ETHICS AND THE INTERNET

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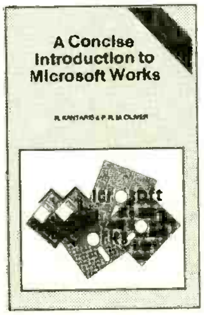

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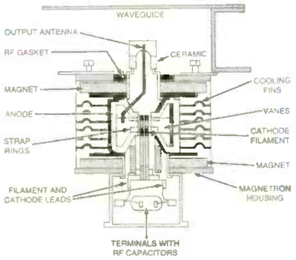

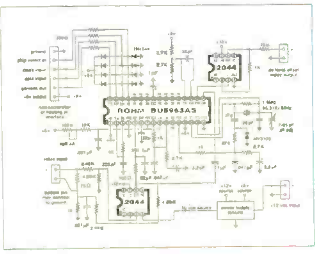

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EDITORIAL

How Am I Doing?

In the 1980s, New York City had a Mayor, Ed Koch, whose trademark refrain was "How am I doing?" Any time he met the public, you could be sure that the phrase would also make an appearance.

For a while, everything was just fine, then the novelty began to wear off and people actually started to answer him. To make a long story short, he ignored just enough of the suggestions and advice to cost himself an election. He forgot that the people who hired him (the voting public) were also capable of firing him.

Well, while I am not Mayor of anything, and I have no plans to ever run for public office, I still have a constituency that I must serve. That, of course, is you, our readers. And while I'm not going to ask "How am I doing?" every month, it is important to step back once in a while and assess what we've done, and what we are going to do.

It's been about a year since I've taken over the helm of **Electronics Now**, and it's been an exciting time. Among other things, we've made a number of subtle changes in the magazine's content, most notably dropping some departments while relaunching and refocusing others. Behind the scenes, we've totally revamped the way the magazine is produced. And, of course, we've made our long-anticipated move to the Internet, launching a site that offers our readers easy access to article-related software files, back-issue information, an interactive back article index, up-to-the minute article-update information, and lively discussion forums. If you haven't been there yet, why not visit soon? The address is www.gernsback.com.

What's the future to bring? Well, for one thing, our presence on the Internet is expanding. While I can't give you a lot of details just yet, we'll be affiliating with an on-line magazine site that will feature, among other things, the complete text and illustrations from some of our best articles of the past, as well as brand new articles that will appear nowhere else.

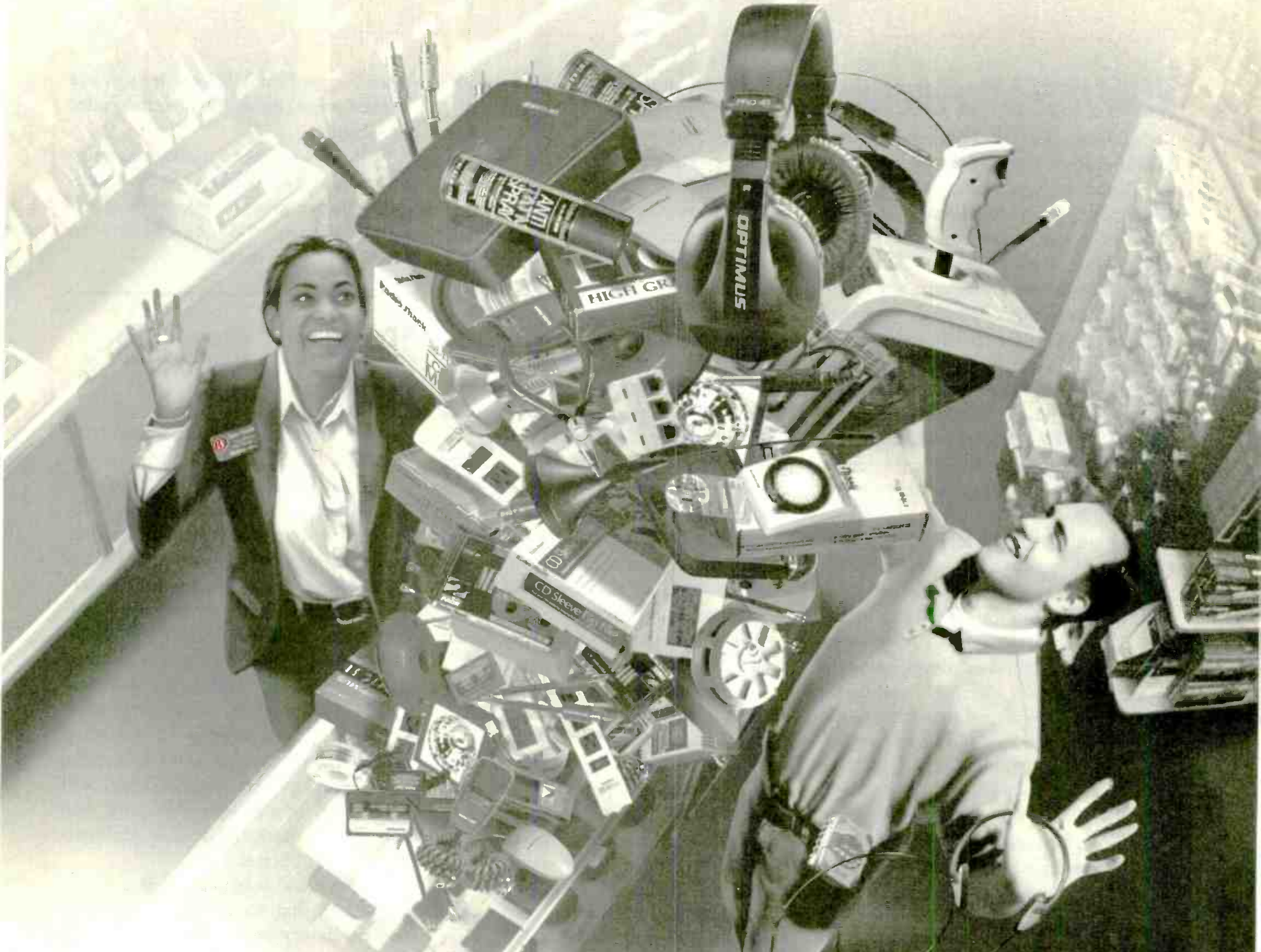
But let's not get too far off the track. What I think is not important. Instead, it's what you think that counts. I'd like you to take a few minutes and tell me what you think of **Electronics Now**, the directions we are going in, what you'd like to see continued, and what you would like to see changed or dropped.

I can't promise to respond to every letter we receive (we do have to publish a magazine!). But I can promise to read each and every one and consider your suggestions. You can write to me at **Electronics Now**, 500 Bi-County Blvd., Farmingdale, NY 11735, or e-mail me at eneditor@gernsback.com.

Let's hear from you, and please tell me, "How am I doing?"

