suitable place to fit the sensor has been selected, measure how long the connecting, two-wire, sensor cable should be. Purchase the wire from an automotive store that carries wire intended for automotive use. Get the lowest current rating available. That will reduce cost and give you a flexible wire easy to work with. Add on a foot or two to the length you measured to play safe—kinks and bends chew up the length quickly. Do not splice the two-wire cable. It will take the worst the road has to offer—dust, water, salt, vibrations, and sand and pebble impacts—all of which will work to weaken the spliced area.

Special care should be taken to make a waterproof connection between the thermistor sensor and the cable. Fit shrink tubing on both leads of the cable. Solder the terminals and then push shrink tubing over the solder connections. Apply

PARTS LIST FOR THE FROST INDICATOR

SEMICONDUCTORS

LED1—Light-emitting diode, red
Q1—BC547, BC548, or BC549 transistor
SR1—Thermistor, NTC resistor, with metal case and mounting screw
U1—LM324 quad opamp, integrated circuit or equivalent

RESISTORS

(All fixed resistors are ¼-watt, 5%-precision units.)
R1, R2—27,000-ohm
R3, R4—2200-ohm
R5, R6—4700-ohm
R7–R12—100,000-ohm
R13—220,000-ohm
R14—680-ohm
R15—1000-ohm, PC-mount, trimmer potentiometer

CAPACITORS

C1—.001-µF
C2—100-µF, electrolytic
C3, C4—4.7-µF, electrolytic

Suitable plastic or aluminum box to protect the circuit, printed-circuit materials, automotive-grade insulated wire, 14-pin socket for U1, 4-post screw-connector terminal strip, wire, solder, hardware, etc.

A complete set of parts that mount on the printed-circuit board, the printed circuit board, and the thermistor sensor can be purchased as the Frost Indicator Kit K2644 from Tapto Corporation for $23.95 which includes postage and handling. Send order to Tapto Corporation, PO Box 44247, Denver, CO 80201; or call 1-800-873-8001 (to order only).

For a catalogue of kits and other interesting products you can write to Tapto at the address above, or circle No. 90 on the Free Information Card.

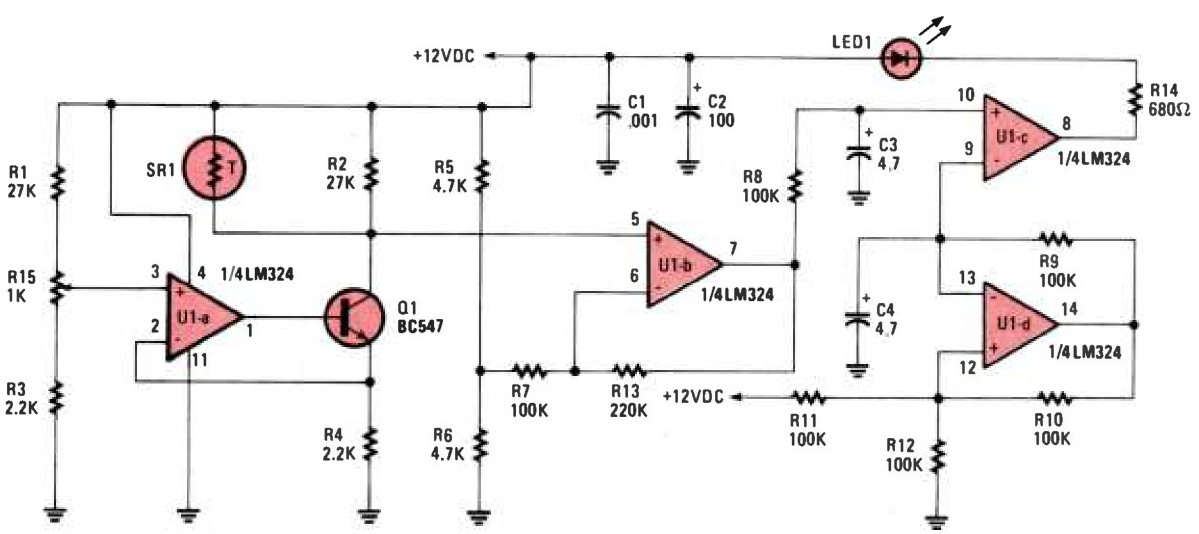


Fig. 1—The Frost Indicator schematic diagram makes the project look more complex than it really is. The four opamps are packaged in one chip. You spend more time setting up to work on the Frost Indicator and cleaning up afterwards than the actual time spent soldering the parts to the PC board.

Here are your free *FactCards!*

Introducing Hands-On-Electronics® *FactCards*.

Each issue, **Hands-On-Electronics®** will present 3 new *FactCards*, each dealing with one of a variety of electronics topics. Some will deal with electronics basics, some will deal with discrete components, some will deal with IC's, and some will deal with circuits and applications.

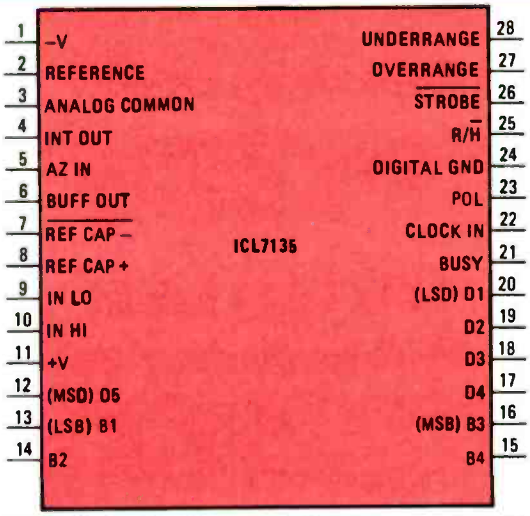
All will contain the type of information electronics hobbyists need, but sometimes must search to find. With *FactCards*, you can find that information in a hurry.

Clip your cards, save them, and start building your *FactCards* library today!

Hands-on Electronics

---

73 Hands-on Electronics FactCard — ICL7135: 4½ Digit A/D Converter



FEATURES

- Accuracy guaranteed to ±1 count over entire ±20,000 counts (2.0000 volts full scale)
- Guaranteed zero reading for 0 volts input
- 1pA typical input current
- True differential input
- True polarity at zero count for precise null detection
- Single reference voltage required
- Over-range and under-range signals available for auto-ranging capability
- All outputs TTL compatible
- Blinking display gives visual indication of over-range
- Six auxiliary inputs/outputs are available for interfacing to UARTs, microprocessors or other complex circuitry
- Multiplexed BCD output versatility

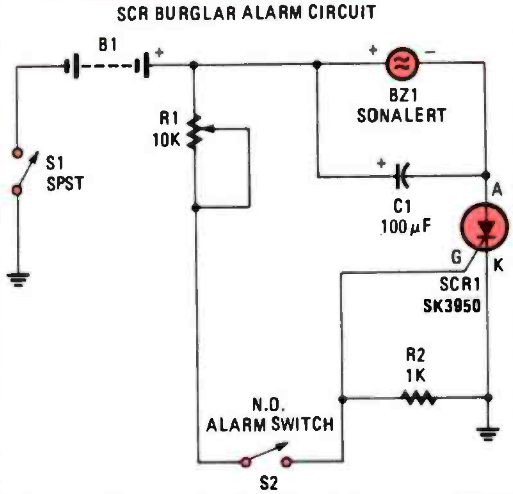
ABSOLUTE MAXIMUM RATINGS

Ceramic Package	1000mW
Plastic Package	800mW
Operating Temperature	0°C to +70°C
Storage Temperature	−65°C to +160°C
Lead Temperature (Soldering, 10 sec)	300°C
Supply Voltage V⁺	+6V
V⁻	−9V
Analog Input Voltage (either input) (Note 1)	V⁺ to V⁻
Reference Input Voltage (either input)	V⁺ to V⁻
Clock Input	Gnd to V⁺

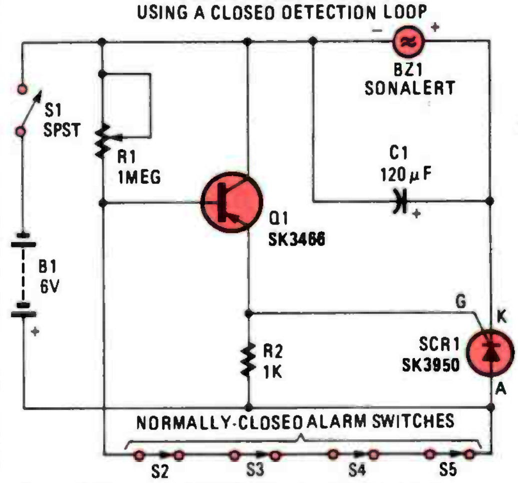
---

74 Hands-on Electronics FactCard — Thyristors Circuits

SCR BURGLAR ALARM CIRCUIT

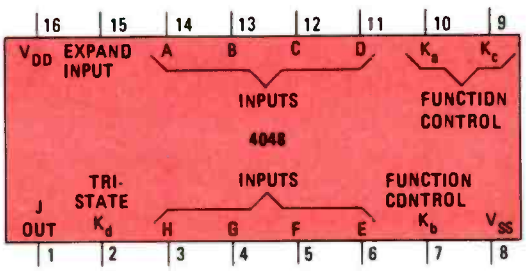


SCR BURGLAR ALARM CIRCUIT USING A CLOSED DETECTION LOOP



---

75 Hands-on Electronics FactCard — 4048: Tri-State Expandable 8-Function 8-Input Gate



FEATURES

- Wide supply voltage range — 3.0V to 15V
- High noise immunity — $0.45V_{DD}$ (typ.)
- High sink and source current capability
- TTL compatibility — drives 1 standard TTL load at $V_{CC} = 5V$, over full temperature range
- Many logic functions in one package

ABSOLUTE MAXIMUM RATINGS

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

RECOMMENDED OPERATING CONDITIONS

V_{DD} Supply Voltage	3V to 15V
V_{IN} Input Voltage	0V to V_{DD}
T_A Operating Temperature Range	
CD4048BM	−55°C to +125°C
CD4048BC	−40°C to +85°C

73 Hands-on Electronics FactCard — ICL7135: 4½ Digit A/D Converter

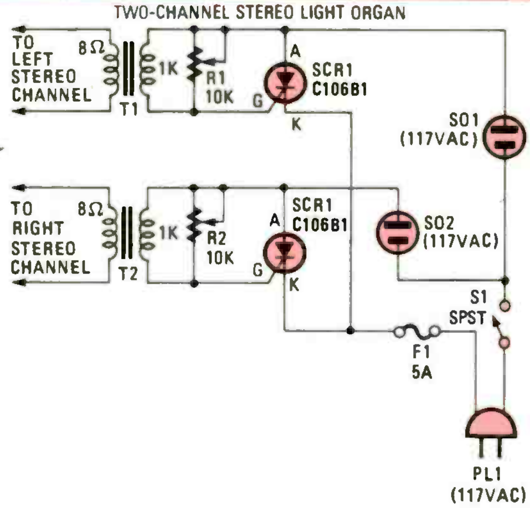
ELECTRICAL CHARACTERISTICS

	Characteristics	Conditions	TYP	UNITS
ANALOG	Zero Input Reading	V_{IN} = 0.0V Full Scale = 2.000V	±0.0000	Digital Reading
	Ratiometric Reading	V_{IN} = V_{REF} Full Scale = 2.000V	+0.9999	Digital Reading
	Linearity over ± Full Scale	$-2V \le V_{IN} \le +2V$	0.5	Digital Count Error
	Differential Linearity	$-2V \le V_{IN} \le +2V$	.01	LSB
	Rollover error	$-V_{IN} \equiv +V_{IN} \approx 2V$	.01	Digital Count Error
	Noise	V_{IN} = 0V Full scale = 2.000V	15	µV
	Leakage Current at Input	V_{IN} = 0V	1	pA

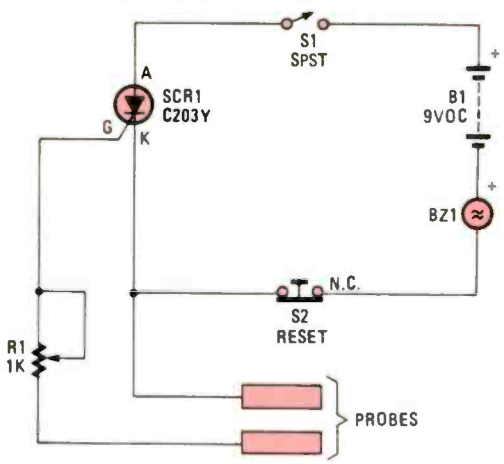
		Characteristics	Conditions	TYP	UNITS
DIGITAL	INPUTS	Clock In, Run/Hold	V_{IN} = 0 V_{IN} = +5V	2.2 1.6 0.02 0.1	V mA µA
	OUTPUTS	All Outputs B_1–B_8, D_1–D_5, BUSY, STROBE, OVER/UNDER-RANGE POLARITY	I_{OL} = 1.6ma I_{OH} = −1mA I_{OH} = −10µA	0.25 4.2 4.99	V V V
	SUPPLY	+5 Supply		+5	V
		−5 Supply		−5	V
		+5 Supply Current	f_c = 0	1.1	mA

74 Hands-on Electronics FactCard — Thyristors Circuits

TWO-CHANNEL STEREO LIGHT ORGAN



SCR CONTINUITY CHECKER CIRCUIT

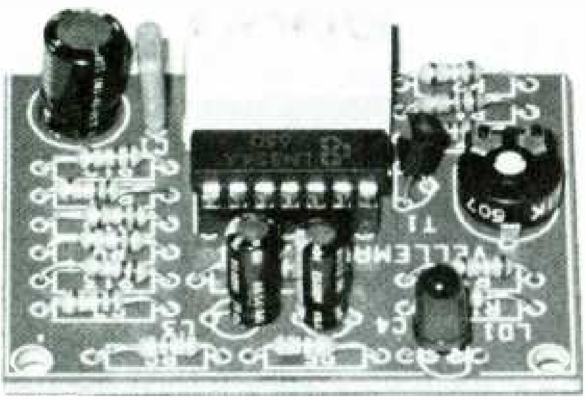


75 Hands-on Electronics FactCard — 4048: Tri-State Expandable 8-Function 8-Input Gate

STATIC ELECTRICAL CHARACTERISTICS

CHARACTERISTIC	CONDITIONS V_O (V)	V_{IN} (V)	V_{DD} (V)	LIMITS at 25°C (Typ.)	UNITS
Quiescent Device Current, I_{DD} Max.	—	0,5	5	0.01	µA
	—	0,10	10	0.01	
	—	0,15	15	0.01	
	—	0,20	20	0.02	
Output Low (Sink) Current I_{OH} 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	
3 State Output Current, I_{OUT}	0,18	0,18	18	$\pm 10^{-4}$	µA

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



The kit supplied by Tapto Corp. contains a board made by Vellman complete with silk screening for proper placement.

heat to the shrink tubing for a firm fit. You can heat the tubing with a soldering iron (do not touch the tubing); or match or lighter flame (do not char the tubing); or hair-dryer set at the highest heat.

Cover the cable-sensor connections with RTV cement, resin paste, or epoxy to make them waterproof. Do not dip the entire sensor in the waterproofing gunk. Cover the metal part of the sensor with as little waterproofing gunk as possible. The waterproofing gunk sets up a thermal barrier that makes the thermistor sensor react slower on temperature variations. Keep in mind where the sensor is going on the car—you may have to pre-shape the gunk-covered leads before the waterproofing material hardens.

Test and Calibration

Check the assembled printed-circuit board carefully before proceeding. Check for correct placement of parts, especially those that are polarized. Inspect your soldering for cold-solder joints, solder bridges, and wiring errors. If any, take corrective steps before proceeding. Do not mount the printed-circuit board in a box just yet.

Connect the sensor's cable to the THERM terminals on the terminal strip—the thermistor sensor is not polarized. Connect a 12-volt, DC supply to the + and – terminals. Check the polarity of the power supply very carefully before turning power on.

When power is applied, LED1 may be on for a short while, but should then extinguish as the temperature in your lab is far above 3°C (Eskimos excepted).

The calibrating temperature is 0°C or 32°F. Put the sensor in a container that is packed with ice and add cold tap water. After a short stabilizing period of a few minutes, the melting ice and chilled water will keep the mixture at 0°C. Gently stir the mixture. As long as not all of the ice is melted the temperature will be at 0° C.

Now adjust potentiometer R15 so that LED1 will flash with equal intervals of on and off. Remove sensor SR1 and the flash period will diminish until LED1 goes dark. The parameters of the circuit are such that LED1 will be off when the temperature is +3°C and higher. Now place sensor SR1 in a freezer and the flashing will begin again, LED1 staying on longer each moment until it is continuously on. When LED1 just stays on continuously, the temperature is 3°C below freezing.

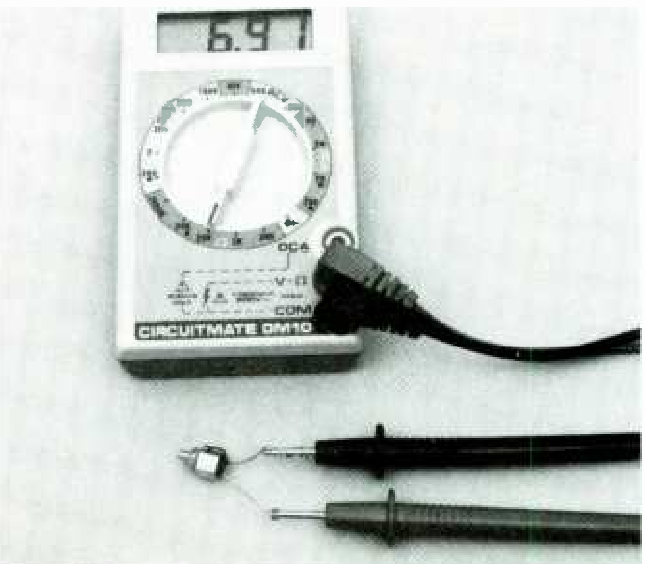
Packaging

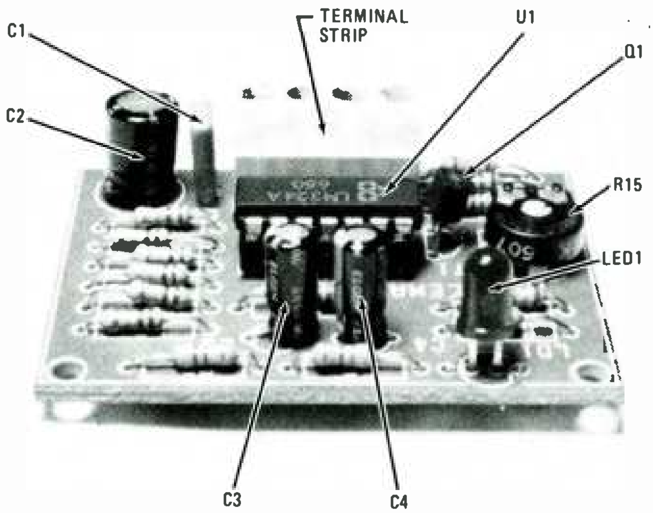
Mount the printed-circuit board in a plastic box. A hole has to be drilled to pass the six leads that bring power and connect to the sensor and LED.

The light-emitting diode should be mounted on the car's dashboard as close to the centerline vision of the driver as possible. When it comes on, the warning should be seen immediately. The LED replaces LED1 mounted on the board. Two wires from the LED on the dashboard connect to the two holes along side the LED on the board. Disconnect LED1 for it will not be needed. Remember to observe the polarity of the LED when making the connection.

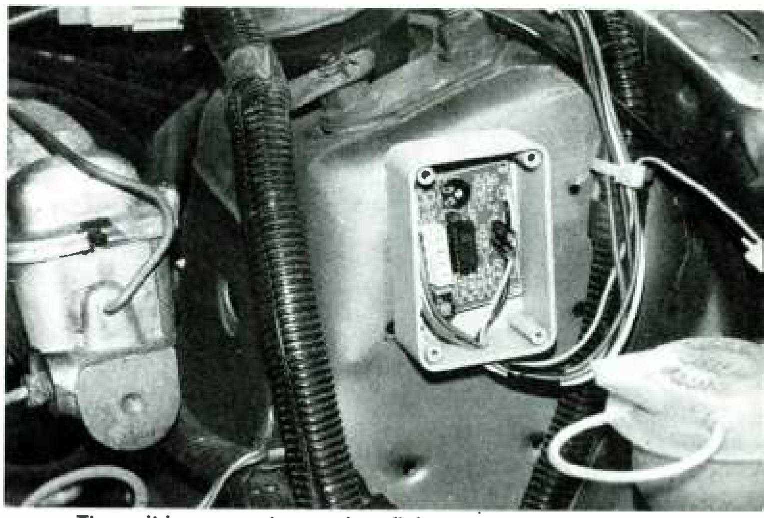
Connect the power ground lead to the car's frame as close as possible to the box (providing your car has a negative ground, otherwise switch the leads). There is no need for a long lead. The power lead connects to any accessory or

When the resistor is in a low-temperature environment (such as ice water), its resistance is higher than it is at room temperature. Measuring the current though it is an indirect way of measuring the temperature, because the current will fall with the temperature as the resistance rises.

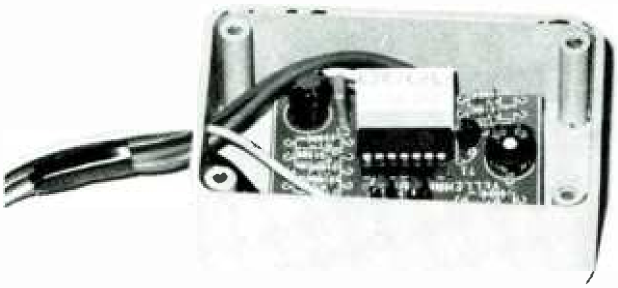




The components requiring the most care in orientation are pointed out in this photo. Be sure that the lead input side of the terminal strip faces outward for quick connection.



The unit is compact enough to fit in any spare space under the hood. Be sure you do not place it in the way of your next tune-up; removing it to change a plug is a pain. The plastic box comes with an aluminum cover plate which should be installed after the unit is adjusted. Wires leave the box from the bottom, providing a natural drain should water somehow enter the box. If necessary seal the cover to the box with some RV cement or acrylic/silicone caulk.



Remember to snake the wires through the hole in the case before connecting them to the connection block. Tape or cable ties should be used to keep the wires in a manageable bundle. The author used velcor strips with self-adhesive backing to mount the printed-circuit board to the bottom of the plastic box. Thus, quick removal is possible, should servicing or inspection be necessary. If your board is mounted in a small plastic box, connect lengths of automotive-grade wire to the terminal strip before mounting the printed-circuit board.

ignition wire that is on when the motor is running. At the point where you tie into the car's harness, include an in-line fuse holder and ½-ampere fuse.

The remaining two leads are the sensor's cable and these connect to the THERM screw-posts and the terminal strip. The sensor wires are not polarized.

The printed-circuit board is mounted on a plastic box. Use either epoxy cement or double-sided stickum pads. Use self-tapping screws to mount the box under the hood where it is not exposed to excessive heat. Keep the hole for the leads at the lowest point so that the box will not fill up with water. That could happen in heavy rain when the car travels through puddles. Use plastic ties to secure the leads in place. It's best to follow existing harness paths and tie the wires to them.

Placing the Sensor

Positioning the thermistor sensor, SR1, in the car requires some thought. The sensor should be close to the ground at the front of the car. Keep in mind that heat from the engine and cooling system will warm up the sensor's environ. Also, the sensor can be damaged by small stones and impact with debris. Now, where to put it?

The temperature of the ground may be a degree or two cooler than the open-air temperature one and two feet above it. This is especially true at sunset and on clear, cold nights. That's why the Frost Indicator is designed to start flashing already at 3°C. So you want to keep the sensor as close to the ground as possible.

Even at 50 miles an hour, heat from the radiator will affect the sensor mounted several inches in front of it, so avoid the car's grille area. The car's driving lights and sealed beams throw off heat, so avoid their locations when installing the sensor. Two sites were tested on the author's car. One was the plastic shroud under the bumper that aerodynamicly guided the air flow under the car and the air-intake scoop found in many cars. Both places were close to the ground and worked well. The rear bumper seemed like a good site, but heat from the exhaust system and engine under the car had some effect at slow speeds.

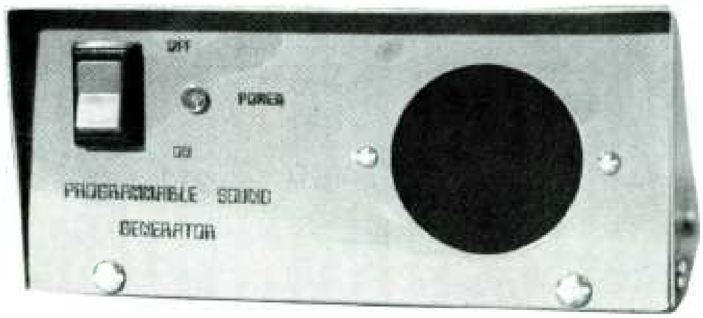
Two sites tested by the author worked very well. The sensor was mounted to a plastic surface in the air cover at the front of the car before it reached the engine's air filter. That site is well in front of the site where heat from an exhaust manifold is mixed with the input air to boost cold starts. The other site was on the plastic shroud under the car that cuts air resistance as the car moves. Both sites worked equally well.

The car's metal body may conduct heat to the sensor and produce a false indication. Avoid connecting the sensor directly to metal parts.

On the Road Again

Now you are all hooked up and ready for winter. When the leaves begin to fall and there is a nip in the air, that is the time to check the Frost Indicator's operation. Place an ice cube against the sensor and have someone watch the LED indicator. It should flash after a few moments. Now you are ready for the road. Put a tiger in your tank, seat belt on, key up the ignition, and hit the road with confidence that should the road freeze up, you'll know about it before it happens—thanks to the Frost Indicator. ■

COMPUSOUND PROGRAMMABLE SOUND GENERATOR



Are you computing more now but enjoying it less?—A simple noise-maker circuit can put the fun back into your keyboard.

By David Ward

PERHAPS YOUR COMPUTER IS SIMILAR TO MY KAYPRO 2X, a real workhorse when it comes to word processing or spreadsheets, but lacking somewhat in some of the "fun" aspects of modern computing—it could only "click" and "beep." So in quest of something a bit more enjoyable, I set out to design a circuit that would, under computer control, emulate the sounds of things like a steam locomotive, a whistling bomb, and a warning siren, among others. The result of that effort is *CompuSound*. In addition to producing the fore-mentioned sounds, CompuSound is also capable of producing tones, which can be strung together to make tunes or songs.

CompuSound, the product of four IC chips—an AY-38910A programmable sound generator (PSG); a 4013 dual D-type flip-flop; a 4069 hex inverter, and an LM386 low-power (0.4-watt) audio amplifier—has at its heart the AY-38910A PSG.

With only a minimum of support components, the PSG can produce 3 channels of tones from frequencies starting from below the human hearing range up through frequencies above the human hearing range. It has 3 channels that are capable of producing noises, which can be mixed and amplitude modulated in several ways to produce various sound effects.

Inside the PSG

Figure 1 shows a block pinout diagram of the AY-38910A PSG. The PSG is operated by loading some or all of its 14 bidirectional registers and 2 I/O ports with data (registers R0 through R17 octal). Data placed into the registers controls tone pitch, noise pitch, channel volume, and amplitude modulation. After the registers are loaded with the proper data, the PSG can produce sounds without any further instructions from the computer, freeing the computer for other tasks.

To take full advantage of all of the PSG's capabilities requires a computer with 8 bidirectional data lines, 2-control lines to control reading and writing to the 16 registers, and 1 line to reset the registers to 000 (octal). Since most computers do not have all of those lines readily available for user applications, it seemed practical to make the PSG appear as a parallel printer to the computer, necessitating the sacrifice of some of the PSG's capabilities.

Fig. 1—Shown here is a block pinout diagram of the AY-38910A programmable sound generator. To take full advantage of the PSG's capabilities requires a computer with 8 bidirectional data lines, 2-control lines, and 1 line to zero the registers. Data loaded into its 14 bidirectional registers controls tone pitch, noise pitch, channel volume, and amplitude modulation.

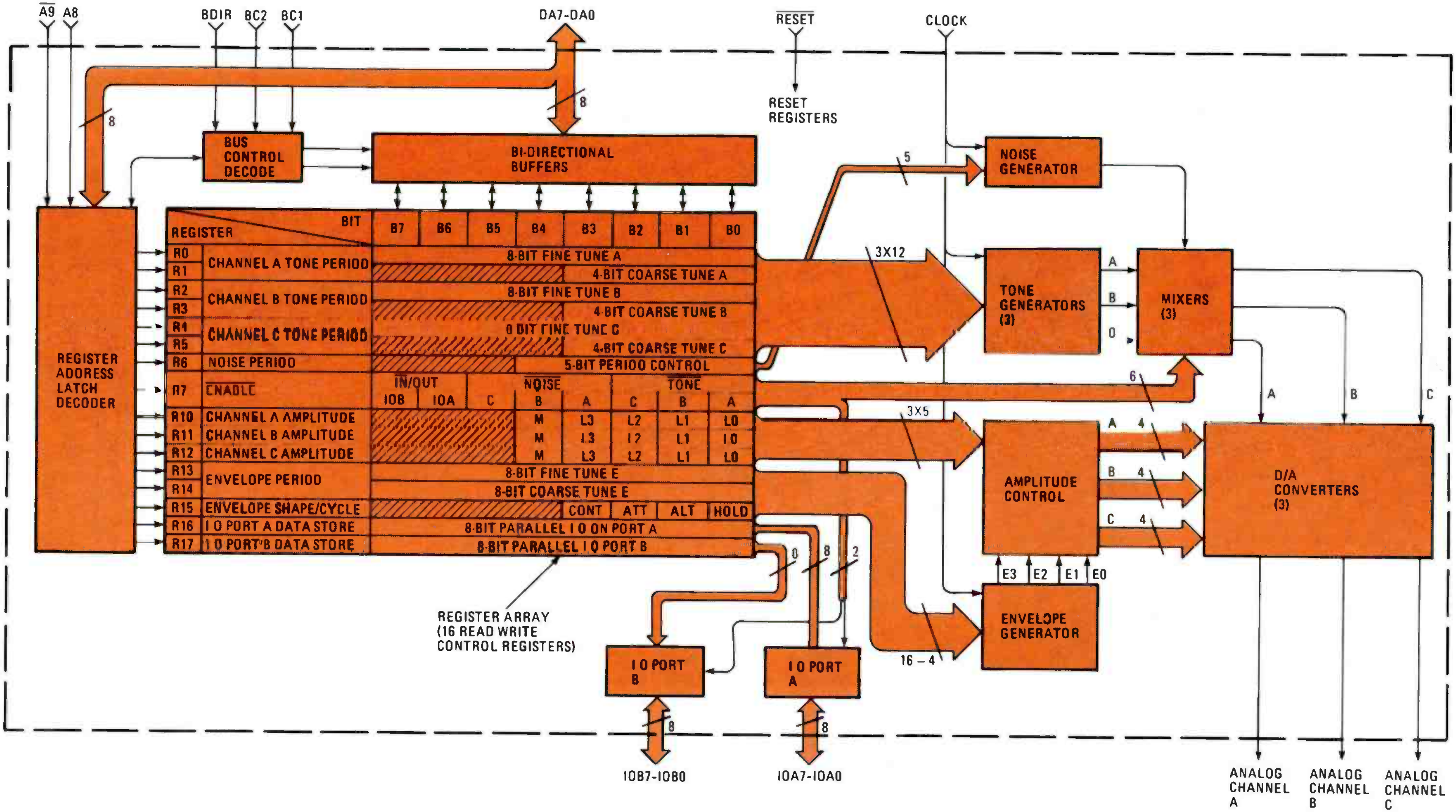
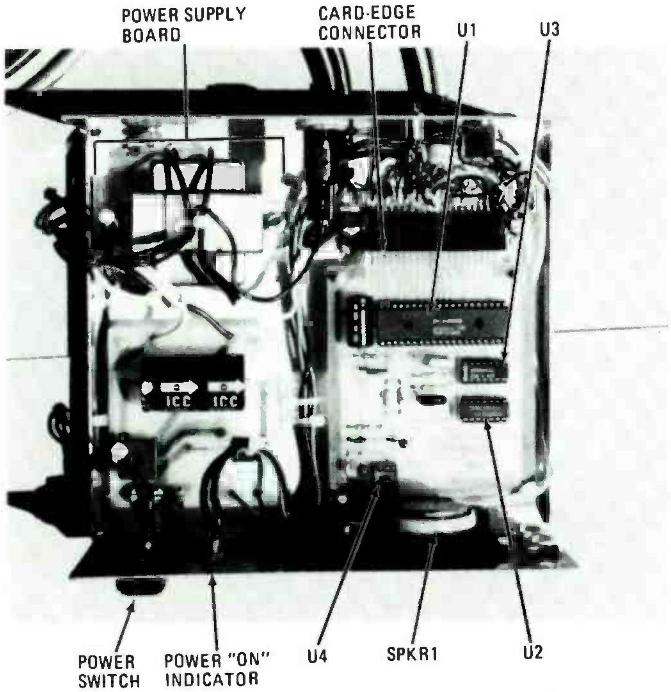


Fig. 2—Shown here is a functional block diagram of the PSG, which should give you some idea of the complexity of the inner workings of the chip.



Shown here is the author's prototype of CompuSound mounted in its modest enclosure. Note the power-supply board—which was not included in the schematic diagram (Fig. 3)—is assembled from readily available parts, and is a simple textbook application of three-terminal regulator devices.

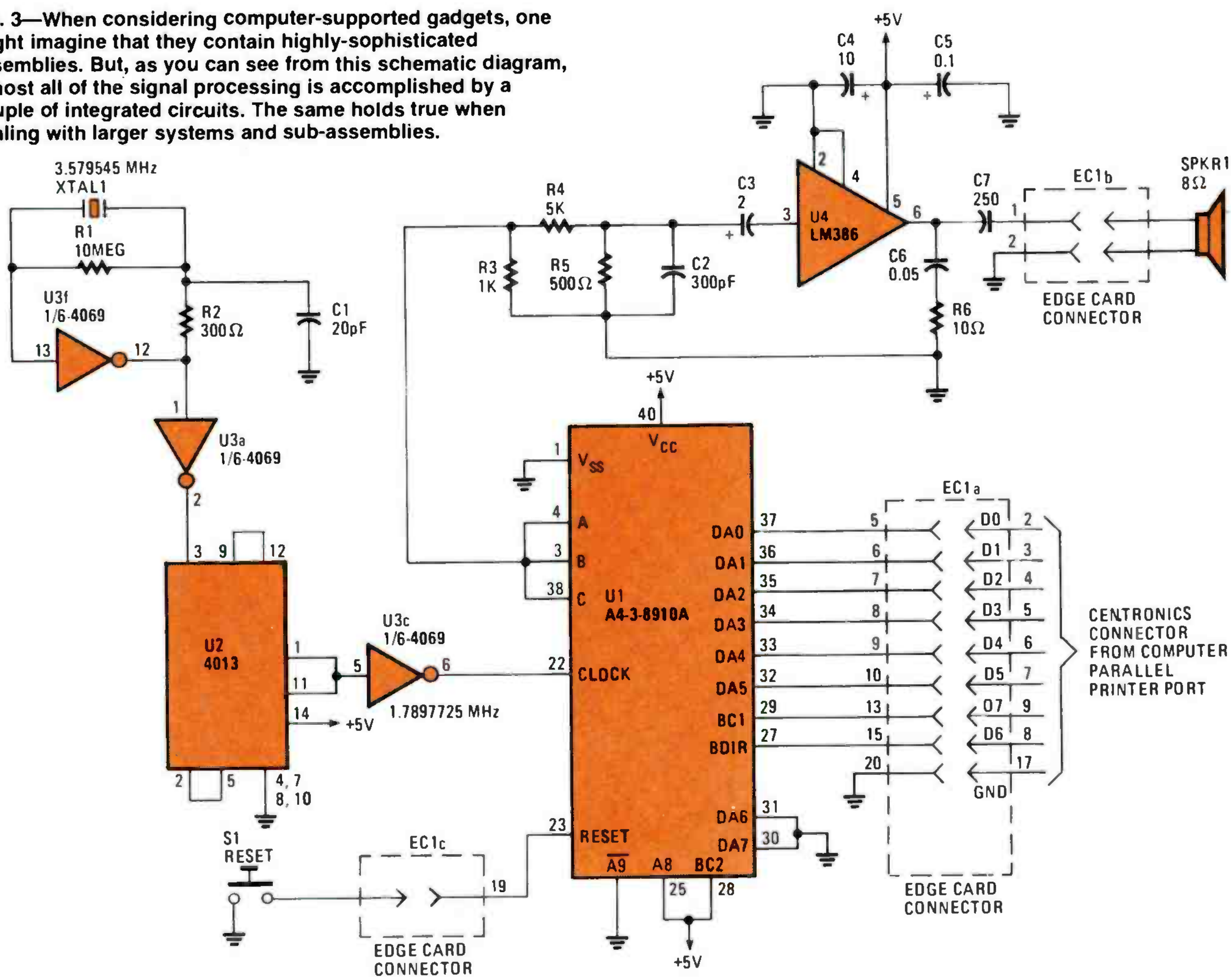
Refer to the functional block diagram of the PSG shown in Fig. 2 during the following discussion. (All register numbers on the diagram are base 8 or octal. Because the parallel-printer ports of many computers have 8 unidirectional data lines that can only send data (WRITE) to a printer and cannot input (READ) data from a printer, the register-reading functions of the PSG are not used. The PC board layout however, is designed so that a computer that does have the ability to read a register can do so.

Another sacrifice that was made was to use the 2 most-significant-bits (D6 and D7) from the computer's parallel-printer port as the register read/write-control lines. While doing so does cut down on some of the PSG's abilities to produce all frequencies, it does not cause a great sacrifice in PSG performance when the registers that are affected by that are closely examined.

The 8-bit registers affected are: R0, R2, R4, R7, R13, R14, R16, and R17. Although that appears to be a major problem, it should be realized that R0, R2, and R4 are the fine-tune bits (least-significant-bits) for channels A, B, and C; and that they are combined with R1, R3 and R5 to form 3, 12-bit numbers.

The 2 most-significant-bits of R7 are used to control R16 and R17, which are not being used anyway. R13 and R14 are both affected by the loss of D6 and D7; and they are used together to form a 16-bit number for the envelope period. The PC board is designed so that if a computer can provide 2 control-lines, in addition to 8 data-lines, it can do so without any problem.

Fig. 3—When considering computer-supported gadgets, one might imagine that they contain highly-sophisticated assemblies. But, as you can see from this schematic diagram, almost all of the signal processing is accomplished by a couple of integrated circuits. The same holds true when dealing with larger systems and sub-assemblies.



One feature that's not available in the PC layout is the use of the two 8-bit I/O ports (R16 and R17). Those I/O ports were probably designed with a dedicated microprocessor in mind that may have needed those two memory registers for data storage and retrieval. A personal computer will have plenty of memory, thus, "writing to" or "reading from" the registers can be handled directly. If the two I/O ports are not needed or wanted, it will be necessary to revise the circuit board.

If a computer does not have a control line to reset the PSG, the computer can simply load registers R0 through R15 with 000s or a normally-open (N.O.) momentary-contact pushbutton switch can be used to provide a manual reset by momentarily pulling the RESET pin (pin 23) to ground (see the schematic diagram in Fig. 3). Again, the PC board does provide for the reset line.

Writing to the PSG

Writing data to the PSG registers can be accomplished using the "LPRINT" command in MBASIC or whatever the equivalent command may be for a particular dialect of BASIC. The process simply places a particular number at the parallel printer-port for the PSG to internally latch. The PSG expects the following sequence to occur when a PSG register is being written to:

INACTIVE->	OUTPUT REGISTER-> ADDRESS	INACTIVE->	OUTPUT DATA->	INACTIVE
BDIR = 0	BDIR = 1	BDIR = 0	BDIR = 1	BDIR = 0
BC1 = 0	BC1 = 1	BC1 = 0	BC1 = 0	BC1 = 0

Reading data from a PSG register would go through the following sequence:

INACTIVE->	OUTPUT REGISTER-> ADDRESS	INACTIVE->	READ DATA-> FROM PSG	INACTIVE
BDIR = 0	BDIR = 1	BDIR = 0	BDIR = 0	BDIR = 0
BC1 = 0	BC1 = 1	BC1 = 0	BC1 = 1	BC1 = 0

The two lines that control the bidirectional data/address lines DA0–DA7 (pins 30 through 37) are BDIR (pin 27) and BC1 (pin 29).

As mentioned earlier, data lines D6 and D7 from the computer can be used to control the registers for READ/WRITE operations. I chose D6 to BDIR and D7 to BC1. The following four base-10 numbers need to be sent to the PSG to control it through the four register-control codes; 0 for an inactive control code, 192 for latching a register address, 64 to WRITE to a previously addressed register, and 128 to READ from a previously addressed register.

Below is a diagram showing how those four base 10 numbers provide the register control codes in binary.

PSG LINES >	BC1	BDIR	DA5	DA4	DA3	DA2	DA1	DA0
PARALLEL PRINTER >	D7	D6	D5	D4	D3	D2	D1	D0
INACTIV 0 =	0	0	0	0	0	0	0	0
LATCH ADDRESS 192 =	1	1	D0-D5 contain register #					
WRITE TO PSG 64 =	0	1	D0-D5 contains data					
READ FROM PSG 128 =	1	0	0	0	0	0	0	0

Shown in Table 1 is a sample program in MBASIC that can be used to load the registers with zero's to reset the PSG one time. The variable "R" is used for the register number in base 10 (the PSG block diagram is in octal). The variable "D" is used for the data that is to be placed into each register. Note that you cannot make the variable "D" larger than 63 base 10 as any number larger than that would be seen as a register-control code rather than as data only.

One item should be considered before using a computer's parallel printer-port to program the PSG. The Kaypro 2X parallel printer-port, for example, has a handshake line called BUSY (line 11 on the parallel printer-port) that expects a low signal from a printer before it will continue. If that line is not tied to ground, the computer will lock-up after the first LPRINT command. So it may be wise to check your own computer's parallel printer-port handshake lines to see if

```
SAMPLE PROGRAM IN MBASIC

10 REM PSG REGISTER LOADING PROGRAM
20 R=0:D=0
30 GOSUB 310
40 R=1:D=0
50 GOSUB 310
60 R=2:D=0
70 GOSUB 310
80 R=3:D=0
90 GOSUB 310
100 R=4:D=0
110 GOSUB 310
120 R=5:D=0
130 GOSUB 310
140 R=6:D=0
150 GOSUB 310
160 R=7:D=0
170 GOSUB 310
180 R=8:D=0
190 GOSUB 310
200 R=9:D=0
210 GOSUB 310
220 R=10:D=0
230 GOSUB 310
240 R=11:D=0
250 GOSUB 310
260 R=12:D=0
270 GOSUB 310
280 R=13:D=0
290 GOSUB 310
300 END
310 LPRINT CHR$(0);          REM INACTIVE
320 LPRINT CHR$(192+R);      REM LATCH REGISTER ADDRESS
330 LPRINT CHR$(0);          REM INACTIVE
340 LPRINT CHR$(64+D);       REM WRITE DATA TO ADDRESSED REGISTER
350 LPRINT CHR$(0);          REM INACTIVE
360 RETURN
```

PARTS LIST FOR COMPUSOUND

SEMICONDUCTORS

U1—AY-38910A programmable sound generator, integrated circuit
U2—4013 dual D flip-flop, integrated circuit
U3—4069 hex inverter, integrated circuit
U4—LM386 low-power, audio amplifier, integrated circuit

RESISTORS

(All resistors are ¼, 5% units unless otherwise noted.)