Carl Laron
Editor

Where do more people go for electronics accessories?



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WHAT'S NEWS

A REVIEW OF THE LATEST HAPPENINGS IN ELECTRONICS

NEMA/NAED Partnership

NEMA, the National Electrical Manufacturers Association, and NAED, the National Association for Electrical Distributors, have joined forces to establish an "industry data warehouse" that will provide product information to all partners in the electroindustry's marketing and distribution channels.

"This partner reflects the importance of electronic commerce to the electroindustry and a commitment to enhance the electronic commerce environment," said NEMA president Malcolm O'Hagan.

NAED president Arnold Farber commented, "This joint effort will change the way business is done in this channel."

A working task force, made up of senior management and technical experts from manufacturer and distributor firms, will develop a plan for creating an industry data warehouse. Before such a warehouse can be established, development of joint standards for electronic commerce between electrical manufacturers and their trading partners will be completed. Two approaches to building the industry data warehouse are being considered. The first, a centrally operated warehouse, would be maintained by a given organization. The second, a virtual warehouse, would link company product databases.

Microscopic 3D Imaging

A team of scientists from Los Alamos National Laboratory and Caltech have created a powerful new technique that marries two existing technologies to probe materials at a microscopic level. The new technique has potential applications in magnetic information-storage technology.

The device combines the techniques of magnetic-resonance imaging (MRI) and atomic-force microscopy (AFM), which can measure the surface structure of materials with microscopic sensitivity. The new approach, called "magnetic-resonance-force microscopy," has already matched the sensitivity of current state-of-the-art magnetic-resonance imaging technology and promises to achieve even better results.

"The ultimate goal is to be able to create three-dimensional images of materials in slices as small as one atom wide," said Los Alamos post-doctoral researcher Zhenyong Zhang.

Magnetic-resonance technology provides scientists with information about the electronic structure and magnetic spin dynamics of a sample, but its limited sensitivity limits the resolution that can be achieved. The atomic-force microscope measures forces with such high sensitivity that it can determine surface structure with atomic-scale resolution. By combining MRI with AFM, researchers can study the interior of a sample, instead of just its surface. Their ultimate goal is single-spin sensitivity, which would allow atomic-scale resolution.

The technique is especially well suited for studying the interfaces in multilayered, thin-film materials, which are used in electronic applications such as disk readers in computers. Researchers expect that studies with magnetic-resonance-force microscopy will improve the understanding of how the performance of electronic devices can be affected by key properties, such as the precision with which the interfaces are formed, the electronic coupling between materials in adjacent layers, and interactions between magnetic properties of adjacent layers.

MRI uses the selective absorption of very high-frequency radio waves by certain atomic nuclei to create three-dimensional images. Magnetic-force microscopy (a variant of AFM) is a mechanical technique that uses a tiny cantilever to reveal magnetic properties of a material's surface. The cantilever is bent slightly by the faint magnetic force arising from the spin of atoms in a sample. The researchers exploit the fact that a radio frequency, similar to those generated for medical MRI, excites spins at targeted points inside the material under investigation.

"When we add a radio-frequency excitation, the cantilever becomes specifically sensitive to subsurface regions," explained Zhang. "We can then scan around inside the sample."

"Enhanced" Standards Service

The American National Standards Institute (ANSI) is launching an enhanced version of its "NSSN: A National Resource for Global Standards," a Web-based service for standards professionals. Available by subscription, the NSSN Enhanced service will have more powerful and flexible search features and provide more detailed information about each standard, such as scopes, references, and equivalences. The service will also include continuously updated information on standards projects that are being developed, allowing users to follow the actual development process. Users will have access to a directory of more than 700 organizations that develop standards in the United States.

The QuickLinks feature is a set of Web links that focus on the standards and regulatory pages that are buried in the sites of various government agencies. Users can directly access the information instead of having to wade through sites to find it.

An "Alerting Service" provides up-to-date information on what standards are being initiated, reviewed, or approved. Users can set up as many as five alerting profiles to be matched against new items, and will be notified when items have moved from one stage of development to another.

"Just having information on approved standards is important," said Gregory Saunders, deputy director of acquisition practices at the Department of Defense and chair of ANSI's Standards and Data Services Committee, "but for those involved in product design and development, information about standards projects that are in development is even more important. This need is met by NSSN Enhanced."

An annual subscription to NSSN Enhanced costs $495. Companies with multiple users will be charged $895 for up to five subscribers or $1695 for more than ten subscribers. For more information, access ANSI's home page at http://www.ansi.org.

Multi-Chip Package Specifications Agreement

Fujitsu Limited and Toshiba Corporation have jointly agreed upon common specifications for the Multi-Chip Package (MCP) that mounts flash memory and static RAM (SRAM) devices in a single package. Flash memories are used for program storage in mobile devices, such as cellular phones; and SRAMs help control operating functions. While the two companies will manufacture and market the chips independently, it is expected that the common specifications will allow them to act as secondary sources for each other to ensure the MCP's overall market penetration and provide a stable supply.

The two companies will introduce a Ball Grid Array (BGA) type MCP with both flash memory and SRAM in a single package measuring about one square centimeter. That configuration takes up about 70% less space compared to the conventional method of using two thin small outline packages (TSOP). The initial configuration will include one 8-megabit (Mb) Flash memory chip and one 2-Mb SRAM chip, which is organized 256K × 8.

With the two types of memory mounted on an MCP and attached to the same bus, the wiring from the memory elements is reduced by half. The cost savings realized from reducing the number of required packages will absorb the higher price of the BGA-type MCP. At mass production levels, it is anticipated that the new MCP will be available at the same price as using compatible flash and SRAM in separate TSOP packages.

More information can be obtained from Toshiba's Web site at http://www.toshiba.com/taec. EN

Q & A

READERS' QUESTIONS, EDITORS' ANSWERS

Ballasts and Inductance

Q *I have been trying to understand how a ballast works without much success. Please educate me.—T. V. N., Jacksonville, FL*

What is the purpose of the choke coil in a fluorescent light? Does it provide high voltage to the tube?—M. P. J., Dammam, Saudi Arabia

A An electronic device that limits current is called a ballast; however, there are several different types of ballasts. For example, the ballast in an old radio or a car ignition system is a resistor. But your letters make it clear that you want to know about the ballast in a fluorescent light.

To explain fluorescent light ballasts, we'll have to explain inductors. An inductor, coil, or choke is the same thing as an electromagnet, except that instead of lifting or pulling external objects, it uses its magnetic field only to regulate the flow of current.

Just like electromagnets, inductors are made by wrapping a wire around and around so it passes through its own magnetic field hundreds of times. A core of iron or another magnetic material increases the effect.

Figure 1 shows what happens when you apply power to a circuit containing an inductor. The current doesn't start flowing with full force instantly. Instead, the increasing magnetic field around the coil limits the rate at which the flow current can build up.

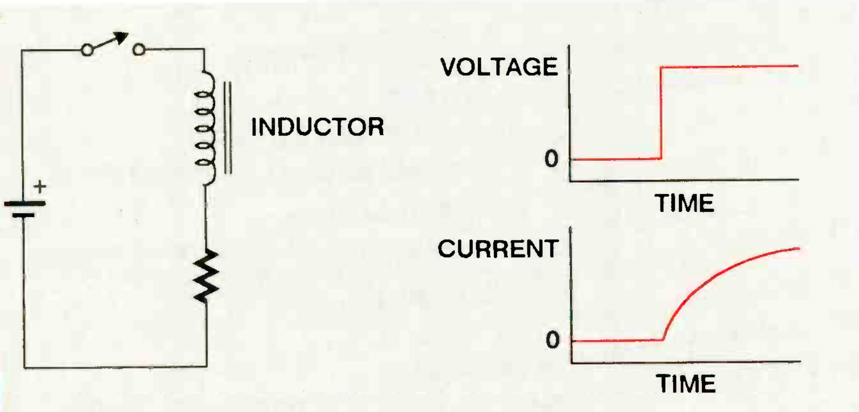

FIG. 1—AN INDUCTOR'S ROLE in a circuit is to limit the rate at which current flow can build up; with an inductor in the circuit, current does not flow immediately when power is applied.

This is the exact opposite of a capacitor, which conducts full current only for a moment, while charging, and then stops conducting as it reaches full charge. If you put an inductor and capacitor together, you get a circuit that will conduct only when the voltage is constantly changing at a specific frequency—that is, a resonant circuit.

But back to fluorescent lights. A fluorescent tube is a "breakdown" device; that is, when enough voltage is applied across it, the mercury vapor inside it suddenly ionizes and begins to conduct heavily. Without a ballast, it would conduct a gigantic current and burn itself up.

In a 60-Hz AC circuit, that breakdown happens 120 times a second. The purpose of the ballast (Fig. 2) is to slow down the buildup of current so that it doesn't become too great too quickly. Within $^1/_{120}$ second, the current will cut off again and the voltage will reverse direction, so the ballast only needs to have an effect for a short time on each cycle. That's why you can't run a fluorescent lamp on DC. (For a circuit that converts 12 VDC to AC for a fluorescent lamp, see the December 1996 installment of this column.)

Why use an inductor rather than a resistor? Because resistors consume energy, converting electricity to heat, but inductors—ideally at least—convert electricity into magnetism and then back again, wasting no energy.

Newer fluorescent lamps use complex solid-state circuits instead of ballasts; they run more efficiently and provide additional features such as dimming. To learn more about them, write to Micro Linear Corporation, 2092 Concourse Drive, San Jose, CA 95131, or look at *http://www.microlinear.com*.

Last, we should explain the push-to-start switch in Fig. 2. The fluorescent tube has filaments at both ends. The push-to-start switch lets you run current through the filaments to heat them so

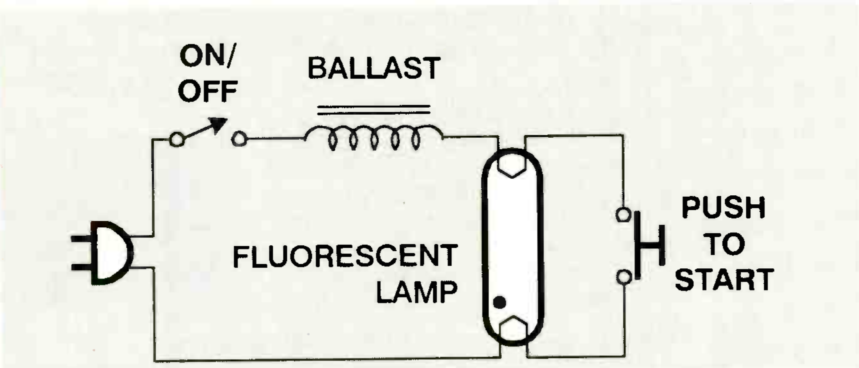

FIG. 2—WITHOUT A BALLAST, a fluorescent lamp would burn up the first time power was applied. An inductor is shown here, but newer fluorescent lamps use complex solid-state circuits that provide features such as dimming.

they start emitting electrons. Once emission starts, the filaments stay warm and you can release the button. A starter is a momentary-contact switch that automatically shuts off after a second or two; it uses a bimetallic strip inside a tiny argon lamp.

Battery Back-Up for Cordless Phones

Q *During the earthquake in Los Angeles, 1994, my phones didn't work; they were the cordless variety and wouldn't work without 117-VAC power. Also, whenever there is a power failure, I lose the phone numbers stored in memory in the base. Could you design a battery back-up circuit?—R. K., Suisun City, CA*

A For safety reasons, every household needs at least one telephone that does not require separate power. Otherwise, as you discovered, any power failure renders you incommunicado.

The handset of a cordless phone contains rechargeable batteries, but the base requires line power. Figure 3 shows how you might add battery backup to your cordless phone base. For batteries, use C or D cells in series to give the correct total voltage, and check them yearly. The diodes serve as an electronic switch so that the batteries are used only when the main power is off.

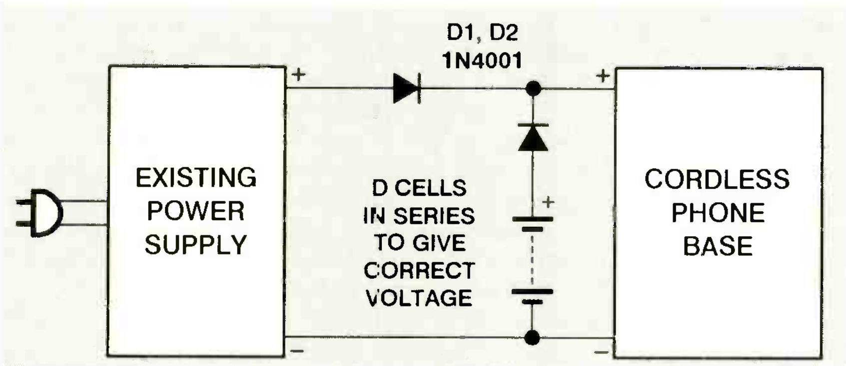

FIG. 3—ADDING A BATTERY BACKUP to a cordless telephone (or other low-current DC device) is a simple matter. Make sure to check your batteries at least yearly.

Have 12 Volts, Need 17

Q *I am trying to extract a ± 17-volt supply from my car's running voltage, 13.5 volts, to power a high-quality active crossover for an audio system. Should I use a 555 timer and a transformer, or do you think I can get a respectable signal-to-noise ratio with a device that will work within the car's supply limits? I would like to keep it simple. Thanks for your suggestions.—J. V., Kitchener, Ont., Canada*

A We presume you're dealing with line-level audio, perhaps 1 volt peak-to-peak, ahead of the final amplifier. If so, the simplest thing to do is redesign the crossover so that it uses a single-ended 9- or 10-volt supply, which you obtain by down-regulating the 13.5-volt line. If you use a 7800-series regulator and some capacitors, you should get very clean DC, cleaner than what you would get from a switching regulator.