R1—10,000,000-ohm
R2—300-ohm
R3—1,000-ohm
R4—5,000-ohm
R5—500-ohm
R6—10-ohm

CAPACITORS

C1—20-pF, ceramic disc
C2—300-pF, ceramic disc
C3—2-µF, electrolytic
C4—10-µF, electrolytic
C5—0.1-µF, ceramic disc
C6—0.05-µF, ceramic disc
C7—250-µF, ceramic disc

ADDITIONAL PARTS AND MATERIALS

S1—Normally-open, momentary-contact, pushbutton switch
SPKR1—8 ohm
XTAL1—3.579545 MHz crystal
Printed-circuit or perfboard, enclosure, IC sockets, 20/40 card-edge connector (0.10" centers), wire, solder, hardware, etc.

experiment with new sounds and to see how the registers affect sounds. Instead of placing "0's" for the "D" variables in the program, place any number less than 64 (base 10) that you want.

Putting it Together

CompuSound is simple enough to be assembled using the construction method of choice. But, it's recommended that a printed-circuit board (produced using the PC-layout pattern shown in Fig. 4) be used to reduce construction time and possible errors.

It is suggested that IC sockets be used for the IC chips; doing so allows for easy replacement of defective components, and lessens the chance of too much heat being applied to those heat-sensitive components. Once the sockets are installed, begin mounting the support components, starting with the most heat resistant units—resistors, capacitors, crystal, and so on, saving the semiconductors for—following the parts-placement diagram shown in Fig. 5.

Note that while the schematic diagram shows no power supply, the photo of the finished and installed board shows a power-supply board, which the author threw together for the project. The power supply is nothing more than a 6-to-12 volt stepdown transformer, mated with a fullwave-bridge rectifier, a three-terminal regulator, and a couple of capacitors—2200-µF at the input to the regulator and 100-µF at its output.

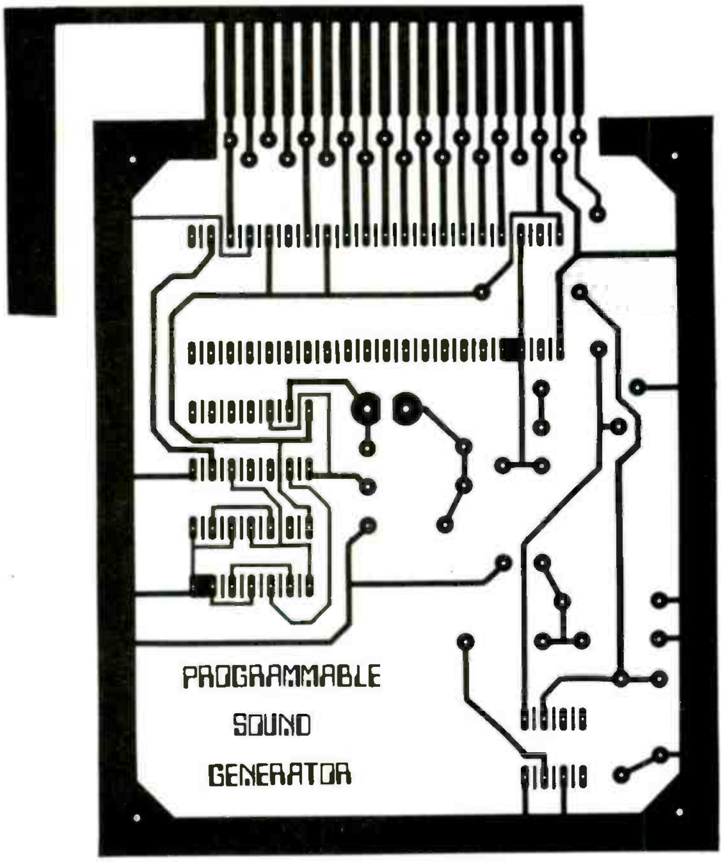


Fig. 4—While CompuSound is a simple circuit that can be assembled using any construction method, it's recommended that you use this PC layout pattern to make your board.

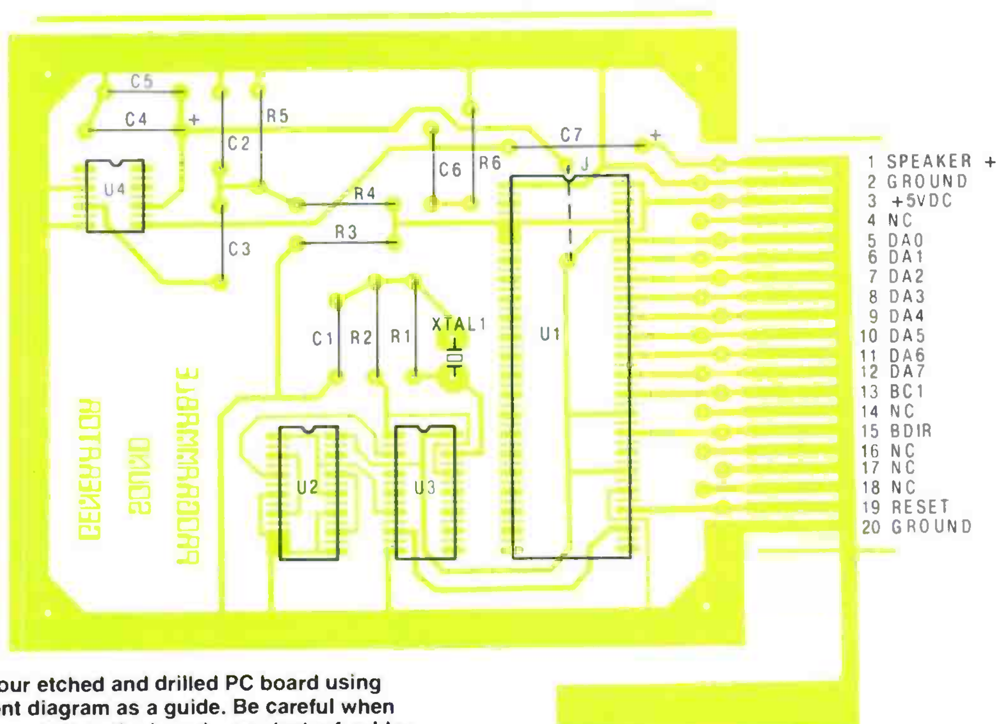


Fig. 5—Populate your etched and drilled PC board using this parts-placement diagram as a guide. Be careful when soldering the components to the board—a splash of solder here, a little too much heat there, or a misoriented component anywhere and you might wind up with burned silicon; or worse, you could find yourself in the market for a new computer. Again, extreme caution is recommended.

anything will need to be done there.

It's a great deal of fun experimenting with new sounds using the PSG. The literature that comes in the PSG package is very informative and even gives several sample programs as well as a list of numbers to produce a full range of musical notes. The sample program given earlier can also be used to

Once the PSG board is fully populated, check your work for obvious (misplaced or misoriented components) and not so obvious (solder bridges, shorts, etc.) errors. If you are satisfied that you haven't made any mistakes (or you've corrected the ones you have found), put the board to the side and prepare the housing for the printed-circuit board.

```
10                              'PSG PROGRAM FOR A STEAM LOCOMOTIVE
20 R=0:D=0
30 GOSUB 470
40 R=1:D=0
50 GOSUB 470
60 R=2:D=0
70 GOSUB 470
80 R=3:D=0
90 GOSUB 470
100 R=4:D=0
110 GOSUB 470
120 R=5:D=0
130 GOSUB 470
140 R=6:D=31                    'SET NOISE PERIOD TO MAXIMUM
150 GOSUB 470
160 R=7:D=6
170 GOSUB 470
180 R=8:D=16                    'ENABLE ENVELOPE SHAPE/CYCLE ON CHANNEL "A"
190 GOSUB 470
200 R=9:D=16                    'ENABLE ENVELOPE SHAPE/CYCLE ON CHANNEL "B"
210 GOSUB 470
220 R=10:D=16                   'ENABLE ENVELOPE SHAPE/CYCLE ON CHANNEL "C"
230 GOSUB 470
240 R=11:D=63                   'SET ENVELOPE FINE TUNE TO MAXIMUM
250 GOSUB 470
260 R=12:D=63                   'SET ENVELOPE COARSE TUNE TO MAXIMUM
270 GOSUB 470
280 R=13:D=8                    'SET ENVELOPE SHAPE/CYCLE TO CONTINUE
290 GOSUB 470
300                             'TRAIN GATHERS SPEED
310 D=64
320 D=D-1
330 FOR T=1 TO 250:NEXT T
340 IF D=2 THEN 380
350 R=12
360 GOSUB 470
370 GOTO 320
380 FOR T=1 TO 10000:NEXT T       'SPEEDING TRAIN
390                             'TRAIN SLOWS DOWN
400 D=D+1
410 FOR T=1 TO 500:NEXT T
420 IF D=64 THEN GOTO 10
430 R=12
440 GOSUB 470
450 GOTO 400
460                             'REGISTER LOADING SUB-ROUTINE
470 LPRINT CHR$(0);
480 LPRINT CHR$(192+R);
490 LPRINT CHR$(0);
500 LPRINT CHR$(64+D);
510 LPRINT CHR$(0);
520 RETURN
```

```
10                              'PSG PROGRAM FOR A EUROPEAN SIREN
20 R=0:D=0
30 GOSUB 390
40 R=1:D=1                      'SET TONE PERIOD FOR HIGH TONE
50 GOSUB 390
60 R=2:D=0
70 GOSUB 390
80 R=3:D=0
90 GOSUB 390
100 R=4:D=0
110 GOSUB 390
120 R=5:D=0
130 GOSUB 390
140 R=6:D=0
150 GOSUB 390
160 R=7:D=62                    'ENABLE CHANNEL "A" TONE
170 GOSUB 390
180 R=8:D=15                    'SET CHANNEL "A" VOLUME TO MAXIMUM
190 GOSUB 390
200 R=9:D=0
210 GOSUB 390
220 R=10:D=0
230 GOSUB 390
240 R=11:D=0
250 GOSUB 390
260 R=12:D=0
270 GOSUB 390
280 R=13:D=0
290 GOSUB 390
300 FOR T=1 TO 300:NEXT T
310                             'SET R0 AND R1 FOR LOW TONE
320 R=0:D=63
330 GOSUB 390
340 R=1:D=2
350 GOSUB 390
360 FOR T=1 TO 300:NEXT T
370 GOTO 10
380                             'REGISTER LOADING SUB-ROUTINE
390 LPRINT CHR$(0);
400 LPRINT CHR$(192+R);
410 LPRINT CHR$(0);
420 LPRINT CHR$(64+D);
430 LPRINT CHR$(0);
440 RETURN
```

After deciding on a suitable enclosure, determine the positions for the front-panel mounted components.

Next drill two holes in the rear panel of the enclosure. Once all holes are drilled, use a file or other tool to remove the burrs. Loosely mount the front-panel components, and temporarily secure the printed-circuit board in the enclosure.

```
10                   'PSG PROGRAM FOR A WHISTLING BOMB
20                   'CLEAR REGISTERS
30 R=0:D=0
40 GOSUB 600
50 R=1:D=0
60 GOSUB 600
70 R=2:D=0
80 GOSUB 600
90 R=3:D=0
100 GOSUB 600
110 R=4:D=0
120 GOSUB 600
130 R=5:D=0
140 GOSUB 600
150 R=6:D=0
160 GOSUB 600
170 R=7:D=62         'ENABLE TONE ON CHANNEL "A" ONLY
180 GOSUB 600
190 R=8:D=15         'SET CHANNEL "A" VOLUME AT MAXIMUM LEVEL
200 GOSUB 600
210 R=9:D=0
220 GOSUB 600
230 R=10:D=0
240 GOSUB 600
250 R=11:D=0
260 GOSUB 600
270 R=12:D=0
280 GOSUB 600
290 R=13:D=0
300 GOSUB 600
310                  'WHISTLING PART OF THE SOUND
320 R=0:D=0
330 D=D+1
340 IF D=64 THEN 390
350 FOR T=1 TO 10:NEXT T
360 GOSUB 600
370 GOTO 330
380                  'EXPLOSION PART OF THE SOUND
390 R=0:D=0
400 GOSUB 600
410 R=6:D=31         'SET FOR MAXIMUM NOISE PERIOD
420 GOSUB 600
430 R=7:D=7          'ENABLE NOISE ON CHANNELS A,B AND C
440 GOSUB 600
450 R=8:D=16         'ENABLE ENVELOPE SHAPE/CYCLE FOR CHANNEL "A"
460 GOSUB 600
470 R=9:D=16         'ENABLE ENVELOPE SHAPE/CYCLE FOR CHANNEL "B"
480 GOSUB 600
490 R=10:D=16        'ENABLE ENVELOPE SHAPE/CYCLE FOR CHANNEL "C"
500 GOSUB 600
510 R=11:D=63        'SET ENVELOPE PERIOD FINE TUNE TO MAXIMUM
520 GOSUB 600
530 R=12:D=63        'SET ENVELOPE PERIOD COARSE TUNE TO MAXIMUM
540 GOSUB 600
550 R=13:D=0         'SET ENVELOPE FOR 1 EXPLOSION SHOT
560 GOSUB 600
570 FOR T=1 TO 2500:NEXT T
580 GOTO 10
590                  'REGISTER LOADING SUB-ROUTINE
600 LPRINT CHR$(0);
610 LPRINT CHR$(192+R);
620 LPRINT CHR$(0);
630 LPRINT CHR$(64+D);
640 LPRINT CHR$(0);
650 RETURN
```

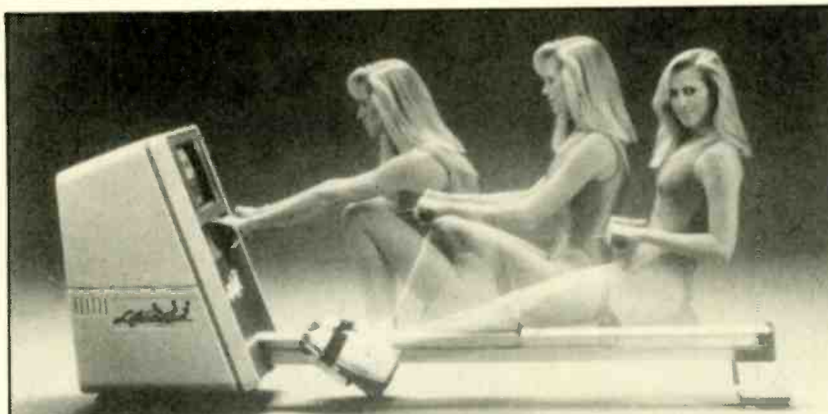
Then solder lengths of hookup wire to the panel mounted components, and connect the other ends to the printed-circuit board. Place a multi-conductor cable through one hole in the rear panel and connect it to the board. To the other end of the cable attach a Centronics-type connector (male or female), which will mate with the parallel-printer port of your computer. Place the power (line) cord through the remaining hole and connect the end to the power-transformer's primary winding.

Once done, check and recheck your work before going any further. If all seems well and you are confident of the integrity of your work, get ready to fire it up for a test run. With the computer turned off, and CompuSound unplugged, insert the mating cable into your computer's parallel printer port, and plug in the power cord. Then turn on the computer and CompuSound. Key-in one of the sample programs in Tables 2, 3, or 4 and output the data to CompuSound via the parallel printer port. If all goes as expected, close up the housing and enjoy. If not, it's back to the shop for some good ol' "hunt and destroy" (read that as troubleshoot and repair). ■

GIZMO

JUNE 1988

VOLUME 1, NUMBER 4



CIRCLE 71 ON FREE INFORMATION CARD

Stationary Scull

LIFEROWER. Manufactured by: Life Fitness Inc., a Bally co., 9601 Jeronimo Rd., Irvine, CA 92718. Price: $2,700.

Nobody ever classified the development of video games in both their arcade and home versions as part of the physical fitness boom. Despite the appearance of a chronic condition in video gamesters akin to *tennis elbow* (joystick thumb or some such), the initial spread of video games was never associated with the same era's rise in health awareness and exercise consciousness.

It took Life Fitness, Inc. (an offshoot of Bally) to bring video arcade illusion into the contemporary gym. Perhaps most elegant is the *Liferower*, a dry-land total body conditioner which simulates the classic sport of rowing. The actual simulations are accomplished via a mechanical system that updates the weights and pulleys that have defined exercise equipment for at least a half century. But up front at the prow of this landlocked rowing scull is the video arcade's bequest to physical fitness.

A 13-inch screen displays two rowing sculls—labeled *you* and *pacer*—accompanied by boxes that digitally list elapsed time, strokes-per-minute rate, and approximate number of calories burned during the session. On the right side of the screen is a keypad for selecting the duration and one of the fifteen *difficulty levels*. Once the variables are entered, one of the screen boxes shows a starter pistol and the words *on your mark...get set...go!* are seen and heard, followed by the sound of the starting gun.

As the user rows, water sounds and the exhortations of a coxswain are heard. The exerciser is encouraged to keep the back straight, legs fully extended, and to stroke, stroke, stroke. After about 15 seconds, the screen tells how many lengths behind or ahead of the video pace boat the exerciser is, and keeps an accurate reading of the user's stroke rate, while listing the recommended rate. At the end of the race, final statistics are read out after a short cooling down period. In a feature borrowed directly from the arcade, exceptional times can be entered into the unit's memory (along with the initials of the excelling user) and displayed on the screen at the end of a session as a challenge to the next person who uses the Liferower.

As physical fitness equipment, the Liferower is touted to deliver an ideal aerobic workout as it strengthens and tones all major muscle groups, in sessions of just 10 to 20 minutes. Its bonafides include endorsements by such world-class athletes as Bruce Ibbetson, seven-time National Rowing Champion and Tiff Wood, America's premier single sculler and captain of the last two U.S. Olympic Rowing Teams.

Although available to individual buyers (The Sharper Image offers it in both stores and through its catalog), Liferower is most often encountered in high-tech health spas, like Manhattan's Vertical Health Club where we watched a battery of these video rowing machines in enthusiastic use.

The trainer we talked to was convinced that the psychology behind the Liferower is sound. Persons serious about exercise, he reasoned, tend to respond to the competitive dimension of the video screen contest, while the readouts are a real way to monitor progress and performance.

Although he observed there are more Liferowers in homes than you might think, he was slightly skeptical about its usefulness in a private exercise program. Why would someone serious enough about exercise to invest in a high-priced rowing machine need the extra inducement of video competition to carry out a fitness regime? One gentleman we talked to was enthusiastic about the system, especially as he was a rower during college. That to us sounded as good an endorsement as the celebrities enlisted by *Bally*.

While Liferower exercisers aren't candidates for seasickness, or likely to jump up after the race to acknowledge the cheers of the admiring throng heard via the unit's audio system, the sound effects are probably as much fun as when heard in a video arcade. And they're certainly a lot less threatening. The sound of your oars as you slice through the water versus the conclusion of World War III from a half dozen, highly amplified arcade battle stations.

Realism, of course, isn't the point. We want the special effects, not the real thing. Years before the microchip, people decided competing against machines was as satisfying in its way as contests involving human beings on both sides.

The Liferower's clever stroke is to take an experience millions are familiar with and join it to what may be a new and difficult activity, physical exercise. If the microchip delivers the motivation, so much the better. Besides, imagine the exotic equipment waiting in the developmental wings. Indoor cross-country skiing using a unit outfitted with an artificial snow blower and wind sound effects. Or there could be a mountain climbing unit that releases an avalanche if the climber falters. Dry land water skiing, jai alai, aerial acrobatics, they're all just a microchip away in some physical fitness game arcade of the (near) future.

CIRCLE 72 ON FREE INFORMATION CARD

Micro Revenge

THE REVENGER. Manufactured by: Express Yourself, Inc., 1800-A Associates Ln., Charlotte, NC 28217. Price: $19.95.

Last Christmas, a little gizmo from Charlotte, North Carolina made a big noise in the national news media. *The Revenger* was said to be one of the season's hottest adult toys, with buyers primarily, men in their 20's or 30's who were buying it to zap (other) drivers perceived as enemies. In appearance, The Revenger mimics a radically down-sized radar detector.

What it does is send forth a trio of electronically produced explosions, resembling either a grenade launcher, a machine gun or something designated death ray, accompanied by the furious blinking of a line of miniature red and green LEDs. Marketed primarily as an automotive accessory, the Revenger was sometimes discussed by the media in the context of last year's tragic outbreak of freeway shootings. Various experts solemnly linked the device to the frustrations and aggression thought responsible for pushing some drivers over the edge. And it wasn't only media experts who were concerned with the toy's aggression component. The box it comes in carries the disconcerting but straight-faced warning, Use for fun only. Do not connect to live weapons.

Having finally examined this adult toy sensation, we think the mass media got it all wrong. Rather than some expression of frustration and rage, the Revenger is a sheepish recognition of powerlessness. It doesn't turn its user into a proto-Rambo. Instead it transforms him or her into an electronic-age stooge, Curly by name.

The Revenger's electronic weeps and beeps remind us of nothing so much as the noises the Three Stooges' Curly would make as he swam against a tide of insults, affronts and attacks, physical and otherwise. Another comparison might be with the primitive (and plaintive) binary communication system utilized by Clarabelle on pioneer TV's *Howdy Doody* show, horns labeled *yes* and *no*. As a herald of physical destruction, the Revenger noises wouldn't scare a pussy cat, the subject of GIZMO's initial test. The gadget's fearsome noises are an updated version of the pop gun showing a flag reading "bang" when fired.

Express Yourself should avoid too close an identification with cars for this pocket-sized sound effects mini-unit. It occurred to us that somebody should work out a Revenger version of the children's game, paper, scissors, stone, Grenade launcher destroys machine gun but is disabled by death ray or something along those lines.

Its power to at least vent frustration in everyday life could make it a valued accessory on line at the supermarket, bank or auto license bureau. Smile sweetly at your tormentors even as you zap them with a touch of the Revenger controls. This therapeutic powerhouse is dependent on two "AA" batteries for its miniature explosions. This toy is unlikely to change the course of history, but it should provide small-scale audio relief until something does.

Magnificent Midget

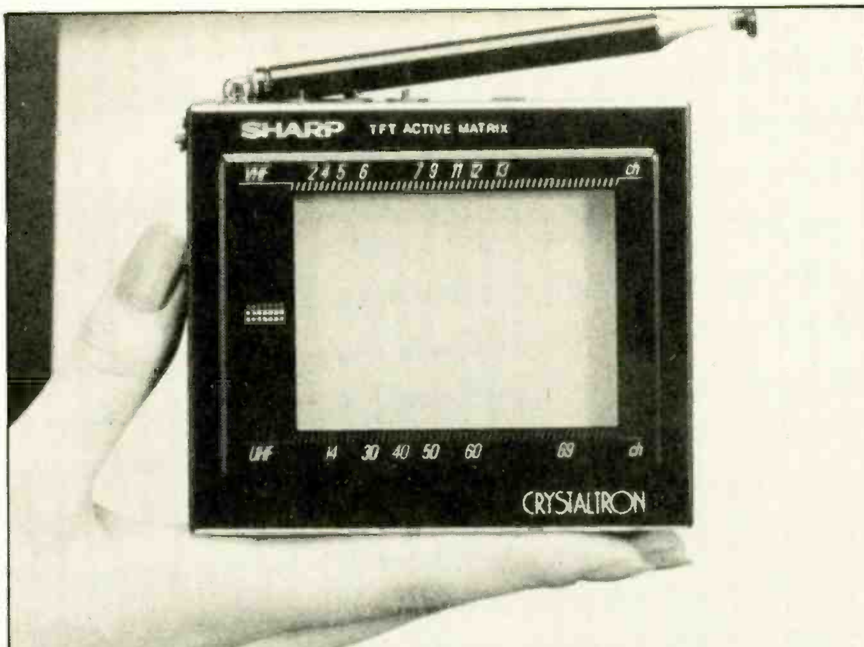
CRYSTALTRON LCD COLOR TELEVISION (3ML100). Manufactured by: Sharp Electronics Corp., Sharp Plaza, Mahwah, NJ 07439. Price: $695.

Is there light, or at least decent reception, at the end of the tiny television tunnel? The story thus far has the consumer electronics industry pursuing the development of a miniaturized TV set, the video equivalent of the Walkman, with varying degrees of success for over a decade.

Cathode-ray tube technology provides a better small screen picture, but downsizing is restricted by CRT requirements. Liquid-Crystal Display (LCD) technology, on the other hand, allows further miniaturization and requires less power. But until recently, the viewability of the end picture ranged from OK to down right miserable. Now a new generation of tiny LCD TV is reaching the market, as represented by Sharp's recently introduced *Crystaltron LCD Color TV*.

LCD color sets (which have been around for just over a year) from the beginning performed to higher standards than their black-and-white LCD counterparts. Saddled with the same ambient lighting requirements—that have inspired all kinds of backlight and reflector systems in LCD mini-sets—the color personal sets produced a brighter, more discernible picture.

The new Sharp 3ML1200 represents perhaps the most-dramatic improvement in miniature-TV design to date. In almost every important respect, the Sharp mini delivers the same image quality as conventional full-sized sets, on a screen that measures a mere 3-inches diagonally, on the front of a television measuring 3-½-inches high, a little less than 4-inch across, and 1-½-inches deep.



CIRCLE 73 ON FREE INFORMATION CARD

We viewed the 3ML100 using its telescoping antenna, connected to a cable system and as a VCR monitor. In all three situations, the picture was clear, properly color adjusted, and easily viewed. Some LCD mini-sets in the past had pictures and image-delivery systems that made viewing them for any length of time a definite strain. We comfortably watched entire programs on this midget for periods of over an hour.

Of course, small size is itself a limitation. For comfortable viewing, the TV should be tilted away at the top and watched from a maximum distance of around 18-inches. Viewed from above or to the side, the sharp, clear picture becomes a fuzzy, cloudy, flat representation of a TV picture. Likewise, the sound is a long way from stereophonic, although easy enough on the ears at normal volume levels. Because of the set's small size, the screen tends to attract greasy palm and finger prints.

Sharp credits the new personal-size set's color filter and thin-film transistor (TFT) active maxtrix system for improvements in picture and color quality. The Sharp system controls each individual color dot, or pixel (all 92,160 of them), as opposed to an area of dots as in other models. Also important is the set's backlight system.

The LCD screen itself is flat and swings away from the main body of the 3ML100 on hinges. Mounted behind it is a fluorescent light (having the same dimensions as the TV screen), measuring 2-½-inches by 1¾-inch. Although the TV supposedly can be viewed without the backlight (with the screen tilted away from the television body), we never did.

All of our viewing was done indoors and the ambient light necessary to replace the backlight boost to the picture wasn't available. A flashlight aimed behind the opened screen made images appear, but otherwise the backlight was a necessary component of tiny TV viewing. Overall, picture quality is best if the screen is viewed at a slight angle. Sharp supplys a stand for the TV that's adjustable for two viewing angles.

Also supplied as part of the purchase price is an AC adapter, an antenna adapter, five "AA" batteries, a hand strap for carrying the TV and earphones. Offered as optional accessories are a vehicle adapter, an A/V cable for monitor use with a VCR, a rechargeable battery pack, and an additional backlight and a sunshade for use with the unit outdoors. Inclusion of batteries is at least a sporting gesture. Although instructions indicate that alkaline batteries are good for only two hours of power using the backlight, or four if the set is viewed in environmental light. (GIZMO's test indicated that the 3ML100 uses up dry cells at an even quicker rate.)

So what's the main drawback to this latest advance in the miniaturization of video? Its price, of course, that pegs the palm-size set at about the level paid for full-size console models. Announced in prototype at last year's summer *Consumer Electronics Show*, the half-pint TV's began reaching the market only this year. As any research and development expert in the electronics industry will tell you, "cutting-edge technology" doesn't come cheap.

Price tag aside, the Sharp 3ML100 LCD TV is a definite harbinger of things to come on the television front. The same flat-screen LCD technology that makes this small-fry possible can be applied to other sizes, bringing the eventual day of the flat TV—the one long promised that you can hang on the wall like a painting—that much closer. And even the price suggested for the 3ML100 isn't permanently engraved in stone. We doubt if we'd pay the price for the pleasures of personal television. But if we were so inclined, this is the TV we'd want.

Examining this 3-inch screen TV, we were struck with the idea that the first televisions in American homes had screens of the same diminutive size. Maybe Sharp should offer the 3ML100 encased in a replica of a pioneer home-TV receiver, if only as a comment on how far the world's favorite appliance has come in its four-decade span.

Chip Thrill

TAPELESS TELEPHONE ANSWERING MACHINE (2010). Manufactured by: Execudyne Ltd., 200-6 13th Ave., Ronkonkoma, NY 11779. Price: $249.95.

Here's an indication of the place of the telephone answering device or "TAD" in modern American life. One afternoon while listening to the radio, we heard no fewer than three different tunes that mentioned answering machines in their lyrics. That made us think of at least a couple of others. When pop songs use an item as a prop, you know there must be a lot of them out there.

With millions of answering machines in use, it isn't surprising that telephone/answer-device marketeers are out to build a better mousetrap. Most notably with the

CIRCLE 43 ON FREE INFORMATION CARD

introduction of tapeless, voice-chip machines, like the telephone/answering machine combos from Execudyne Ltd. The company's line of tapeless answering machines was launched with the New Year.

The 2010 *Tapeless Telephone Answering Machine*, which GIZMO used for several weeks, features the same capabilities found in its tape-cassette predecessors. The 2010's features include beepless remote operation, message playback, skip, repeat, backspace and reverse order playback, security code, speakerphone operation, ring selector, toll saver, hold and call counter.

But since it's brand-new consumer technology, the Execudyne 2010 design incorporates some tough calls in configuring the unit's controls and functions. The telephone's keypad does double duty as control center for the unit's various features. For the first-time user, that inevitably leads to some initial fumbling. We lost a call before we figured out that pressing the pound sign (#) key deactivates the answering function (or does it?). According to the instructions, the answer control merely puts the machine on standby, meaning it won't answer the phone at the user-selected number of rings. Instead, just picking up the handset, cuts off the outgoing message.

All those features listed by Exexcudyne require various manipulations of the keypad to set and activate. For example, selecting the number of rings at which the machine will answer requires that the user press the phone keypad "8" designated rings followed by the numerical key corresponding to the number of *rings* at which incoming calls are to be answered. Similarly, pressing the keypad "7" marked *code* followed by any other two digits will reset the machine's factory-set security code to deny remote access to unauthorized callers.

But programming sequences with unexpected quirks aren't exclusive to tapeless TAD's. Although we noted instructions on what to do if the unit's *in use* light is flashing at a fast rate and cannot be turned off by pressing the "answer" button. We would have headed that section, what to do if your machine becomes really confused.

What is particular to this tapeless answering machine is abbreviated message capacity. The caller can only leave 17 seconds of talk. The same time limit applies to the outgoing recorded message.

According to Execudyne, its tapeless technology is capable of recording 10-to-20 short messages before it's necessary to consult the instruction booklet on what to do when the automatic message is full.

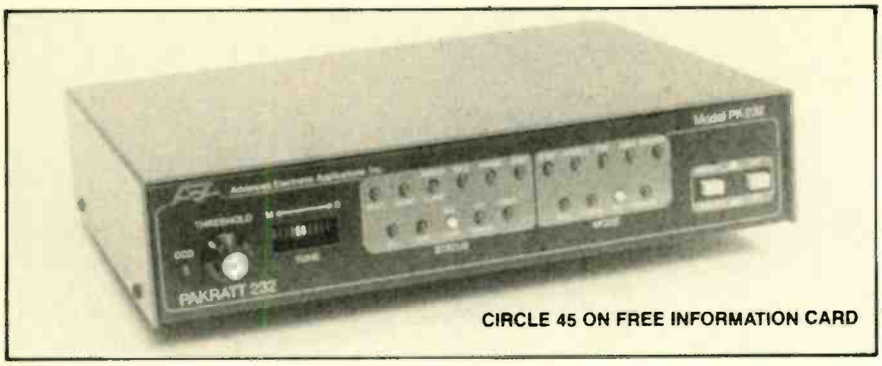
Voice chip technology has faced a trade-off between memory capacity and voice quality, a problem that Execudyne claims to have solved with some proprietary technology the firm has licensed for its units. In use, however, callers did notice a slight distortion of tone (as if you were talking down a long tube was one description) when GIZMO used the instrument.

We were also less than crazy about two 2010 features, its hold and speaker-phone capabilities.

The unit operates as a speakerphone for incoming calls or if the user puts the caller on hold and then resumes the conversation after depressing a control marked "hook." But in its speaker-phone mode, the instrument requires the user to depress a speaker-phone button to speak and release it to hear the other party. Since that's anything but hands-free operation (more like a walkie-talkie than a telephone), it eliminates a main advantage of speakerphone use. Likewise, the hold option makes it impossible for the caller to hear anything from the Execudyne end, while allowing the 2010 user to hear the other end clearly. Plus, as the instructions reveal, your call will be put on hold for a limited time before disconnecting. Which may be the intended end of many calls destined for hold, but not one anyone wants out of their direct control.

Finally, we have a bone to pick with the unit's instruction booklet. Some of its shortcomings are the result of bad proofreading. The factory installed two-digit security code is given as two different numbers on different pages of the booklet. While we enjoyed the term, we can't believe that the description of one machine-produced tone as "bleeping" isn't a typographical error.

Actually, the variety of electronic tones and bleeps was one of its fun aspects. Audio signals tell users if they've correctly erased old messages, set up the recording of outgoing messages, as well as guiding other program functions. Recorded messages are clear, although the unit has a tendency to make the caller sound as if he or she is nursing a head cold. Still, if there are a few hitches in this first step toward tapeless-answering-machine universality, in the words of the Execudyne troubleshooting section, *Don't Paric* (we think they meant panic). This is the first new answering-machine technology introduced to the consumer market in some time, designs have to be tested in real-life situations. The Execudyne 2010 may not be the ultimate tapeless TAD, but it's a clear sign that voice-chip technology has arrived.



CIRCLE 45 ON FREE INFORMATION CARD

Digital Home Telex

A.E.A. PAKRATT (PK-232). Manufactured by: Advanced Electronics Applications, Inc., P.O. Box 2160, Lynnwood, WA. 98036. Price: $319.95.

If you have a shortwave radio, no doubt you've heard numerous strange sounds on the various HF (high-frequency) bands. Some of sounds may come from the guy shaving next door, but others could be words flying through the ether in digital communication guise.

These days thousands of amateur operators are sitting at computer keyboards and type-talking with other hams using radio teletype and other modes of digital communications. A digitally-equipped radio station uses three basic components: A terminal (most often a computer), a data communications unit, and a transceiver for reception and transmission.

The terminal/computer converts typed characters into digital codes and vice versa. The data controller processes digital codes, converting them to analog (audio) tones and vice versa. The transceiver transmits and receives the tones. To put it simply: The stuff typed at the keyboards goes out the radio and stuff the radio hears is seen on the computer screen.

There are numerous modes of digital communications. The *A.E.A. Pakratt* (PK-232) from Advanced Electronic Applications, is a multi-mode data controller for amateur radio digital communications. The unit features operation in Morse code, Baudot RTTY, ASCII, RTTY, AMTOR, packet, and facsimile.

Morse code is one of the original forms of digital communications. With the PK-232, a ham operator can send and receive CW. The old-fashioned way to send and receive Morse code was via telegraph key and human ear. Now modern hams use computers.

With a little careful tuning of the receiver and the PK-232, the "dits and dahs" are translated and appear on the PC monitor screen as letters. And the ham can send out code, at a constant speed and with a perfect "fist" merely by typing on the keyboard—all at sending and receiving speeds much higher than the operator can normally attain manually. Unfortunately, the Federal Communications Commission hasn't demonstrated any interest in allowing such devices in the ham-license test room.

There are three kinds of RTTY (pronounced "Ritty") on the ham bands. The most common, and oldest, is Baudot. This is simply one operator typing to another operator. Both what is sent and received is viewed on the monitor screen. The quality of what is received depends on band conditions. Lots of static, poor signal strength, etc., can make it tough to read what the other ham is saying. There is also plenty of RTTY to tune to outside of the ham bands. Weather reports, messages between ships, dispatches from overseas news bureaus, etc., are easy to find and display on the screen.

With random tuning around the HF bands, operators will discover the sound of RTTY. The PK-232 makes it easy to recognize the different types of signals.

AMTOR (Amateur Teletype Over Radio) has been legal for only five years, but it has the fastest growing form of RTTY in terms of popularity. It differs from other forms of RTTY in that it uses special coding for error checking. Thus, it's much more reliable in terms of "perfect copy" than either Baudot or ASCII.

Packet radio is the most advanced form of digital communication. Fast and efficient in its frequency use, it features 100 percent error-free transmission and reception. In just about any part of the world you can tune into 145.01 MHz and find packet signals buzzing. The nature of packet allows many different operators to use the same frequency. QSO's (conversations) take place as small chunks of computer input are *packeted* up by the TNC (in this case the PK-232) and sent out to the receiving station. The next packet isn't sent until an acknowledgment of perfect copy is received from the other station's TNC. The packets can contain anything from "chit chat" to binary codes of some software being transferred over packet radio.

The PK-232 also features facsimile (FAX) operation—enabling the operator to transmit and receive visual images. Since most of such activity is outside of amateur bands, that feature is used mostly for receiving pictures from a variety of news organizations and government bureaus. On the West Coast, we have copied weather maps, different test patterns, and surface (wind) analysis print-outs from Kodiak, Alaska, Pearl Harbor, Hawaii, and San Francisco, California NOAA stations. Bureaus of various foreign news services still use HF FAX.

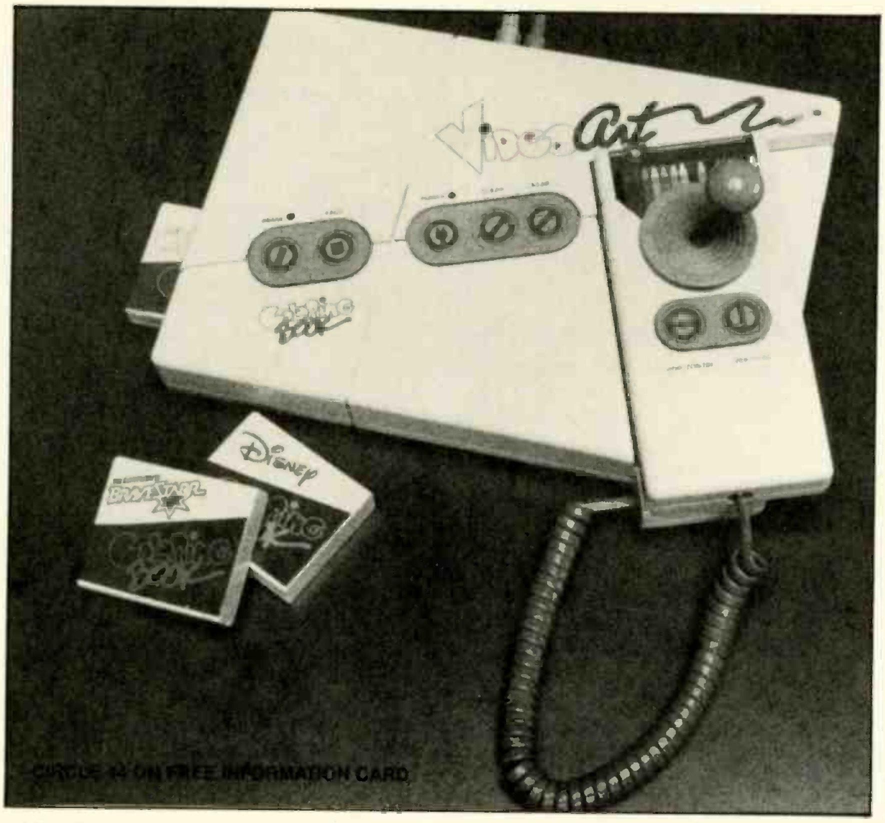
Until recently, PK-232 users could only print out weather charts and facsimile pictures on Epson printers. However, AEA has announced the release of a new "PKFAX" program (priced at about $25) for the PK-232, IBM PC, and true MS-DOS compatible computers. Now users can receive and display FAX pictures directly to the video monitor. Pictures can be saved to disk, read from disk and retransmitted by FAX or packet. In addition, users can transmit pictures created by one of the available *Paintbrush* programs.

The PK-232 also features a mode dubbed SIAM (Signal Identification and Acquisition Mode). Especially useful if the operator doesn't know what each of the modes mentioned above sounds like, using SIAM it's possible to tune in any unidentified digital signal and the PK-232 will analyze the signal and enable the user to switch to the appropriate mode with a quick "OK" command.

The PK-232 weighs about 3 lbs. and is 11.5-inches wide by 8.5-inches deep and 2.5-inches high. The radio and computer ports are in the back and a standard RS-232 connection interfaces with any computer or terminal. Any terminal software (such as programs designed for modems) can be used for communicating with the PK-232.

The front-panel has 21 LEDs that tell the operator which mode the PK-232 is using. Also on the front is a Data Carrier Detect (DCD) indicator, a threshold adjustment knob, an LED bar tuning indicator, and two switches. One is the on/off button and the other toggles between two radios. Most ham operators are on both VHF and HF bands. With a flip of the switch the PK-232 moves from one radio to another.

The PK-232's 280-page manual must be mentioned. Written by Norm Sternberg (W2JUP), it not only covers all aspects of PK-232 operation, but is practically a primer on the various modes of digital communications available to amateur-radio operators. A couple of decades ago, ham operators would have been hard-pressed to imagine gear with those capabilities at any price. Now just about any PC-equipped amateur operator can pull digital words and pictures out of the sky.



CIRCLE 44 ON FREE INFORMATION CARD

Video Art Attack

VIDEO ART. Manufactured by: LJN Toys, Ltd., 1107 Broadway, New York, NY 10010. Price: $89-$100.

For too many consumers, electronics equal complications. If you've ever hooked up a VCR for an electronically-unsophisticated neighbor or friend, you've seen the look of amazed gratitude that greets the first successful functioning of a home-video recorder.