Signal-to-noise ratio is not proportional to supply voltage. In fact, RF circuits with really low noise often operate on 5 volts or less. In your case, you

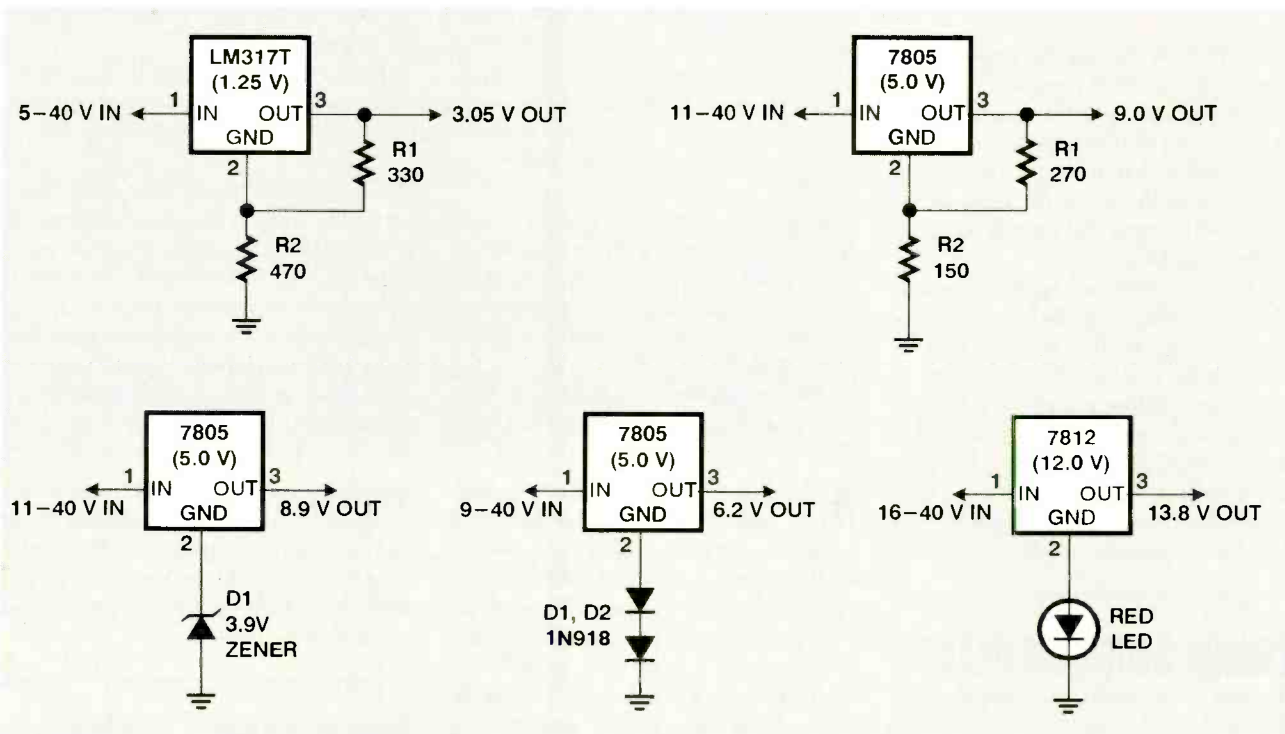

FIG. 4—FOOLING A VOLTAGE REGULATOR into supplying a higher than specified output is easily done using Zeners, or regular silicon diodes. When working with the 78xx series, LEDs, which will light up, could also be used.

should choose some suitable low-noise op-amps and follow the recommendations in their data sheets.

Fooling a Voltage Regulator

Q *Is there a way to "fool" a fixed voltage regulator into producing an output voltage other than its nominal voltage; for example, to make a common 7805 voltage regulator produce 3 volts for a Walkman?—S. J., Palmerton, PA*

A Yes, voltage regulators are easy to fool, if you're willing to accept a small drop in the quality of the regulation, which is still good enough for most purposes. The catch is that you can only raise the voltage, not lower it, so if you want 3 volts, you have to start with an LM317T 1.25-volt regulator.

Figure 4 shows several ways this is done. The standard way is to add two resistors. The regulator then produces its nominal voltage across R1, and R2 scales it up to the desired voltage. The formula is:

$$\text{Output voltage} = V_{REF} \times (1 + R2/R1) + I_{GND} \times R2$$

where V^{REF} is the voltage produced by the regulator itself and I^{GND} is its ground-pin current (50 microamperes for the LM317T, 8 mA for the 78xx series). Note that with the 78xx series, the resistors have to be fairly small (under 500 ohms) and sometimes carry substantial current.

With the 78xx series, you can also raise the voltage by inserting a fixed voltage drop in the ground lead. A Zener diode adds its Zener voltage to the output. Ordinary silicon diodes adds 0.6-volt each, and you can use several in series. LEDs add their forward voltage (1.8 V for red, 2.1 V for green) and light up; an advantage here is that you can use the LED as a power-on indicator.

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To discuss electronics with your fellow enthusiasts, visit the newsgroups sci.electronics.repair, sci.electronics.components, sci.electronics.design, and rec.radio.amateur.homebrew. "For sale" messages are permitted only in rec.radio.swap and misc.industry.electronics.marketplace.

Many electronic component manufacturers have Web pages; see the directory at http://www.hitex.com/chipdir/, or try addresses such as http://www.ti.com and http://www.motorola.com (substituting any company's name or abbreviation as appropriate). Many IC data sheets can be viewed online.

Books: Several good introductory electronics books are available at RadioShack, including one on building power supplies.

An excellent general electronics textbook is *The Art of Electronics*, by Paul Horowitz and Winfield Hill, available from the publisher (Cambridge University Press, 1-800-872-7423) or on special order through any bookstore. Its 1125 pages are full of information on how to build working circuits, with a minimum of mathematics.

Also indispensable is *The ARRL Handbook for Radio Amateurs*, comprising 1000 pages of theory, radio circuits, and ready-to-build projects, available from the American Radio Relay League, Newington, CT 06111, and from ham-radio equipment dealers.

Copies of past articles: Copies of past articles in **Electronics Now** and **Popular Electronics** (post 1992 only) are available from our Claggk, Inc., Reprint Department, P.O Box 4099, Farmingdale, NY 11735; Tel: 516-293-3751.

Electronics Now and many other magazines are indexed in the *Reader's Guide to Periodical Literature*, available at your public library. Copies of articles in other magazines can be obtained through your public library's interlibrary loan service; expect to pay about 30 cents a page.