Most often you're hailed as an electronic whiz for what comes down to reading the instructions carefully and following through with some confidence that the thing will work. For folks entirely at home with the electronic era, that attitude of mystification can be a little disconcerting. But a product we looked at, LJN Toy's *Video Art* helped us understand the soil in which that attitude grows.

Called the electronic video drawing system, Video Art has been around for a couple of years. The idea is clever and straightforward. Using a control unit that incorporates a cord-connected joy-stick-style controller, a slide-switch color selector, a slot into which an activity cartridge is plugged, and seven controls, Video Art enables the user to color and draw on the screen of a television set.

Eight different cartridges provide fill-in, coloring-book-like outlines. Or, *sans* cartridge, Video Art's bouncing cursor can color free-hand on the screen. The color selector allows the electronic artist to control either the shade of the background shown on screen or the cursor-carried color being applied. The resulting drawings even have some permanence, they can be recorded on video cassette for later viewing.

The main unit controls turn on the unit, erase drawings from the TV screen, and page forward through the cassette's drawing outlines. Two clear buttons prepare for each new sketch by clearing the Video Art memory of previous colors and lines. The controller joystick includes a draw button that must be depressed for strokes to register on-screen.

The product would seem to be a clever and different use for the TV and it was among the first of the so-called TV interactive toys to reach the market. Having spent a few frustrating sessions with Video Art, we understand why this is the kind of product that might be a small-scale nightmare for the electronically inept.

Set-up seemed simple, except that as with a VCR, the hook-up depends on what combination of antenna/cable/VCR is joined with the TV set. Our activity-cartridge coloring outline on the TV screen floated and wobbled. It was nearly impossible to discern the coloring book-style outline. The small cursor light was equally elusive and while lines of color could be put on the screen, they couldn't be controlled.

Back to the directions, where the most valuable information we found was LJN Toys 1-800 consumer-assistance number. Although we had followed directions correctly in hooking up our cable-equipped TV with the supplied switch-box/converter, the helpful voice on the other end of the line made it clear that the Video Art requires an empty channel 3. Since our cable system transmits on 3, we would have to disconnect the cable in order to use the Video Art system. Improvement was immediate. The picture was clear and stable and each of the user controls worked, but after a few exploratory lines it proved impossible to get color onto the TV screen with the joystick. We again returned to the instructions. Buried deep on page 12 was the admonition, "whenever the activity cartridge is plugged in, the outline is not available for use."

Meaning, we guessed, that the activity cartridge couldn't be plugged into its slot during drawing. But another warning said "be sure machine is turned off before plugging or unplugging the activity cartridge. If the *power on* indicator is lit, the cartridge could be damaged." Removing the activity cartridge with the power off also took the coloring outline off the screen.

That's when we began to ponder the proviso regarding the outline. It seemed to refer to the on-screen coloring outline. We went back to take another look at the instruction diagrams, none of them illustrated anything labeled an outline.

The person at the 1-800 number admitted to being as mystified as we were by the statement, "outline not available for use when the activity cartridge is plugged in." But when we described our inability to get color onto the screen, she immediately identified the problem as being in the joystick *draw* control, apologetically explaining that it would be at least six weeks before a new controller could be supplied, exclusive of sending the defective unit to LJN, and the company mailing a new unit back.

We could only imagine (with horror) the reaction of parent and offspring to a Video Art that behaved like the GIZMO test unit. Especially if they were consumers who automatically classify electronics as user-unfriendly. We like the idea of Video Art. But our experience with the product made us dubious of its execution. The joystick sphere end was made of plastic approximately the same gauge as those throw-away capsules used to hold trinkets in a vending machine. Given that, we weren't surprised when LJN's telephone representative fingered that component as possibly the source of the malfunction.

In theory, Video Art's a neat idea. We were especially impressed by the vividness and distinctiveness of the video colors. We just wish there had been some way to consistently get them onto the screen with this electronic video drawing system.

Portable Java

QUICK CAFE PROGRAMMABLE (QC5). Manufactured by: Ronde Division, Advanced Products & Technologies, P.O. Box 2014, Redmond, WA 98073. Price: $80.

Has there ever been a class of consumers so variously catered to as mobile coffee drinkers? A fair-sized emporium could be stocked with the accessories, appliances, and accouterments designed to get hot coffee to those who crave consumption of the beverage in all manner of places and situations.

The quest for the universally accessible (and acceptable) cup of Java has lead to some of contemporary consumer technology's most ingenious products. If anyone is planning to open a coffee equipment emporium, they'd be well advised to place a large order for the *Ronde Quick Cafe Programmable*. If not the final word in personal portable coffee-brewing systems, it's at least an intelligent contribution to the ongoing beverage quest.

With the right power source, this cleverly compact beverage brewer would be a welcome addition to a salesperson's road kit or a shop foreman's workbench. With its two-cup capacity, it also strikes us as a way to control not only coffee supply, but intake as well.

There are three detachable Quick Cafe components; a filter chamber that fits inside the unit's water reservoir, a Ronde World Time Clock on the front of the base, and a plastic mug that (for travel and storage) fits over the base water reservoir. Also included with the kit are a plastic mug lid and a fabric carry case for the World Time Clock (offered as a separate travel product, TT-24, by Ronde at a suggested retail price of $26).

Storage-ready, the Quick Cafe takes up about as much room as a shaving kit or cosmetics bag. Although the traveler (and truly dedicated coffee drinker) will want to leave luggage space for ground coffee and preferred beverage condiments. Once out of the bag, the QC5 sets up for brewing in a space not more than that demanded by a standard telephone.

The most obvious limitation on the portability of this coffee maker is its power source, a standard 120-volt outlet. Ronde offers an optional voltage adapter (VA-1), but shouldn't there be some cordless option for ultimate two-cup sufficiency?

To brew, the user repositions the filter chamber outside of the water reservoir and fills the dual permanent, micro-mesh filter baskets about two-thirds full of coffee or one teaspoon per basket for tea. Atop the filter unit is a dial for brew setting. If the user has filled only one of the baskets, or wants to make two separate cups of coffee, the designation "right" or "left" is set, sending hot water through the appropriate filter basket. "Blended" sends water through both. Water temperature is also controlled via the dial, while the blend setting can be selected for the strongest cup of coffee or the blending of two varieties of coffee.

CIRCLE 67 ON FREE INFORMATION CARD

The Quick Cafe design takes an esoteric, but charming, turn with its filter chamber-mounted permanent, micromesh filter baskets. The twin units, easily held in the palm of a hand, in appearance resemble two halves of a peak-roofed house. One end is actually a tiny hinged door through which the coffee is added with a supplied plastic spoon.

By virtue of the filters' size, filling the Quick Cafe is a cumbersome process. If coffee adheres to the exteriors of the filter baskets, grounds end up in the beverage. Emptying and cleaning the baskets, too, is an involved ritual. A traveler might want to use his or her hair-dryer to speed the drying of the filter basket's metal sides before packing them away in the filter chamber.

But for the dedicated coffee drinker, the proof is in the final brew and in that all-important respect, the Quick Cafe brews up an entirely serious cup or two at a time. The entire cycle, from water and coffee in place, brew button pushed, and cup filled takes about 8 minutes.

It was in the automatic timing function that the Quick Cafe Programmable presented its major vexation. Our reading of the instruction booklet lead us to believe that the unit's World Time Clock automatically turns on the brew cycle. But repeated efforts made us think that we were the victims of ambiguous documentation. Maybe the directions only seemed to say that setting the alarm would activate the QC5. However closely we followed the clock's alarm setting directions, nothing beyond a buzzer was ever set off by the detachable World Time Alarm Clock.

Even minus an automatic brew function, the clock is a useful travel-oriented addition to the package. Besides an alarm, the unit offers calendar, second, local, and world time readings, adjustable for daylight saving. To the right of the clock LED, there's a rotary dial surrounded by the names of major cities. With the indicator positioned at a name, the readout shows world time for the selected city and below that displays the correct time for the area the user is in. And that's a big asset to anyone having business outside their present time zone.

As a travel alarm clock, the Ronde includes a ten-minute snooze function. The instrument requires its own watch-style battery and fits into a compartment on the front of the Quick Cafe Programmable.

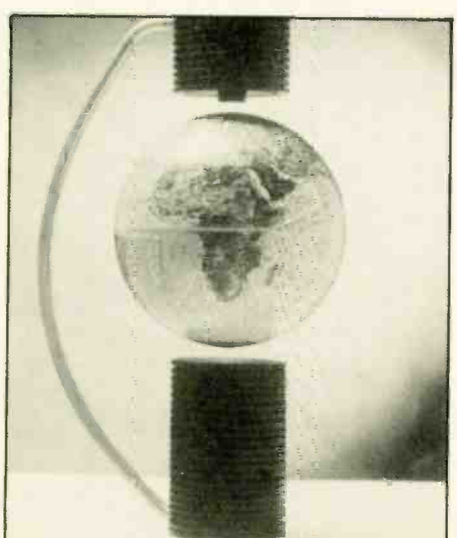
An intriguing hybrid of the fussy and the futuristic, the Ronde personal coffee system is already established as a popular travel accessory. In the office, we found it to be a neat, two-cup coffee machine—albeit with a tendency to drip water (the coffee spigot is clumsily close to the cup's lip)—that brews the beverage as well as some larger, if less involved, utensils.

The Quick Cafe Programmable (or its non-clock-equipped counterpart, the Quick Cafe Gourmet, QC-2) isn't likely to put the take-out coffee industry out of business anytime soon. But the QC-5 is a perfectly functional alternative to unacceptable or otherwise inferior coffee connections.

Gizmo/Bytes


Casio Analog/Digital Data Bank Watch

Discwasher Gold-ENS Connector Cable


Maglev Sales
Magnetic Levitation World Globe

Start-n-Charge

A prime candidate for design improvement in the automotive accessory field are jumper cables. Motorists using them always seem to end up knowing more about the inside of an engine compartment than should be necessary. In addition, the cables' bulk always looms large when you're trying to fit that last suitcase into a jam-packed trunk. Haverhills (131 Townsend St., San Francisco, CA 94107) offers what it calls one of the most useful automobile accessories to come along in years, the *Start-n-Charge*. Connection from dead to live battery is through the cars' cigarette lighters (via a supplied 15-foot cable), far from engine grime, battery acid, and electric shock. Price: $19.95.

CIRCLE 49 ON FREE INFORMATION CARD

Casio Analog/Digital Data Bank Watch

It's a lot more than time that wristwatch wearers carry on their arms nowadays. The latest from Casio Inc. (570 Mt. Pleasant Ave., P.O. Box 7000, Dover, NJ 07801) is a data bank instrument that combines both analog and digital watch faces. The Casio *Analog/Digital Data Bank Watch* (AB10WG) can store twenty telephone numbers of four letters and a dozen numerals each. The watch also provides calendar, alarm and chronograph functions. Time comes in the form of a traditional hour-minute-second hand equipped analog main dial with a digital readout below. Price: $42.95.

CIRCLE 47 ON FREE INFORMATION CARD

Discwasher Gold-ENS Connector Cable

In show business, performers are traditionally resurrected by popular demand. Discwasher (4310 Transworld Rd., Schiller Park, IL 60176) is claiming something like that for its reintroduced RCA-style *Gold-ENS Connector Cables*—back on the market as a result of demands from dealers. The connectors feature gold-plate ends, copper conductors, and special age-resistant insulation. It's the cables' lengths (4 and 5 meters) that have apparently sparked dealer demand. Price: $17.95 (4-meter), $19.95 (5-meter).

CIRCLE 69 ON FREE INFORMATION CARD

Canine Audio Security Device

Speaking of peoples' attitudes towards dogs, the Synchronics Catalog (Hanover, PA 17333-0042) offers an audio product working the opposite side of the same street. Called *Man's Best Friend*, it's described as an electronic security device that perfectly reproduces the sound of a barking dog. An ordinary looking loudspeaker, the MBF is sound sensitive, plugs into a standard outlet and barks for 45 seconds at a stretch. Synchronics describes the bark as menacing and thanks to the miracle of microchip technology, the bark is as mean and clear the 1,000th time as it is the first.

Not only is this electronic Fido tapeless, but it's touted as the guard dog you never have to walk. So what happens if some intruder hears Man's Best Friend and reaches for his trusty Dog Dazer? Woof. Price: $59.95.

CIRCLE 48 ON FREE INFORMATION CARD

Magnetic Levitation World Globe

Talk about a product that expresses the spirit of its times, the announcement from Maglev Sales (suite 31, 1k030 W. Georgia St., Vancouver, B.C. V6E 2Y3) describes the new *Magnetic Levitation World Globe* in terms that might well apply to the planet it represents. The world globe floats in space without visible means of support. The company says the product (besides appearing in upcoming episodes of *Wise Guy* on CBS TV) uses the same operating principle as the levitated train currently being tested by Japan Airlines...electronically sensing the position of the globe and regulating the power of the lifting magnet to maintain its position in mid-air. No doubt this old planet can use a lift. Price: $189.99

CIRCLE 68 ON FREE INFORMATION CARD

Gizmo/Bytes

Olympia Compact-i Electronic Typewriter

Typewriters, electronic or otherwise, are typewriters and PC printers are printers and never the twain shall meet, but that doesn't deter manufacturers from trying. The latest effort to straddle the market is the upgradable *Compact-i Electronic Typewriter* from Olympia U.S.A., Inc. (Box 22, Somerville, NJ 08876-0022). With the new optional multipurpose communications interface, the Compact-i can be used as a letter-quality printer, while a serial RS-232C port enables the typewriter to communicate with other products (we assume the press release is referring to other electronic products and not boxes of cornflakes or other spooky possibilities). The communications interface also enables bidirectional printout and features an 8K buffer, which is expandable to 32K memory. The upgraded Compact-i also offers four character sets—Diablo, IBM, ASCII, and, of course, Olympia. Price: $399.

CIRCLE 46 ON FREE INFORMATION CARD

Olympia Compact-i Electronic Typewriter

Startone Volume Control Handset

Targeting background static and weak connections plaguing telephone conversations since industry deregulation in 1984, Plantronics, Inc. (345 Encinal St., Santa Cruz, CA 95060) markets a *Startone Volume Control Handset* for both the hearing impaired and those who use phones in noisy surroundings. The device allows a receiver's volume to be increased to up to eight times that of normal levels.

Modular and easy to install, the Startone is hearing aid-compatible and will work with telephones equipped with carbon microphones, most common in home and small offices. Virtually indistinguishable from a traditional handset, the Startone is also available in an amplifier configuration for use with electronic phones. In that version, the handset is plugged into a small base unit that contains a volume control and a mute/hold switch that enables the user to hear the caller without being overheard. Price: $29.95.

CIRCLE 53 ON FREE INFORMATION CARD

Plantronics Startone
Volume Control Handset

Sima Sports Pouch

Electronic products may be getting bolder in their shapes and sizes, but what about the packages they come in—or more to the point, the containers they're carried in? That seems to be a question asked by Sima Products Corp. (4001 W. Devon Ave., Chicago, IL 60646) in designing its new *Sports Pouch*.

The carry-all is fabricated of vinyl and also inflates around contents to cushion them if dropped. And it floats if lost in the water. For toting camera and video gear, the Sports Pouch is available in two sizes: 14- by 12-inches, which inflated can float up to 10 lbs. of equipment, and a 17- by 17-inch size with a floatable capacity of up to 20 lbs. The pouches are outfitted with a detachable, adjustable shoulder strap. Price: $17.95-$22.95.

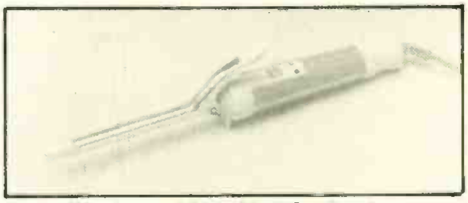
CIRCLE 50 ON FREE INFORMATION CARD

Sima Products Sports Pouch

Micro Mini Curling Iron

Precision hair styling, there's a new fashion frontier for the 1990's. When it arrives, Windmere Corp. (4920 N.W. 165th St., Hialeah, FL 33014) plans to be there already. Take the recently introduced *Micro Mini Curling Iron* (SL1-2). With a heating cycle of just 90 seconds, the Micro Mini's ⅜-inch chrome barrel creates the tightest, bounciest curls in all of home hair curling. The unit also features a cool safety tip, power indicator lamp, and an LED that shows when the SL1-2 is ready to curl, all with dual voltage (110 or 220), a swivel cord, stand and a soft grip handle. Price: $20.

CIRCLE 54 ON FREE INFORMATION CARD



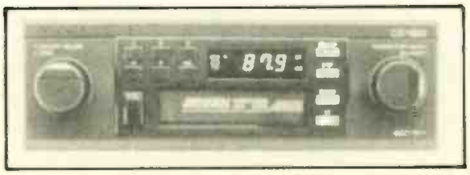
Windmere Micro Mini Curling Iron

Jensen Combo Pack Car Stereo System

With the rate at which stereos disappear from vehicles in the dead of night, dedicated car-driving music lovers may be interested in the new *Combo Pack Stereo System* (CP-3) from International Jensen, Inc. (4136 N. United Parkway, Schiller Park, IL 60176).

Labeled a limited budget system, it features Jensen's CS-1000 AM/FM stereo cassette receiver and a pair of 6-½-inch dual-cone, car speakers. The receiver offers ten station presets (5 AM and 5 FM), electronic tuning, a digital LED readout and phase lock loop circuitry for precise, drift-free reception. Price: $159.95.

CIRCLE 51 ON FREE INFORMATION CARD



Jensen Combo Pack Car Stereo System

Gizmo/Bytes

Radio Shack/Realistic Portavision TV AM/FM Stereo Cassette Recorder

Realistic Portavision TV AM/FM Stereo Cassette Recorder

Nowadays if someone says they watch very little TV, they could just be referring to the size of the set. Like the Realistic *Portavision* portable unit with a 4½-inch TV screen, along with an AM/FM radio and cassette recorder/player from Radio Shack (500 One Tandy Center, Fort Worth, TX 76102).

It's power is derived from 10 "D" batteries, standard AC current, or an optional DC adaptor. With this unit entire taped-audio libraries of daily soap operas, as well as more conventional radio recordings, could be created. Other features include telescoping antenna, terminals for external TV-antenna hook-ups, and headphone and external mike jacks. Price: $219.95.

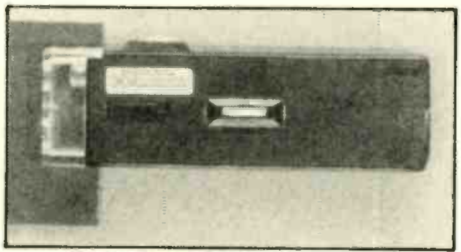
CIRCLE 74 ON FREE INFORMATION CARD

Worlds of Wonder Julie' Intelligent Doll

Julie Intelligent Doll

They've got great expectations for *Julie*, described as no less than an exciting combination of a beautiful doll and state-of-the-art-technology, by her proud parents, the toy industry's Worlds of Wonder, Inc. (4209 Technology Dr., Fremont, CA 94538). The toddler is programmed for 100 discrete, sound-activated responses, making her way through the doll world with the help of a 64K resident memory and, according to the manufacturer, sensitivity to light and dark, temperature and motion. Other kids grow up, but this blue-eyed, blonde is expandable via Worlds of Wonder voice cards with accompanying sticker activity books. Also in contrast to real kids, this one takes batteries—just how many, the product release doesn't indicate. Price: $125.

CIRCLE 75 ON FREE INFORMATION CARD

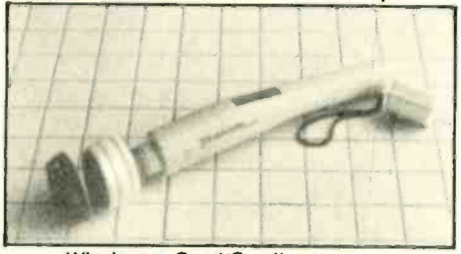


Radio Shack/Micronta Illuminated Microscope

Micronta Illuminated Microscope

Among the best things about magnifying tools like the *Micronta Illuminated Microscope* is how often they come in handy. The Radio Shack (500 One Tandy Center, Fort Worth, TX 76102) catalog describes this as a pocket-size, thirty-power field microscope with the advantage of projecting light directly onto the object examined. The unit requires two "AA" batteries and is 5-½-inches long. Price: $9.95.

CIRCLE 76 ON FREE INFORMATION CARD

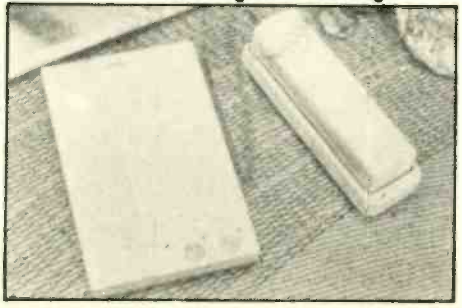


Windmere Cord/Cordless Rechargeable Massager

Cord/Cordless Rechargeable Massager

Tension, pressure, daily stress, no wonder there's a steady demand for various massaging appliances, including the *Prelude Deluxe Rechargeable Massager* (3303) from Windmere Corp. (4920 N.W. 165th St., Hialeah, FL 33014). The unit features three speed settings and is sold with a battery charger and can also be plugged into a standard outlet. Price: $34.95.

CIRCLE 40 ON FREE INFORMATION CARD



Sharp Cordless Modular Phone System

Cordless Modular Phone System

Enthusiastic? They certainly seem to be at Sharp Electronics Corporation (Sharp Plaza, Mahwah, NJ 07430) where no less than the golden age of wireless telephones has been proclaimed. The company is understandably excited about its introduction of a *Cordless Modular Phone System* (CL-300), Sharp's first cordless unit ever.

The system includes a home-base unit and a wall-mountable battery charger/handset cradle component. The mounted home base (suggested for office, bedroom or kitchen) functions as an intercom and a pager, and also doubles as a hands-free speakerphone. The component includes a modular jack for convenient hook-up of a non-system phone of conventional, wired design.

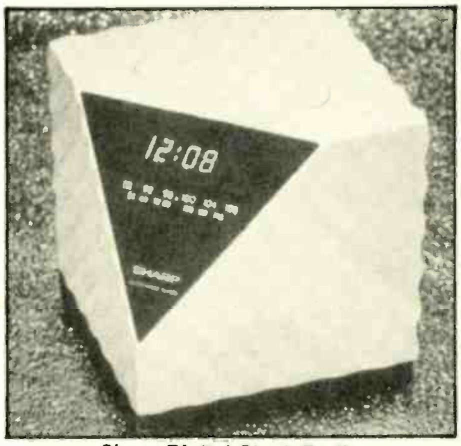
The Sharp CL-300 comes onto the market with a 20-call auto-dial number memory, automatic redial, message transfer, pulse/tone switch, ring-volume control, electronic hold and flash functions, preset security code, and a 10-choice frequency selector. That enables the user to select the clearest, strongest signal available. All of which comes wrapped in decorator shades of light gray. Price: $189.95.

CIRCLE 55 ON FREE INFORMATION CARD

Digital Clock Radio

They're calling it the groove cube and it includes such deluxe features as dual alarm set; AM/FM reception and buzzer alarm option. What's being described here is the FX-C25 *Digital Clock Radio* from Sharp Electronics Corp. (Sharp Plaza, Mahwah, NJ 07430) and it features a fluorescent display with a two-step dimmer control that's described as elegant. The FX-C25's dual alarm allows two people to set separate wake-up times, or a single person to wake up twice the same day. Colors available are blue, red, and white. Price: $49.95

CIRCLE 79 ON FREE INFORMATION CARD



Sharp Digital Clock Radio

Casio Digital Horn

If any field best represents the wild blue yonder of consumer electronic design, it's probably musical instruments. Incredible systems and effects are fabricated for recording studios and a few years later the technology shows up in a budget priced digital synthesizer. Anyhow, Casio, Inc. (570 Mt. Pleasant Ave., P.O. Box 7000) has charted a first in electronic instrument design, the world's first *Digital Horn* (DH-100).

The unique horn features a half-dozen built-in sounds, uses recorder fingerings (9 keys) and is breath-pressure sensitive. Available in May, the instrument has a MIDI out-jack for triggering external modules, built-in speaker and line-out jack. Power is supplied by "AA" batteries (included) or an optional AC adaptor (AD-1). If the DH-100 features an auto-performance function, you can play it and still save your breath. Price: $169.50.

CIRCLE 77 ON FREE INFORMATION CARD

Panasonic Steammate Travel Iron/Fabric Steamer

Dog Dazer

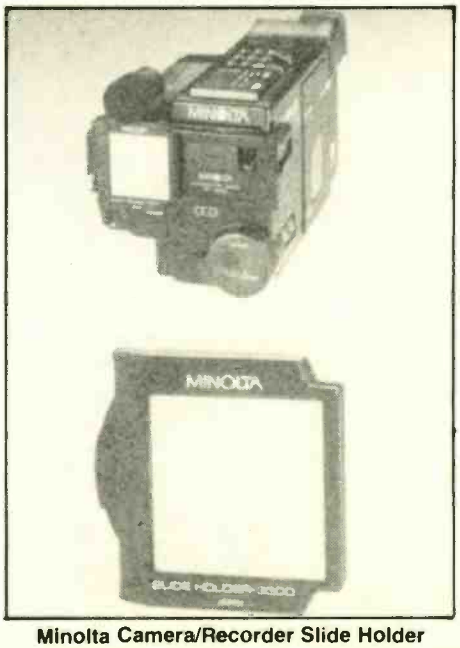
As far as some folks are concerned, faithful Fido isn't necessarily man, or woman's best friend. It isn't just the occasional letter carrier who's faced with a menacing set of canine choppers. It's at those consumers, we suppose, that the *Dog Dazer* is aimed. Available from Haverhills (131 Townsend St., San Francisco, CA 94107), the device looks like a pocket flashlight, but what it does is emit a barrage of harmless, silent ultrasonic waves that are supposed to confuse dogs who might be in an aggressive posture in the vicinity of a Dog Dazer carrier. Good to a range of 25-feet, the unit can operate on a single 9-volt battery for months and is sold with a belt clip. Haverhills cautions, that it cannot guarantee that Dazer will repel all dogs in all situations. Price: $29.95.

CIRCLE 100 ON FREE INFORMATION CARD

Steammate Travel Iron/Fabric Steamer

Living out of a suitcase isn't quite the wrinkled proposition it was years ago—thanks, in part, to products like the *Steammate Travel Iron/Fabric Steamer* from Panasonic Co. (1 Panasonic Way, Secaucus, NJ 07094). This compact unit weighs less than 1.5 lbs. and features a 1.8 oz. water container. When filled, the unit generates steam in just one minute, signaled with a pilot light. Pressing a single button, then depressing a lockable steam lever, makes the Steammate ready to press and steam clothing. It has what Panasonic calls 360-degree continuous steaming action and features a coated ironing plate to prevent sticking. Price: $39.99.

CIRCLE 99 ON FREE INFORMATION CARD



Minolta Camera/Recorder Slide Holder

Minolta Camera/Recorder Slide Holder

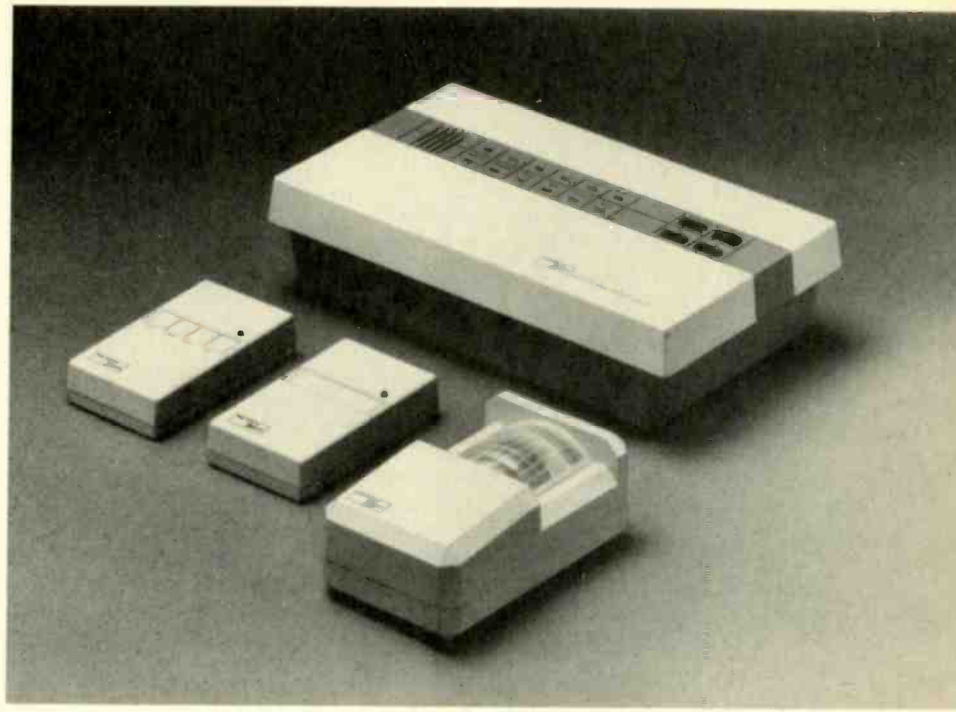
Video and 35mm slide photography seem to be coming to something like co-existence. Minolta Corp. (101 Williams Dr., Ramsey, NJ 07446) has just introduced an optional accessory for its Master Series-C 330 video camera/recorder (reported on in the March GIZMO) dubbed *The Slide Holder* (SH-3300).

With this gizmo, owners of Minolta camcorders can screen and copy their 35mm slides. Attaching the Slide Holder to the unit automatically sets the camera's lens to the 9mm focal length. The user inserts a slide, waits a few seconds while the lens focuses and then presses the camera's autofocus button. To merely project slides onto a TV screen, the monitor button is engaged. Recording slides onto VHS cassettes is triggered with the camcorder record control. Price: $25.

CIRCLE 78 ON FREE INFORMATION CARD

HANDS-ON REPORT

Heath/Zenith Wireless Security System Components



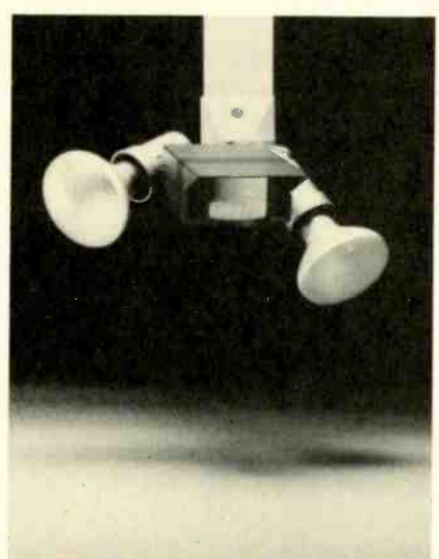
CIRCLE 70 ON FREE INFORMATION CARD

Plan to protect your home with its first primary security system, or add to an existing system with backup and new features that were not available previously.

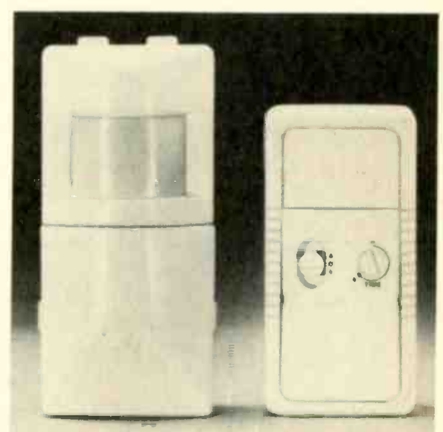
☐DURING THE NEXT FOUR YEARS, ONE in four homes in the United States will be burglarized. That means that your home, or the one to either side of your home, or the one behind you will experience damage from a break-in; or theft of valuable property; or loss due to vandalism; or worse, injury to a member of the household; or any combination of those personal affronts to you, your family, and your private property. The crime statistic stated was provided by the Federal Bureau of Investigation.

Too many homes presently have no protection or, at best, have some form of perimeter protection that uses window foils and magnetic door trips. Now is the time to consider an evaluation of your home's security and how best you can sculpture a design or redesign solution with the various security components available on the marketplace. Don't think that this reviewer is dreaming up a scenario for you to rush out and buy products. Today, sales due to consumer demand for home security products is at an all-time high. In fact, home and apartment owners like you will spend more than $2.7 billion on home security systems by 1990.

This *Hands-on Report* discusses several new products offered by the Heath/Zenith company to combat home intrusions. The products discussed in detail were actually installed in a home and they are currently offering protection to the family. In particular, the SS-5910 Wireless Security System and allied devices are discussed in detail.



The SL-5320 Motion Sensor Light Control uses passive infrared (PIR) technology to detect the presence of heat and motion. Once detected, the lights come on.

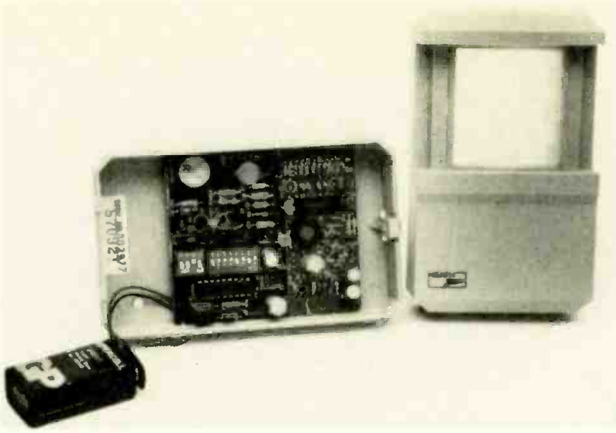


The SL-5420 Wireless Motion Sensor Light Control operates house lights through the X-10 system by detecting heat and motion.

All in the Box

For indoor security and safety, Heath/Zenith offers a complete home wireless security system, the SS-5910. Unlike most home security systems, the SS-5910 is wireless, so it can be used right out of the box. The SS-5910 comes with a wireless remote control, two wireless door-window sensors, wireless passive infrared-motion area sensor and the control console. The control console allows for up to eight zones of coverage (two of which are

The SSA-5910-1 PIR Area Detector contains a combination heat and motion sensor that detects the presence of heat in motion to trigger an alarm.



dedicated to *panic* and *fire*), and it has a tamper detection mechanism which sounds an alarm if someone tries to disable the control console.

The Heath/Zenith SS-5910 Wireless Security System was installed in a test home that already had a wired-perimeter circuit installed. That wired circuit was connected to the SS-5910 using two separate zones. Although the SS-5910 is a wireless system, it can be attached to a wired system of a continuous loop. A Heath/Zenith siren (the SSA-5910-6 Speaker Horn accessory) was connected and the new installation would have been complete except that certain areas of the test home were still unprotected. That's where the home owner using Heath/Zenith security systems and components can sculpture the system to the home's needs.

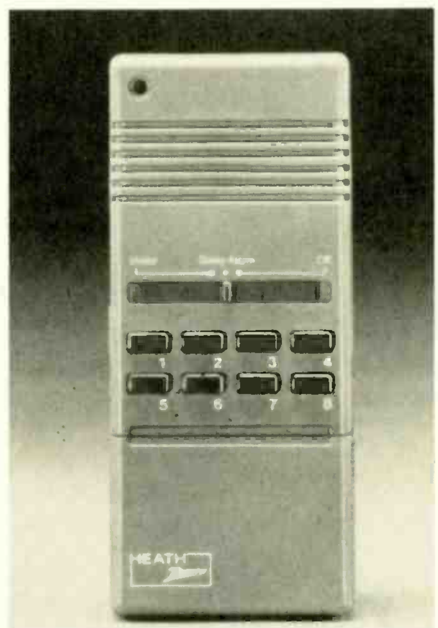
With the limitations of the previously installed security system in the test home, the garage could not be hard wired, so it was left *unprotected* except for a magnetic switch for the inside door to the house. The SS-5910 system permitted the insertion of additional SSA-5910-1 PIR (passive infrared) Area Detectors, a heat and motion sensor that operates on batteries and uses a wireless system to signal the alarm. Now, the presence of the perpetrator will signal the alarm.

Passive infrared (PIR) technology involves a heat-seeking sensor that detects the presence of heat in motion to trigger an alarm. Unlike other types of motion detectors, PIR products are very sensitive and very accurate. As a result, they are less susceptible to false alarms caused by pets or blowing leaves crossing their detection fields.

When the PIR sensor detects a variance in the monitored area, it sends a radio-frequency signal back to the control console which activates the alarm. With six zones of coverage, it is easy to identify the areas of concern.

The beauty in the design of the SS-5910 security system is that additional SSA-5910-1 PIR Area Detectors can be added to the system in any one of the 6 zones. That was a natural feature for the home that was being made secure. Two basement windows are frequently left open in the summer time. A second PIR Area Detector was purchased and installed to cover those two possible forced-entry locations.

There was need for still one more SSA-5910-1 PIR Area Detector. A home in the neighborhood was entered when no one was at home. The entire house was perimeter wired with the exception of one security weakness. The front door had panels, one of which was kicked in and an undersized thief



The SSA-5910-2 Wireless Door/Window Sensor mounts on a door or window along with a magnetic-contact switch, in such way that when the contact switch is separated from the Sensor unit, the alarm is activated.

crawled into the home without opening the door. That act must have taken all of 30 seconds to accomplish. I decided to place one PIR Area Detector in the livingroom, facing the house entrance and had the device detect anyone who would enter the door, walk down the entrance hallway, or go up the stairway to the upper bedrooms. The use of additional PIR Area Detectors is not limited

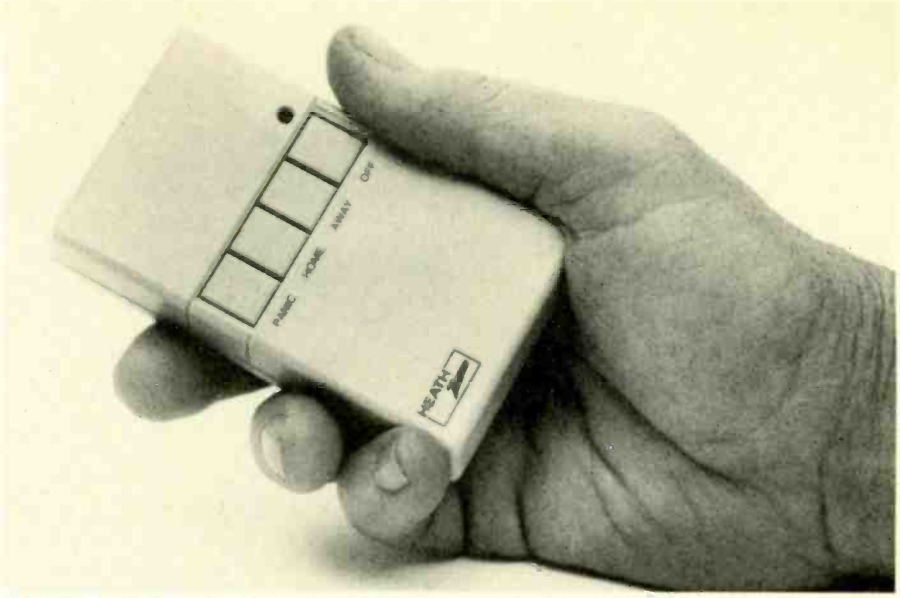
Designed for installation in a variety of situations, the SD-5710 Door Alarm/Chime alerts users to area penetration by activating an alarm or a pleasant chime any time a door or window is opened.

by the system. The SSA-5910-1 PIR Area Detectors sell for $119.95 each.

Door Alarms

The two SSA-5910-2 Wireless Door/Window Sensors supplied with the SS-5910 Wireless Security System were a windfall. One was attached to the rear door and the other to the workshop door in the basement.

The SSA-5910-2 Wireless Door/Window sensor mounts on a door or window along with a magnetic-contact switch that mounts on the stationary frame. When the contact switch is separated by opening the door or window, the SD-5710 activates its alarm. The device is powered by a 9-volt battery and only draws from the battery when the contact switch has been separated. Additional units can be purchased for $29.95.



The SSA-5910-4 Personal Command Remote Control, a pocket-size device, can remotely activate the panic zone with a press of a button.

Chimes Plus Protection

Heath/Zenith came up with an unusual add-on component for the SS-5910 Wireless Security System—the SD-5710 Door Alarm/Chime ($29.95). Designed to be installed in a variety of situations, the device alerts users by activating an alarm or a pleasant chime any time a door or window is opened. When used in the alarm mode, a 4-digit code allows up to 11,680 different combinations to de-activate the alarm.

In the test installation, the SD-5710 was mounted on the front door along with a magnetic-contact switch that mounts on the stationary frame. When the contact switch is separated by opening the door (or window), the SD-5710 activates its alarm. Two operating modes allow complete control of the Alarm/Chime. In the *alarm* mode, the unit creates a piercing alarm, alerting listeners that the contact has been separated. In the *visitor* mode, the SD-5710 creates a pleasant two-tone chime for announcing that the door has been opened. The SD-5710 is powered by a 9-volt battery and only draws from the battery when the contact switch has been separated.

The Basic System

The SS-5910 Wireless Security System consists of a Wireless Control Console, a Personal Command Remote Control, two Wireless Door/Window Sensors, and a Passive Infrared Area Detector. Because the system is entirely wireless, all elements can be placed wherever the homeowner desires.

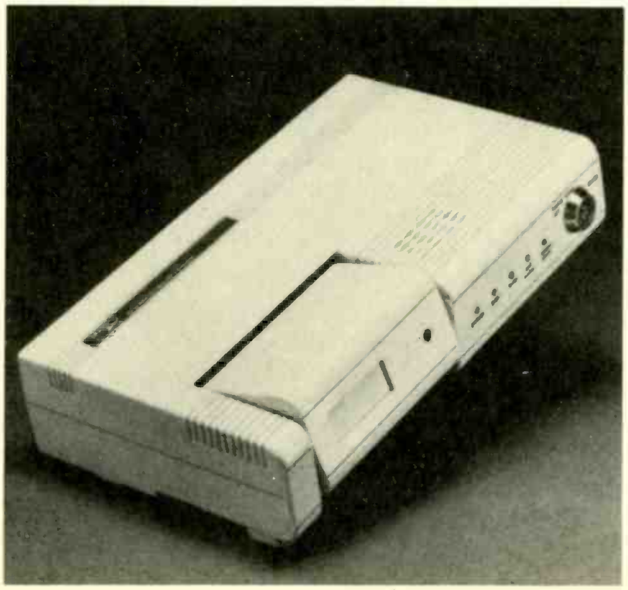
The SS-5910 Wireless Security System has three operating modes: Off, Home, and Away. The desired mode is selected by using the Control Console key switch or the SSA-5910-4 Personal Command Remote Control.

When a sensor detects motion or the opening of a door or window, it transmits a signal to the Control Console. The Console decides whether or not to sound the alarm depending on which mode the system is in.

Each sensor is assigned to one of eight zones. More than one sensor can be assigned to a zone. Multiple switch banks in each sensor are preset to the setting for the desired zone. Two of the zones, *panic* and *fire*, have special uses. The *panic* zone responds to signals without any delay in any mode. The SSA-5910-4 Personal Command Remote Control ($59.95), a pocket-size device, can remotely activate the panic zone with a press of a button. It would be used in cases of extreme emergency when you want an alarm to sound. The *fire* zone responds without delay in any mode and is compatible with certain existing smoke detectors.

There are two types of alarms: the *panic/fire* alarm and the *intrusion* alarm. The former is a series of steady, piercing beeps. The intrusion alarm is an ascending, wailing tone. The Control Console has a built-in speaker for alarms and it can power an external siren. Both types of alarms sound for three minutes and then turn off, at which time they can be activated again.

(Continued on page 95)



The SS-5910 Wireless Security System's Control Console has three operating modes: Off, Home, and Away. Mode selection is made via the Control Console key switch or the SSA-5910-4 Personal Command Remote Control. When a sensor detects motion or the opening of a door or window, it transmits a signal to the Control Console, which decides whether to sound the alarm.

THE COLOR CODE DRILL

Here's a computer program designed to help you improve your speed and accuracy at using the resistor code.

By James E. Tarchinski

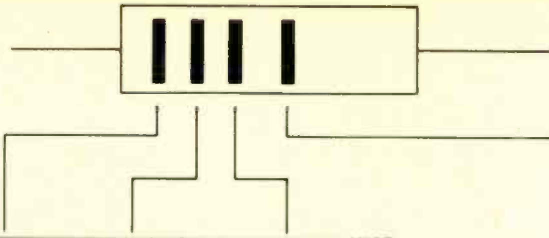
NOT EVERYONE HAS A KNOWLedge of the resistor color code that is as good as it could be or should be. Think about it; how many times have you been sorting resistors and then found yourself forced to count the colors out on your fingers because you've forgotten whether blue is a six or a seven? Or how many of you had to make a color list for ready reference posted above your desk or workbench? Have you ever purchased a "color wheel" to translate the color code into resistor values?

If any of those statements toggles a bit or two in your memory bank, or if you're new to electronics and have never learned the color code, then this month there's a computer program for you! The *Color Code Drill* (CC-DRILL.BAS) is a BASIC program for the IBM PC (and PC compatibles) to help make the color code second nature to you.

What it Does

CC-DRILL.BAS teaches the color code by displaying a resistor on the screen, complete with the color bands labeled, and asking you what the displayed resistor represents. If you answer correctly the computer will display another value and the process repeats. If, however, you enter an incorrect value,

```
1000 'CC-DRILL.BAS - Resistor Color Code Drill Program
1010 '(c) 1987 by James E. Tarchinski
1020 '
1030 '*********** INITIALIZE PROGRAM ***********************
1040 '
1050 CLEAR : DIM R(177) : DIM CL$(11)
1060 SCREEN 0.0,0.0 : COLOR 11,0.0 : KEY OFF : WIDTH 80 : CLS
1070 '
1080 RANDOMIZE
1090 PRINT : PRINT "Initializing, please wait...";
1100 '
1110 RESTORE : FOR I=1 TO 72 : READ R(I) : NEXT I
1120 RESTORE : FOR I=73 TO 144 : READ J : R(I)=J*1000 : NEXT I
1130 RESTORE : FOR I=145 TO 177 : READ J : R(I)=J*1000000! : NEXT I
1140 '
1150 RESTORE 1890 : FOR I=0 TO 11 : READ CL$(I) : NEXT
1160 '
1170 J1$=STRING$(79.196) : J2$=STRING$(33.32)
1180 '
1190 '
1200 '*********** PRINT SCREEN ******************************
1210 '
1220 CLS : PRINT J1$
1230 LOCATE 2.25 : COLOR 14 : PRINT "THE COLOR CODE DRILL PROGRAM"
1240 LOCATE 3.25 : PRINT "(c) 1987 by James Tarchinski"
1250 COLOR 11
1260 PRINT J1$
1270 PRINT
1280 PRINT J2$+"     3"
1290 PRINT J2$+"     3"
1300 PRINT J2$+"ZDDDDDDDDD?"
1310 PRINT J2$+"3         3"
1320 PRINT J2$+"3         3"
1330 PRINT J2$+"3         3"
1340 PRINT J2$+"3         3"
1350 PRINT J2$+"3         3"
1360 PRINT J2$+"3         3"
1370 PRINT J2$+"3=========3"
1380 PRINT J2$+"3         3"
1390 PRINT J2$+"@DDDDDDDDDY"
1400 PRINT J2$+"     3"
1410 PRINT J2$+"     3"
1420 LOCATE 23.1 : PRINT J1$;
1430 '
1440 '
1450 '*********** GENERATE & PRINT VALUE ********************
1460 '
1470 VL=R(INT(177*RND(1)+1)) : IF VL=VL.OLD THEN 1470
1480 VL.OLD=VL : J=VL :TB=0
1490 IF J>=100 THEN J=J/10 : TB=TB+1 : GOTO 1490
1500 IF J<10 THEN TB=9
1510 IF J<10 THEN J=J*10 : TB=TB+1 : GOTO 1510
1520 '
1530 COLOR 15
1540 FB=VAL(MID$(STR$(J).2.1)) : LOCATE  9.36 : PRINT CL$(FB);
1550 SB=VAL(MID$(STR$(J),3,1)) : LOCATE 11,36 : PRINT CL$(SB);
1560 LOCATE 13.36 : PRINT CL$(TB);
1570 '
1580 '
1590 '*********** GET ANSWER & CHECK IT ********************
1600 '
1610 LOCATE 21,1 : PRINT STRING$(79.32)
1620 LOCATE 21.1 : INPUT "Resistor Value: ",CD$
1630 IF CD$="" THEN 1610
1640 '
1650 J1$=""
1660 FOR I=1 TO LEN(CD$)
1670   J2$=MID$(CD$,I.1)
1680   IF J2$=" " THEN J2$=""                        'remove spaces
1690   IF ASC(J2$) >= 97 THEN J2$=CHR$(ASC(J2$)-32)  'make capitals
1700   J1$=J1$+J2$                                   'add to new cd$
1710 NEXT I : CD$=J1$
1720 IF CD$="QUIT" THEN CLS : END
1730 '
1740 GVL=VAL(CD$)
1750 IF RIGHT$(CD$.1)="K" THEN GVL=1000!*VAL(LEFT$(CD$,LEN(CD$)-1))
1760 IF RIGHT$(CD$.1)="M" THEN
 GVL=1000000!*VAL(LEFT$(CD$.LEN(CD$)-1))
1770 '
1780 IF GVL<>VL THEN BEEP : GOTO 1610
1790 GOTO 1470
1800 '
1810 '
1820 '*********** DATA SECTION *****************************
1830 '
1840 DATA 1.1.1,1.2.1.3.1.5.1.6.1.8,2.0.2.2.2.4,2.7.3,3.3.3.6.3.9
 ,4.3.4.7.5.1
1850 DATA 5.6.6.2.6.8.7.5.8.2,9.1.10.11,12.13.15,16.18.20.22.24.27
 .30
1860 DATA 33,36.39.43.47.51.56.62.68.75.82.91,100.110.120.130.150
 .160.180
1870 DATA 200.220.240.270.300.330.360.390.430.470.510.560.620.680
 .750,820,910
1880 '
1890 DATA "BLACK "."BROWN "."RED    ","ORANGE"."YELLOW"."GREEN ",
 "BLUE  "
1900 DATA "VIOLET"."GRAY  "."WHITE ","GOLD  "."SILVER"
```



COLOR	DIGIT-1	DIGIT-2	MULTIPLIER
BLACK	0	0	X 1
BROWN	1	1	X 10
RED	2	2	X 100
ORANGE	3	3	X 1,000
YELLOW	4	4	X 10,000
GREEN	5	5	X 100,000
BLUE	6	6	X 1,000,000
VIOLET	7	7	–
GRAY	8	8	–
WHITE	9	9	–
GOLD	–	–	÷ 10
SILVER			÷ 100

TOLERANCE BAND		
GOLD:	+/-	5%
SILVER:	+/-	10%
NONE:	+/-	20%

EXAMPLE: COLOR BANDS = ORANGE, BLUE, YELLOW, GOLD

3 6 X 10,000 = 360K OHMS +/- 5%

Fig. 1—This chart shows the meaning of each of the four bands and the numeric value associated with each of the colors for a particular band. Also, an example of the encoding of a 360K resistor is given at the bottom.

TABLE 1—
STANDARD VALUES FOR ±5% CARBON RESISTORS

Ohms				Kilohms				Megohms	
1.0	5.6	33	180	1.0	5.6	33	180	1.0	5.6
1.1	6.2	36	200	1.1	6.2	36	200	1.1	6.2
1.2	6.8	39	220	1.2	6.8	39	220	1.2	6.8
1.3	7.5	43	240	1.3	7.5	43	240	1.3	7.5
1.5	8.2	47	270	1.5	8.2	47	270	1.5	8.2
1.6	9.1	51	300	1.6	9.1	51	300	1.6	9.1
1.8	10	56	330	1.8	10	56	330	1.8	10
2.0	11	62	360	2.0	11	62	360	2.0	11
2.2	12	68	390	2.2	12	68	380	2.2	12
2.4	13	75	430	2.4	13	75	430	2.4	13
2.7	15	82	470	2.7	15	82	470	2.7	15
3.0	16	91	510	3.0	16	91	510	3.0	16
3.3	18	100	560	3.3	18	100	560	3.3	18
3.6	20	110	620	3.6	20	110	620	3.6	20
3.9	22	120	680	3.9	22	120	680	3.9	22
4.3	24	130	750	4.3	24	130	750	4.3	
4.7	27	150	820	4.7	27	150	820	4.7	
5.1	30	160	910	5.1	30	160	910	5.1	

the computer beeps and allows you to try answering the question again.

Because of the method The Color Code Drill uses to generate resistor values, there is something else you will learn by using this program: the standard 5%-resistor values. That means that you can purchase every value of resistor that appears on the screen, and you'll soon learn not to design something like a 525 ohm, ± 5 percent resistor into your projects, you'll know that *there aint no such animal.*

A summary of the color code, along with a brief example, is given in Fig. 1, while Table 1 contains a list of the standard 5% resistor values. The table and figure are presented here only to refresh your memory, it is hoped that CC-DRILL.BAS will eliminate your need to refer to them!

The Program Startup

As indicated by the REM (remark) statements in the listing, lines 1000-1190 of CC-DRILL.BAS are used to initialize the program. First, the screen is cleared and setup in 80-column text mode. Next, the resistor values are loaded into the R(i) array using READ commands in conjunction with the DATA statements of lines 1840-1870. Line 1150 uses a similar format to load in the color names from the data in lines 1890 and 1900. It is important to note that all of the strings in those two DATA statements are exactly six characters in length.

Line 1080 of the initialization procedure contains the RANDOMIZE command. When the program is run, this statement will prompt you to enter a number which will be used by the computer to help generate "random" numbers. If you do not include this line in the program the chances are that the computer will always quiz you on the same resistor values, in the same order (real fun, huh?)

Screen Output

The next section of code, namely lines 1200–1440, prints a diagram of a resistor on the screen using J1$ and J2$, two string constants defined in line 1170. The series of equal signs in line 1370 is used to represent the tolerance band of the resistor, which is not used in CC-DRILL.

A random resistor value is selected and printed on the screen in the next section of the program. Line 1470 generates a resistor value (the variable VL) and checks to make certain that that same value was not picked the previous time through the loop. Lines 1490–1510 break the variable VL up into the first three bands of the color code (the variable FB stands for the first band value, SB is the second band value, and TB is (you catch on quick) the third band value). Lines 1540–1560 then print this information on the screen.

Input and Checking

In the last major section of The Color Code Drill the user is asked to enter the value of the resistor being displayed on the screen. That answer is entered as the string variable CD$. String CD$ is then stripped of all spaces and all lower-case characters by lines 1650–1720.

Next, the program checks the last character in CD$ to handle cases where the user enters a resistor value using the kilo- (k) or mega- (M) notation. That makes the program very compatible with how we are used to classifying resistors. A 100,000-ohm resistor, for example, could be entered in any of these three ways: (1) 1,000,000, (2) 100k, or (3) 0.1M.

If the resistor value the user enters is not correct, line 1780 will cause the computer to beep and return to line 1610, where the user is given another chance to enter a correct response.

(Continued on page 102)

The Simplest HAM RECEIVER

A step back in the state-of-the-art to the early days of radio. Here's an amateur receiver that grand dad would have used if he had transistors.

By Larry Lisle

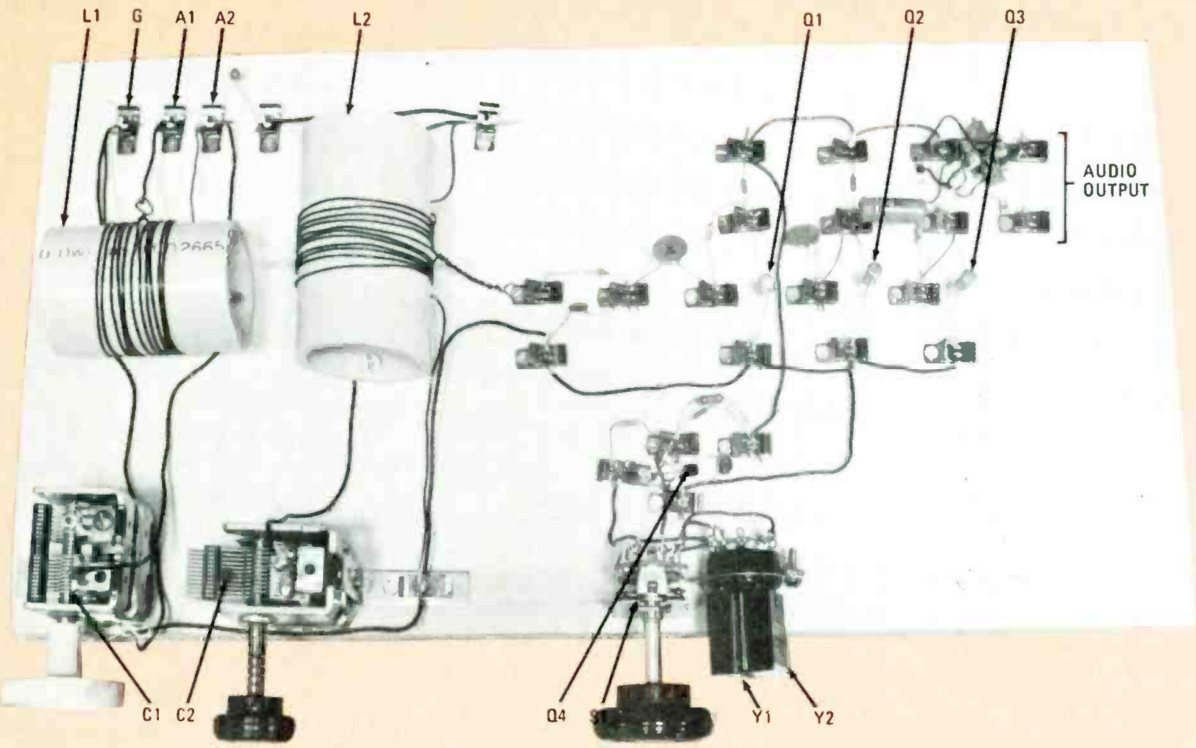
☐DID YOU EVER HAVE THE FEELING THAT YOU WANTED TO KICK yourself? I did! For years I've been trying to design a basic ham receiver for students in my electronics and ham radio classes—a companion receiver for the *Gaseous State Transmitter* construction-project article that appeared in the November, 1987 issue of **Hands-On Electronics**. I wanted a receiver for Morse code that was reasonably sensitive, wouldn't drift, or be bothered by hand capacity; and yet, it would be easy to build.

Light suddenly dawned when I realized that if the transmitter was crystal controlled, there was no point in tuning the receiver, and it could be *rock steady*, too!

Using crystal-controlled tuning eliminates a host of problems in building a high-frequency receiver. There's no worry about drift, and shielding isn't needed (well, almost not needed) to prevent detuning by hand capacity. Best of all, with a tuning crystal in the circuit, the receiver is simple and reliable.

Later, after you built the receiver described in this article and as your building skills develop, you might want to add a tunable oscillator to the receiver. Don't give up on your crystal oscillator section should you step-up to a better receiver. You can use the crystal oscillator to check the calibration, or you might want to leave it as it is and use the crystal-controlled receiver for portable or emergency work.

Don't let the concept of crystal-control circuitry scare you off. You don't need to cover an entire amateur-radio band. Four or five inexpensive crystals, clustered one or two kHz apart will provide lots of contacts—and the crystals can be used in the transmitter, too!



Ham radio receivers don't come much simpler than this one and it really works! The Simplest Ham Radio uses the oldest receiving principle still in use--direct conversion. The high frequency Morse code signals are mixed because of their close proximity and rectified by a diode with a signal generated by the crystal controlled oscillator to produce an audible beat note. It's a good companion receiver for a crystal controlled transmitter. The parts lay-out follows the circuit diagram closely—it's a beginner's receiver that you can really build.

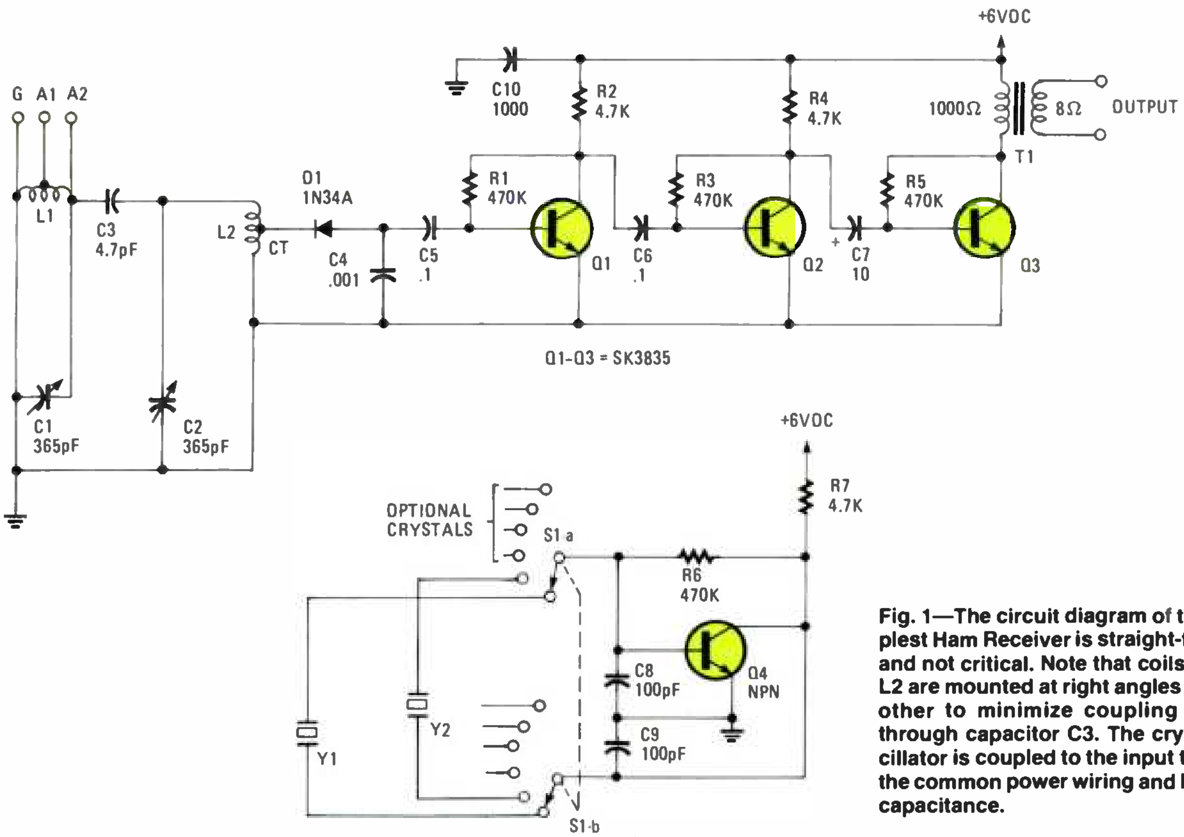


Fig. 1—The circuit diagram of the Simplest Ham Receiver is straight-forward and not critical. Note that coils L1 and L2 are mounted at right angles to each other to minimize coupling except through capacitor C3. The crystal oscillator is coupled to the input through the common power wiring and by stray capacitance.

How It Works

The Simplest Ham Receiver uses the oldest principle of radio reception still in use—direct conversion. Fessenden came up with the idea about 1901 and used an arc to generate the local oscillator signal. He was ahead of his time, for his receiver predates the crystal set that first appeared in 1906; triode vacuum tube, 1906-7; regenetation circuit, 1912; and the superheterodyne circuit (1918).

An incoming signal, for instance 7103 kHz, is mixed with a continuous signal generated by the crystal within the receiver, say 7102 kHz. The difference between the two is 1 kHz or 1000 Hz, an audio frequency, which is amplified and can be heard in the earphones or speaker. The sum of these two signals (14,205 kHz) is not within the audio range—thus it is not used!

Actually, it's not quite that simple, since an incoming signal 1000 Hz on the other side of the crystal may also be heard, plus all the frequencies mentioned along with their sums and harmonics can get into the amplifier too. Still, that's the basic idea of how the receiver works. Recall that in 1901 there were almost no radio transmitters in operation. An interfering signal was a marvelous catch.

The circuit is shown in Fig. 1. Notice that it is in three parts. One part is the radio-frequency detector circuit which includes the antenna and tuning coils L1 and L2, tuning capacitors C1 and C2, and detecting diode D1. The local oscillator circuit consisting of two switchable crystals Y1 and Y2, and oscillator transistor Q4 produces a signal that heterodynes with the received signal to produce an audio signal. Although there is no direct connection between the two circuits, leakage capacitance of space provides enough signal from the oscillator to operate the receiver.

The resultant heterodyning signal (actually the difference between signal and the oscillator signal) is detected (rectified) by D1 and filtered by C4 so that the audio stages consisting of transistors Q1 through Q3 amplify the signal and drive the listening device.

Today's earphones and small speakers are rated at an impedance of 8-10 ohms, so transformer T1 loads down the output to match the output device used. Should you own a headset rated at 2000-ohms, it is recommended that you use a 1:1 impedance match (audio isolation transformer, 1000-to 1000-ohms or there about) for T1. You could use the headphone as a load for Q3, but the former use of a transformer is advised.

The entire circuit is powered by a 6-volt battery pack. D cells are suitable for this purpose, although you may want to use a lantern-type battery pack. Capacitor C10 is a decoupling capacitor that prevents the amplifier from motorboating (oscillating).

Construction

Building the Simplest Ham Receiver isn't difficult and the parts layout on the board generally follows the circuit diagram. Fahnstock clips fastened to the pine board by wood screws are used for point-to-point wiring. Capacitor C10 isn't shown in the parts-identification photo, because it's mounted on the battery. Coils L1 and L2 are wound on plastic pipe having an outside diameter of 2-1/4-in., but other forms such as paper and wood can be used as long as the diameter is about the same. Note that the axes of the two coils are mounted at 90-degree angles from one another to reduce mutual interaction. The variable capacitors, C1 and C2, were salvaged from old broadcast sets.

A word about the variable capacitors. The coming of the imported transistor radio and the economics of stocking radio parts has brought about the lack of available variable capacitors of the type used in this article and in receivers and transmitters designed a decade ago or longer. The best bet is to salvage variable capacitors from discarded and damaged vacuum-tube radios found in dumps, attics, and flea markets. It is interesting to note that a worthless, worn, cracked-cabinet, vacuum-tube radio can be purchased for two or three dollars and it can yield parts worth many times the purchase price.

Only two crystals are shown in the photo and diagram, but more can be added. The crystal-selector switch and extra socket can be eliminated if the receiver is to be used on only one frequency. You can always unplug and replace the crystal to change frequency.

Either an 8-ohm speaker or low-impedance earphones will work, but for code *copying 'phones* (old timers call them *cans*) are generally preferred. If the volume is too loud connect capacitor C7 to the base of Q2 instead of to the collector. This will bypass one stage of amplification.

The audio amplifier is routine in design to modern-day standards, and it can be changed to a different type if desired. Keep the output terminals and other circuit parts well away from the antenna circuit or radio-frequency feedback may result. This may not bother you too much, but it will play havoc with other hams on the same and higher bands.

PARTS LIST FOR THE SIMPLEST HAM RECEIVER

SEMICONDUCTORS

D1—1N34A germanium diode, or equivalent
Q1, Q2, Q3—SK3835 or ECG103A transistor, NPN, germanium, or any equivalent type
Q4-Transistor, NPN, high-frequency, small-signal, silicon (almost any common type will work)

CAPACITORS

C1, C2—365-pF variable
C3—4.7-pF, 15-WVDC, ceramic-disc
C4—.001-µF, 15-WVDC,ceramic-disc
C5, C6—.1-µF, 15-WVDC, ceramic-disc
C7—10-µF, 15-WVDC, ceramic-disc
C8,C9—100-pF, 15-WVDC, ceramic-disc
C10—1000-µF, 15-WVDC, electrolytic

RESISTORS

R1, R3, R5, R6—470,000-ohm, 1/4-watt, 10%
R2, R4, R7—4700-ohm, 1/4-watt, 10%

ADDITIONAL PARTS AND MATERIALS

HS1—Speaker or earphone, 8-ohm, or equivalent (see text)
L1, L2—11 turns of #20-22 enameled wire on 2-1/4-inch OD form (plastic pipe or wood), loose-wound, spaced 1-inch (see photo), center-tapped
S1—2-pole, 6-position, break-before-make, rotary switch
T1—Transformer, 1000-ohm to 8-ohm, audio
Y1, Y2—Crystals for 80- or 40-meter amateur bands (refer to text)
(Crystals are $2.50 each, or $1.95 each in quantities of 5 or more for 40 meters; or $2.95/$2.50 80 meters plus $.30 postage from: CW Crystals, 570 N. Buffalo St., Marshfield, MO 65706. Write for complete prices.)
Pine board 1- × 10-in. × 17 in. long, three brackets for variable capacitors and switch, octal socket; 28 Fahnstock clips and #4 wood screws 1/2-in. long, insulated wire, #6 wood screws 1/2 in. long, machine hardware, knobs, solder, etc.

After the wiring is completed and checked, connect the battery (be careful to observe polarity) and tune capacitor C2 until you hear signals, then peak capacitor C1. The best time to try the receiver is at night when the bands are sure to be full of transmitting stations. Most hams work during the day, and signal conditions are better at night. The antenna may be connected at either the top of coil L1 or at its center tap, whichever works best. Capacitor C1 and C2 should be retuned whenever the antenna is changed or a substantial shift in frequency is made (crystal is changed). If more signal is needed from the local oscillator (Q4), a clip lead can be attached to the unused antenna post and draped near the oscillator circuit. No direct connection or a capacitor should be made between the the two circuits except for the common power supply. Needless to say, you require an amateur radio license to transmit, but you can listen for all it's worth without a license.

With the values shown, the receiver will cover the 80-and 40-meter bands. Don't be afraid to experiment if you want to try 30- or 20-meters with suitable crystals. Stay away from the 160-meter band—it is too close to the broadcast band—you might interfere with the broadcast band. Angry neighbors are what no amateur radio operator needs!

Results

To check out the Simplest Ham Receiver, I first tried to pick up the nightly code practice transmissions from station W1AW in Connecticut since this would be something my students would find useful. A color burst crystal from an old TV (3579.545 kHz) was just right for hearing W1AW's powerful signal on 3580 kHz in the 80 meter band, while a 7081 kHz crystal did the job in the 40-meter band. I've had no trouble hearing W1AW on one band or the other (usually both) every night I've tried.

Using the Simplest Ham Receiver in combination with the Gaseous State Transmitter on 40-meters, my first CQ (call to all stations) was answered by a fellow a couple of states away. He was also using a home-built transmitter, but his power output was only 3/4-watt. So much for questions about the receiver's sensitivity!

Since then, I've made many solid contacts from several states using the *home-brew two*—Simplest Ham Radio and Gaseous-state Transmitter.

In General, the receiver works about as well as the less-expensive commercial ham receivers many of us started with 20 or 30 years ago, such as the Hallicrafters S40 or the National NC-88.

The stability is much better of course, while the resistance to overload by stations outside the receiver bandpass is poorer. Sensitivity and selectivity are about the same. Of course, the receiver is not tunable except to selected crystal frequencies within the amateur-radio bands.

In the old days we had three rules for using receivers with wide open selectivity; try to operate at other than times of peak activity, concentrate on the tone of the one signal you want to hear, and talk to the person with the *loudest signal*!

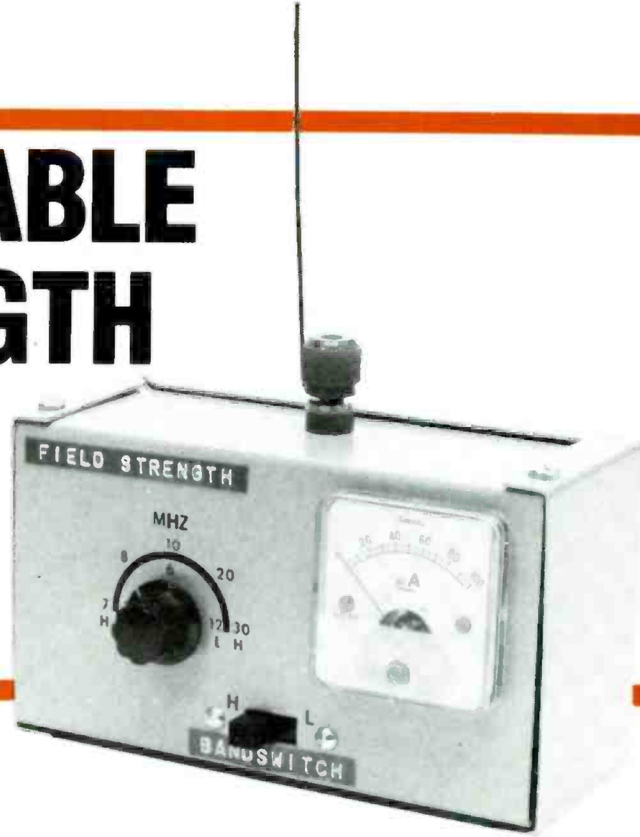
There are many ways to improve the Simplest Ham Receiver: a volume control would be nice, a tunable audio filter will help almost any receiver, a balanced detector will help eliminate some out-of-bandpass interference, and so on.

Still, I've had a lot of fun with the radio just the way it is. There's nothing like talking to someone hundreds of miles away using equipment you've put together with your own hands. ■

BUILD A TUNABLE FIELD-STRENGTH METER

This field-strength meter lets you distinguish between spuri and the real thing.

By Herb Friedman



IN THIS MODERN ERA OF THE FAST AND THE BIG BUCK, some perfectly good devices are no longer manufactured. Not that they're not useful, popular, and profitable, but because they can't produce obscene profits—enough to make a 23-year old entrepreneur a multi-millionaire by the age of 24.

One of the most popular and useful devices to fall before the *God of big bucks* was the 3–30-MHz tunable, *F*ield-*S*trength *M*eter (FSM), which used no batteries, amplifiers, or anything else that wore out or had to be replaced. The tunable FSM was always ready for use because it basically consisted of a small wire antenna, a calibrated tuned circuit, a diode rectifier, and a sensitive meter; just like the model shown in the photographs.

The closer the FSM was tuned to an RF frequency, the higher the meter's reading. Similarly, the closer the FSM was placed to the signal source, the greater the meter's reading.

You Really Know

The advantage to having calibrated tuning, compared to an equally sensitive but non-tuned "broadband" meter, is that you know what you're measuring. For example, assume you've constructed a small-signal oscillator, or a ham transmitter, or whatever. It seems to work, but the RF output-level isn't what you expected. Or maybe a neighbor down the block claims your gizmo is producing interference on a frequency that's nowhere near what the gizmo's output frequency is supposed to be.

If you use one of the modern broadband/amplified FSMs your chance of finding the problem, or even knowing it exists, is slightly less than the life expectancy of a snowball in Hell. But use a Tunable FSM and you can quickly and easily check to see if the gizmo is really generating RF output at its design frequency. And any changes made to the circuit that increases or decreases the gizmo's output power is instantly indicated by the FSM.

As for complaints about off-frequency operation, simply adjust the tuning dial s-l-o-w-l-y through the FSM's complete tuning range, and if the meter kicks at any frequency other than the one for which it's designed, you know for certain that the gizmo is generating harmonics, or just plain spurious emissions.

For example, if you've built a 3–4-MHz Novice transmitter and the tunable FSM shows output at about 7 or 14 MHz, you know you're dealing with harmonics of the desired fundamental frequency. But if the FSM also tunes in signals at, say, 5, 11, 13, 23, or 29 MHz, you know you've got big trouble: spurious emissions.

Tunable FSMs also come in handy for trimming transmitting antennas to a gnat's eyelash. Simply set up the meter as far from the antenna as you can see it (or have someone else observe the meter readings), tune the meter to the operating frequency, and then adjust the antenna for a maximum reading on the FSM. When the meter reading peaks, the antenna tuning is right on the money; it can't even give change.

The Circuit

As shown in Fig. 1, the circuit is about as simple as anything can be. We could throw in a handful of ICs and transistors just to make the circuit look *hi-tech*, but the extra hardware wouldn't make it work any better. The input signal is received through a short length of wire attached to 5-way binding post BP1. Depending on the setting of switch S1, the signal at BP1 is applied across a tuned circuit, consisting of

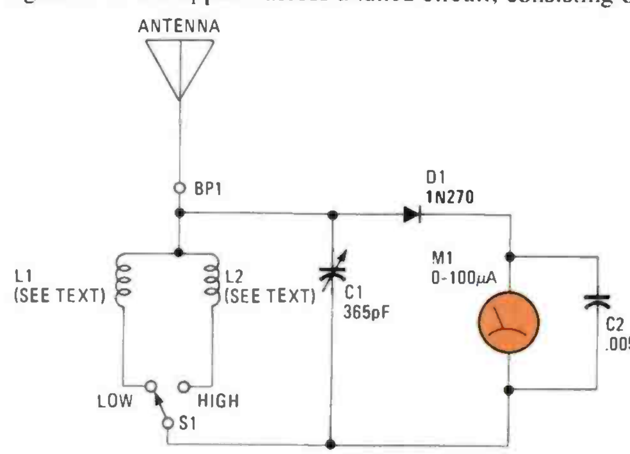


Fig. 1—Although the FSM uses few parts and has no amplifier, it is one of the most sensitive designs available because it can be tuned to any frequency from 3–30 MHz.

L1/C1 or L2/C1. L1 is for the *low band* (3–12 MHz); L2 is for the *high band* (7–30 MHz). Since L1/C1 and L2/C1 comprise a parallel-resonant circuit, the voltage developed across C1 is very high.

The voltage across C1 is applied to diode D1, which rectifies the RF to a DC current that is displayed by meter M1. Capacitor C2 simply bypasses any RF that might get across D1 and into the meter. Its larger-than-usual capacitance also serves to filter any modulation of the RF signal that would cause the meter's reading to flicker.

Before we go any further, a word about D1. The term "diode" is generic, in that it can represent any of several different devices. In this project D1 must be a small-signal *germanium rectifier*, because the project only works properly with a germanium rectifier—with no other diode. A germanium rectifier, such as the specified 1N270 or its equivalent, has a barrier voltage of 0.2 volts, meaning it takes 0.2 volts across the anode and cathode before the rectifier conducts.

On the other hand, a silicon rectifier requires from 0.7 to about 1.2 volts across the anode and cathode before conduction takes place. Other kinds of rectifiers—all generically called diodes—take even greater voltage for conduction. Obviously, germanium is the most sensitive: it will result in full-scale meter readings, while other rectifiers won't pass enough current to even budge M1's pointer off its pin. So if you have any ideas of using a non-germanium substitute for D1, forget it; and that goes for the ever-popular 1N914.

Construction

The hardest thing about building the project will be getting the components. Tuning capacitor C1 can be any type that has a maximum capacitance of 365-pF. You can even salvage something from an old transistor radio, but make certain that it's a 365-pF unit. Most modern transistor radios use tuning capacitors having a maximum value of about 150-pF, and that's just not enough.

The tuning capacitor used for the model shown is a miniature type known as a *Polyvaricon*. The type having a shaft haven't been imported into the U.S. since Radio Shack discovered there was more profit to be made in just about anything else. The only known source for shafted Polyvaricons is the one given in the Parts List. They don't have many left, so if you plan on building the FSM do it now.

Meter M1 is another problem. If you want the FSM to sense the signal produced when a gnat blinks its eyes, M1 should be rated 50-µA full-scale. But that can prove to be a little too sensitive for conventional use. A 100-µA meter is suggested as the optimum value. Less-sensitive meters (such as 250 µA, 500 µA or 1 mA) will be so insensitive that a "California Kilowatt" will hardly budge the pointer.

The problem is, however, that 50- and 100-µA meters now cost almost a week's wages, even though they used to sell for pocket change. Many 1½-inch diameter models, such as the one shown, are still available from time-to-time for under $10 at surplus dealers. Shop around for the best buy because one meter is as good for this project as any other. Try to get a 1½-inch model because it's easy to enlarge the hole cut by a "standard" 1⅜- or 1¼-inch chassis punch to 1½ inches.

There is no chance in Heaven or Hell that you'll be able to buy the correct coils in quantities under 100 pieces, so you'll have to wind them yourself. Since the wire size used for L1 is as thin and delicate as Angel Hair, get your practice by making coil L2 first.

PARTS LIST
FOR THE TUNABLE FIELD-STRENGTH METER

BP1—5-way binding post
C1—365-pF, miniature Polyvaricon with shaft.
C2—.005-µF, ceramic disc
D1—1N270 germanium diode (or equivalent, see text)
L1—Coil, (see text)
L2—Coil, (see text)
M1—Meter, 50- or 100-µA DC (see text)
S1—Single-pole, double-throw (SPDT) slide switch
Cabinet, knob, wire, solder, hardware, etc.

Note: A 365-pF Polyvaricon capacitor with shaft is available for $5.95, plus $2 shipping and handling, from Custom Components, Box 153, Malverne, NY 11565. New York State residents must add appropriate sales tax.

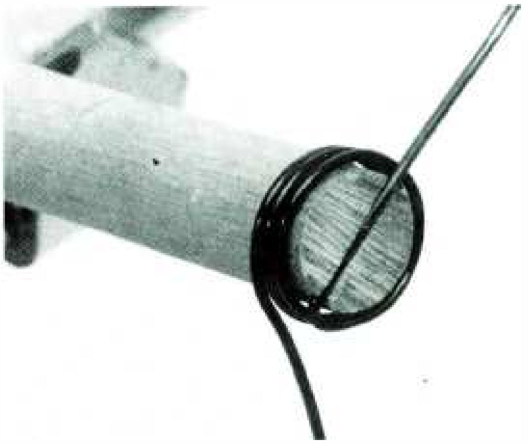


Fig. 2—Use a wood dowel with a slot cut in one end as the coil form for L2. The slot will prevent the unraveling of the coil as you wind the turns.

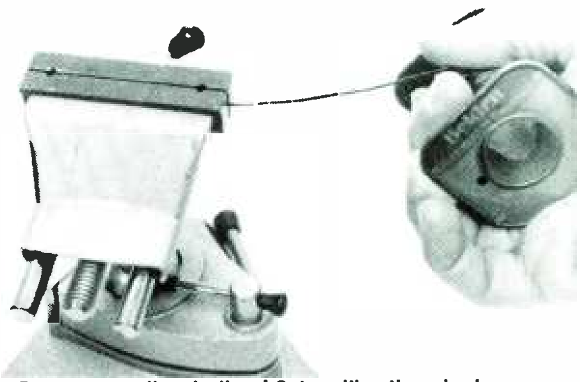


Fig. 3—Before actually winding L2, tensilize the wire by clamping one end in a vise and pulling on the other end until the wire goes dead slack.

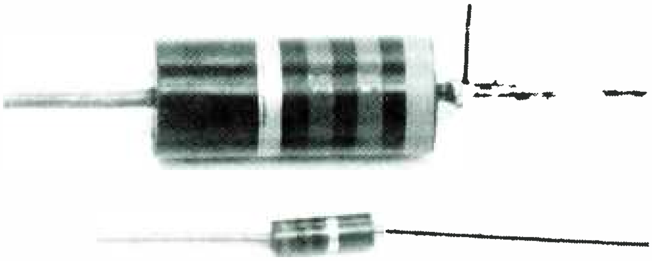


Fig. 4—The large 2-watt carbon resistor at the top is the coil form for L1. The ¼-watt resistor at the bottom is shown just for size comparison.

Winding L2

L2 is wound using enameled #16 solid-copper wire and a 1/4-inch coil form. Now many projects suggest using a drill bit as a coil form. Forget it. The wire won't stay steady and you'll end up with finger cuts and a coil that won't work. Instead, buy (for well under $1) a short length of 1/4-inch wood dowel, and as shown in Fig. 2, cut a slot in one end that is just wide enough to slip in one end of the wire. Do not wind any turns yet: Figure 2 is only to show how the slot and wire should fit.

Next, tensilize the wire so it won't unwind after you complete L2. Tensilize means "to stretch." Unwind a couple of feet of wire, and as shown in Fig. 3, clamp the free end in a vise and pull on the wire until it goes dead slack. (You'll actually feel it go slack.) Put the end of the wire in the slotted dowel and wind 22 close-wound turns. Scrape the insulation from the ends, tin the ends with solder, and set the coil aside.

Winding L1

L1 is a whole 'nother ball game. The wire is enameled #28 or #30 solid copper, and is very delicate. Use an old-style 2-watt carbon resistor of 10,000 ohms or higher as the form. (The old-style 2-watt resistors have a 5/16-inch diameter and are 11/16-inch long.)

Again, tensilize the wire, but be extremely careful because the insulation flakes off if the wire is over-stretched, causing the turns to short-circuit. Give just an *itsy-bitsy* pull on the wire. If you don't think that you can get the tensilization correct, then don't do it. Using fine sandpaper, remove about 1-inch of insulation from the free end of the wire, and as shown in Fig. 4, solder it on one resistor lead close to the resistor's body. (For size comparison, a standard 1/4-watt resistor is also shown in Fig. 4 .) Then wind either 30 turns of #28 wire or 36 turns of #30 wire in a single layer and stretch the turns almost the full length of the resistor coil form. Solder the new free wire end to the remaining resistor lead, and then coat the coil with Radio-TV cement or *coil dope* to prevent damage to the turns and to hold them in place.

Figure 5 shows how both coils should look after their leads are cut and shaped to fit, and their leads tinned.

Final Assembly

Use the photographs as a guide for cutting the 3 × 2 1/8 × 5 1/4 inch aluminum cabinet and the general layout.