Service manuals: Manuals for radios, TVs, VCRs, audio equipment, and some computers are available from Howard W. Sams & Co., Indianapolis, IN 46214 (1-800-428-7267). The free Sams catalog also lists addresses of manufacturers and parts dealers. Even if an item isn't listed in the catalog, it pays to call Sams; they may have a schematic on file which they can copy for you.

Manuals for older test equipment and ham radio gear are available from Hi Manuals, PO Box 802, Council Bluffs, IA 51502, and Manuals Plus, Box 637, Spanaway, WA 98387.

Replacement semiconductors: Replacement transistors, ICs, and other semiconductors, marketed by Philips ECG, NTE, and Thomson (SK), are available through most parts dealers (including RadioShack on special order). The ECG, NTE, and SK lines contain a few hundred parts that substitute for many thousands of others; a directory (supplied as a large book and on diskette) tells you which one to use. NTE numbers usually match ECG; SK numbers are different.

Remember that the "2S" in a Japanese type number is usually omitted; a transistor marked D945 is actually a 2SD945.

Hamfests (swap meets) and local organizations: These can be located by writing to the American Radio Relay League (Newington, CT 06111; http://www.arrl.org). A hamfest is an excellent place to pick up used test equipment, older parts, and other items at bargain prices, as well as to meet your fellow electronics enthusiasts—both amateur and professional.

Vintage Sanyo Computer

Q *I have a Sanyo MBC-550 computer with an 8088 CPU. Electrically it appears to be OK, but I have no boot disk, and Sanyo can't help me. Do you have any information in your files, or perhaps a reference I can go to?—J. C., Camarillo, CA*

A The Sanyo MBC-550 is a "PC-similar" (not PC-compatible) MS-DOS computer manufactured around 1983. It used an early version of DOS, and its diskette format was compatible with the IBM PC, but most of its software wasn't. (We presume you've tried an IBM PC boot disk and it didn't work.) With the demand for complete PC compatibility in the mid-1980s, computers of this type quickly became obsolete.

For help with it, get on the Internet and post a query in the newsgroup alt.folklore.computers. That's where the computer historians and connoisseurs of vintage computers hang out. If a reader would care to send us a copy of a boot diskette for your computer, we'd be glad to forward it.

Play It Again . . . Slowly

Q *Recently I have been hearing about portable cassette tape recorders that run the DC motor at 1/4 of normal speed in order* *to get four hours of audio on one side of a C-120 tape. Do you know of a simple variable-speed motor circuit that I could build to accomplish this? —D. P., Sacramento, CA*

A This would be a mechanical project, not an electrical one. When you slow a motor down electrically, you sacrifice power and smoothness (although pulse-width-modulation circuits perform better than simple resistors). But if you change the diameters of some gears or pulleys, you can reduce the speed and *increase* the power. Simply replace the main pulley on the motor with a bigger one, and see what happens.

Audio Mixer

Q *I would like to build the audio mixer shown in the October 1993 installment of "Q&A" and have two questions:*

(1) How can I upgrade the circuit to have twice as many inputs, with bass and treble controls on each input?

(2) Would it be possible for you to get all the components and circuit board for me? If so, please let me know the cost and postage. These parts are not easily accessible here in St. Lucia.—T. G., St. Lucia, West Indies

A To increase the number of inputs, just build two mixers (which can share a power supply) and tie the outputs together. (With some mixer circuits, tying the outputs together would not be a good idea, but you can still feed the output of one mixer to an input of another.) Adding bass and treble controls would be more complicated and might require additional stages of amplification.

We cannot supply parts, but plenty of our advertisers can. Write to several advertisers for catalogs; they will be glad to help.

BNC Trivia

Q *I read once that the letters in "BNC connector" were given for the designer's name. If so, do you know the name? —G. R., Waco, TX*

A BNC connectors are the push-and-twist connectors commonly used on oscilloscope inputs and video equipment. The origin of the name "BNC" was debated at length on the Internet (in the sci.electronics newsgroup) about

continued on page 57

LETTERS

SEND YOUR COMMENTS TO THE EDITORS OF ELECTRONICS NOW MAGAZINE

Bye-Bye BBS

I recently tried to reach your BBS system but was not able to connect. Can you tell me what is going on with it?
WILLIAM GREYSON
Boston, MA

*The Gernsback BBS officially closed on May 1, 1997. There were a lot of reasons for that, but the primary one is that most of its functions have been transferred to our Web (www.gernsback.com) and ftp (ftp.gernsback.com) sites on the Internet. For example, all article-related files formerly on the BBS, as well as all new ones, are on the ftp site. To find the files for **Electronics Now**, simply point your browser to ftp.gernsback.com/pub/EN, or, using anonymous login, connect with any ftp client. The Web site features discussion forums where you can interact with readers and get project and article updates faster than ever before, an index to articles in **Electronics Now** and **Popular Electronics**, and lots more. Why not check it out.—Editor*

Cross About a Transistor

I picked up the June 1997 issue of **Electronics Now**, because I was intrigued by the article on BEAM robotics. When it came time to build the circuit, however, I ran into a problem. The circuit contains a 2N2646 unijunction transistor. My local parts house told me that the device had been discontinued and the closest substitute would run me $28. I find it surprising that a circuit in a current issue of your magazine would contain a discontinued part. Are they correct, and, if so, is there anything else you could suggest?
CHRIS SEIDEL
Berkeley, CA

The 2N2646 has been a standard, easily available component for years, or actually decades. A quick check in a current catalog for one of the major electronics-components distributors showed it still being stocked, so we proceeded with the project. Unfortunately, however, the part does appear to have been discontinued.

The good news is that there is an inexpensive, industry-standard, direct substitute for it—the NTE 6401 (or the identical ECG 6401). That part is available nationwide from a wide variety sources, and is relatively inexpensive. For example Mouser Electronics (958 North Main St., Mansfield, TX 76063; Tel: 800-992-9943; Web: www.mouser.com) carries it for around $6 plus shipping. To find a local distributor, you can contact NTE by telephone (800-683-6837), or visit their Web site (www.nteinc.com).

Incidentally, the NTE Web site is a really useful reference for the electronics hobbyist or professional. There is a continually updated cross-reference search engine, a distributor list, data sheets for selected devices, and more.—Editor

An Author's Comments

First of all, I'd like to congratulate the staff at ***Electronics Now*** on an excellent job in the editing and layout of my article, "Boundary Scan Testing." My peers, after having looked over the article, were all very impressed at the quite professional job that had been done.

Also in the June issue, Jeff Holtzman's "Computer Connections" column contained some good information on accessing hardware ports under Windows 95. That information proved very useful to a software engineer on my team.
J. DANIEL CONNELL EN

Write To:
Letters,
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Due to the volume of mail we receive, not all letters can be answered personally. All letters are subject to editing for clarity and length.