Save the meter installation for the very end. In fact, set it aside until it's ready to be installed. As shown in Fig. 6, both the 50- and 100-µA meters are usually supplied with a very fine wire shorting the meter terminals. The wire damps the movement so that the pointer can't swing wildly and be damaged if the meter is moved rapidly. Leave the wire in place until the meter is installed and connected. Cut the wire as the very last step in the FSM's assembly.

Keep in mind that one of C1's solder lugs is eventually connected to C1's shaft, and that one is the ground lug, the one to which the wires from M1's negative (–) terminal and S1 eventually connect. Both of C1's solder terminals look the same, so make sure you know which is the ground terminal. The FSM will be unstable or not work at all if you get them mixed up.

Try to approximate the assembly shown in Fig. 7. Notice that the coils are reasonably apart, and they are actually positioned between the front and rear panels. (Don't get too fussy. Anywhere near being centered between the front and rear is OK.)

The antenna is any length of wire connected to BP1. A 6- or 12-inch solid wire will work fine, but you can use almost anything; even a telescopic antenna salvaged from an old transistor radio. The antenna simply isn't critical.

The dial calibrations shown in the photograph are approximate. If you want a more-precise calibration, hold the FSM near a calibrated signal source (such as a signal generator), set the generator to the desired frequency, adjust C1 for a maximum meter reading, and mark the panel accordingly. ■

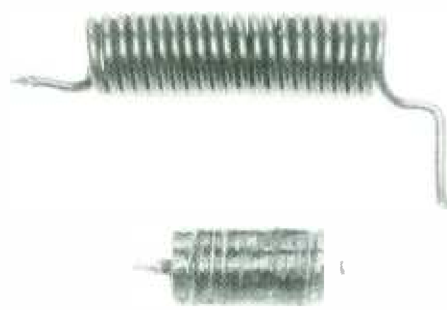


Fig. 5—This is how the two coils should look when ready for installation. Make sure you tin their ends with solder before installing the coils.

Fig. 6—Your meter will most likely come with a shorting wire across its terminals. Leave the wire in place until the FSM is completely assembled. Then cut the wire free.

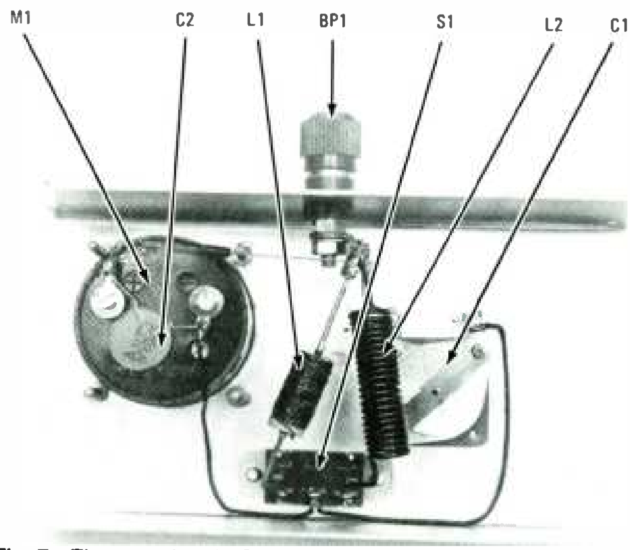


Fig. 7—The completed FSM. The coils are actually positioned just about centered between the front and rear panels.

BUILD THE ACCESS-TWO TONE DIALER

This portable touch-tone, telephone dialer provides easy and inexpensive access to services that require DTMF signals.

By Jim Stephens

MANY TELEPHONE INFORMATION AND ORDERING SERVICES are now available (that's good!). But on the down side, they require that the caller press the appropriate button on his or her phone to make their necessary selections.

Even the cable TV suppliers are getting in on this fad. Many cable companies now allow you to order special movies via the phone; but, alas, they too require a touch-tone phone to gain access to said service.

And not one to be left out, the IRS has joined the club, supplying income-tax filing information to tax payers via the phone by simply pressing the correct button(s) on a touch-tone phone. The only problem is that most of those services simply won't work with rotary or pulse-dialing sets.

I recently bought a beeperless remote-access, telephone-answering machine for use at home. Later, I found that it did, in fact, need a beeper or a remote tone-dialing phone to retrieve messages (left on my home phone) from another location. Of course, my phone at work was of the old pulse type, which (as one might imagine) simply would not operate the machine.

What I needed was a small tone dialer—such as the *Access-Two*. Construction of the circuit is simple, inexpensive, and (if you play your cards right) it's likely to work on the very-first try. It sits next to my phone at work and provides the beeps that my beeperless system needs.

A Look at the Circuit

Figure 1 shows the complete schematic diagram of Access-Two—which is built around National Semiconductor's TP53130 DTMF (*D*ual *T*one *M*ulti-*F*requency) Generator, U1 (an 18-pin chip capable of generating 16 dual tones within the frequency ranges required by the telephone-switching network) and an LM386 low-power audio amplifier.

At the heart of the circuit is the TP53130 DTMF (U1), which takes the keypad input and converts the input to tone signals. The keyboard can be an old rewired surplus calculator keyboard or a standard telephone keypad. The tone signals are produced by intricate dividers within the chip and are activated through a simple 2-of-8 line keyboard matrix. Each tone is held to close tolerances by an inexpensive 3.579 MHz colorburst crystal (which can be purchased from most electronics parts suppliers).

The tone signal, output at pin 18 of U1, is then fed to the LM386 amplifier, U2, which is configured to provide a gain of up to 20. The gain of U2 is dependent upon the setting of R2 (a 10,000-ohm potentiometer), which is connected in shunt and used as the volume control.

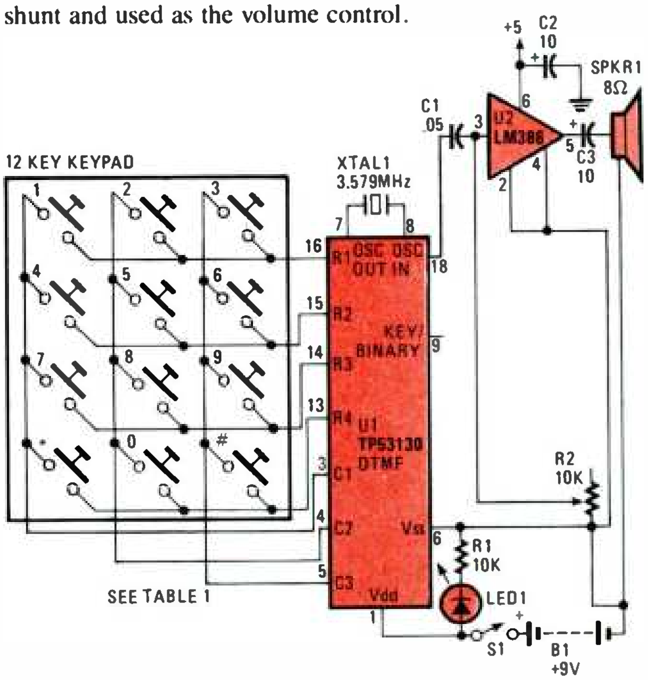
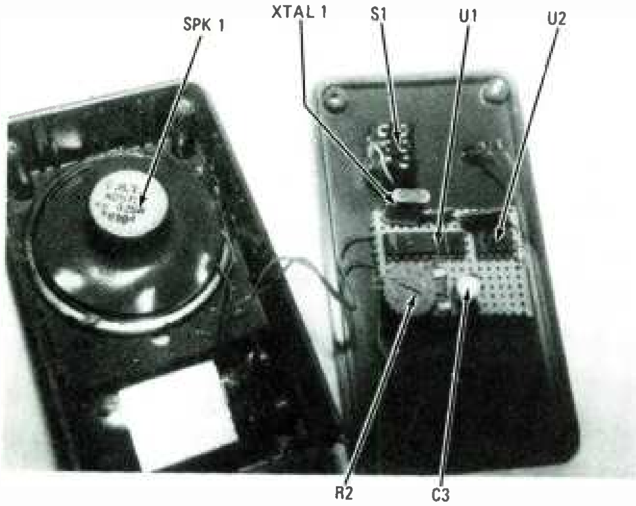


Fig. 1—The Access-Two Tone Dialer is built around National Semiconductor's TP53130 dual-tone, multi-frequency generator, U1 and an LM386 low-power audio amplifier. The TP53130 (U1) takes the keypad input and converts it to tone signals, which are output at pin 18 and fed to the LM386 amplifier, U2.



There are so few connections that any construction method may be used, including perfboard with the connections accomplished through point-to- point wiring. It's recommended that the integrated circuits be mounted in sockets (although the author chose not to heed his own advice).

The volume control was added into the circuit to boost the output of Access Two for areas with weak line connections. On the other hand, the tones easily distort if the amplifier is over-driven, thus the volume control was necessary to allow the signal drive to be reduced to obtain the purest tonal quality. A light emitting diode, LED1, was included as and on/off indicator. However, if not desired, it can be left out of the circuit, thereby increasing battery life.

Although Access-Two could just as easily be connected directly to the telephone line via a modular phone plug (commonly available from Radio Shack as well as other electronics parts suppliers), to keep it portable, a small amplifier and an 8-ohm speaker was added. Power for the circuit is provided by a standard 9-volt transistor battery. Since the idle current of the chip is only one milliamp, the battery should last many months.

The 8-ohm speaker, SPK1, is driven by U2, which is used mainly to obtain a slightly higher level of sound than would be provided by the speaker without the extra drive. Some phone line connections are not as strong as others and a higher volume is needed when accessing services on some long distance connections.

Most of the support components for the amplifier circuit can just approximate the values shown, and will still provide proper operation. Some experimenting with the volume control will be necessary for the best sound level for the phone that is used most.

The circuit board can be mounted in a small plastic construction box with keyboard mounted on the lid. Holes should be drilled in the case to ensure that the touch-tone output has easy access to the telephone mouthpiece.

The circuit can also be activated via a home computer or can be set up as an automatic dialer. In that mode, the keyboard matrix is connected to the data buses of the computer, which then can be programmed to dial selected numbers.

The KEY/BINARY select line (pin 9) must be held low in such applications. (Syntronics Inc. sells a small construction manual showing a complete circuit for automatic dialing and automatic cassette playing of advertising tapes by use of the Commodore 64 computer. Their address is shown at the end of the Parts List.)

Construction

Most any type of wiring may be used, and parts placement is not critical. There are so few connections that even point-to-point wiring can be used. It's recommended that the integrated circuits be mounted in sockets. A 16-pin IC socket for the 18-pin IC (U1) may be used by simply letting pins 9 and 10 hang over the side of the socket—those pins are not used in this application.

PARTS LIST FOR THE ACCESS TWO TONE DIALER

C1—.05-µF, ceramic disc capacitor
C2—.001-µF, ceramic disc capacitor
C3—10-µF, electrolytic capacitor
LED1—Jumbo green light-emitting diode
R1—10,000-ohm, ¼-watt, 5% resistor
R2—10,000-ohm PC-mount potentiometer
S1—Single-pole, single-throw (SPST) toggle switch
SPK1—8-ohm, .5-watt speaker (RS 40-245 or similar)
U1—TP53130 or MM53130 DTMF touch-tone generator
U2—LM386 low-power, audio amplifier
XTAL1—3.579 color-burst crystal (RS 272-1310)
Perfboard or printed-circuit board, enclosure, keypad (12-key SPST matrix type), IC sockets, wire, solder, hardware, etc.

Note: The TP53130 DTMF generator is available from Syntronics Inc., 514 Wanda Dr., Nashville, Tenn. 37210 for $6.00. A construction manual for computerized dialing is also available for $4.00. A Matrix Keypad is available from A. Caristi, 69 White Pond Rd., Waldwick, NJ 07463 for $6.95 plus $1.00 shipping and handling.

A small plastic construction box is used to house the circuit board and other components, with the keyboard mounted on the lid of the box. Holes were drilled in the bottom of the case where the speaker mounts to allow the audible output easy access to the telephone mouthpiece.

All connections between the components should be kept as short as possible to prevent the amplifier from picking up stray RF. Bypass capacitor C2 helps to eliminate that problem. Capacitor C3 is an electrolytic type with the positive side tied to the output of the amplifier. All other capacitors are standard ceramic types. U2 may be mounted in the first 8 pins of a 16-pin, solder-tail socket—8-pin sockets usually can be hard to find.

Although any keyboard with a 2-of-8 matrix can be used, a standard telephone keyboard, such as those found on touch-tone phones would probably be the best choice. (Check the Parts List for suppliers.) If only one or two tones are needed—say, for accessing your home answering machine—the keyboard can simply be two separate pushbuttons that

(Continued on page 96)

E-Z MATH

CONQUERING THE SINEWAVE

By Louis E. Frenzel

Without a thorough understanding of sinewaves, your projects better all be digital and run on batteries

THE SINEWAVE IS THE BASIC ALTERNATING CURRENT (AC) waveform used in electronics. Radio signals are sinewaves, the AC power line is a sinewave, and audio tones are sinewaves. Even pulse and digital signals are made up of multiple sinewaves. Because the sinewave is an integral part of almost all electronic signals, it is used in the mathematical analysis and design of components and circuits. To understand how components and circuits work, you must understand that important waveform. In this article we take an in-depth look at the sinewave. Like many other electronic things, the sinewave seems to be mysterious and difficult. It's the same with anything that we don't understand. This article will erase all your fears and misunderstandings and replace them with fresh knowledge.

The Basic Sinewave

You've seen them a *jillion* times. In magazines, textbooks, science fiction films, on oscilloscopes and in other places. And even though you may not understand it, you know what it is—a sinewave. It is a particularly familiar shape to those working in electronics and to electronic hobbyists. The sinewave is so ubiquitous (that's a big word meaning all over the place) in electronics that you cannot escape it. Understanding it unlocks the doors to thousands of fascinating electronic secrets. So let's get at it.

A sinewave is a voltage or current that varies as shown in Fig. 1. The sinewave is an analog signal since it varies smoothly and continuously with time. If the waveform represents a voltage, you can see that the voltage starts at zero and rises gradually to a peak, then gradually drops to zero. That is called the positive alternation. It then reverses polarity, falls to a trough, then moves back to zero. That is the negative alternation. The sinewave will repeat that pattern over and over again as time passes.

Figure 2 shows an AC generator which is a source of a sinewave-shaped voltage. At A, the generator polarity is indicated during the positive alternation. At B, we show the generator polarity during the negative alternation.

Now, if we connect the AC generator to a resistor or other load (light bulb, etc.), current will flow. Recall that current flow is the movement of electrons. Electrons are negatively charged, sub-atomic particles that are part of any wire, resistor or other conductor. The AC voltage from the generator causes the electrons to flow. During the positive alternation, electrons flow from the negative terminal of the generator to the positive terminal as shown.

When the polarity reverses, electrons still flow from negative to positive, but the electrons flow in the opposite direction. That is because as the AC voltage polarity reverses, so does the direction of electron flow. And since Ohm's law tells us that the current is directly proportional to the voltage, then the current waveform is also a sinewave. As the voltage rises, the current rises. When the voltage decreases, the current decreases. So the current is in step with the voltage. Figure 3 shows the voltage sinewave and the current it produces.

Frequency

There are several important specifications that go into defining a sinewave. Those are voltage and frequency or

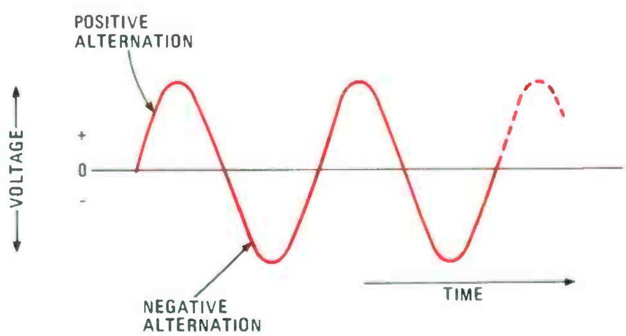


Fig. 1—The sinewave voltage can be viewed in two parts: a positive and a negative swing in voltage. Unlike what is shown here, the center of the wave need not be zero volts.

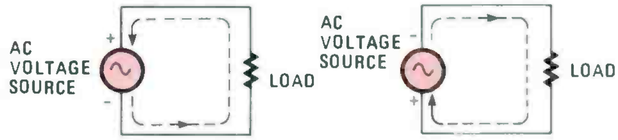


Fig. 2—The polarity of an AC voltage source switches with each cycle, causing the current to flow back and forth.

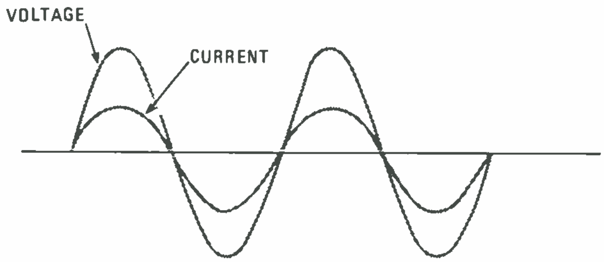


Fig. 3—In a simple, resistive network, the the current changes in coordination with the changes in voltage.

current and frequency. Let's assume a sinewave of voltage for our discussion.

Refer to Fig. 4. A sinewave consists of repeating positive and negative alternations. One positive alternation together with one negative alternation form what we call a cycle. The main thing we want to know is how many of those cycles occur per second. The number of cycles per second (denoted cps) is known as the frequency. In Fig. 4, three cycles occur in one second. Therefore, we can say that the frequency is 3 cps. If 1000 positive and negative alternations occur in one second, the frequency is 1000 cps. You get the picture.

You don't have to measure one cycle between the beginning of the positive alternation to the end of the negative alternation as we show in Fig. 4. One cycle is also the time between any two adjacent positive peaks or any two adjacent negative peaks as shown in Fig. 4. When measuring the time for one cycle on an oscilloscope, it is faster, easier and more accurate to measure between peaks than it is between zero crossing points as the zero crossing points are not always clearly known.

Hertz

While the frequency of a sinewave is still sometimes expressed in cps, usually another unit called the Hertz is used. Abbreviated Hz, one Hertz is directly equal to 1 cps. In our previous examples, we would express the frequency as 3 Hz or 1000 Hz.

Typical AC signals can have a frequency from a fraction of a Hertz to many billions of Hertz. A common low-frequency sinewave is the AC power that comes right out of the wall receptacle. It has a frequency of 60 Hz. Audible tones have frequencies in the 20 Hz to 20,000 Hz range. Radio signals have frequencies from about 30,000 Hz to 300,000,000,000 Hz.

To shorten and simplify the writing of very-high frequency values, we use a prefix in place of many of the zeros. The most commonly used prefixes are:

$$\text{kilo (k)} = 1000 = 10^3$$
$$\text{mega (M)} = 1{,}000{,}000 = 10^6$$
$$\text{giga (G)} = 1{,}000{,}000{,}000 = 10^9$$

Take the frequency 30,000 Hz. We can shorten that by dividing by 1000, then adding the prefix k to the unit Hertz or

$$30{,}000 \text{ Hz} = 30{,}000/1000 = 30 \text{ kHz}$$

or 30 *kilo*hertz.

Or take the common AM radio-station frequency of 1,490,000 Hz. You never see it expressed like this. Instead, it is expressed in kiloHertz (kHz) or:

$$1{,}490{,}000 \text{ Hz} = 1{,}490{,}000/1000 = 1490 \text{ kHz}$$

Alternately, you could divide by 1,000,000 to express it in megahertz (MHz).

$$1{,}490{,}000{,}000/1{,}000{,}000 = 1.49 \text{ MHz}$$

TV frequencies are very high. Channel 2 is in the 54,000,000 Hz range. Typically it is expressed in megahertz.

$$54{,}000{,}000/1{,}000{,}000 = 54 \text{ MHz.}$$

Satellite frequencies are even higher. A common one is 6,000,000,000 Hz. We can divide by one billion, 1,000,000,000, to get the frequency in gigahertz (GHz).

$$6{,}000{,}000{,}000/1{,}000{,}000{,}000 = 6 \text{ GHz}$$

You can also convert from kHz, MHz or GHz to Hz by simply reversing the operation.

To convert 455 kHz to Hz is just multiply by 1000 since k means 1000.

$$455 \text{ kHz} = 455 \times 1000 = 455{,}000 \text{ Hz}$$

Or, to change 10.7 MHz to Hz, you multiply by 1,000,000 because M means 1,000,000.

$$10.7 \text{ MHz} = 10.7 \times 1{,}000{,}000 = 10{,}700{,}000 \text{ Hz}$$

The process of changing GHz to Hz is the same. For example, 7.5 GHz is:

$$7.5 \times 1{,}000{,}000{,}000 = 7{,}500{,}000{,}000 \text{ Hz}$$

because G = 1 billion.

Table 1 shows how to convert any unit to any other unit.

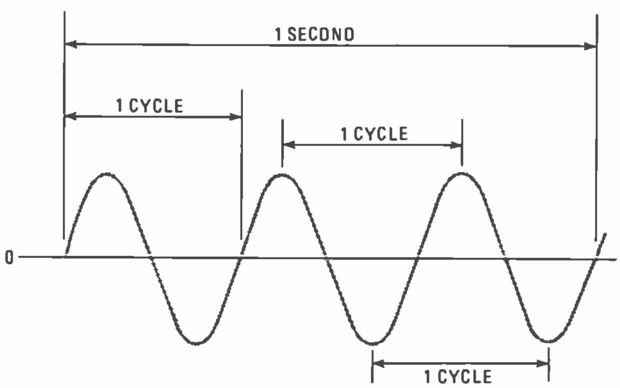


Fig. 4—The period of a sinewave can be measured as the time between successive identical portions on the wave.

TABLE 1—FREQUENCY UNITS

To Convert	To	Then
Hz	KHz	÷ 1000
Hz	MHz	÷ 1,000,000
Hz	GHz	÷ 1,000,000,000
KHz	Hz	× 1000
KHz	MHz	÷ 1000
KHz	GHz	÷ 1,000,000
MHz	Hz	× 1,000,000
MHz	KHz	× 1000
MHz	GHz	÷ 1000
GHz	Hz	× 1,000,000,000
GHz	KHz	× 1,000,000
GHz	MHz	× 1000

Just follow the directions.

Practice Exercises

Try some of those frequency conversions yourself for practice.

1. 262 kHz = ______________ Hz
2. 9,500,000 Hz = ______________ MHz
3. 14.7 GHz = ______________ MHz
4. 2.182 MHz = ______________ Hz

Period

There's another characteristic associated with the sinewave that is related to the frequency (f). It is called the period which we represent by the letter "T." The period is the time for one cycle to occur. If we know the frequency, we can compute the period with the simple expression:

$$T = 1/f$$

The period is simply the reciprocal of the frequency. The reciprocal of any quantity is just 1 divided by that quantity.

Let's figure out the period for a 60-Hz power-line sinewave.

$$T = 1/f = 1/60 = .01667 \text{ sec}$$

We can convert that to milliseconds (mS) by multiplying by 1000.

$$T = .01667 \times 1000 = 16.67 \text{ mS}$$

Therefore, it takes 16.67 mS to complete one cycle or a positive and a negative alternation.

Here's another example. What is the period of a 500-kHz sinewave? First, convert to Hz:

$$500 \text{ kHz} = 500 \times 1000 = 500{,}000 \text{ Hz}$$

The period is:

$$T = 1/f = 1/500{,}000 = .000002 \text{ sec}$$

We usually multiply by 1,000,000 to express it in microseconds (μS).

$$.000002 \text{ sec} \times 1{,}000{,}000 = 2\ \mu\text{S}$$

Figuring Frequency From the Period

As you have probably already guessed, you can find the frequency if you know the period. Rearranging our basic formula with simple algebra we get:

$$T = 1/f \text{ so } f = 1/T$$

If we know the period was 2 μS, we could calculate the frequency. First, convert microseconds to seconds by dividing by 1,000,000:

$$T = 2\ \mu\text{S} = 2/1{,}000{,}000 = .000002 \text{ sec}$$

Now you can compute the frequency:

$$f = 1/.000002 = 500{,}000 \text{ Hz}$$

Or divide by 1000 to get kHz:

$$f = 500{,}000 \text{ Hz}/1000 = 500 \text{ kHz}$$

That relationship is very widely used to determine the frequency of a sinewave or any other shape signal by making a time measurement on an oscilloscope. The horizontal axis on an oscilloscope screen is calibrated in time units. We can measure the time for one cycle, then compute the frequency.

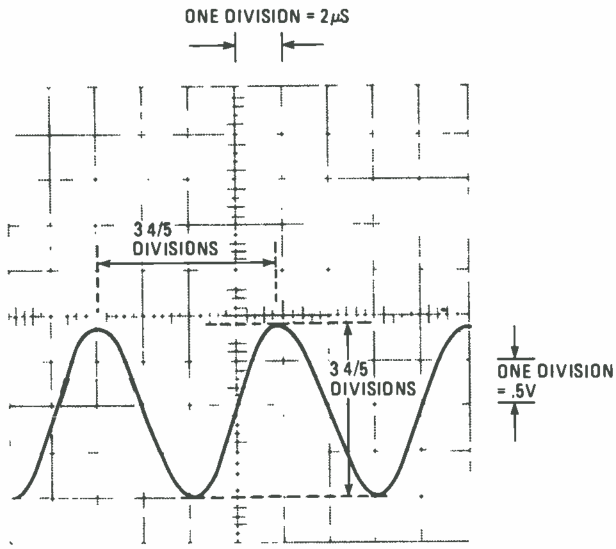


Fig. 5—An oscilloscope allows you to measure both period and peak value of a waveform. Those are the most important characteristics of a wave as you can calculate all the voltage parameters by knowing only those two.

Figure 5 shows a sinewave displayed on an oscilloscope screen. The horizontal sweep speed is set to 2 microseconds per division. Each division is divided into 5 equal segments of ⅖ = .4 μS each.

To determine the period, you count the divisions between two peaks as indicated in Fig. 5. There are 3⅘ divisions between the peaks. If each division is 2 μS, then the period is:

$$2 \times 3\tfrac{4}{5} = 2 \times 3.8 = 7.6\ \mu\text{S}$$

Now we can compute the frequency. Convert 7.6 μS to seconds.

$$7.6\ \mu\text{S} = 7.6 \times 10^{-6} = .0000076 \text{ S}$$

The frequency is:

$$f = 1/t = 1/.0000076 = 131{,}578.95 \text{ Hz}$$

or

$$131.57895 \text{ kHz}$$

rounded off it comes to 131.6 kHz.

Practice Exercises

Try a couple of the period and frequency conversions yourself.

5. 20 kHz = ______________ μS
6. 1.25 mS = ______________ Hz

Voltage

A sinewave is a varying voltage or current. That is, its value changes continuously over time. But we've still got to specify it or give it a numerical value. There are several ways to do this. First, we can specify the maximum or peak value that it attains. Refer to Figure 6. The voltage rises to a peak value, then declines to zero. It then reaches a "peak" in the opposite direction. The peak voltage we designate as V_p.

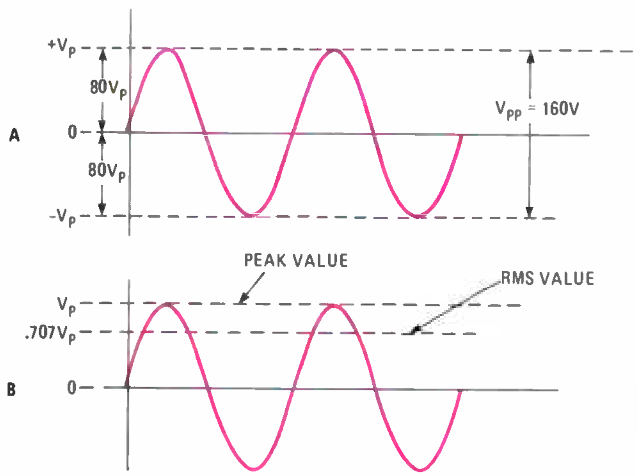


Fig. 6—The relationship between peak and peak to peak voltage is shown in A. The peak to peak value is double the peak value for any wave centered at zero volts. The RMS value (B) is .707 times the peak, but only for a sinewave.

The positive peak is equal to the negative peak. In Figure 6A, $V_p = 80$ volts.

We can also express the voltage as a peak-to-peak value (V_{pp}). That is the sum of the positive and negative peaks as shown in Fig. 6A.

$$V_{pp} = V_p(pos) + V_p(neg)$$

Since the positive and negative peaks are equal we can say that:

$$V_{pp} = 2V_p$$

If the peak voltage is 80 volts, then the peak-to-peak value is:

$$V_{pp} = 2V_p = 2(80) = 160 \text{ volts}$$

Peak-to-peak expressions are very common because that is how we measure voltage on an oscilloscope. The display of a sinewave does not indicate where the zero reference line is so we really can't measure the peak value. So we just measure the peak-to-peak value. Then to get the peak value, we just rearrange our formula:

$$V_{pp} = 2V_p$$

So:

$$V_p = V_{pp}/2$$

If we measured 15 volts peak-to-peak, the peak value would be:

$$V_p = V_{pp}/2 = 15/2 = 7.5 \text{ volts}$$

Refer back to Figure 5. To measure the peak-to-peak voltage of a sinewave on an oscilloscope, you count the divisions between the two peaks. There are 3⅘ divisions. The vertical sensitivity of the scope is .5 volt per division. Therefore, the peak-to-peak value is:

$$V_{pp} = 3\tfrac{4}{5} \times .5 = 3.8 \times .5 = 1.9 \text{ volts}$$

The peak value is half this:

$$V_p = V_{pp}/2 = 1.9/2 = .95 \text{ V.}$$

There's one other very frequently used AC voltage value. It is known as the effective or root mean square (or rms) value (V_{rms} or V_{eff}). It is 70.7% of the peak value as Fig. 6B shows.

$$V_{rms} = .707\ V_p$$

If our peak value is 80 volts, the rms value is:

$$V_{rms} = .707(80) = 56.56 \text{ volts}$$

Of course, knowing the rms value you can compute the peak value by rearranging the above formula:

$$V_p = V_{rms}/.707$$

Dividing by .707 is the same as multiplying by 1.414 because 1/.707 = 1.414. So we can rewrite this as:

$$V_p = 1.414\ V_{rms}$$

If you had an rms value of 60 volts, then the peak is:

$$V_p = 1.414(60) = 84.84 \text{ volts}$$

Computing effective or rms values is pretty simple. But what does it really mean? Well, the rms or effective value of AC voltage is equal to the amount of DC voltage that produces the exact amount of heat or power.

Take a look at Fig. 7. Here an AC generator with $V_{rms} = 25$ volts causes current to flow in a resistor. Thus the resistor dissipates power. Of course, it gets hot. Assume we measure its temperature.

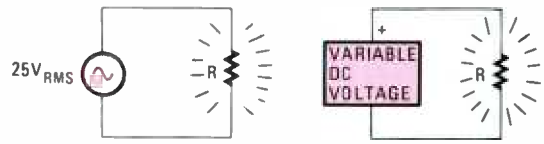


Fig. 7—A good definition of RMS voltage is a DC voltage that would produce the same amount of heat (provide energy) in a resistor as the AC circuit flowing in the circuit.

Now, we hook-up another circuit using the same value of resistance and we apply a DC voltage to it. We increase the DC voltage until the resistor heats up to exactly the same temperature. Now we measure the DC voltage. Lo and behold, the DC voltage is equal to 25 volts. So we conclude that 25 volts rms AC produces the same heating effect as would 25 volts DC.

Another important fact is that all multimeters, both analog and digital, give their readings in rms when measuring AC voltage. As a result, most AC voltages are quoted or expressed in rms. A good example is the common AC power-line voltage as the wall outlet. Its nominal value is 120 volts, and remember that's an rms value.

Practice Exercise

7. The AC voltage at the wall outlet is 120 volts rms. What are its peak and peak-to-peak values?

8. A sinewave of voltage is measured on an oscilloscope and found to be 35 volts peak-to-peak. If that sinewave were measured with a multimeter, what would the meter read?

Degrees

A sinewave is an analog voltage whose amplitude—and polarity—varies with time. When you draw a sinewave, the horizontal axis is time while the vertical axis is voltage. The horizontal axis can be divided into units of time such as milliseconds or microseconds. But we can also calibrate the horizontal scale in degrees. Each full cycle represents 360

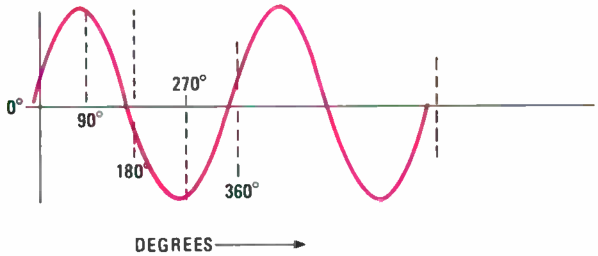


Fig. 8—Plotting a sinewave is easy because you only have to plot 0 to 360 degrees as it repeats after that.

degrees as shown in Fig. 8. You can see that the positive alternation extends from 0 to 180 degrees with the peak occurring at 90 degrees. The negative alternation extends from 180 to 360 degrees with the negative peak occurring at precisely 270 degrees.

Degrees, of course, are the units with which angles are measured. An angle is the measure of the space between two lines that come to a point as Fig. 9A shows. But what's that got to to do with a sinewave? I'll show you in just a minute. First, I want to introduce you to another unit of angle measurement—the radian.

Radians

Take a look at the circle in Fig. 9B. If you remember your high school geometry, a circle has 360 degrees. Refer to the boxed text for a review of circle terminology.

If you divide up the circumference (C) into 360 equal increments, then the angle between two lines from the center to one increment as shown, is one degree.

Now if you mark off an arc or distance on the circumference equal to the radius, then draw lines from the center of the circle to the ends of the segment on the circumference (radii), the two radius lines form an angle of one radian (abbreviated rad). One radian is equal to 57.3 degrees. To find out how many radians there are in a full circle, we can just

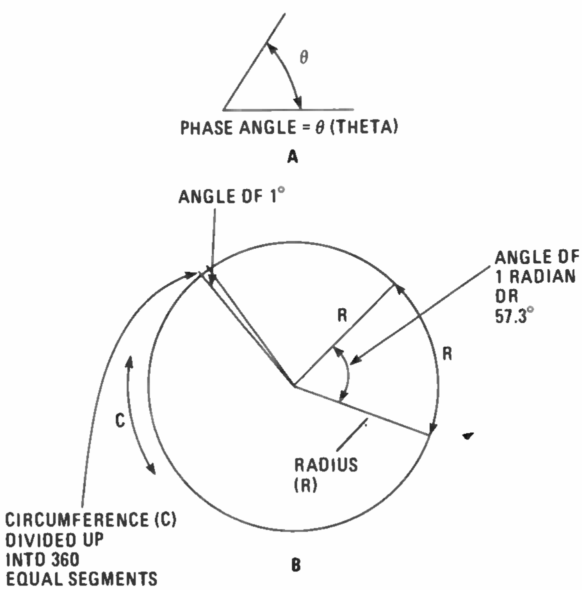


Fig. 9—An angle (A) measures the amount of tilt that exits between two lines. An angle of one radian in size cuts out an arc whose length is equal to the radius of the circle.

Circle Terminology

Arc—A segment of the circumference

Center—A point exactly in the middle of the circle an equal distance from all points on the circumference.

Circumference—The total distance around the circle (C).

Diameter—A straight line drawn from one side of the circle to the other passing through the center (D). Twice the radius. D = 2R.

Radius—A line from the center to the edge of the circle (R). One-half the diameter. R = D/2.

divide the circumference by the length of the radius (R).

$$\text{radians} = C/R$$

Now remember that the radius is one-half the diameter:

$$R = D/2$$

Substituting that above we get:

$$C/R = C/(D/2) = 2(C/D)$$

Recall that the ratio of the circumference (C) to the diameter (D) is a familiar constant we call pi (denoted π) which is about equal to 3.14. Therefore, our ratio becomes:

$$C/R = 2\pi$$

So there are 2π radians in a circle.

Well, $2\pi = 2 \times 3.14 = 6.28$. If we divide that into 360 degrees, we get:

$$360/2\pi = 360/6.28 = 57.3 \text{ degrees}$$

Proving that one radian is equal to 57.3 degrees.

We can now use radian measure to divide up the horizontal axis of the sinewave as Fig. 10 shows. Note that we use π in the Figures. The equivalent degree values are given.

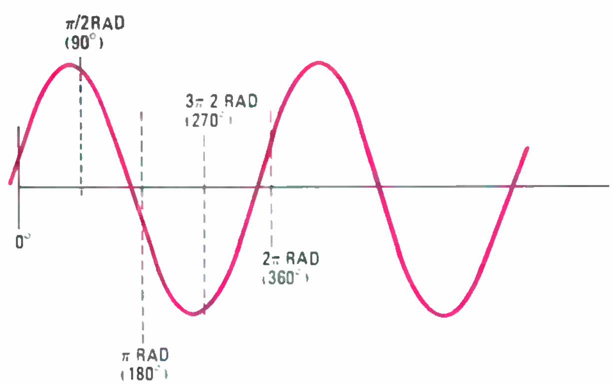


Fig. 10—Using radians to plot a sinewave does not force you to deal with strange numbers because everything can be written in terms of Pi. All the important points on the graph occur at multiples of Pi over 2 for all sinewaves.

Degree to Radian Conversion

To convert between degrees and radians, you can use the simple formulas below. Note that the radians are expressed in terms of π.

$$\text{rad} = (\pi/180)(\text{degrees})$$

An angle of 150 degrees is:

$$\text{rad} = (\pi/180)(150) = 5\,\pi/6 \text{ rad}$$

An angle of π/3 rad is:

$$\text{degrees} = (180/\pi)(\text{rad})$$
$$\text{degrees} = (180/\pi)(\pi/3) = 60 \text{ degrees}$$

Phase Angle and Shift

The reason why we use degrees to mark the horizontal axis is so that we can measure the phase shift between two sinewaves. Phase shift is a time difference between sinewaves of the same frequency. One sinewave does not have to vary in step with the other, even if they have the same frequency. A phase shift is illustrated in Fig. 11A. Sinewave A is shifted from sinewave B. The phase shift is 90 degrees. If the two sinewaves are in phase, they will appear as shown in Figure 11B. Note that the peaks and zero crossing points occur at the same time. Here there is no phase shift so the phase angle is said to be 0 degrees.

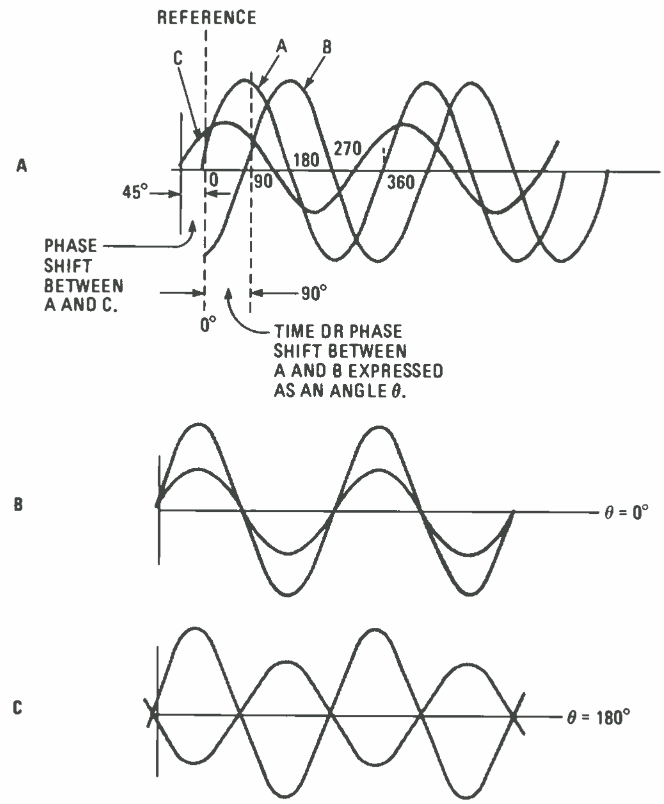


Fig. 11—In A you can see that wave C is trailing wave A and wave B is leading trail A. Note that phasing has nothing to do with amplitude (height) as you can see in B since they are in phase put have different amplitudes. The waves in C demonstrate phase inversion as they are 180° out of phase.

If the zero crossings occur at the same time but the positive peak occurs at the same time as the negative peak as in Fig. 11C, we have phase inversion. The phase shift is 180 degrees.

Refer again to Figure 11A. Sinewave B is shifted to the right of the reference line. That means that it occurs later in time than sinewave A. So we say that B lags A. If a sinewave is shifted to the left as C is, it occurs earlier in time. So we say that C leads A. The lead or lag is caused by various circuit conditions.

Expressing Phase Shift

Even though phase shift is actually a time displacement, we don't usually express it in time units such as microseconds. We express it in degrees. But to do that we have to convert from time to degrees. When you measure phase shift, you normally read the shift as the time between two adjacent peaks of the two sinewaves. You use a dual-trace oscilloscope and overlay the two waveforms as shown in Fig. 12. The time between the two peaks is the same as the time between the corresponding zero-crossing points we showed in Fig. 11A. Measuring the time shift (A) between the peaks is easier and more accurate.

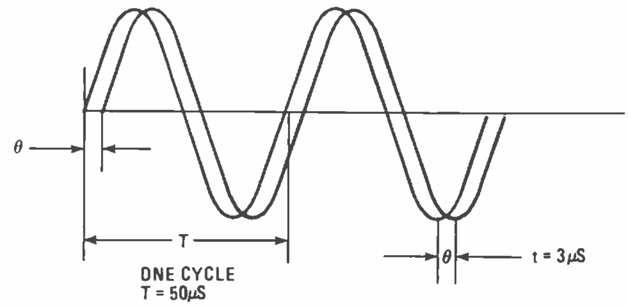


Fig. 12—You can use an oscilloscope to determine the phase angle between two waves by measuring the time between identical portions of the wave in time units and converting.

Suppose we measured 3 microseconds as Fig. 12 shows. To find out the phase shift, we need to know the period of the sinewave (T). So we either measure it or compute it from the frequency. Suppose T = 50 microseconds.

Now we set up a ratio of the time shift to the period (t/T). That ratio tells us what percentage the time shift is to one cycle. Since one cycle is 360 degrees, all we have to do is multiply that ratio by 360 to get the phase angle:

$$0 = 360(t/T)$$

so the phase shift in our example is:

$$0 = 360/(3/50) = 360(.06) = 21.6 \text{ degrees}$$

Practice Exercises

9. a. How many radians are in a phase shift of 90 degrees?
b. Convert an angle of π/5 rad to degrees.
c. Convert 120 degrees to rad.

10. A time shift between two sinewaves is 2.5 mS. The period of the waves is 18 mS. What is the phase shift in degrees?

Phasors

When analyzing or designing electronic circuits that process sinewaves, we must often express the sinewave in some simple graphical form or to represent it mathematically so that calculations can be made. Looking at a drawing of a sinewave or observing it on an oscilloscope helps in many cases. But there are times when we need more.

For example, a sinewave is hard to draw accurately. Further, when two or more sinewaves are involved, drawing them all with the proper amplitudes and phase relationships is an enormously time consuming and complex process. As it turns out, there is a simpler way to represent a sinewave graphically. It's called a phasor diagram.

Another need is to write a mathematical expression for the sinewave. Most electronic circuits that process sinewaves perform some mathematical operation on them such as addi-

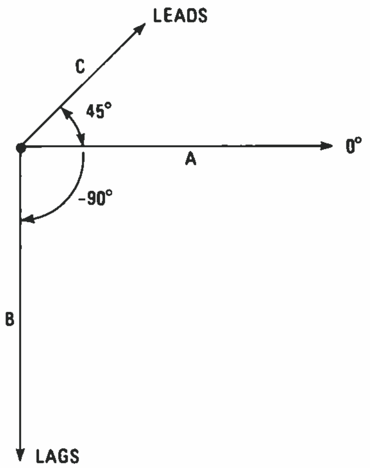


Fig. 13—The phase relationship between waves can be displayed in a phasor diagram. The A phasor is used a the reference wave here, but B or C would of done just as well.

tion, subtraction, multiplication, division or even more complex operations such as a logarithm or square root. If we can express the sinewave mathematically, we can actually compute the expected output.

Using Phasors

One way to show a sinewave pictorially is to use a phasor. A phasor is just a straight line or arrow as those shown in Fig. 13. Its length represents the peak value of the sinewave. The direction in which it is pointing represents the phase relationship to some reference. A phasor pointing directly to the right (such as A), represents a sinewave that has no phase angle (or a phase angle of zero).

Phasors are great for showing the phase relationship between sinewaves. Figure 11A shows three sinewaves with different amplitudes and phase relationships. Those same sinewaves are represented by phasors in Fig. 13. Sinewave A is the reference while B lags A and C leads A. The phasor diagram is obviously simpler and easier for us to draw and interpret.

Amplitude Variation

Sinewaves vary in amplitude over time. To show that with a different kind of phasor diagram we rotate the phasor about the center of a set of axes as shown in Fig. 14. The starting or reference position is shown. That represents 0 degrees. Then we rotate the phasor in the counter-clockwise (CCW) direction. When the phasor is vertical, it represents the sinewave at the positive peak or 90-degree point. Rotating it another 90 degrees puts it at 180 degrees, a zero amplitude point. Rotating it another 90 degrees puts it at 270 degrees on the negative peak. Rotation another 90 degrees obviously completes the sinewave and brings us back to the zero degree (360 degrees) starting point.

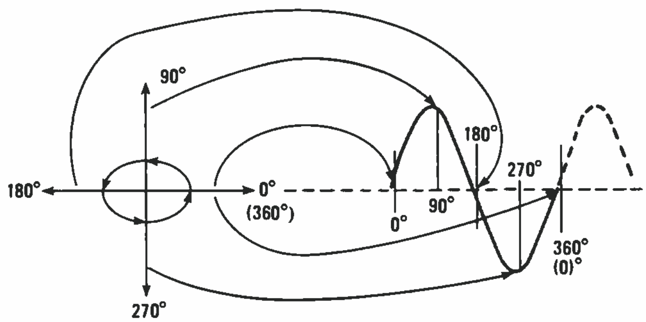


Fig. 14—You can rotate a phasor around a set of axes to represent a waves alternations. The "shadow" it would project on the y axis would represent its amplitude.

As we rotate the phasor, we can actually plot out the sine at each phase angle. To see how that is done, take a look at Fig. 15. Here we show the phasor at 30 degrees. Now let's draw a vertical line down from the point of the phasor perpendicular to the horizontal axis. In doing that, we form a right triangle with sides A, B, and C. We know the length of the phasor which is the hypotenuse (C) and one angle, 30 degrees. Using trigonometry, we can calculate the other sides.

Using Trig

Remember from trig that the ratios of the sides give us the various trig functions. Giving the sides names C for hypotenuse, A for the side adjacent to the angle, and B for the side opposite the angle, we can write the trig functions. Let the angle be X. The trig functions are:

$$\text{sine} = \text{Sin}X = B/C$$
$$\text{cosine} = \text{Cos}X = A/C$$
$$\text{tangent} = \text{Tan}X = B/A$$

If we know the length of any two sides, we can compute the angle X with the reverse or arc function:

$$X = \text{Arcsin}(B/C) = \text{Sin}^{-1}(B/C)$$
$$X = \text{Arccos}(A/C) = \text{Cos}^{-1}(A/C)$$
$$X = \text{Arctan}(B/A) = \text{Tan}^{-1}(B/A)$$

Just compute the ratio of the sides, then press INV and the trig function (SIN, COS, TAN) buttons on your calculator to get the angle X. For example, if $B = 3$ and $C = 4$, angle X is:

$$X = \text{Sin}^{-1}(B/C) = \text{Sin}^{-1}(3/4) = \text{Sin}^{-1}(.75)$$
$$X = 48.59 \text{ degrees}$$

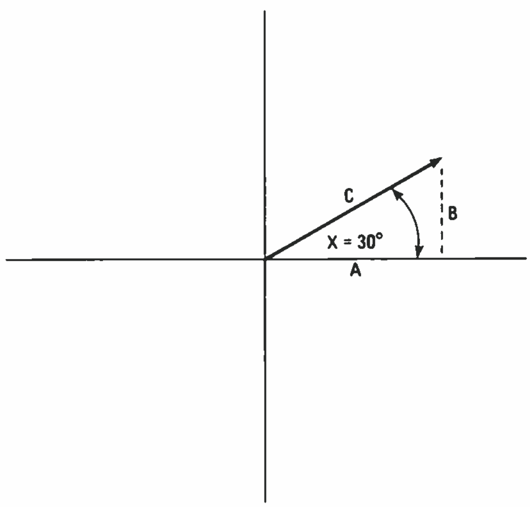


Fig. 15—By dropping a line down from the tip of a phasor to the x axis (like line B) it becomes apparent that trigonometry can be used to analyze how a phasor is used.

Using the Cosine

Knowing one side and the angle as we do in Fig. 15, we can compute any other side. Let's say that the phasor (C) which represents the peak value of the sinewave is 20. Our angle is 30 degrees. What are the lengths of A and B?

Going back to the original trig functions, you can see that we can use sine and cosine if we rearrange them algebraically.

$$\text{Sin}X = B/C \text{ therefore}$$
$$B = C\ \text{Sin}X$$
$$\text{Cos}X = A/C \text{ therefore}$$
$$A = C\text{Cos}X$$

Using the values in our example then:

$$B = 20\ \text{Sin}30$$
$$B = 20(.5) = 10$$

Also:

$$A = 20\text{Cos}\ 30$$
$$A = 20(.866) = 17.32$$

Plotting a Sinewave

We can use the trig functions to actually plot out a graph. Let's do this with the sine function because after all, that's what we are interested in. We will rotate the phasor, starting at zero, in the CCW direction and compute the value of side B of the right triangle at different angles. Then, we will plot those B values. If we do that, we get the result shown in Fig. 16. What do you know? Rotating the phasor and plotting the B side amplitude gives us a sinewave. To do that, we assumed values of angles between 0 and 360 degrees. We used 20 for the phasor or hypotenuse (C) value and calculated B using the formula:

$$B = C\ \text{Sin}X$$

When angle X is 0, B is 0. When X is 30, B is 10, as you saw earlier. When X is 90 degrees, SinX is 1 so B is equal to C or 20. At 135 degrees:

$$B = 20\ \text{Sin}135$$
$$B = 20(.707) = 14.14$$

At 240 degrees:

$$B = 20\ \text{Sin}240$$
$$B = 20(-.866) = 17.32$$

Note that angles between 180 and 360 degrees have negative sine values. That's how we get the negative half cycle.

As you can see, we used the trig expression to plot the sinewave.

$$B = C\ \text{Sin}X$$

Since a plot of B versus the angle X is a sinewave, then obviously that formula is the mathematical representation of a sinewave. We can change the letters to represent familiar electronic values. We'll let B = v for the instantaneous voltage value of the sinewave at some phase angle which is usually called theta (in Greek θ). C becomes V_p or the peak voltage value of the sinewave. The revised equation is:

$$v = V_p\ \text{Sin}\theta$$

That's the formula you see in textbooks and articles with sinewave analysis. As you can see, it's simpler than it looks.

Plotting the Cosinewave

Incidentally, we could also use the cosine trig function to plot the sinewave. Recall that the adjacent side of the right triangle (A) is:

$$A = C\ \text{Cos}\ X$$

If we assume angles of 0 to 360 degrees for X, then plot the value of A vertically at each corresponding angle, the waveform will be like that shown in Fig. 17. Assume C is 20 as before. At 0 degrees cosine is 1, so A is:

$$A = C\ \text{Cos}X$$
$$A = 20\ \text{Cos}0$$
$$A = 20(1) = 20$$

At 60 degrees, A is:

$$A = 20\ \text{Cos}60$$
$$A = 20(.5) = 10$$

At 90 degrees, A is:

(Continued on page 99)

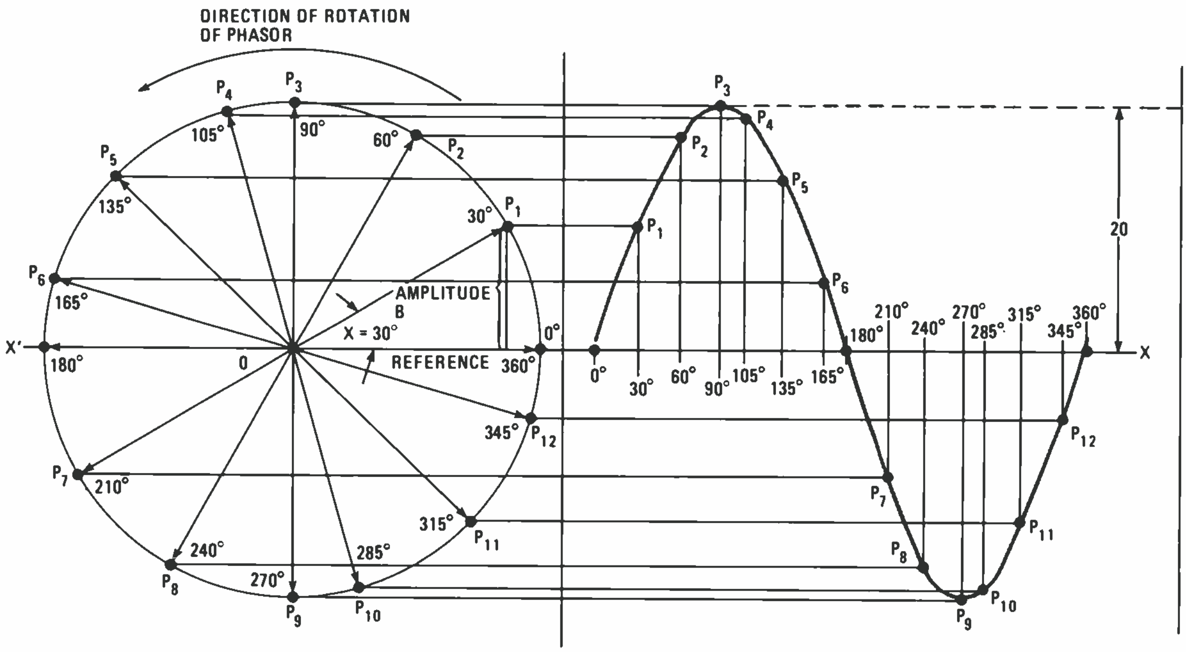


Fig. 16—You can view a phasor as a point on a wheel rotating with a constant velocity. If you plot the height of the point on the wheel against the angle its radius makes with the x axis, you'll get a sinewave.

MAKE MUSIC MAGIC WITH THE WAND-O-DYNE

By Charles D. Rakes

If you want to make sounds with a difference, or just learn about voltage-controlled oscilators, then build the Wand-O-Dyne

KEEPING THE KIDS ENTERTAINED TODAY CAN BE A REAL challenge with their exposure to so many new toys and gadgets, but that's where the electronics hobbyist can be a real hero by building that special one-of-a-kind electronic project that can't be purchased anywhere.

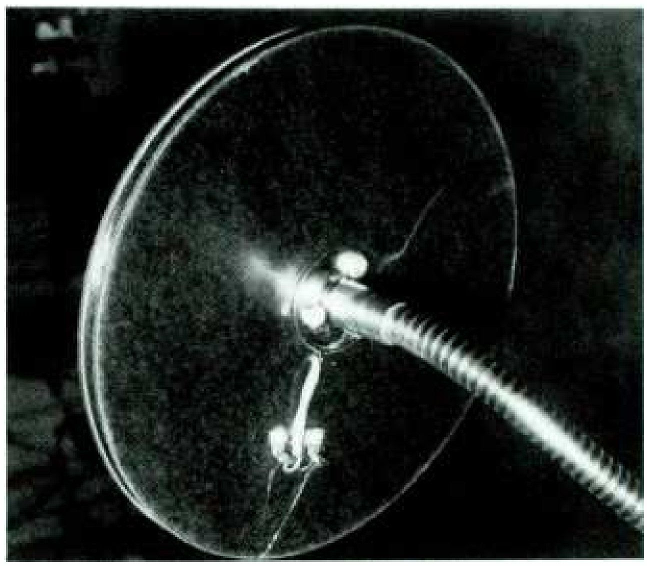
The Wand-O-Dyne will certainly qualify as an electronic musical project that will keep junior busy for hours. This unusual musical instrument is not just another version of the Old Theremin, but a project with its own unique approach to creating electronic music and sound effects. A "magic wand" controls the instrument's pitch, and a shifter lever sets the audio-output level. A combination tremelo/vibrato effect is added with a flip of a switch.

The heart of the music machine is a low radio-frequency oscillator circuit that produces a near-linear variation in RF output, as a wand is moved toward a coil. The linearly varying RF voltage is converted to DC and fed to an audio-frequency voltage-controled oscillator, that produces the necessary musical output.

How the Circuit Sounds Off

The schematic diagram of the Wand-O-Dyne is shown in Fig. 1. Transistors Q1 and Q2 are connected in a low frequency oscillator circuit. A 9-in. loop, L1, is connected to the input circuitry of Q1, which is operating as an impedance-matching emitter-follower amplifier. The oscillator is tuned to about 40KHz with C2. Transistor Q2 is the oscillator's gain stage with its output inductively coupled through the wand's ferrite coil to the pick-up loop, L1. Resistors R19 sets the gain of the oscillator circuit and determines the maximum operating range of the wand from the 9-in. loop.

As the wand is moved toward the pick-up loop the output of the oscillator increases in an almost perfect linear manner and the rectified output produces a DC varying envelope that is in step with the movement of the wand. The varying DC voltage is connected to the input of a two op-amp voltage-controlled oscillator circuit that converts the wand's movement into a varying audio tone. With the wand at its maximum working distance form the loop the tone output will be a low frequency growl and as the wand is moved toward the loop the tone will increase to a high-frequency howl.



The large loop can be attached to the microphone gooseneck with three screws. Notice that the lugs for the connections are on the backside of the coil so as not to be unsightly.

The remaining two op-amps in the quad are connected in a similar VCO circuit that is operating at a much lower frequency than the wand-controlled oscillator. Switch S2 is a center-off toggle switch that adds either an up or down beat tremolo/vibrato effect to the musical output. Resistor R23 sets the tremolo/vibrato frequency and R21 determines the depth or level that the circuitry has on the wand's VCO. The combined signals are fed to the two watt audio amplifier, U2, with R20 setting the output level. Transistors Q3 and Q4 are an integral part of the voltage-controlled oscillators.

Building Your Own

If you want to duplicate the author's version just follow the pictures and drawings, or if you would like to do your own thing that's okay too, because the circuit isn't critical, and if an acceptable wiring scheme is properly followed no problems should occur.

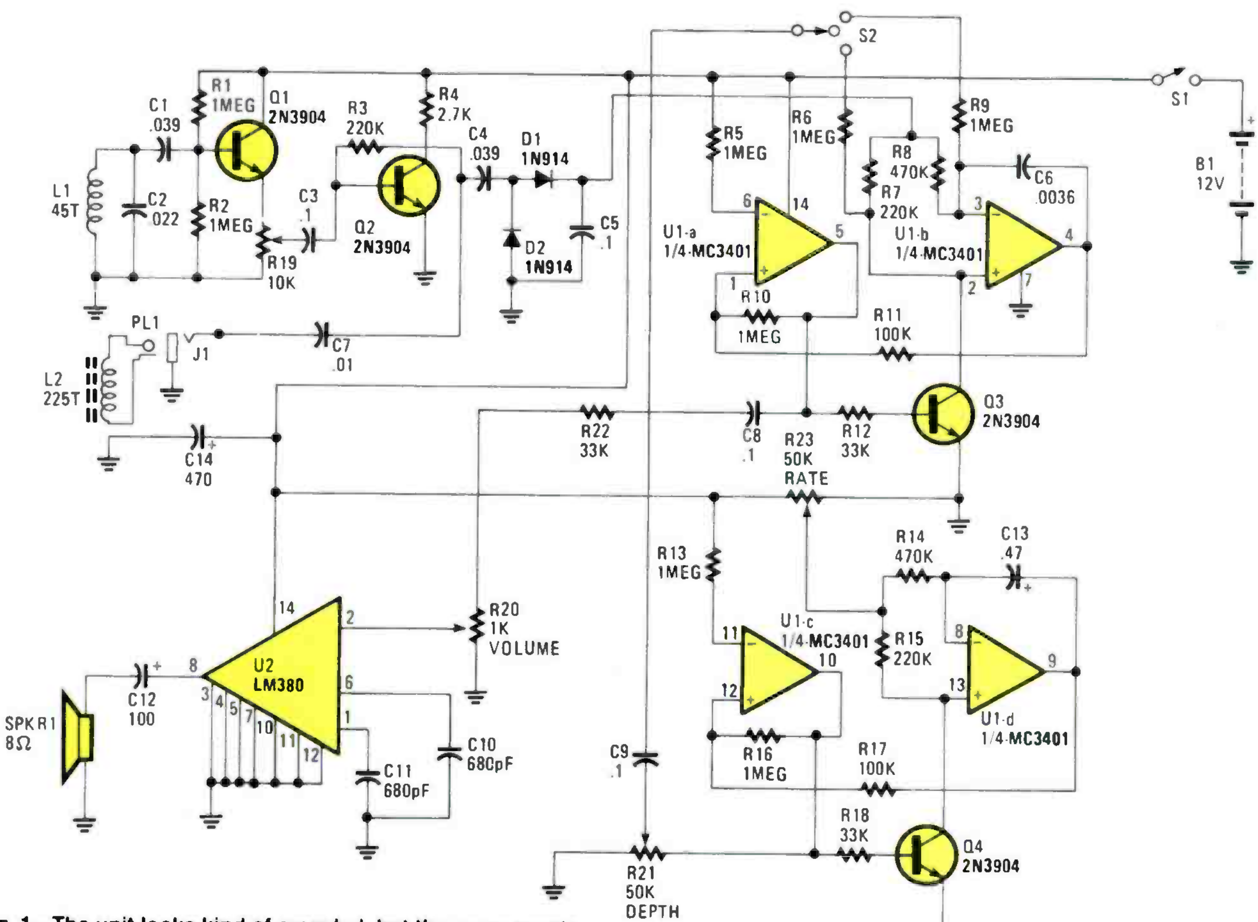


Fig. 1—The unit looks kind of crowded, but the components really are not extensive. That is because a quad op-amp is used for signal processing. Most of the circuit is simple.

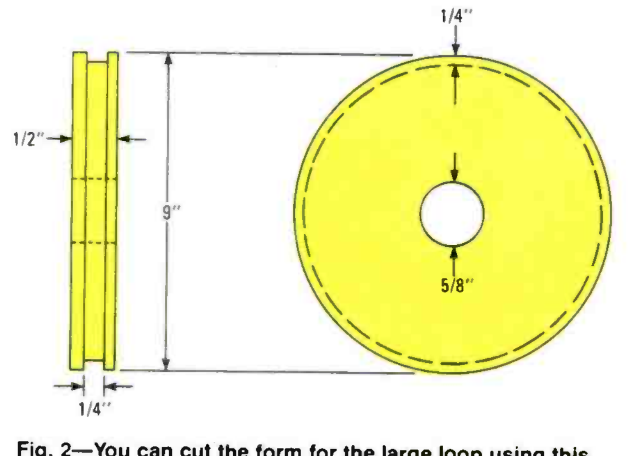
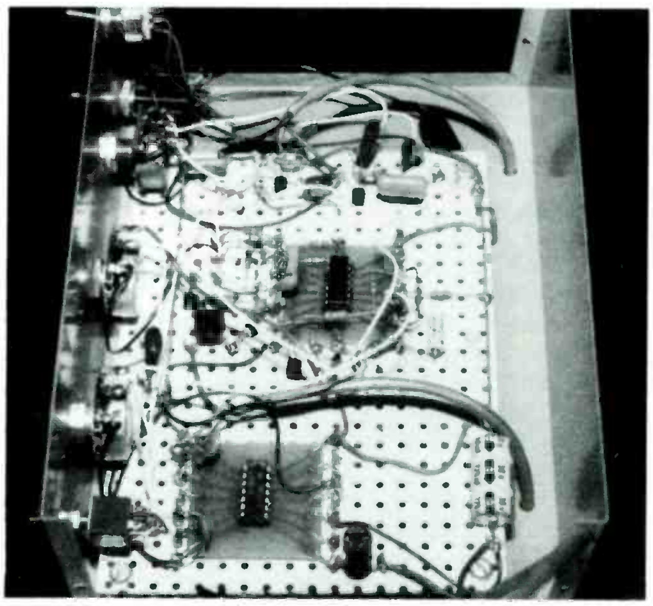


Fig. 2—You can cut the form for the large loop using this as a guide. If you don't have the tools necessary to mill the grove in the half-inch stock, then nail two nine-inch diameter circles on opposite sides of an 8¾-diameter circle. Drill the center hole after assembling it though.



The unit need not be built on a single piece of perf board as shown here. You can divide it up into subassemblies.

A metal cabinet 3 × 8 × 6-in. in size houses the circuitry, with the majority of the components mounted, with push-in pins, on a 5 × 6-in. section of perfboard. The cabinet sets on the middle of a metal bar that supports the 9-in. loop on the left and the volume potentiometer on the right. A 13-in. gooseneck mike extension connects the loop to the metal bar, and a cast-iron mike stand supports the instrument.

Making the Two Inductors

The pick-up loop is wound on a 9-in. round wood or fiber form cut from a piece of ½-in. stock. Cut a ¼ × ¼-in. groove in the outside edge of the form for the loop's winding. See the drawing in Fig. 2. A ⅝-in. screw flange is mounted in the center of the 9-in. form with 6-32 hardware, and two small solder lugs are mounted with two ¼-in. wood screws, see photo, to the form to attach the loop wires. Wind 45 turns of

#26 wire in the groove and solder the ends to the two lugs. Connect the loop to the circuit with a length of two conductor, non-shielded, cable running through the gooseneck mike extension and the back off the cabinet.

Winding the wand's loop is a simple matter of taking a 4 × ¼-in. piece of ferrite rod material and filling it up with 225 turns of #26 wire (see Fig. 3). Unlike Fig. 3, the turns do not have to be neat, wind them any old way. Two rubber grommets are placed at each end of the rod to help hold the jumble

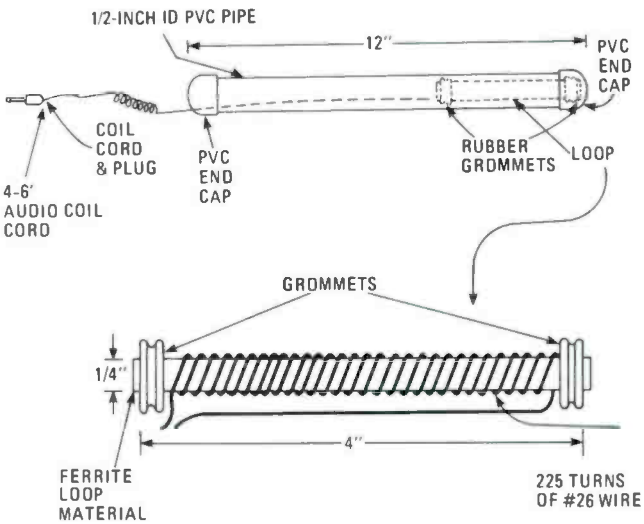
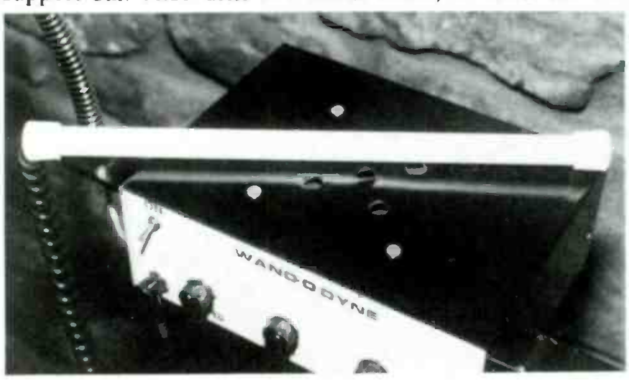


Fig. 3—Unlike the drawing, the coil can be wound in any haphazard fashion around the ferrite rod, just be sure it will fit inside the PVC tube when you're done.

winding in place and to give the coil a snug fit in the PVC tubing. A 12-in. length of ½-in. tubing houses the loop and doubles as the wand's handle. Plastic end caps cover both ends of the wand, with the coil cord going through the rear cap and the front cap protecting the coil. After the circuit has been checked out, and everything is operating as it should, silicon rubber the coil and end caps in place.

The Wand-O-Dyne's cabinet, pick-up coil, volume control, and support stand are all tied together with a metal mounting bar. The support bar can be fabricated from about any rigid material that's handy, but aluminum will drill and shape easier than the harder metals. The drawings in Fig. 4 show the support bar with hole sizes and locations. A ⅞-in. hole is needed in the center of the bottom of the metal cabinet to clear the mounting nut holding the mike stand to the support bar. Also drill two small holes, to clear the 6-32



If your cabinet doesn't have speaker holes you'll have to drill them yourself. You may wish to make a bracket to hold the wand while it is not in use. Velcro fasteners connected to the wand and base would work well for such a purpose.

PARTS LIST FOR THE WAND-O-DYNE

SEMICONDUCTORS
D1, D2—1N914 silicon diode
Q1–Q4—2N3904 NPN general-purpose transistor
U1—MC3401P or LM3900, quad op-amp integrated circuit
U2—LM380 2-watt audio amp, integrated circuit

CAPACITORS
C1, C4—.039-µF, 100-WVDC, mylar
C2—.022-µF, 100-WVDC, mylar
C3, C5, C8, C9—.1-µF, 100-WVDC, mylar
C6—.0036-µF, 100-WVDC, mylar
C7—.01-µF, 100-WVDC, mylar
C10, C11—680-pF disc
C12—100-µF, 16-WVDC electrolytic
C13—.47-µF, 100-WVDC, mylar
C14—470-µF, 25-WVDC electrolytic

RESISTORS
(All fixed resistors are 1/4-watt 5%-tolerance units unless otherwise indicated.)
R1, R2, R5, R6, R9, R10, R13, R16—1-megohm
R3, R7, R15—220,000
R4—2700-ohm
R8, R14—470,000-ohm
R11, R17—100,000-ohm
R12, R18, R22—33,000-ohm
R19—10,000-ohm potentiometer
R20—1,000-ohm potentiometer
R21, R23—50,000-ohm potentiometer

ADDITIONAL PARTS AND MATERIALS
B1—12-volt battery pack, 8 AA-size cells
J1—¼-in. phone jack
L1—45 turns of #26 wire on a 9-in. round form, (see text)
L2—225 turns of #26 wire on a ¼-X 4-in. ferrite rod, (see text)
PL1—¼-in. plug and cord. 5-feet long
SPKR1—4-in. 8- or 16-ohm speaker
S1—SPST mini toggle switch
S2—DPDT mini toggle switch, on-off-on
3³⁄₁₆ × 8¼ × 6⅛-in. metal cabinet, or similar size, 9-in. loop form, ¼-in. × 4-in. ferrite rod, ¼-in. shaft coupler, length of ¼-in. rod material, perfboard, pins, battery holder, etc.

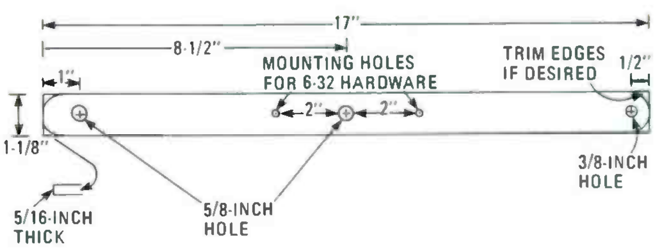


Fig. 4—An alternative to creating a stand using this bar to group the unit's components, you may wish to attach all controls directly to the project cabinet itself.

screws, in the bottom of the cabinet to match up with the two mounting holes in the support bar.

The volume-control arm is made from a 13-in. piece of ¼-in. rod material of soft iron or brass, and shaped to match the one shown in the drawing of Fig. 5. A 1-in. brass drawer pull, or similar round knob is attached to one end of the rod and the other end is connected to the volume pot with a ¼-in. shaft coupler. The actual length and shape of the volume shifter can be modified. *(Continued on page 106)*

By Marc Ellis

ELLIS ON ANTIQUE RADIO

The mailbag opens again to disclose an outpouring of reader interest

☐SO MANY LETTERS HAVE ACCUMULATED from you wonderful folks who read this column that it's definitely time to give you the floor. But before I stop talking, I want to tell you about a very interesting item for your home study or workshop.

I discovered the *1988 Vintage Radio Calendar* by accident while shopping in the book department of a large department store. Featuring radios from the collection of Dale Boyce (Milwaukee, Wisconsin), the calendar is beautifully designed, photographed, and printed. When hung on the wall, it falls into two-page spreads (pages are approximately 11 × 13 inches). The upper page has a large color calendar for that month, some background material on the radio, and some additional smaller photographs (such as original advertisements for the set).

The calendar that I have in my study is for 1988, but the publishers tell me that the 1989 edition (virtually identical to the 1988 version except for a couple of photos) will be available after July 30th. If you'd like a copy, it is available by mail. Send $7.95 for the calendar and $2.00 for shipping and handling (a total of $9.95) to *Affordable Adventures*, 6330 W. North Ave., Milwaukee, WI 53213.

OK readers, the floor is yours. Let's get started with those perennial favorites, the want lists!

The *Vintage Radio Calendar* (depicting radios of yesteryear) from *Affordable Adventures* will be available after July 30th. See text for details.

Information Wanted

The following readers are looking for *schematics, service data* and other information on specific radios. If you can help, please contact the person directly: *General Electric Receiver Model 1948* Dan Moore, 2061 St. Rt. 125, Lot 176 Amelia, OH 45102; *Atwater Kent Model 40* Jose L. Delgadillo, 1463 W. Morgan Rd., San Bernardino, CA 92407; *General Electric Model X-430* Carlos Martinez, 21 Colonel Irizarry St., Cayey, Puerto Rico 00633; *RCA Model 19K* Bill Bledsaw, P.O. Box 126, Niantic, IL 62551-0126; *Precision Model 920 Tube and Set Tester* Edward Brenda, P.O. Box 98, Crab Orchard, KY 40419; *Eico ST-70 amplifier* John Fessant, P.O. Box 70 Post #1, Mason, Mich 48854; *Hallicrafters S-41G* Dan Calendine, 7500 N. Elmhurst Rd. Lot 506, Des Plaines, IL 60018; *Grundig Model 4088* Gerard Szaulis, Box 1074, Edson, Alberta, Canada TOEOPO; *Atwater Kent Type TA* Richard L. Von Steuben, 2012 South Third St., Philadelphia, PA 19148; *International Radio Model 53 S.W. (Kadette)* A. Galea, 49-50 169 St., Flushing, NY 11365; *Ballast tube reference information* Parke S. Barnard, 216 Davenport Ave., New Haven, CT 06519; *US Signal Corps B.C. 322 Field Radio* Peter Hormes, Box 23, Lillooet BC VOK1VO; *RCA Radiola III* John Smart, 2360 Audrey Dr., Newark, OH 43055; *Cross reference of equalization curves to various record labels for pre-RIAA records* Don Pehike, #22 Prairie Trails Subdivision, Rural Route 2, Bloomington, IL 61701.

Sets and Parts Wanted

If you can supply any of the following *sets or parts*, please contact the requester directly: *1942 Zenith Trans-Oceanic Model 5Y4OGT* (the very first one), *1960 Philco T9 shortwave portable, 1948 Hallicrafters S-38*, any *1960's Zenith shortwave* (non Trans-Oceanic), *1942 allwave Philco Transitone with pushbuttons* all wanted by Bill Morris, P.O. Box 66, Swinford Hall, Ball State University, Muncie, IN 47306; Knobs, grill cloth and service information for a *Ward's Airline W.G. 24, Series A3, Model 62-303*; manual and various parts for a *Loewe-Opta (Fonovox) Type 05778W* Thomas Q. Radigan, 264 Addison Rd., Riverside, IL 60546; Slug-tuned RF coil for *Hallicrafters S-40B* Henry L. *Crosley 50 radio* M. Ruggere, 504 Grill Ave., Shillington, PA 19607; Kit to build *old-style crystal set with cat's whisker detector* Lennart H. Beims, 28-04 44th St., Long Island City, NY 11103; 1940's vintage *Vibroplex automatic key* H. Wulfekuhler, 500 Shady Trail, Fairview Heights, IL 62208; *WD-12 tube* R. Girres, 16-9th St., Havre, MT 59501; *WD-11 tube* Richard A. Holland, 4803 Maureen Circle, El Paso, Texas 79924.

The Self-Destructing 35Z5

Back in the December issue, I answered a question from a reader who was puzzled by what seemed to be an odd phenomenon. While testing a 1940's-vintage 5-tube AC/DC receiver, he noticed that the pilot light would flare up and burn out. After shutting off the set to do some trouble-shooting, he turned it on again only to have the filament in the 35Z5 rectifier tube flare up and burn out again. Following that, the set went dead.

I commented that the 35Z5 filament is made in two sections to provide a tap for connecting the pilot light. Apparently the non-pilot-light half of the filament had shorted out, allowing too much current to flow through the other half. That burned out first the pilot light, then the remainder of the filament. I felt that a new tube and pilot light would correct the problem.

Two readers have sent in interesting comments about that problem. Frank J. Steffanelli (El Cerrito, CA) pointed out the the cause of the 35Z5 rectifier tube's demise was not necessarily a shorted filament. The 35Z5 usually received its AC plate input voltage through the pilot-light half of its filament (the 35Z5 plate was connected directly to the pilot light tap) as shown in Fig. 1.

The 35Z5's DC output voltage then passed through the filter circuit and on to the other stages in the set via the B-plus line. A short (or unusually low resistance) at a filter capacitor or other spot in the B-plus line would cause too much current to flow through the 35Z5 tube, and hence through the pilot-light half of the tube's filament. That would completely blow both the pilot lamp and the filament.

Thus, Frank recommends checking

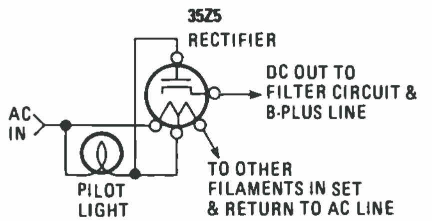


Fig. 1—Reader Steffanelli's schematic sheds additional light on rectifier burnout problems that were common to AC/DC sets of times past.

the B-plus line (especially the filter capacitors, audio-output-tube, plate-bypass capacitor and audio-transformer primary) for shorts or low resistance before changing a blown 35Z5 and/or pilot. Otherwise, they may both burn out again. His recollection is that the resistance from B-plus line to ground should be 30-50K if everything is OK. (Be sure to disconnect the line cord and discharge the filter capacitors before making a resistance check).

Reader Albert E. Orr (Export, PA) has a slightly different story to tell. As an Army radio repairman stationed in Germany towards the end of World War II, he was frequently asked to fix sets for fellow soldiers. Many of the sets were 5-tube AC/DC sets, and not a few suffered from the burned-out-pilot-light-and-35Z5-filament syndrome. Since both 35Z5 tubes and pilot lights were virtually unobtainable in Germany at that time, he worked out a clever temporary fix. Breaking the glass envelope of the burned-out pilot light, he twisted together the wires inside. This bridged the burned-out half of the filament, allowing current to flow through the other half and bringing the set back to life.

That temporary expedient allowed many GIs to continue using their sets until they could get back to the states, where they could buy a new tube and pilot light. Obviously, that sort of fix

ECHOPHONE Commercial
Communications Receivers
Model EC-1

Here's a high-quality, low cost 3-band 6-tube AC-DC communications receiver that is as amazing in performance as it is in price. Three bands cover 545 kc. to 30.5 mc. Has electrical bandspread throughout—ideal for the Ham, S.W. fan and experimenter. Features include: AC-DC operation, 115/125 volts 50/60 cycles; electrical bandspread on all bands; beat frequency oscillator for c.w. and for locating weak DX stations; Dial calibrated in megacycles with important service indicated; bandspread logging scale; self-contained speaker. Tube lineup includes: 12K8 converter; 12SK7 i.f.; 12SQ7 2nd det., AVC and 1st a.f.; 35L6GT "beam-power" output; 12J5 beat frequency oscillator and 35Z5 rectifier. Controls include: main tuning bandspread, bandswitch, A.F. gain, standby, speaker-headphone switch, combined AVC on-off and BFO switch. Housed in attractive grey crackle metal cabinet; cadmium plated chassis; speaker opening in top. 7½x11x7⅝". Shpg. wt. 14 lbs.
K21332—Complete with tubes. YOUR COST.................... **$24.50**

This description of the Echophone EC-1 comes from the 1941-1942 Lafayette Radio catalogue courtesy reader Lou Supek. Catalogues are collectables.

Why didn't the set designers connect the plate of the 35Z5 directly to the AC line, thus avoiding filament burn-outs caused by B-plus line shorts? Well, according to Frank, the filament was needed as a limiting device—to keep the current passing through the 35Z5 from ever becoming excessive. With a direct connection, the entire current-delivering capacity of the AC-line—15 or 20 amperes—would be available at the 35Z5's plate.

That is a problem unique to AC/DC sets. AC-only radios don't have it because all of their operating voltages are derived from the secondary of a power transformer, which has limited current-delivering capabilities.

would not be effective if the tube-and-pilot failure had been caused by an outright short in the B-plus line. In fact, it could lead to further component burnout and destruction within the set.

The EC-1 Saga Continues

Mail continues to come in on the Echophone EC-1 restoration project even though we concluded it with several letters. But every time a new batch arrives, I find them so interesting that I can't resist sharing them with you. First of all, for those of you who aren't familiar with the EC-1, I'm including a photo and description. It comes from the Lafayette Radio 1941-42 catalogue, and

(Continued on page 102)

By Charles D. Rakes

CIRCUIT CIRCUS

Motor speed and direction control circuits need not send you into a tailspin!

□THIS MONTH WE'RE GOING TO PLAY around with a couple of motor control circuits that can be used in your next robotic project, or any application in which motor speed and direction of rotation must be controlled. Even if there's no robot in your future, both controls are made up of several individual circuits that can stand alone or become a key part in some new project of your own design.

Starting off this month's discussion is a circuit (see Fig. 1) that uses both AC and DC circuits to control the speed and direction of rotation of a permanent-magnet, brush-type DC motor. The application of that circuit, which can be used to drive or move just about anything—is limited only by your fertile imagination and the size of the current-carrying components.

The voltage and current rating of the transformer, diodes, SCR's and the power transistor sets the maximum current that can pass through the output load and determines the largest motor that the circuit can safely control.

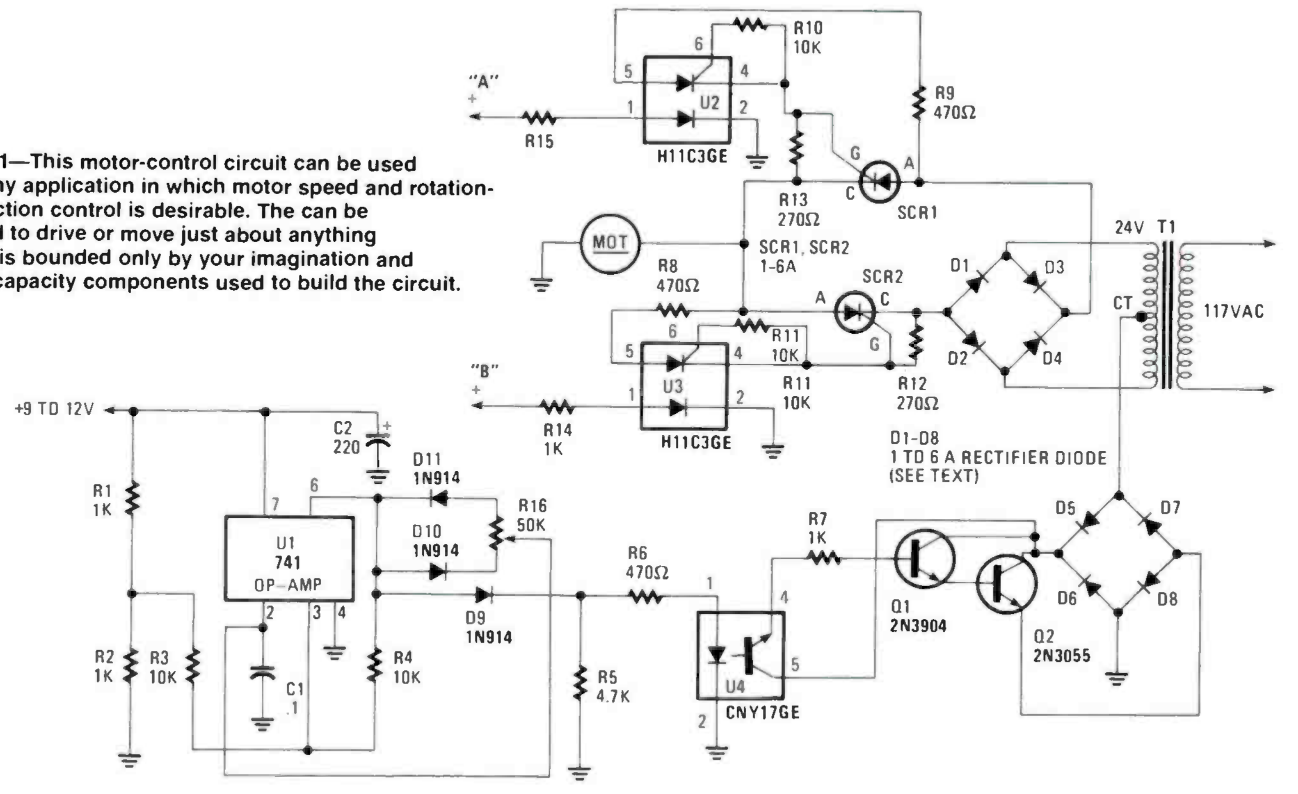
Left, right, fast, or slow here's the way the circuit goes. Diodes D1 and D2 supply a raw-negative 12-volts to the cathode of SCR2, and diodes D3 and D4 a positive 12-volts to the anode of SCR1. Two opto-isolator/couplers, U2 and U3, provide input-to-output circuit isolation and a means of supplying gate current to the two power SCR's. By using the opto-isolator/couplers the input control voltage can be driven by almost any logic-output source, or interfaced to a computer, without the motor or SCR switching noise being coupling back into the control circuitry.