Budget Project and Computer Books

☐ **BP317–Practical Electronic Timing $6.95.** Time measurement projects are among the most constructed gadgets by hobbyists. This book provides the theory and backs it with a wide range of practical construction projects. Each project has how-it-works theory and how to check it for correct operation.

☐ **BP415–Using Netscape on the Internet $7.95.** **BRAND NEW** Get with the Internet and with surfing, or browsing, the World Wide Web, and with the Netscape Navigator in particular. The book explains: The Internet and how the World Wide Web fits into the general scenario; how do you go about getting an Internet connection of your own; how to download and install the various versions of Netscape browsing software that are available; and how to use Netscape Navigator to surf the Web, and to find and maintain lists of usful sites. There's a heck of a lot more, too!

☐ **BP325–A Concise User's Guide to Windows 3.1 $7.95.** Now you can manage Microsoft's Windows with confidence. Understand what hardware specification you need to run Windows 3.1 successfully, and how to install, customize, fine-tune and optimize your system. Then you'll get into understanding the Program Manager, File Manager and Print Manager. Next follows tips on the word processor, plus how to use Paintbrush. There's more on the Cardfile database with its auto-dial feature, Windows Calendar, Terminal, Notepad, etc.

☐ **BP327–DOS: One Step at a Time $5.95.** Although you spend most of your time working with a word processor, spreadsheet or database, and are probably quite happy using its file management facilities, there will be times when you absolutely need to use DOS to carry out 'housekeeping' functions. The book starts with an overview of DOS, and later chapters cover the commands for handling disks, directories and files.

☐ **PCP119–Electronic Music and Midi Projects $14.95.** Save cash by building the MIDI gadgets you need. Want a MIDI THRU box, program change pedal, Metronome, analog echo unit, MIDI patchbay or switcher? Over 16 practical and very useful music and MIDI projects—all in this book! The projects are explained in detail with full instructions on assembly.

☐ **PCP120—Multimedia on the PC! $14.95.** What is Multimedia? What can it do for you? It can do lots of nice things! This 184-page book helps you create your own multimedia presentation. Multimedia applications by people like you can revolutionize educational and business applications as well bring more fun, fun, fun into your leisure computer activities.

☐ **BP404–How To Create Pages for the Web Using HTML $6.95.** **BRAND NEW**

Companies around the world, as well as PC users, are fast becoming aware of the World Wide Web as a means of publishing information over the Internet. HTML is the language used to create documents for Web browsers such as Mosaic, Net-scape and the Internet Explorer. These programs recognize this language as the method used to format the text, insert images, create hypertext and fill-in forms. HTML is easy to learn and use. This book explains the main features of the language and suggests some principles of style and design. Within a few hours, you can create a personal Home Page, research paper, company profile, questionnaire, etc., for world-wide publication on the Web.

☐ **BP377—Practical Electronic Control Projects $6.95.** Electronic control theory is presented in simple, non-mathematical terms and is illustrated by many practical projects suitable for the student or hobbyist to build. Discover how to use sensors as an input to the control system, and how to provide output to lamps, heaters, solenoids, relays and motors. Also the text reveals how to use control circuits to link input to output including signal processing, control loops, and feedback. Computer-based control is explained by practical examples.

☐ **BP411—A Practical Introduction to Surface Mount Devices $5.95.** This book takes you from the simplest possible starting point to a high level of competence in working with Surface Mount Devices (SMD's). Surface mount hobby-type construction is ideal for constructing small projects. Subjects such as PCB design, chip control, soldering techniques and specialist tools for SMD are fully explained. Some useful constructional projects are included.

☐ **BP136—25 Simple Indoor and Window Aerials $5.50.** Many people live in flats and apartments where outdoor antennas are prohibited. This does not mean you have to forgo shortwave listening, for even a 20-foot length of wire stretched out under a rug in a room can produce acceptable results. However, with experimentation and some tips, you may well be able to improve further your radio's reception. Included are 25 indoor and window antennas that are proven performers. Much information is also given on shortwave bands, antenna directivity, time zones, dimensions, etc. A must book for all amateur radio enthusiasts.

☐ **BP336—A Concise User's Guide to Lotus 1-2-3 Release 3.4 $7.25.** Discover how to use a three-dimensional Lotus spreadsheet in the shortest and most effective way. The book explains how: to generate and manipulate 3-dimensional worksheets and how to link different files together; to generate and add graphs to a worksheet, edit them, and then preview and print the worksheet; to use the SmartIcons and become more productive with your time; to use the WYSIWYG add-in to produce top quality screen and printed displays; and much more.

☐ **BP379—30 Simple IC Terminal Block Projects $6.50.** Here are 30 easy-to-build IC projects almost anyone can build. Requiring an IC and a few additional components, the book's 'black-box' building technique enables and encourages the constructor to progress to more advanced projects. Some of which are: timer projects, op-amp projects, counter projects, NAND-gate projects, and more.

☐ **BP401—Transistor Data Tables $6.95.** The tables in this book contain information about the package shape, pin connections and basic electrical data for each of the many thousands of transistors listed. The data includes maximum reverse voltage, forward current and power dissipation, current gain and forward transadmittance and resistance, cut-off frequency and details of applications.

☐ **BP403—The Internet and World Wide Web Explained $6.95.** You've heard about the Information Superhighway. Sort of makes you feel timid about getting on the Web. Put your fears aside! This book eliminates the mystery and presents clear, concise information to build your confidence. The jargon used is explained in simple English. Once the tech-talk is understood, and with an hour or two of Web time under your belt, your friends will call you an Internet guru!

☐ **BP92—Electronics Simplified: Crystal Set Construction $2.69.** This book is written for those who wish to participate in electronics more through practical construction than by theoretical study. It is designed for all ages upwards from the day when one can read intelligently and handle simple tools. The crystal set projects are designed to use modern inexpensive components and home-wound coils. A book highly recommended for all newcomers.

☐ **ETT1—Wireless & Electrical Cyclopedia $5.75.** Step back to the 1920's with this reprinted catalog from the Electro Importing Company. Antiquity displayed on every page with items priced as low as 3 cents. Product descriptions include: Radio components, kits, motors and dynamos, Leyden jars, hot-wire meters, carbon mikes and more. The perfect gift for a radio antique collector.

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EQUIPMENT REPORTS

A NEW TROUBLESHOOTING TOOL FROM HEWLETT PACKARD

Breeze through digital troubleshooting with Hewlett Packard's Logic Dart.

There's an ideal tool for every type of troubleshooting need, and every engineer or technician has a favorite tool for preliminary testing. Just as a mechanic might use a flashlight first to determine if the floor jack is necessary, a technician will likely use a logic probe before resorting to a logic analyzer. Quite often, however, a logic probe's performance limitations make it unsuitable for testing advanced digital circuitry. That's why Hewlett Packard (HP) aimed for the convenience of a logic probe in something a lot more capable. The result is the HP E2310A Logic Dart, an advanced logic probe that's no bigger than a DMM, yet loaded with features and capabilities that ordinary DMMs and logic probes only dream of having.