When input "A" is connected to a + V source (5 to 12-volts), U2 supplies gate current to SCR1, turning it on, which in turn applies a positive 12-volt drive to the motor. If the return current path from the transformer's center tap is tied to the circuit's common through the speed-control circuitry (assuming the speed control circuit is calling for full speed), the motor will run in one direction at full speed. Remove the control voltage from input "A" and connect it to input "B" and the motor will run at full speed in the opposite direction.

Controlling the Speed

Diodes D5–D6 are connected in a fullwave-bridge arrangement between the center tap of T1 and ground, so no matter what polarity is being fed to the motor, the voltage between the emitter and collector of Q2 is always correct. Since neither the positive nor negative output of the bridge circuit is at ground

Fig. 1—This motor-control circuit can be used in any application in which motor speed and rotation-direction control is desirable. The can be used to drive or move just about anything and is bounded only by your imagination and the capacity components used to build the circuit.



level, another opto-isolator/coupler, U4, offers DC isolation between the speed control and the power switching circuit. That allows the speed-control circuit to operate with a common ground.

If we placed a jumper between pin 4 and pin 5 of U4, transistors Q1 and Q2 would be biased on, and assuming either the "A" or "B" input is positive, the motor would operate at full speed. If we were fast enough to rapidly make and break the circuit between pins 4 and 5, the motor's speed could be lowered but the degree of regulation would be poor at best. Unless you're *Jack-Be-Micro-Quick* it would be wise to use the pulse-width modulator circuit to handle the on/off switching.

Fat and Skinny

U1 (a 741 op-amp) and its associated components comprise a variable pulse-width, astable-multivibrator that drives U4's internal LED, which when illuminated bombards the light-sensitive area of the output device (in this case an SCR) with light energy, thereby causing it to turn on. The multivibrator's off/on rate is set by the values of C1 and R16, and with the values given the frequency is about 250 Hz.

The simplest way to change the operating frequency is to increase the value of C1 to lower the frequency, or decrease C1 to increase the frequency. Keep the frequency between 100 and 1 kHz for the best results.

The simple modification that changes the generic multivibrator circuit into a special variable pulse generator is in the way that the two diodes, D10, D11 and R16 are connected in the feedback path of the op-amp. That simple modification allows for the pulse output to be adjusted from a minimum "on" time of less than 50 microseconds to a maximum "on" time of about 95% of the cycle period. With that range of adjustment, the motor's speed can be controlled from a crawl to full speed in a single rotation of the control potentiometer, R16.

Bet several of you are wondering what would occur if both the "A" and "B" inputs were tied to a positive voltage at the same time. Fireworks and much smoke is a good guess. An electronic insurance circuit can be added (for pennies) that will virtually stop Murphy's interference.

The add-on circuit in Fig. 2 shows

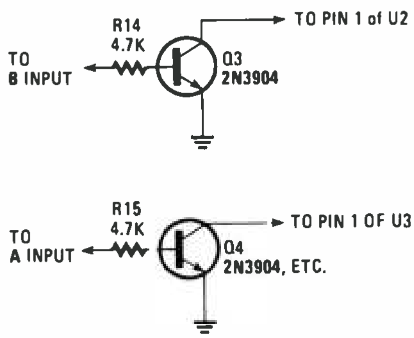


Fig. 2—The addition of this subassembly to the circuit shown in Fig. 1 (connected with the base and collector leads cross connected to the input of the control circuit) prevents the simultaneous triggering of U2 and U3.

two NPN transistor subassemblies that, when connected (base and collector leads criss-cross connected to the input of the control circuit) as indicated in the illustration, prevent the simultaneous triggering of U2 and U3. If, for some reason, the two inputs are connected to a positive voltage at the same time, transistor Q3 will be biased "on" and its collector will clamp the voltage at pin 1 of U2 to ground, thus keeping it from turning on SCR1.

At the same time, Q4 is biased "on" and its collector clamps the voltage at pin 1 of U3 to ground, keeping SCR2 from firing. But if only one of the inputs is tied high, its associated opto-isolator/coupler provides a trigger current to the gate of the SCR connected to it, causing it to turn on. At the same time, a clamping signal is applied to the other input, guaranteeing that only one SCR is turned on at a time.

The second motor control circuit is produce by combining the circuit in Fig. 1 with the one shown in Fig. 3. The center tap of T1 (see Fig. 1) is disconnected from the speed-control circuitry and is tied to ground. None of the speed-control components are used. Rewire the LED section of the U2 and U3 to match the schematic in Fig. 3, and add U5 (¼ of an LM324 quad op-amp) and the remaining parts.

An important function comes with the new control circuit, and that's the feedback feature that allows the motor to move an object to an exact position and stop automatically.

A version of that circuit has been used to drive a satellite dish to a designated point with excellent success. Robotic controlled movement is a real possibility with this as well.

Knowing Which Way to Go

The object that the motor is moving is mechanically linked to the shaft of R18

(Continued on page 102)

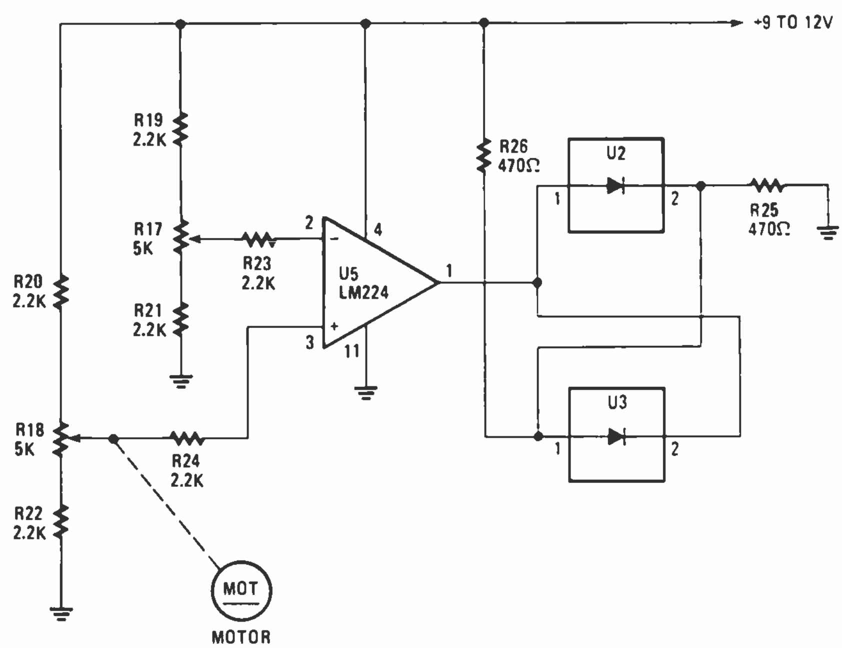


Fig. 3—A second motor control circuit is produce by a combining the circuit in Fig. 1 with the one shown here. The center tap of T1 (see Fig. 1) is disconnected from the speed-control circuitry and tied to ground (there are no speed-control components used); the LED input of U2 and U3 to match the schematic, and U5 added.

By Herb Friedman

FRIEDMAN ON COMPUTERS

A computer-aided design program that's really meant for the hobbyist.

MANY YEARS AGO, AT THE AGE OF 13, my son Larry became the first regular computer columnist for several national magazines by writing simple but useful BASIC programs. While hard-core programmers raised on time-share computers were trying to peddle Fortran programs on how to calculate the limits of the universe, and how to turn gold into lead, Larry, using an original Radio Shack TRS-80 Model I computer with cassette-tape storage, was writing short 30-line BASIC programs on such things as how to handicap horse races and football games, how to print mailing labels (there was no personal-computer mailing label program), and how to calculate hobbyist hardware values from parts lying around the house. If you had a 50-pF capacitor in the junkbox, his programs would quickly calculate such things as the wire size and parameters for various coils and frequencies, the conventional values for filters and amplifiers, etc.

An historic note: Larry's Radio Shack computer was originally a gift from Radio Shack to the Editor of the first hobbyist magazine to regularly cover personal computers as something other than a new tool for engineers and scientists, or as a new way to play action games. That editor is now the Editor of this magazine. He realized that the Model I and BASIC were the harbinger of a new era in computers, electronics, education, and business, and gave the computer to Larry so that Larry could start a column on personal computers and BASIC programs that was specifically intended for electronic hobbyists, and general school and business users. In a sense, Julian Martin is the godfather of personal computing as we know it today.

Unfortunately, Larry moved on to other interests, such as artificial intelligence, and the programmers that followed were of serious mien. They were interested in "serious programs for serious people," whatever that hogwash is supposed to mean. The electronic hobbyist and the newcomer to personal computing was all but forgotten. The general rule became "the thicker the manual the more serious—and the more impressive—the program;" even if the program had more bugs than your garden. It got so bad that the manual on how to use a filter-design program was often thicker than a potboiler about the peccadilloes of mythical Hollywood and TV "personalities."

CompDes

Well, the wheel has come full circle. We're back to programs for electronics hobbyists, and this month I'll cover a *real winner*, a software package known as *CompDes*.

Basically, *CompDes* is a collection of formulae and circuits that you'd write for your own use if you were a top-hand at programming. It will handle any basic electric or electronic calculation, wire-size data/calculations, all kinds of resonance problems, design active- and passive-filter circuits, actually display or print the circuits, design transistor amplifiers, oscillators, power supplies, attenuators, even striplines made on printed-circuit boards. And best of everything, the entire manual for the menu-driven software is only 61 pages of readable English. (Do you realize that for technical writers readable English is a lost art form?)

If it all sounds familiar, it's because *CompDes* has been around for a couple of years. The big difference this time out is that *CompDes* can display an electronic circuit on IBM-compatible computers having a graphics monitor, or on those compatibles using a TTL monitor, a Hercules monochrome card, and the program SIMCGA.COM. (SIMCGA.COM is a program, that when used with a true Hercules mono card, causes the TTL monitor to function as a graphics display for most—not all—graphics programs.) If your computer is all-mono the program works exactly the same, except it won't display a circuit on the screen.

A typical *CompDes* graphics display—for an active Tee-notch filter—is shown in Fig. 1. It was made on a TTL monitor using SIMCGA.COM. You can tell it's a TTL monitor because the screen prompt "Want A Hardcopy" are crisp characters, rather than the difficult-to-read characters of a graphics (CGA) monitor.

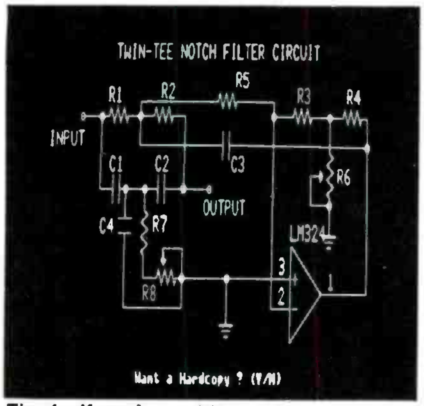


Fig. 1—If you've got the right hardware, *CompDes* will create a screen display of the circuit that you are designing.

Another plus for the new version of *CompDes* is that it will provide a hardcopy of the screen display. Figure 2 is the hardcopy from an IBM/EPSON printer. Compare it with the screen dis-

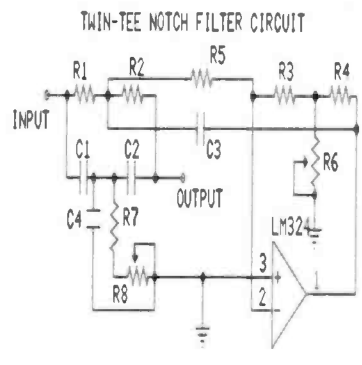


Fig. 2—*CompDes* will also provide an exact hardcopy printout of the circuit as it appears on the screen.

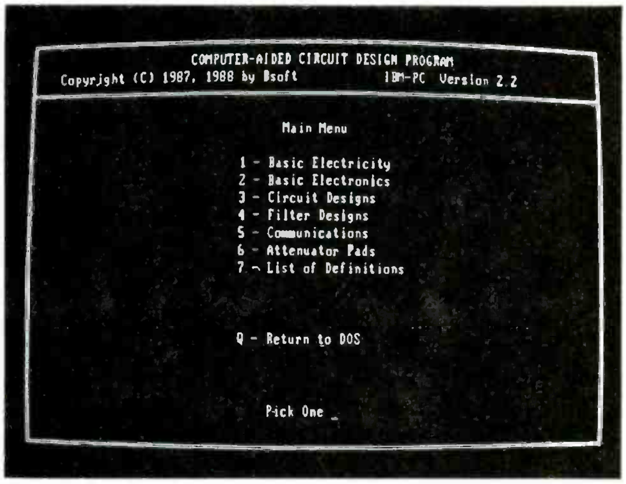


Fig. 4—*ComDes* is completely menu driven, as shown by its opening main menu.

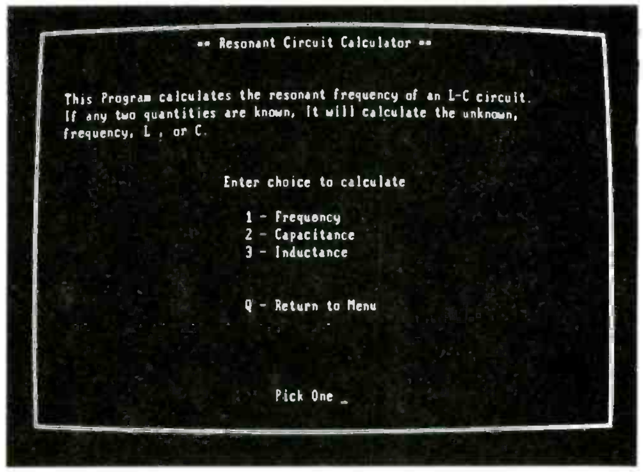


Fig. 5—For resonant circuits, you'd simply thumb through the menus until you come to the one shown here.

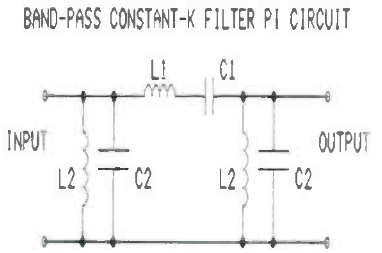


Fig. 3—This the hardcopy of a band-pass filter circuit.

play shown in Fig. 1. Figure 3 shows the hardcopy for the circuit of a passive band-pass filter.

Menu Driven

The program "comes up" with the main menu shown in Fig. 4. Each category leads to related sub-menus. For example, if we wanted to calculate anything having to do with frequency we'd select item 2, *Basic Electronics*, bringing up the sub-menu shown in Fig. 5.

If we needed a filter to notch out 60- or 120-Hz hum from a tape recording, we would select item 4, *Filter Designs*, from the main menu, which would eventually lead us to the input screen for a Twin-Tee Notch Filter (Fig. 6). As shown in Fig. 6, in response to screen prompts, we entered the desired center frequency of 60 Hz, and the main capacitance value of 100 μF, because 100-μF capacitors are easy to locate.

Almost as fast as Clark Kent changing into Superman, *CompDes* calculates the correct values and displays them on a single screen (Fig. 7). Notice that you have the option of printing a hardcopy. Actually, all screens are printable. For example, Fig. 8 is the hardcopy of the Fig. 7 display, while Fig. 9 is the hardcopy for the band-pass filter circuit shown in Fig. 3. Figures 8 and 9 are found on page 106.

Now you might ask what purpose is served by listing values if your computer is incapable of displaying a graphic representation of the circuit? Simple, the wonderful but thin manual shows all the needed circuits. You can simply photocopy or redraw the circuit from the manual and plug in the displayed values. If you can display graphics, you can make a large screenprint of the circuit, as shown in Figs. 2 and 3.

For those of you who might think *CompDes* is too elemental for "advanced" hobbyists, Fig. 10 shows the submenus for both Communications and Circuit Designs. If you'd like to see how good and how accurate a *CompDes* design or calculation can be, try designing the coils for this issue's Field Strength Meter project using any tables, nomographs, or calculator you want. Then keep in mind that I designed the coils for the FSM in about three minutes by using selection 4 from the Communications Design submenu (Fig. 10 on page 106)—and I was talking to someone on the telephone while punching in the data for the coils.

(Continued on page 106)

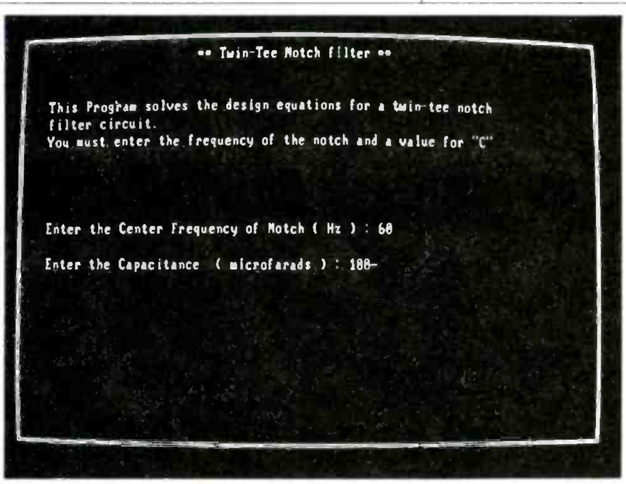


Fig. 6—This menu lets you design an active Tee-Notch filter. You select the center frequency and the main capacitor value.

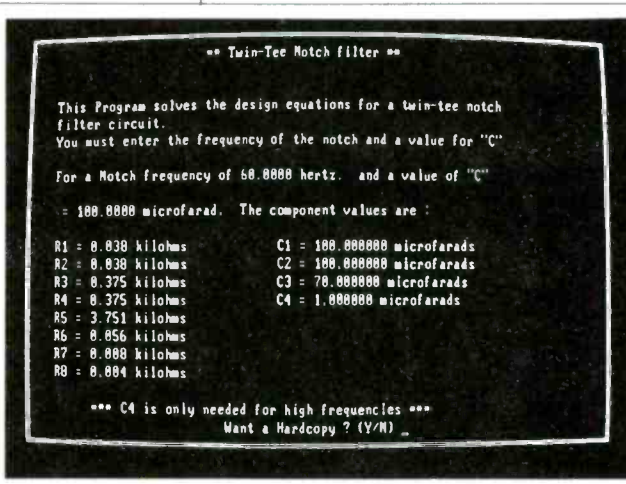


Fig. 7—And here it is. All the values for an active Tee-Notch filter based on the data input shown in Fig. 6.

By Don Jensen

JENSEN ON DX'ING

Some changes come exceedingly slow

This attractive multi-colored QSL card has been sent to DXers by Radio Mocambique in east Africa—enscribed with the words *Temos o prazer de confirmar a informacao de escuta;* which roughly translated means, We are pleased to confirm your reception report.

☐A TIN WHISTLE THAT HAS RUN OUT of steam!" That pointed criticism, made by a hobby radio club last fall, made national headlines in New Zealand. The organization, the *New Zealand Radio DX League* was referring to the rickety shortwave service in that Down Under island nation. *Radio New Zealand International*, which this year celebrates its 40th anniversary on shortwave, has long been considered the poor relation in the family of international broadcasters.

Most of the major national shortwave broadcasting countries, and a goodly number of the smaller ones too, have long since gone to high transmitter powers; 100, 300, even 500 kilowatts. Still, New Zealand's SW broadcaster is making do with a pair of seven and a half kilowatt World War II vintage units, which were secondhand when they were installed back in 1948.

That's not to say that Radio New Zealand is a failure with shortwave listeners. In fact, most veteran DXers have a soft spot in their hearts for that broadcasting runt. There's almost a nostalgic, out-of-the-past feeling listening to that Pacific area shortwave.

But, let's face the facts. Its signals are not going to come booming in like the *British Broadcasting Corporation* (BBC) or Germany's *Deutsche Welle*, or even Holland's *Radio Nederland* (RN), the international voice of a smaller nation that has made a major commitment to shortwave broadcasting.

Within New Zealand, over the past few years, there has been a running debate over whether the government should fork over the money needed to upgrade its international shortwave facilities. At one point, in fact, the foreign-shortwave service disappeared entirely. For a bit over a month back in 1976, the station shut down, but then came back on the air after a worldwide protest from listeners.

In March 1982, the New Zealand government withdrew its annual subsidy of $180,000. But the shortwave station stayed on the air thanks to a commitment by the *Broadcasting Corporation of New Zealand*, which relays home-service, medium-wave programming to shortwave listeners.

While the station often can be heard overseas, even in the mid-Pacific, where New Zealand has long been interested in maintaining its influence, reception is unreliable. Local AM stations, like Tonga, now choose to relay news broadcasts from the BBC, *Voice of America* (VOA) or *Radio Australia*, rather than rely on the inconsistent signals from New Zealand.

The *Royal Commission on Broadcasting and Related Telecommunications* has recommended upgrading the external broadcasting facilities.

When the Labour government took office in 1984, it promised that shortwave service would be improved. In 1986, the then Minister of Broadcasting, Jonathan Hunt, said "expansion of the external service would not be left in limbo, as has been the case for a number of years."

Still nothing has happened. The current renewed interest stems from last year's political turmoil in Fiji, where a bloodless, military coup overturned the elected government. New Zealand, which has long assumed a big-brother role in the area, found itself losing the competition for listeners. Fijians tended to turn on Radio Australia for uncensored news.

In its wake of this embarrassment came the NZRDXL criticism and a call by a major New Zealand trade union group for a clear and sustained, strong voice for New Zealand in the Pacific. Said the labor organization, "there is still no clear indication of government policy or financial commitment to upgrade shortwave."

In Fiji, the Coalition for Democracy even suggested to Radio New Zealand's

International director general, Beverley Wakem, that its programs might be relayed via Radio Australia's powerful SW transmitters. The question now is whether the New Zealand government will accept that sort of broadcasting humiliation or get serious about upgrading its own shortwave facilities.

Now while Radio New Zealand's puny transmitters may not deliver the sort of powerful and consistent signal that its detractors would prefer, SWLs in this part of the world, with careful and persistent tuning, often will find suitable reception. Try around 0400 and 0730 Universal Coordinated Time (UTC) on 15,150 or 17,705 kHz, or from 0930 'til past 1100 UTC on 9,540 or 11,780 kHz.

Can We Talk?

Indiana reader, Michael Lester writes about some big plans and a few questions.

"I read with interest an article in the December **Hands-on Electronics** about the FCC closing down the high-seas pirate broadcaster, *Radio Newyork International*. I'm interested in starting up a radio station," Michael continues. "I have been in contact with the FCC in Washington about applying for a construction permit and, as I understand, once granted, I can apply for call letters. At the present time, I hold a restricted radio telephone operator's permit.

My questions are, what do you recommend in the way of equipment for startup and can you recommend any place to obtain the necessary equipment? I will be working on a very limited budget; low priced!

I plan an R&B music format, with news and weather, on an AM frequency. I would be interested in a 5000-watt transmitter, such as mentioned in the article. I will be setting up in a storefront in a downtown area of Whiting, Indiana.

Well, Mike, I'm afraid your parade is set for a drenching. I respect your attempt to get on the air legally, since taking the other route with an unlicensed, hidden pirate station can get you into a heap of trouble. However there are major problems ahead before you can hope to realize your broadcasting dream.

First, and foremost, there's money!

The engineering studies needed before you can get your construction permit are costly. And odds are slim for finding a used 5-kilowatt transmitter that will cut the mustard as far as the FCC is concerned, not to mention one which you can afford on your very limited budget.

Then there's the rest of your equipment to buy and a staff to pay—unless you plan to spin records yourself for 12 or more hours a day, 7 days a week. And the power costs to fire up a 5000-watt transmitter also will be substantial.

The second problem is whether the FCC would even issue a construction permit for another AM station in the greater Chicago area. I think that's equally unlikely. Sorry!

Down the Dial

Here is what has been heard on the shortwave bands recently. Why not add your name to the list of contributors by sending your questions, comments, and—for our "Down the Dial" segment—to Don Jensen, *Jensen on DXing*, **Hands-on Electronics**, 500-B Bi-County Blvd., Farmingdale, NY 11735. After all, this is your column.

And now to the business at hand.

Chad—4,905 kHz, *Radiodifusion Nationale Tchadienne* from N'djamena, the captial of this West African country, wanders about this frequency. You can hear it sign on in French at 0500 UTC; although it is subject to jamming from Libya, with whom Chad has been fighting a nasty little off-and-on war.

Cuba—4,765 kHz, From this island nation comes a strong Russian language station operating on or about this frequency. You can hear the *Radio Mayak* programming, featuring lots of music, around 0530 hours UTC.

Dominican Republic—6,025 kHz, A relatively new station is *Radio Amanecer* located in Santo Domingo. Listen for it signing on shortly after 1000 UTC with religious programming in Spanish.

Germany—13,790 kHz, Increasingly, international broadcasters are turning up on this new shortwave band. For instance, *Deutsche Welle* is heard at 1830 UTC with English-German lessons.

Hong Kong—15,435 kHz, Another BBC relay facility is the recently constructed station at Hong Kong. It has been heard on North America's west coast at 0030 UTC, with the well-known news program, "Radio Newsreel."

Japan—3,377 kHz, While *Radio Japan's* international programming is not difficult to receive in North America, the home service station of NHK at Osaka, broadcasting in Japanese, is much more difficult to hear. Those in the western U.S. and Canada may find this one around local dawn.

United Arab Emirates—11,730 kHz, Another Middle Eastern station, adio Dubai from the United Arab Emirates on the Persian Gulf can be heard with English and Arabic programs until signoff, about 1645, or so, UTC.

United Kingdom—6,190, The BBC World Service programs in English which you may hear on this frequency around 0400 UTC are being relayed by a transmitter in Lesotho in southern Africa. The much stronger but parallel *BBC* programming on 6,175 kHz, just 15 kilohertz down the dial, is being aired by another BBC relay, this is Antigua in the West Indies.

Yemen—7,190 kHz, The shortwave broadcaster at Aden in the Yemen Democratic People's Republic can be heard on this frequency, signing on in Arabic at 0300 UTC. And on 9,780 kHz, at about the same hour, the Yemen Arab Republic's *Radio San'a* can be heard broadcasting here, also with programming in Arabic. ■

ABBREVIATIONS

AM	amplitude modulation (modulated)
BBC	British Broadcasting Corporation
DX	long distance (over 1000 miles)
DXer(s)	listener(s) to shortwave broadcasts
FCC	Federal Communications Commission
kHz	kiloHertz (1000 Hertz or cycles)
NZRDXL	New Zealand Radio DX League
RNZI	Radio New Zealand International
SRI	Swiss Radio International
SWL(s)	shortwave listener(s)
UTC/GMT	Universal Time Code/ Greenwich Mean Time

Credits:
Kirk Allen, OK; Kevin Malin, WA; Wally Rhyne, NC; Paul Buer, FL; Richard D'Angelo, PA; Michael Hardester, PA; Robert Ross, ONT.; Rufus Jordan, PA; North American SW Association, 45 Wildflower Road, Levittown, PA 19057; Ontario DX Association, P.O. Box 161, Station A, Willowdale, ONT. M2N 5S8 Canada)

By Joseph J. Carr, K4IPV

CARR ON HAM RADIO

Should you be using an antenna tuner?

IF YOU ARE NEW TO AMATEUR RADIO operating, you might notice that some amateurs use antenna tuners on the high-frequency (HF) bands, while others do not. In this article, we are going to look at the applications of tuners and some of the circuits used for making your own. Right up front, I will declare my own bias: I am unabashedly a fan of antenna tuners, even though for years I'd not use one.

What is an *antenna tuner*? Simply put, antenna tuners are resonant-tuned circuits that perform several functions. First, they transform antenna impedances to the impedance your transmitter wants to see. The transmitter typically wants to see a purely resistive impedance of, usually, 50-ohms. In an ideal system, the transmitter-output, the transmission-line characteristic, and the antenna-feedpoint impedances are all resistive and equal to each other. Such a system will have a VSWR (*V*oltage *S*tanding *W*ave *R*atio) of 1:1, and is optimally efficient.

Practical antennas, on the other hand, typically do not produce purely-resistive impedances. Antenna impedances usually, **1**. have a resistive component that is not equal to the coaxial-cable impedance; and **2**. have a capacitive- or inductive-reactance component in addition to the resistive portion. Those factors create a sub-optimal VSWR of more than 1:1; and in fact, the VSWR can become quite high.

Further complicating things is the fact that solid-state, final-stage amplifiers used in transmitters these days are not tolerant of high VSWRs. Older vacuum-tube transmitters were more forgiving. In the "old days," when the first practical solid-state rigs were 5-watt CB rigs, we frequently saw blown final amplifiers, due to either accidentally keying the transmitter when the antenna was disconnected, or because of a defective antenna.

But today, manufacturers incorporate VSWR shut-down circuitry that will turn down the power level as the VSWR rises...with full shut-down at 2.5:1 or 3:1. The results to your signal level are painfully obvious. But, an antenna tuner can correct the impedance mismatch and cause the antenna to work.

Second, the antenna tuner acts as another frequency-selective circuit between the output of the transmitter and the antenna. Although broadband-RF and balun transformers can perform limited impedance matching, just like a tuner, they are not frequency selective. An advantage of the tuner is that it selectivity attenuates harmonics that could cause TVI and other forms of interference to your neighbor's equipment. While some readers might argue that harmonic attenuation is the function of the low-pass filter, I maintain that both are useful and, in fact, use both myself.

Let's Talk Tuners

Figure 1 shows the configuration for an antenna tuner that does not have a built-in VSWR or RF power meter. Before discussing the rest of the circuit let me point out the coaxial switch (S1) and the dummy load. When transmitters have to be adjusted, as is the case with vacuum-tube based, final-stage amplifiers (and most external linear amplifiers), it is usually best to adjust the rig off the air.

To accomplish that, the switch is set to feed RF power from the transmitter to the dummy load, and the transmitter is adjusted. The switch is then set to send the transmitter's RF-output power to the input of the antenna tuner. The antenna tuner is then adjusted.

Besides reducing interference on the bands, that procedure also helps you to make the antenna adjustments correctly. The transmitter is already adjusted to load its standardized-output impedance (*e.g.*, either 50 or 75-ohms, in most cases), so that the antenna can easily be adjusted to match that impedance. Otherwise, the considerable interaction between the output tuning of the transmitter and the circuits of the antenna tuner could lead to a misadjustment.

Adjustment of the antenna tuner requires the measurement of either the VSWR or reflected RF power in the transmission line. The idea is to adjust the tuner in such a manner so as to

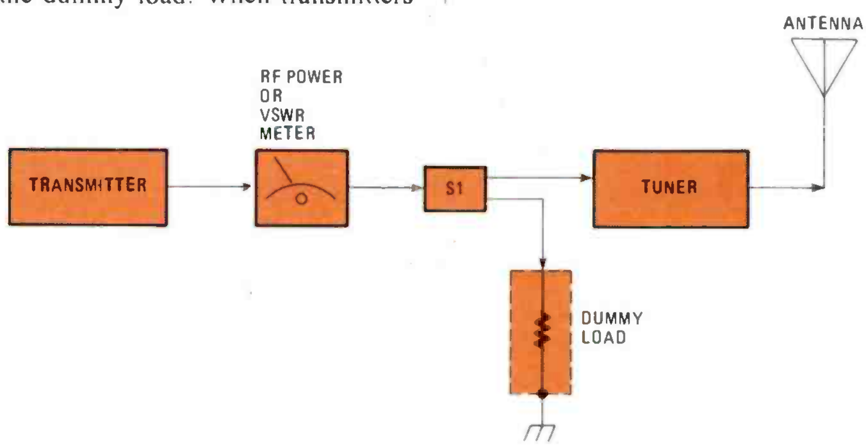


Fig. 1—Shown here is the typical setup for an antenna tuner that does not have a built-in VSWR or RF power meter. When transmitters have to be adjusted, it is best to adjust the rig while off the air. That's accomplished by feeding RF power from the transmitter to the dummy load, and making the transmitter adjustment. The switch is then set to send the transmitter's RF-output power to the input of the antenna tuner, and it too is adjusted.

reduce the reflected power to zero, or a 1:1 VSWR or as nearly as possible). If the antenna tuner does not have a built-in VSWR or RF-power meter, then use an external meter.

Adjustment of the antenna tuner should be done at minimum power. Crank down the transmitter's RF output until it is sufficient to raise the forward power meter needle only about one-third to one-half scale. Adjust the antenna L and C controls for minimum reflected power. Do not worry too much about the forward-power meter reading.

Digging Deeper

Figure 2 shows several possible antenna-tuner circuits that find common use on the amateur HF bands. Although the specific values of the capacitors and inductors vary from band to band, and with differing values of antenna-load (R2) and transmitter-output (R1) impedances, a couple of "rule of thumb" values work for most practical cases. Except for the pi-network, use a capacitor with a maximum value of 140-pF or 250-pF, and a voltage rating that is at least 1500 volts...preferably larger. A so-called "transmitting variable" will usually suffice.

The variable inductor can be either tap-selected or roller type, and should have a maximum value of 15-µH to 30-µH. In many antenna tuners, either 18-µH or 28-µH coils are used because those values are "standard." If only the upper HF band (*i.e.*, 10 and 15-meters) will be used, then a 10-µH variable inductor can be used. The specific values are calculated from equations found in standard reference works (see end of article).

Keep in mind as you examine the circuits of Fig. 2 that the antenna input impedance is called "R2" and the transmitter output impedance is called "R1." There will be one exception to that notation when we discuss the pi-network. The terms "input" and "output" are almost meaningless in relation to the pi-network, because the networks are bilateral.

As long as the relationship between R1 and R2 is maintained (*i.e.*, R1 < R2 or R1 > R2), then the designs will work. We use the terms "input" and "output" simply because of the impedance relationships that normally exist in antenna circuits. For example, in a random-length, long-wire antenna the antenna impedance (R2) is normally much higher than the 50-ohm output impedance of the transmitter.

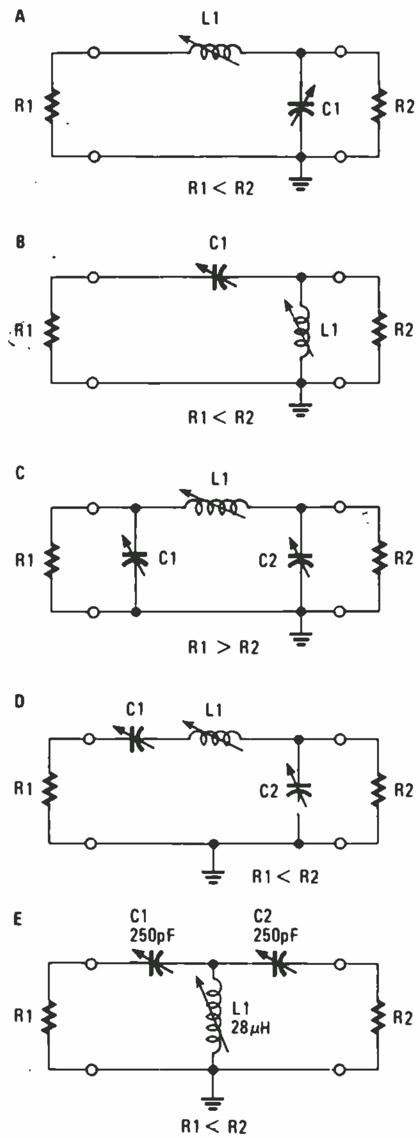


Fig. 2—Shown here are several antenna-tuner circuits that are commonly used on the amateur HF bands. The simple L-section network shown in "A" is used for matching random-length, "long-wire" antennas to 50 or 75-ohm coaxial outputs. Another variation, the reverse L-section network, is shown in "B." The pi-network in "C," which uses two parallel connected capacitors, gets its name from the circuit's resemblance to the Greek letter "*pi*," and is almost universally used in tube-type transmitter or linear-amplifier output circuits. A three-element L-section network, shown in "D," is sometimes seen in tuners that are reconfigurable. The alternate configuration in "E," is commonly used in tuners that are so-called "coax-to-coax," which probably accounts for most tuners in use today.

The simple L-section network in Fig. 2A is used for matching random-length, "long-wire" antennas to 50 or 75-ohm coaxial outputs (which are standard on modern transmitters). The characteristic of such antennas is a very high-input impedance. The L-section network commutes that impedance to the lower impedance that the transmitter wants to see.

Another variation, the reverse L-section network, is shown in Fig. 2B. That circuit also transforms the higher impedance (R2) to the lower impedance of (R1).

The pi-network of Fig. 2C, its two capacitors, is almost universally used in tube-type transmitter or linear-amplifier output circuits because it will convert the vacuum-tube plate impedance (R1) to the 50-ohm antenna impedance (R2). Thus, the pi-network is the opposite of the L-section network. When turned around backwards, however, the pi-network can be used to match high-impedance antennas such as the long-wire.

A three-element L-section network is shown in Fig. 2D. That circuit also requires that the antenna impedance be higher than the transmitter impedance (R1 > R2). That circuit is sometimes seen in tuners that are reconfigurable. The alternate configuration, shown in Fig. 2E, is commonly used in tuners that are so-called "coax-to-coax," which probably accounts for most tuners in use today.

Those tuners "tune out" impedance variations that could upset the operation of the transmitter because of high VSWR. In the "good ol' days" when tubes were used, we could overlook a 2.5:1 VSWR and simply accept the lost power represented by the reflections. In solid-state rigs, however, that level of VSWR will turn off the transmitter in order to prevent damage to the output transistors.

The arithmetic equations for calculating component values for those tuners (as well as others) are given in my book *Commodore 64 & 128 Programs for Amateur Radio & Electronics* (Sams Cat. No. 22516). BASIC programs to make those calculations are also given in the book. Anyone wanting the book can get it from me, or from Sams book dealers ($14.95). The C-64 diskette, containing all forty programs, is available from me at the address below ($15). (Note: $25 for both book and diskette if ordered together).

Joe Carr, K4IPV, can be reached at PO Box 1099, Falls Church, VA 22041. And don't forget, he welcomes your comments and suggestions for this radio amateur column. ■

By Marc Saxon

SAXON ON SCANNERS

Ten-channel programmability and super frequency range in a handheld scanner

Monitoring-identification letters (used on correspondence, reception reports, QSL cards, etc.) have existed since 1970. Upon registering as a monitor, you receive a colorful certificate—hand inscribed by a professional calligrapher—with your name, ID letters, and the date of issuance.

Radio Shack's PRO-31—featuring ten-channel programmability, channel lockouts, optional two-second scan delay, memory-backup battery, a keyboard-lock, belt clip, rubberized antenna, and LCD display (which indicates channel status and frequencies being scanned, monitored, or programmed)—has excellent frequency range and provides VHF low-band coverage from 30 to 54 MHz and VHF high-band runs straight through from 138 to 174 MHz. UHF coverage begins at 380 MHz and is continuous to 512 MHz, making it one of the growing legion of handhelds giving full monitoring of the exciting 406 to 420 MHz federal communications band.

☐RADIO SHACK'S PRO-31 IS A RECENT addition to the company's line of versatile handheld scanners. Selling in the $200 price range, this ten-channel programmable has an excellent frequency range.

The unit's VHF low-band coverage is from 30 to 54 MHz, while the VHF high-band runs straight through from 138 to 174 MHz. Its UHF coverage begins at 380 MHz and is continuous to 512 MHz. That makes it one of the growing legion of handhelds to permit full monitoring of the exciting 406 to 420 MHz federal-communications band, and a welcome addition at that!

Inside the unit's rugged case is a handful of features comprised of a phase-locked loop IC, two MOS ICs including microprocessors, 2 integrated circuits, 30 transistors, 40 diodes, and an LCD display. The LCD display indicates channel status and frequencies being scanned, monitored, or programmed.

The PRO-31 has channel lockouts, an optional two-second scan delay, memory-backup battery, a keyboard-lock button, belt clip, rubberized antenna, and display light. The unit is powered by six AA-size batteries (can be rechargeable types), or a vehicle DC adapter.

The fact that the PRO-31 sells for such a relatively-low price (for a programmable) reminds us that it is still basically a straightforward *meat'n taters* workhorse. Despite the fact that it offers many operating features, the fact that it provides ten channels (versus as many as 200 in some other more expensive handhelds) and no search/scan capabilities, it is probably intended more for the person who is starting out with certain specific frequencies that need to be monitored, as opposed to the pure hobbyist hoping to hear anything and everything on known and yet-to-be-discovered frequencies.

Wielding A Club

One of the more popular topics in our daily mail asks about the availability of scanner clubs in general, or our opinion of several groups that presently exist. The major national organization reaching the most listeners is SCAN (P.O. Box 414, Western Springs, IL 60558). Another group, headquartered in California, has been a disaster for several years now. A regional club in Ohio, for a while at least, seemed to hold some promise, but looks to be running out of steam of late.

Reader Michael P. Welsh of Illinois asks about the use and source of

(Continued on page 101)

SUPERCONDUCTIVITY
(Continued from page 34)

be designed to fit in much smaller volumes.

Another application of superconductivity that has had an impact in electronics is the Josephson Junction. As mentioned before, Josephson Junctions may replace the transistor in some high-speed computers because they are capable of switching 100 times faster. Using Josephson Junctions, a computer more powerful than today's most powerful supercomputers could be built in an area no larger than a filing cabinet.

Science and Medicine

Science and medicine have already greatly benefited from superconductivity. In those areas the ability of superconductors to generate powerful magnetic fields and to detect weak magnetic fields has been exploited.

Physicists have long used superconducting electromagnets to generate extremely powerful magnetic fields. The powerful superconducting electromagnets have been used as part of atomic colliders. An atomic collider uses a ring of pulsating magnets to accelerate atomic particles to extreme speeds where the particles are smashed in an attempt to learn more about the behavior of the particles.

Another use of the superconducting electromagnets in the physics laboratory is in attempting to generate a "magnetic bottle" capable of containing a fusion reaction. In a fusion reaction, atoms are combined and energy is released—the same method our sun uses to generate its energy. Today's fission reactors split atoms apart to generate energy and leave many radioactive waste products behind. Fusion reactors are clean. However, fusion reactions are so violent and hot that they require powerful magnetic fields to contain them. Physicists hope that future superconducting magnets will generate magnetic fields strong enough to contain fusion reactions.

In medicine, superconductivity is used in imaging equipment. The NMR (Nuclear Magnetic Resonance) or MRI (Magnetic Resonance Imaging) machines are capable of generating detailed images of the inside of organisms. For example, an MRI machine can generate an image of a patient's heart without having to cut the skin or inject dyes into the blood. The same can be done for the other organs as well. MRI machines work by placing the patient in a powerful magnetic field generated by a superconducting electromagnet.