The Logic Dart

The HP Logic Dart certainly sports a futuristic look with its narrowed down hand grip area and widened LCD readout on top. A tilt stand is built into the back to make for easier viewing, although there is no backlight on the display. An included AC adapter plugs into the top of the unit, or it can run off 3 AA batteries that fit inside. The batteries will generally power the unit for 15 to 20 hours. The top also houses infrared emitters that can send data to an optional portable HP thermal printer for a hard copy of measurement and screen results.

Input probes plug into the bottom end of the HP Logic Dart, with channel 1 (of three) in the center position. Control buttons are spread out across the face of the unit, with a shift key providing secondary functions. While it might at first appear to be complicated to use, a built-in help screen can always get you out of a bind. At its widest points, the unit measures 7.8 inches long by 3.5 inches wide by 1.5 inches thick. It weighs 12 ounces.

You can't troubleshoot today's digital circuitry with yesterday's clumsy logic probe—surface-mount parts are just too small. In contrast, the HP Logic Dart lets you quickly pinpoint problems with the included bundle of ultra-precise miniature probes and accessories. The probe tips are small and very sharp, spring-loaded, and stay put even on the tiniest of component leads. The probes are as delicate as you'll ever see, with very thin grounding wires and ultra-miniature grabbers on the ends. The accessory pack contains assorted clips and leads that make it easy to connect to various points in a circuit.

Of course any tool of this caliber and quality is rarely inexpensive, but, at least here, you get what you pay for. The HP E2310A Logic Dart with a full set of precision probes, carrying case, user manual, batteries, and AC adapter costs $795. That includes a three-year warranty. The HP 82240B portable printer costs $135.

Features

The HP Logic Dart gives you a head start on digital troubleshooting with a 100 megasample-per-second timing analyzer, logic monitor, DC voltmeter, 33-MHz frequency counter, continuity tester, and diode tester in an instrument with graphical, numeric, LED, and audible readouts. All measurements are taken using the same probe without having to change the input connection. The unit has three independent channels, each with independent triggering that can be set for edge, pattern, and combination triggering. It detects high, low, and tri-state conditions with visual and audible feedback on circuit activity; and it offers 15-nanosecond glitch detection.

The probe is preset for TTL, ECL, and CMOS logic, but can also handle custom functions. All three inputs can be displayed simultaneously, with up to 10-nanosecond resolution. Pan and zoom capabilities allow the use of cursors to make precise time measurements. The Logic Dart has enough internal memory to store up to ten 2048-sample waveforms. It even knows the time and date!

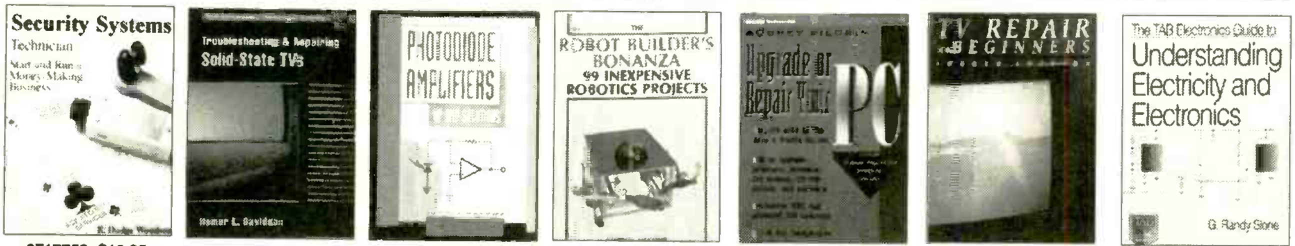
While the unit really shines when it comes to digital troubleshooting, it does offer many DMM-like features that can be useful in many situations. For example, continuity can be checked with an audible indicator. This is useful for checking circuit board traces even before you apply power to the circuit under test. Resistance up to 120,000 ohms can be measured, but this is really just an extension of being able to check continuity. On the down side, it can't measure current or AC voltage, and DC measurements are limited to plus or minus 35 volts. More than 40 volts on any input or ground can damage the unit.

The Logic Dart turns on and off with the same button, although you have to first press the shift key to turn it off to prevent unintended shut down and premature loss of data. All settings and waveforms are saved when you turn it off and are restored when you turn it back on. The contrast of the display can be adjusted according to ambient lighting conditions. Five unlabeled buttons below the display are menu keys whose functions change depending on the display mode. Cursor keys and other dedicated buttons handle all other functions.

A logic monitor built into the Logic Dart consists of two LED indicators and, optionally, an audible indicator of the logic levels at the channel-1 input. The logic monitor is always working unless you turn it off. The green LED and a high-tone beep are on when the input is above the high threshold and a red LED and low-tone beep are on when the input is below the low threshold. Both LEDs and the beep are off when the input is between the high and low thresholds (tri-state), and the LEDs alternately flash with a changing signal. The LEDs do not indicate frequency or duty cycle.

The Logic Dart is a unique digital troubleshooting tool that's just what you need to help locate trouble spots in sophisticated circuitry. It provides many more functions than a logic probe, and is nearly as small as one. If the limited functions of a logic probe are always slowing you down, then you might want to give Hewlett Packard's Logic Dart a try.

For more information on the Hewlett Packard E2310A Logic Dart, contact the manufacturer directly (Hewlett Packard Company, Test and Measurement Organization, PO Box 50637, Palo Alto, CA 94303-9512; Tel: 1-800-452-4844, ext. 1893; Web: http://www.hp.com/info/LogicDart5), or circle 15 on the Free Information Card. **EN**



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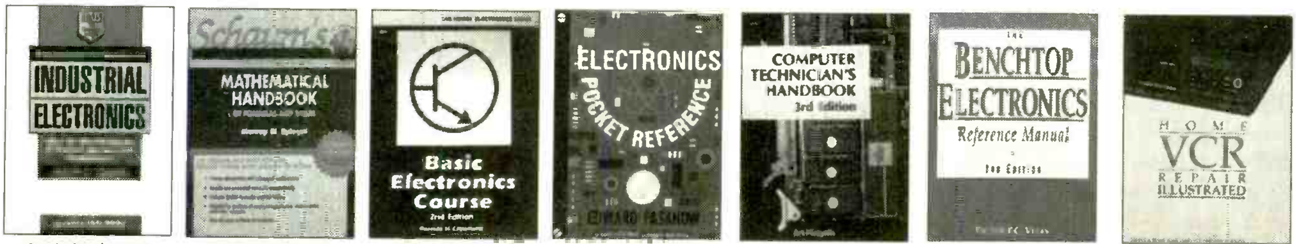