Transportation

Superconductivity could affect transportation in several ways. Compact superconducting electromagnets could be used to levitate special trains above the tracks. The *MagLev* (Magnetic Levitation) trains would float on a magnetic field as they whisk along at speeds twice as fast as today's fastest trains. Efficient superconducting electric motors could be used in a new breed of electric car, as well as in ships and submarines.

The Military

The military is conducting research into several superconductivity applications. Superconductive rail guns may replace explosive projectiles, and superconductive motors may allow submarines to operate much quieter, making their detection more difficult. Superconductive electronics will enhance sensors, making them more sensitive over greater ranges.

With the scientific community, private industry, and the military all showing interest in superconductors, it's no wonder that it has filled the papers in recent years. And it can be easily predicted that in the near future it will become very much a part of our lives. ■

SECURITY SYSTEM
(Continued from page 60)

There is a very remote possibility that your system may interfere with your neighbor's system. In each system component, there is an eight-pole binary switch, whereby the home owner can select his own personal code—a code that is almost impossible to duplicate.

The manual supplied with the security system is complete and easy to read and understand. It has only 27 pages and includes all the information an installer and operator needs for any type of home installation.

The SS-5910 Wireless Security System is easily expandable, and features a tamper alarm (which sounds off if someone tries to disable the unit), plus a self-test control for checking the operation of the entire system. An AC powerpack plug supplies the power required to operate the console. In the event of a power failure, an optional unit, the SSA-5910-3 Emergency Backup Power ($29.95), will keep the security system operating up to five hours.

Adding Light Backup

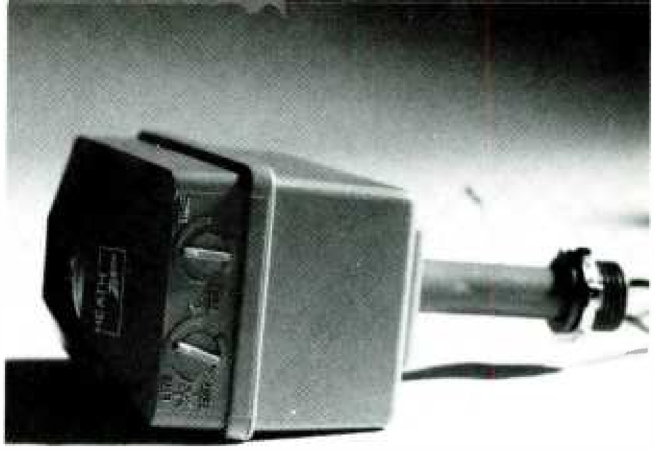
The last thing a prowler wants to do is enter a house that looks occupied, or possibly one that signals to a neighbor that something is amiss. Heath/Zenith offers two motion sensor products that are easy to install and operate, and best of all, they're very economical to use, since they only turn the lights on at night only when there is the presence of heat and motion.

The SL-5320 Motion Sensor Light Control ($99.95) is a PIR device which is designed to activate outdoor lights such as floodlights, plus an indoor light, to create the impression that someone is home, as well as alerting the homeowner that someone is outside. The lighting control connects to any standard outdoor lighting fixture, and it can monitor an area of up to 60 feet deep in a 110 degree arc (which provides total coverage of more than 2,000 square feet). The SL-5320 has a suggested retail price of $99.95. I installed the SL-5320 to cover the front lawn and roadway. Whenever anyone walked or drove by, the master bedroom light would come on.

The SL-5420 Wireless Light Control ($99.95), also designed for outdoor use, can be mounted on fence posts, walls, or virtually anywhere within 150 feet of the light it will turn on. As the sensor detects heat in motion, it transmits a radio signal to an X-10 receiver device to automatically switch the light on. I placed the SL-5420 so that anyone walking up the driveway, or driving into it will cause the garage light to come on. Curious children have looked for the sensor, but always assumed it to be near the garage outdoor light. The sensor is behind them and has yet to be spotted.

Should you have an indoor application, the SL-5420 will work equally as well there. I imagine it would be ideal for large plants and warehouses.

I found the Heath/Zenith PIR sensors that were installed to be very sensitive and very accurate. As a result, they are



The SL-5410 Entryway Light Control, like other sensor modules in the SSA-5910 Security System, is capable of detecting heat given off by moving objects. When someone enters it sphere of detection, the SL-5410 can switch on up to a 500-watts of lighting. It also has a built-in light sensor, which turn the lighting of during the day-light hours.

less susceptible to false alarms caused by pets or even when blowing leaves cross the detection field.

Should You Want One

A typical, professionally-installed burglar alarm system will set a homeowner back an average of $1,500 for a basic system, but the Heath/Zenith SS-5910 easy-to-install security system can be installed by homeowners at a fraction of the cost. The SS-5910 has a suggested retail price of $399.95. At that price, the Heath/Zenith SS-5910 Wireless Security System is more within the budget of a larger segment of homeowners than comparable systems on the market.

All Heath Zenith Consumer Products carry a one-year limited warranty and are available through hardware/home centers across the United States. Heath/Zenith Consumer Products Group is a division of Heath Company, a wholly owned subsidiary of Zenith Electronics Corporation. For more information on the new motion-sensor light controls or on other consumer products, contact Heath/Zenith, Department 150-595, Hilltop Road, St. Joseph, MI 49085; or you can circle No. 70 on the Free Information Card found in the back pages of this issue. ■

BUILD THE ACCESS TWO TONE DIALER

(Continued from page 70)

connect to the correct keyboard matrix lines. (Table 1 shows the combination of IC connections necessary to obtain any of the numbers and symbols.) The author used a miniature calculator keypad with some keys rewired in his prototype.

Check-out and Operation

After wiring the circuit, using Fig. 1 as a guide, check your work against the schematic diagram. A pinout of U1 is shown in Fig. 2 to help make wiring the circuit a bit easier. It will also help should you decide to make some type of modification to the circuit.

Double check the power connections from the 9-volt battery to the chip before flipping on the power switch. Improper wiring of the power supply can result in an inoperable circuit or worse, *fried silicon* or a dead battery.

Once you are reasonably sure of the integrity of your work, apply power and press any key. You should hear a clear tone. If the tone is very loud, it could be distorted and the volume may need to be reduced.

TABLE 1—KEYPAD WIRING SCHEME

Keypad Input	U1 Connections
1	C1-R1
2	C2-R1
3	C3-R1
4	C1-R2
5	C2-R2
6	C3-R2
7	C1-R3
8	C2-R3
9	C3-R3
*	C1-R4
0	C2-R4
#	C3-R4

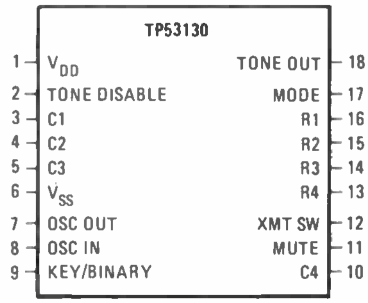


Fig. 2—This pinout of U1 is provided to help make wiring the circuit a bit easier. It will also help should you decide to make some modification to the circuit.

If the tones contain much vibration, some distortion is present. The tones do not have to be loud, but they do have to be clear. Adjustment of R2 will lower the volume and correct most of the distortion.

To properly check the operation, the unit's speaker should be held close to the mouthpiece on a touch-tone phone. If the tone phone can dial a number, the small dialer can also. When the first number is pressed, the dial tone should stop. That means that the volume and clarity is correct. Hang up and then dial a complete telephone number using only the new dialer. If you constantly get a wrong number, recheck the wiring between the keyboard matrix and U1.

If Access-Two is to be used to access your home answering machine, the dialer should be taken to another remote phone, such as the one at work, and tested. If the unit does not respond as it should, try lowering or increasing the volume setting. Also, holding the dialer slightly away from the mouthpiece of the phone sometimes helps. Recheck the wiring on the project if all else fails. ■

CONQUERING THE SINEWAVE

(Continued from page 80)

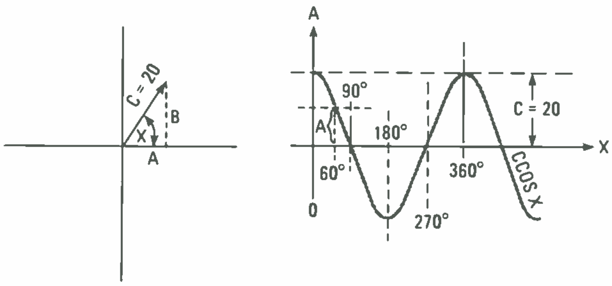


Fig. 17—A plot of the cosine function for a phasor yields a sine wave that is ninety degrees out of phase.

$$A = 20 \ \mathrm{Cos}90$$
$$A = 20(0) = 0$$

The resulting waveform has a sinewave shape but its only difference is that at 0° the positive peak occurs while the negative peak occurs at 180 degrees. The zero crossing points are 90 and 270. So we can conclude that a cosinewave is just a sinewave shifted to the left by one quarter cycle or 90 degrees. The cosinewave leads a sinewave by 90 degrees. Looking at a waveform on an oscilloscope you can't tell if it is a sinewave, a cosinewave or some phase shifted version of either. In fact doesn't matter. The only way to tell for sure is to know where the 0 degree reference point is.

You will also see the cosine expression in electronic formulas: $v = V_p \ \mathrm{Cos}\theta$

When you see it, just remember it's just a sinewave that occurs 90 degrees earlier.

Practice Exercises

11. A sinewave has a peak voltage of 42 volts. What is the instantaneous value at 67 degrees?

12. What is the phase relationship between a sine and cosinewave? ■

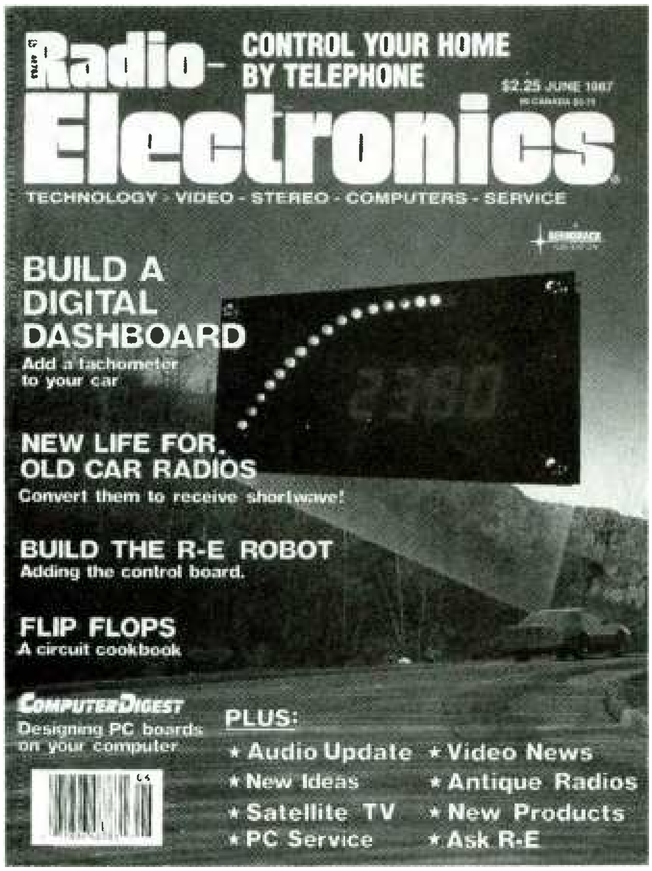
Answers To Practice Exercises

1. 262,000 Hz
2. 9.5 MHz
3. 14,700 MHz
4. 2,182,000 Hz
5. 50 µS
6. 800 Hz
7. $V_p = 169.68$ V., $V_{pp} = 339.36$ V.
8. 12.37 V.
9. a. 1.57
   b. 36 degrees
   c. 2 π/3 rad
10. 50 degrees
11. 38.66 volts
12. A cosinewave leads a sinewave by 90 degrees.

"Byron, when I asked you to build a time machine I didn't mean a watch!"

This will be coming to you when you subscribe to **Radio-Electronics**

- **HELPFUL CONSTRUCTION ARTICLES...**
  - Test Equipment
  - Hi-Fi Accessories
  - Telephone Accessories
  - Music Synthesizers
  - Computer Equipment
  - Automotive Equipment
  - Intruder Alarms-Home & Car
  - Video Accessories
- **NEWS ON NEW TECHNOLOGY**
  - Computers
  - Microprocessors
  - Satellite TV
  - Teletext
  - Automotive Electronics
  - Speech Synthesizers
  - IC Applications
- **FASCINATING "HOW TO DO IT" ARTICLES...**
  - Build Your Own Projects
  - Make Your Own PC Boards
  - Wiring Techniques
  - Soldering and Desoldering
  - Design and Prototyping



- **HOW YOU AND THE COMPUTER CAN BE FRIENDS...**
  - Getting Started
  - Programs, Circuit Design, Games
  - A/D-D/A Interfacing
  - Peripheral Equipment
- **NEW AUDIO DIMENSIONS FOR YOUR PLEASURE...**
  - Noise-Reduction Devices
  - How to Connect that Extra Add-On
  - Hi-Fi Accessories
  - New Technology
- **TV WONDERS FOR YOUR FUTURE...**
  - Latest Receivers and Circuits
  - The Home Entertainment Center
  - Projection TV
  - Satellite TV Receivers
  - Jack Darr's Monthly Service Clinic
  - Service Problems and Solutions
- **REGULAR MONTHLY FEATURES**
  - DESIGNERS NOTEBOOK by Robert Grossblatt
  - HOBBY CORNER by "Doc" Savage, K4SDS
  - STATE-OF-SOLID-STATE by Bob Scott
  - WHAT'S NEWS, new products, stereo news and NEW IDEAS, STEREO PRODUCTS, NEW COMPUTER PRODUCTS FOR HOME/JOB and MUCH MORE!

Radio-Electronics covers all aspects of the fast moving electronics field...featuring
COMPUTERS • VIDEO • STEREO
TECHNOLOGY • SERVICE
COMMUNICATIONS • PROJECTS

Get it all!

Subscribe today to **Radio-Electronics!** Don't miss a single issue and...see subscription card in this issue for big savings.

When you select one of the subscription offers listed on the handy coupon—you'll be assured of having your copy reserved, even if it sells out on the newsstand. Make sure you get all the excitement in every issue of **Radio-Electronics**, every month, by filling in and mailing your subscripton card today.

SAXON ON SCANNERS

(Continued from page 94)

monitoring-identification letters such as KIL9GW, KTX5CJ, KCA6HS, etc. that he's noted being used in conjunction with the names of many scanner enthusiasts. Those IDs have been in existence since 1970, and are used on correspondence, reception reports, QSL cards, etc. Such an identification identifies the user within the large and rapidly growing corps of those participating in HF/VHF/UHF communications monitoring.

My own registered monitoring-station ID is KUSOAL, which I have proudly held for a number of years. When a person registers as a monitor, the ID is sent on a handsome 8½-by-11 inch colorful certificate, with their name, ID letters, and the date of issuance hand inscribed by a professional calligrapher.

To register and receive your own personal monitoring ID, send the $5 fee to Monitoring Registry, CRB Research Books, Inc., P.O. Box 56, Commack, NY 11725.

Business Band Business

In our January column we spoke of the large influx of inexpensive little two-way handheld transceivers currently being mass marketed to those who need short-range business communications, often without wishing to bother with the necessary formalities of getting an FCC license for same. We noted that we had seen some of this equipment set up for operation on 457.525, 457.55, 457.575, 457.60, 458.025, 458.125, and 458.175 MHz, and suggested that our readers might find some interesting listening on those channels.

Now comes a letter from Alex W. McIlwain, Lakeland, FL who comments on that and offers additional information. Alex notes that equipment he's seen is being offered around with the frequencies we listed in January, plus many other channels carefully "borrowed" from the itinerant-frequency assignments belonging to a wide variety of FCC radio services.

Alex says that low-power handheld transceivers seem to be offered to the general public for (unlicensed, and therefore unauthorized) operation on the following frequencies worth monitoring on scanners: 27.49, 33.42, 35.04, 39.06, 46.30, 151.49, 151.625, 153.83, 154.57, 154.60, 158.40, 451.80, 464.50, 464.55, 467.775, 467.80, 467.825, 467.85, 467.875, 467.90, and 467.925 MHz.

Alex's advice caused me to program those frequencies into my own scanner and I did pick up communications traffic that seemed to me to be unauthorized. For instance, 29.06 and 153.83 MHz are supposed to be for police and fire use (respectively). Yet there isn't any way in the world that the communications that I heard there came from police or fire agencies.

As an extra piece of related trivia, when I scanned 35.04 and 154.60 MHz, I heard the internal order-taking communications at a McDonald's fast-food franchise in my community! A friend tells me that those two frequencies are used nationally by many McDonald's facilities.

(Continued on page 105)

CIRCUIT CIRCUS

(Continued from page 87)

(a 5K ten-turn potentiometer). As the object moves, the voltage at the arm of R5 is moving either toward ground or the plus bus. Another 5K ten turn potentiometer, R17, is preset to a desired voltage that indicates an exact location in the path of the moving object.

When the motor has moved the object to the preset location, the voltage at the wiper of R18 equals that at the wiper of R17 and the inputs to the comparator-amplifier, U5, are at the same level. That causes U5 to be at a balanced condition with a voltage output equal to ½ of the supply voltage. Under a balanced-output condition neither of the opto-isolator/couplers are activated, and the motor stops. If the motor continues past the preset position try reversing the motor leads.

Good luck with your circuit experiments and may you rotate in the right direction until next month. ■

PARTS LIST FOR THE MOTOR SPEED/DIRECTION CIRCUIT

SEMICONDUCTORS

D1–D8—1-to-6 ampere silicon diode (see text)
D9–D11—1N914 general-purpose small signal diode SCR1, SCR2—1–6 ampere silicon-controlled rectifier (see text)
U1—LM741 general-purpose, op-amp, integrated circuit
U2, U3—H11C3GE, or similar, SCR-output opto-isolator/coupler, integrated circuit (Digi-Key)
U4—CNY171GE, or similar, transistor-output optoisolator/coupler, integrated circuit (Digi-Key)
Q1—2N3904 general-purpose NPN silicon transistor
Q2—2N3055 NPN silicon power transistor

(All resistors are ¼-watt, 5% units unless otherwise noted.)
R1, R2, R7, R14, R15—1000-ohm
R3, R4, R11, R10—10,000-ohm
R5—4700-ohm
R6, R8, R9—470-ohms
R12, R13—270-ohms
R16—50,000 100-turn potentiometer

ADDITIONAL PARTS AND MATERIALS

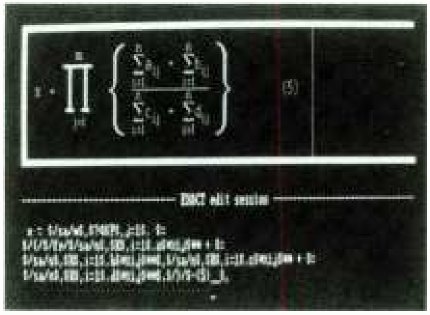
C1—.1-µF, 100-WVDC Mylar capacitor
C2—220-µF, 25-WVDC electrolytic capacitor
T1—24-volt center-tapped 1-to-6A transformer, see text
Printed circuit or perfboard materials, small DC motor (9 to 12-volt), 9 to 12-volt DC power supply, enclosure, IC sockets, wire, solder, hardware, etc.

NEW PRODUCTS

(Continued from page 17)

the word processor, the user can call a pop-up, split-screen Edit Session. The user types Exact commands in the bottom screen and sees the mathematical expressions instantly created in the top screen. Editing the commands results in immediate update and redisplay of the mathematics.

Once an expression looks right, the user exits the pop-up Edit Session and is returned to the word processor. The user then positions the cursor where the expression should appear in the document and injects the command lines created in the edit session into the text.



CIRCLE 52 ON FREE INFORMATION CARD

The software package includes 20 fonts with over one thousand symbols and characters. Any character can be rescaled up to 81 times its size. Also contained in the package is a font editor which allows users to create their own characters and use them as easily as the standard fonts.

Exact can also be used to remap the keyboard to allow typing in user-developed foreign fonts such as Arabic, Russian, or Hebrew.

Drivers are available for all common dot matrix and laser printers. Exact requires from 64K to 128K of RAM depending on the number of fonts loaded at one time. The program runs on IBM PC, XT, AT and compatibles, with any graphics card. Exact is also available in the Hercules high resolution format.

The software costs $475 (students discount available), and is available from TSSI, 72 Kent St., Brookline, MA 02146; Tel. 617/734-4130. ■

THE COLOR CODE DRILL

(Continued from page 62)

When the entered answer is correct, however, line 1790 causes the program to jump back to line 1470 where a new resistor value is generated for display.

Line 1720 contains one last statement that you should be aware of; it lets you exit the program gracefully by typing the word "QUIT" at the "Resistor Value" prompt. This keyword may be entered in either upper or lower case letters.

You know as well as I do that when you are debugging a project, nine times out of ten, the cause of all your trouble turns out to be something so simple that you initially thought it *could not possibly be* the source of your problems.

Putting the wrong value of resistor in a circuit is one of those potential problems. The Color Code Drill Program can go a long way to help combat this problem that *could not possibly be* a problem. ■

ELLIS ON ANTIQUE RADIO

(Continued from page 85)

was shot from a Xerox sent to me by reader Louis Supek (Brunswick, OH). Thanks a lot, Lou!

Reader Albert Colianni (Arlington Heights, IL) sent a very nice photo of an interesting variant of the EC1. It's in a furniture-style cabinet instead of the usual crackle-finish metal one and has a simplified main tuning dial scale.

Al says that it doesn't have the usual BFO, earphone-speaker switch, and standby switch. It carries the label "Made by Hallicrafters," and Al thinks it's a Model EC-2. But, as it happens, Lou Supek's Lafayette catalogue page had a description of the EC-2 in addition to the EC-1. Though the EC-2 is not pictured, it is described as having a metal cabinet as well as the earphone-speaker, BFO, and standby switches.

Ray Musick (Oklahoma City, OK) had an EC-1 during World War II. It was afflicted with a lightning-damaged RF coil, which he was never able to replace. Just after the war, he discovered that the Hallicrafters S-38 had an identical coil. (Hallicrafters had purchased the Echophone company by then, so the similarity wasn't a coincidence.

Les McCord (Korumiburra, Australia) used an EC-1 while serving as a radio officer on British tankers during World War II. Prior to one Atlantic crossing, Canadian Navy personnel came on board to check the RF radia-J tion of all radio receivers on the ship. Les was ordered to remove the tubes from his set and lock them up for the duration of the crossing. It turned out that the EC-1's oscillator emitted a signal that could be easily picked up by the enemy's DF equipment.

By the way, Les recently visited a US merchant ship and spotted an EC-1 tucked in with the sleek, modern RCA communication equipment. Asking why it was there, he was told it was used as a stand-by! That's about all I have room for this month, and I still have quite a few interesting letters left to discuss. We'll probably make room for them in next month's column so that I can empty the in-basket and get it ready to receive more mail.

Please keep those letters coming; your comments and questions are always most welcome! Limited free time makes it impossible for me to respond individually—even if you include an SASE. So save your stamps and envelopes. But most of the letters I receive are eventually acknowledged in the column so that everyone can share them. Write to Marc Ellis, C/O **Hands-on Electronics**, 500-B Bi-County Blvd., Farmingdale, NY 11735. ■

STARLIGHT SYNTH

(Continued from page 27)

insides removed and an IR LED in its tip (a perfect fit, held there permanently with a drop of super glue). A hole is punctured in the end cap to run the wire out and into the enclosure when it is connected to the 1.5-volt battery and

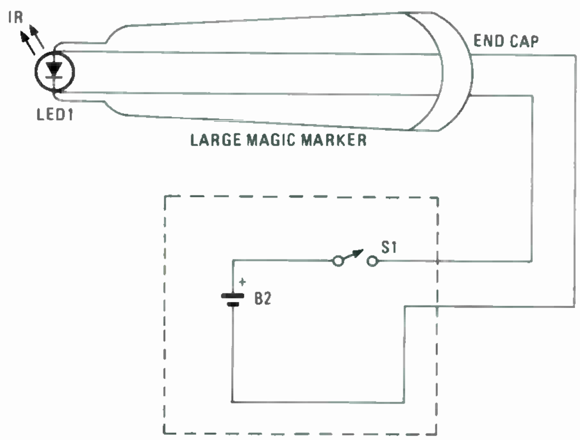


Fig. 2—The wand is powered by its own cell, but switched on by one half of switch S1. Be sure not to confuse the two supplies or you'll end up with a well-done IR emitter.

PARTS LIST FOR STARLIGHT SYNTH

SEMICONDUCTORS
LED1—SEP8703-001 infrared light-emitting diode
LDR1—CdS photocell
Q1-Q15—TIL414 infrared phototransistor
U1—556 dual timer, integrated circuit

RESISTORS
(All fixed resistors are 5% precision, 1/4-watt units.)
R1—1000-ohm
R2—100,000-ohm
R3—100,000-ohm potentiometer
R4-R17—4700-ohm

CAPACITORS
C1—0.047-µF
C2—0.22-µF
C3—0.68-µF

ADDITIONAL PARTS AND MATERIALS
B1—9-volt, transistor-radio battery
S1—DPST switch
S2—SPST switch
SPKR1—8-ohm speaker
Large magic marker, battery-clip terminals, printed-circuit board, hardware, wire, enclosure, solder, etc.

switch (see Fig. 2). Switch S1 applies the 1.5-volt battery to the IR wand and the 9-volt battery to the synthesizer. Switch S2 activates the photocell.

After everything is installed in the enclosure, the top of the box was covered with a design and lettering. Then it was covered with clear frosted contact plastic. That not only protects the design and lettering, but keeps dirt and other objects out of the tubes and protects the IR transistors. After the plastic is in place, the photocell, switches and dial were added.

The project can be built in a couple of evenings. A well stocked junk box can be cut down on the time and expense of building this project. Even though all parts can be obtained from Radio Shack, they can be about half price through mail order or other sources. If you only build one project this year for fun, make it this one. But be careful, you may have the kids fighting to get it away from you. ■

HANDS-ON MARKETPLACE

PLANS/KITS

BUILD this five-digit panel meter and square wave generator including an ohms, capacitance and frequency meter. Detailed instructions $2.50. **BAGNALL ELECTRONICS**, 179 May, Fairfield, CT 06430.

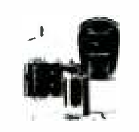
PROJECTION-TV...Convert your TV to project 7 foot picture...Results comparable to $2,500.00 projectors...Total cost less than $30.00...Plans and 8" lens $21.95...Illustrated information **free. MACROCOMA-HJ**, Washington Crossing, PA 18977. Creditcard orders 24 Hours. (215) 736-3979.

DJ beatmeter you can build. Organize your L.P.s by beats per minute like the pros do to make "mixing" faster and and easier. Plans and instructions $2.00. **LERCOM**, P.O. Box 2274. Sta.1. Kingsville. TX 78363.

VOICE disguisers! FM bugs! Telephone transmitters! Phone snoops! More! Catalog $1.00 (refundable): **XANDI ELECTRONICS**, Box 25647, 32N, Tempe. AZ 85282.

DETECTIVES, experimenters. Exciting new plans. Hard to find micro and restricted devices. Large catalog $5.00 refundable on 1st order. **WILSON**, P.O. Box 5264. Augusta. GA 30906.

AWSOME light sequencer with unbelievable sound sync. **Plans**, board, and Cpu $39.95; **complete** and tested unit $199.95. **ELECTRONIC ARTS**, 27 Linda. Colonia. NJ 07067.



TUBES - 2000 TYPES
DISCOUNT PRICES!
Early, hard-to-find, and modern tubes. Also transformers, capacitors and parts for tube equipment. *Send $2.00 for 20 page wholesale catalog.*
ANTIQUE ELECTRONIC SUPPLY
688 W. First St.•Tempe, AZ 85281•602/894-9503

PC boards made to order. Details—SASE. Eprom programmer plans $3.50. Includes semiconductor bonus! **GALLIUM JUNCTION**, 540-C N.E. Northgate Way, Suite 542, Seattle, WA 98125.

CATALOG: hobby/broadcasting/HAM/CB: Cable TV, transmitters, amplifiers, bugging devices, computers, **more! PANAXIS**, Box 130-F(6), Paradise, CA 95967.

TESLA coils—Kirlian Electrophotography—Plasma Bulbs...Free 1988 science plan catalog! **SCIENTIFIC**, Box 1054HHE, Duvall, WA 98019.

DIGITAL dashboards: complete plans: $14.45. Details free. **MODERN LABS**, Dept. 3M, 2900 Ruisseau, St. Elizabeth, QC, J0K 2J0, Canada.

INTERFACE, solid state, for 8 bit microprocessors. Control 8 devices AC/DC and detect status with microswitches, etc. Expansion to 32 devices. **INNOVATIVE ENGINEERING**, P.O. Box 30252, Knoxville, TN 37923.

DAZER defense weapon kit $45.00 assembled $60.00 catalog free! **QUANTUM RESEARCH**, 17919-77 Avenue, Edmonton, Alberta, T5T 2S1.

SURVEILLANCE electronics, debugging, kits. Latest high tech catalog $2.00. **TECHNOLOGY SERVICES**, 829 Ginette St., Gretna, LA 70056.

SATELLITE TV

DISHES systems **upgrades** Chaparral, Drake, Houston, etc. **Save $$$$$** toll **free** (800) 334-6455. **SKYVISION**, 2066P Collegeway, Fergus Falls, MN 56537.

TAKE the beep out and get a clear picture any channel call now (313) 979-8356. **BENNY**.

BUSINESS OPPORTUNITIES

YOUR own radio station! AM, FM, TV, cable. Licensed/unlicensed. **BROADCASTING**, Box 130-F(6), Paradise, CA 95967.

PARTS

1200 parts $10.00. All new. Long leads. Resistors, diodes, etc. All good stuff. No junk. **BARGAIN CITY**, P.O. Box 121H, Glen, MS 38846.

CLASSIFIED AD ORDER FORM

To run your own classified ad, put one word on each of the lines below and send this form along with your check to:

Hands-on-Electronics Classified Ads, 500-B Bi-County Boulevard, Farmingdale, N.Y. 11735

PLEASE INDICATE in which category of classified advertising you wish your ad to appear. For special headings, there is a surcharge of **$10.00.**

( ) Plans/Kits ( ) Business Opportunities ( ) For Sale
( ) Education/Instruction ( ) Wanted ( ) Satellite Television
( ) ____________

Special Category: $10.00

PLEASE PRINT EACH WORD SEPARATELY, IN BLOCK LETTERS.
(No refunds or credits for typesetting errors can be made unless you clearly print or type your copy.) Rates indicated are for standard style classified ads only. See below for additional charges for special ads. **Minimum: 15 words.**

1	2	3	4	5
6	7	8	9	10
11	12	13	14	15 ($21.00)
16 ($22.40)	17 ($23.80)	18 ($25.20)	19 ($26.60)	20 ($28.00)
21 ($29.40)	22 ($20.80)	23 ($32.20)	24 ($33.60)	25 ($35.00)
26 ($36.40)	27 ($37.80)	28 ($39.20)	29 ($40.60)	30 ($42.00)
31 ($43.40)	32 ($44.80)	33 ($46.20)	34 ($47.60)	35 ($49.00)

We accept MasterCard and Visa for payment of orders. If you wish to use your credit card to pay for your ad fill in the following additional information (Sorry, no telephone orders can be accepted.):

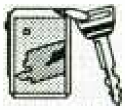
Card Number ____________ Expiration Date ____________

PRINT NAME ____________ / SIGNATURE ____________

IF YOU USE A BOX NUMBER YOU MUST INCLUDE YOUR PERMANENT ADDRESS AND PHONE NUMBER FOR OUR FILES. ADS SUBMITTED WITHOUT THIS INFORMATION WILL NOT BE ACCEPTED.

CLASSIFIED COMMERCIAL RATE: (for firms or individuals offering commercial products or services) $1.40 per word prepaid (no charge for ZIP code)...**MINIMUM 15 WORDS.** 5% discount for same ad in 6 issues within one year; 10% discount for 12 issues within one year if prepaid. **NON-COMMERCIAL RATE:** (for individuals who want to buy or sell a personal item) $1.15 per word, prepaid....no minimum. **ONLY FIRST WORD AND NAME** set in bold caps at no extra charge. Additional bold face (not available as all caps) **25¢ per word additional.** Entire ad in boldface, $1.70 per word. **TINT SCREEN BEHIND ENTIRE AD:** $1.75 per word. **TINT SCREEN BEHIND ENTIRE AD PLUS ALL BOLD FACE AD:** $2.05 per word. **EXPANDED TYPE AD: $1.85 per word prepaid.** Entire ad in boldface, $2.20 per word. **TINT SCREEN BEHIND ENTIRE EXPANDED TYPE AD:** $2.30 per word. **TINT SCREEN BEHIND ENTIRE EXPANDED TYPE AD PLUS ALL BOLD FACE AD:** $2.70 per word. **DISPLAY ADS:** 1" × 2¼"—$160.00; 2" × 2¼—$320.00; 3" × 2¼"—$480.00. **General Information:** Frequency rates and prepayment discounts are available. **ALL COPY SUBJECT TO PUBLISHERS APPROVAL. ADVERTISEMENTS USING P.O. BOX ADDRESS WILL NOT BE ACCEPTED UNTIL ADVERTISER SUPPLIES PUBLISHER WITH PERMANENT ADDRESS AND PHONE NUMBER. Copy to be in our hands on the 18th of the third month preceding the date of issue (i.e.; Aug. issue copy must be received by May 18th). When normal closing date falls on Saturday, Sunday or Holiday, issue closes on preceding work day. Send for the classified brochure. Circle Number 35 on the Free Information Card.**

REMOTE CONTROL KEYCHAIN



Complete w/mini-transmitter and +5 vdc RF receiver
Fully assembled including plans to build your own auto alarm and extend the range.

$19.95 Check, Visa or M/C 30 days return

VISITECT INC. (415) 872-0128
PO BOX 5442, SO. SAN FRAN., CA 94080

FOR SALE

STRANGE stuff, complete items, plans, kits. Laser eavesdropping, hidden weapons, bugging and counter-measure sources, adult toys. Informational photo package $3.00 refundable. **DIRIJO CORPORATION,** Box 212-H, Lowell, NC 28098. Information (704) 868-3408.

TEKTRONIX 545 scope $100.00 lowest prices test equipment and parts. **EF ELECTRONICS,** Box 249, Aurora, IL 60507.

COPYGUARD corrector restores rental movies. Connects between VCRs. Satisfaction guaranteed. $59.95 plus $4 handling. 1-(800) 338-8751.

ATTENTION laser holographic experimenters: optical computer components, instructions. $22.95 postpaid. **STELLAR TECHNOLOGIES,** 4710 University Way, N.E., #1003, Seattle, WA 98105.

CABLE TV equipment S.A., Jerrold, Zenith, Hamlin, Oak, Eagle filters remotes and more. Best prices C.O.D.'s accepted dealers needed. Ours work where others failed and we guarantee it! **TRANS-WORLD CABLE, Co. (218) 543-6671.**

COMMUNICATIONS

TRANSISTORS-tubes: MRF421 $24.00, MRF454 $14.50, MRF455-MRF477 $11.75, MRF492 $16.00, SRF2072 $12.75, SRF3800 $17.50, 2SC2290 $16.75, 2SC2879 $22.00, 6LF6, 6LQ6, 6JS6, 8950, etc-call. New **Ranger** AR3500 all mode 10 meter transceiver $319. Quantity discounts! Best prices on hard-to-find parts, antennas, mics, power supplies, & equipment! Catalog $1.00 (refundable), or free with order. **RFPC, Box 700,** San Marcos, CA 92069. For information or same day shipment—**Call (619) 744-0728.** Visa/MC/C.O.D.

CABLE EQUIPMENT

CABLE TV secrets—the outlaw publication the cable companies tried to ban. HBO, movie channel, Showtime, descramblers, converters, etc. Suppliers list included. $8.95. **CABLE FACTS,** Box 711-H, Pataskala, OH 43062.

BATTERIES

HARD to find sizes Lithium/Gelyte/Nicad/Custom Paks discount prices; call or write **BATTERY TERMINAL,** 2492 Merrick Road, Bellmore, NY 11710. (516) 679-8600.

CABLE TV CONVERTERS

CABLE TV converters. Scientific Atlanta, Jerrold, Oak, Zenith, Hamlin. Many others. **"New" Video Hopper** "The Copy Killer." Visa, M/C & Amex **1-(800) 826-7623. B&B INC.,** 10517 Upton Circle, Bloomington, MN 55431.

CABLE TV DESCRAMBLERS

CABLE TV equipment all types and models Tri-Mode, Z-Tac, Hamlin. 24 hr shipping. **UNITED ELECTRONIC SUPPLY,** P.O. Box 1206, Elgin, IL 60121. (312) 697-0600.

ADVERTISING INDEX

HANDS-ON ELECTRONICS magazine does not assume any responsibility for errors that may appear in the index below.

SAXON ON SCANNERS

(Continued from page 101)

Leading the Wild Life

Buck Holiday, of Michigan, says he'd like information on monitoring the wildlife activity in his home state. My first reaction was to tell him to roll down his windows while driving along Detroit's main drag any Saturday night. On second thought, I think that just maybe Buck wants to use his scanner to monitor the wildlife and fisheries conservation in his state. That being the case, we'd suggest punching up 44.64, 44.72, 44.80, and 44.84 MHz for those operations.

Well, once again we've come to the end of the space allotted to us for the month. But, we'll be back on this stand next month with more comments and commentary on scanners and scanning. And we hope that you'll be with us then and every month.

And don't forget, we're always happy to hear from you with your questions, opinions, photos, and whatever relates to two-way communications on the scanner bands.

Address your communications to "Marc Saxon," *Saxon on Scanners*, **Hands-on Electronics**, 500-B Bi-County Boulevard, Farmingdale, NY 11735. ■

MAKE MUSIC MAGIC WITH THE WAND-O-DYNE

(Continued on page 83)

Perfboarding It

The circuitry is layed out on a 5x6-in. piece of perfboard and components are mounted on push-in pins and soldered in place. The general layout of the solid state devices is shown in the photos. Use wire-wrap sockets for the two IC's and take care in soldering all of the components in place. Inspect your soldering when finished.

Checking Out and Tuning Up

Turn the wand's gain control to its maximum setting, flip S2 to its center-off position, move the volume shifter to mid position, and turn the power switch on. Move the wand toward the 9-in. pick-up coil and when the end of the wand comes within ten to twelve inches of the coil, a low-frequency tone from the loudspeaker should be heard. As the wand is moved closer to the loop, the frequency of the tone should rise by an amount determined by the distance of the wand to the pick-up loop.

If the Wand-O-Dyne does nothing when the wand is moved in close proximity to the pick-up, it's possible that the two coils are out of phase keeping the oscillator from working. To correct that problem just reverse the leads of either coil and the oscillator should take off.

The Wand-O-Dyne's frequency range is determined by the value of C6, and to increase the range just lower the capacitor's value, and to lower the range increase the value. The tremelo/vibrato frequency range is set by the value of C13, and can be changed in the same manner as the main frequency oscillator to obtain a different operating range.

Try both positions of S2 and experiment with the settings of R21 and R23 to obtain that just-right combination of sounds. The fun with the Wand-O-Dyne comes with practice and experimenting with the wand and controls to create a special sound effect or to sound out that popular tune. So build it and have a musical ball. ■

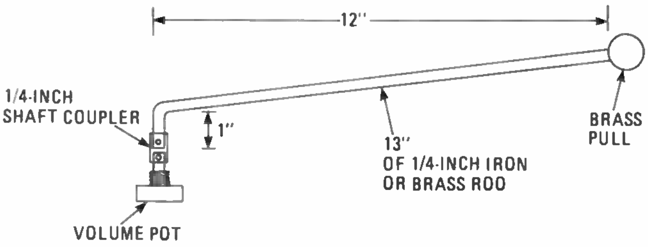


Fig. 5—An interesting volume control can be made from a rod and a cabinet knob. Be sure you know the diameter of the pot shaft before purchasing the rod and coupler.

FRIEDMAN ON COMPUTERS

(Continued on page 89)

CompDes can be purchased direct from Bsoft Software, 444 Colton Rd., Columbus, OH 43207. Telephone 614-491-0832. The postpaid price (shipping and handling included) is $49. Ohio residents must add the appropriate sales tax. ■

```
                 ** Twin-Tee Notch filter **

This Program solves the design equations for a twin-tee notch
filter circuit.
You must enter the frequency of the notch and a value for "C" .

For a Notch frequency of 60.0000 hertz.  and a value of "C"

 = 100.0000 microfarad.  The component values are :

R1 = 0.038 kilohms              C1 = 100.000000 microfarads
R2 = 0.038 kilohms              C2 = 100.000000 microfarads
R3 = 0.375 kilohms              C3 = 70.000000 microfarads
R4 = 0.375 kilohms              C4 = 1.000000 microfarads
R5 = 3.751 kilohms
R6 = 0.036 kilohms
R7 = 0.008 kilohms
R8   0.004 kilohms

     *** C4 is only needed for high frequencies ***
```

Fig. 8—If you need long-term reference, a hardcopy can be made on your printer of the screen shown in Fig. 7.

```
               ** Bandpass Constant-K Pi Filter **

This Program designs band-pass " Pi " configuration constant-K filters.
You must enter the terminating resistance and the upper and lower
bandpass frequencies.


Enter the terminating resistance ( ohms ) : 600
Enter the Low frequency ( hz ) : 350
Enter the High frequency ( hz ) : 3000


the filter component values are :

         L1  = 72.070 millihenries
         L2  = 241.006 millihenries
         C1  = 0.334731 microfarads
         C2  = 0.100097 microfarads
```

Fig. 9—Another example of hardcopy data. This is for the band-pass filter shown in Fig. 3.

```
         Communications Designs


1 - Gaussian Pulse Bandwidth Calculation
2 - Microstrip Design Calculator
3 - Voltage Standing Wave Ratio Calculator
4 - RF Air-Core Inductor Design
5 - Decibel ( dB ) Calculator
6 - Strip-Line Design Calculator


    0 - Return to Main Menu


              Pick One
```

```
              Circuit Designs


1 - Two Transistor Schmitt Circuit Design
2 - Class A Transistor Circuit Design
3 - Phase Shift Oscillator Design
4 - Bridged-Tee Oscillator Design
5 - Transformerless DC Power Supply Design
6 - Two-Diode Full-Wave Power Supply Design
7 - Bridge Rectified DC power Supply Design
8 - Dual Voltage Output Power Supply Design


    0 - Return to Main Menu


              Pick One
```

Fig. 10—Submenus keep everything simple and goof-proof. These are the submenus for Communication and Circuit Designs.