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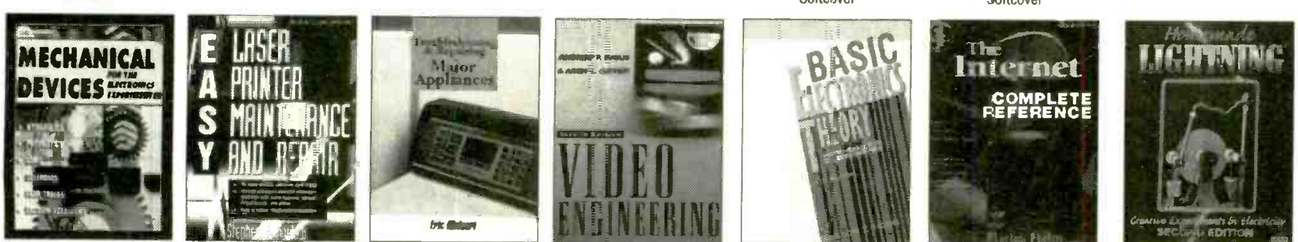

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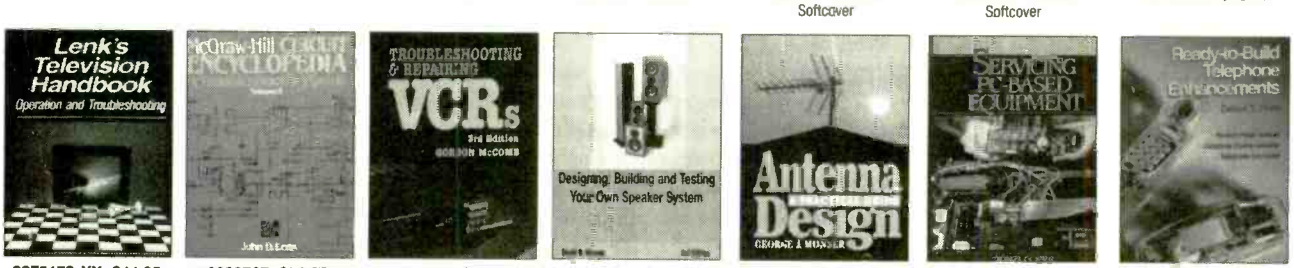

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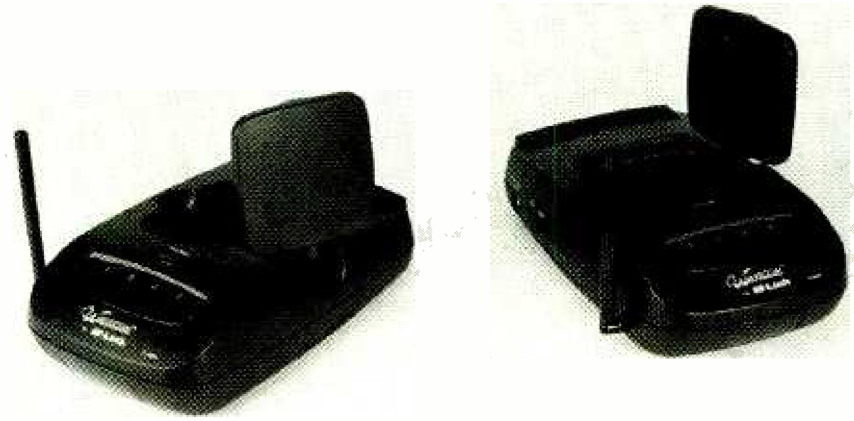

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television viewers and music listeners to enjoy crisp, interference-free video and stereo audio reception anywhere in or around their homes or offices without having to run wires up walls or under carpets. A built-in remote-control extender even allows users to change the channel, adjust the volume, or control their VCR, satellite receiver, laserdisc player, or CD player from anywhere with their existing remote control. The Wavecom Sr. can be used to watch cable or satellite programs on a bedroom TV without a separate hookup, or watch a movie in a bedroom without moving the VCR from the family room. Parents can keep an eye on their children playing or sleeping in another room using the Wavecom Sr. and a camcorder. By using a TV-to-VGA converter card, computer users can watch anything on their monitor that they usually watch on TV.

The Wavecom Sr. consists of a small portable transmitter and receiver pair. Using the 2.4-GHz ISM band, the system avoids the crowded 900-MHz band away. The remote-control extender works by converting the infrared signal to an RF signal and then back to infrared at the equipment to be controlled.

The Wavecom Sr. has a suggested retail price of $249.95.

RF-LINK TECHNOLOGY, INC.
411 Amapola Avenue
Torrance, CA 90501
Tel: 888-2RF-LINK
Web: http://www.rflinktech.com

Automatic Antenna Coupler

One of SGC, Inc.'s series of "Smartuners," the SG-231 automatic antenna coupler uses microprocessor control of its pi or L network to match virtually any load to any transceiver. It features expanded frequency coverage—1.0 to 60 MHz continuous—and complete frequency agility with no operator intervention. Tuning solutions are stored in a non-volatile memory for fast (10 ms) automatic recall. The SG-231 operates with any HF or VHF (up to 60-MHz)

CIRCLE 21 ON FREE INFORMATION CARD

transceiver, 3 to 100 watts, and requires only 12-VDC and RF connections.

Measuring a slim 1.8 × 10 × 11.5 inches, and weighing just three pounds, the SG-231 will fit easily in the most compact installations. The waterproof unit is designed to be mounted at the antenna feed point for maximum efficiency. Common applications include end-fed wires, center-fed dipoles, inverted "Ls," loops, and mobile whips.

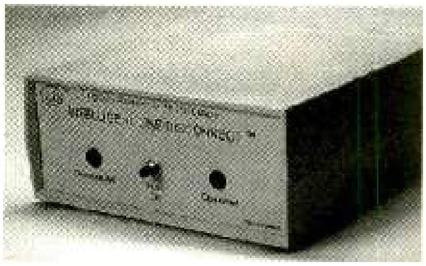
The SG-231 automatic antenna coupler has a suggested retail price of $595.

SGC, INC.
13737 S.E. 26th Street
P.O. Box 3526
Bellevue, WA 98009
Tel: 1-800-259-7331 or 206-746-6310
Fax: 206-746-6384
E-mail: sgcmktg@aol.com
Web: http://www.sgcworld.com

Lightning Protection System

Sensitive electronic equipment and circuitry can suffer catastrophic failures and/or reduced reliability due to surges on coax, telephone, data, control, or power lines connected to that equipment. Although the best way to prevent equipment damage is to unplug or disconnect each piece, that is usually too inconvenient to be practical.

The Intelligent Line Disconnect from Rabun Labs removes that inconvenience. When you turn off your equipment, the device automatically disconnects and grounds everything that is plugged into it. To turn your equipment back on, press a pushbutton switch on the device, power up your gear, and all connections are automatically restored. The Intelligent Line Disconnect also simultaneously disconnects/isolates, and grounds coax, telephone, data, and control line I/Os.



CIRCLE 22 ON FREE INFORMATION CARD

While the equipment is operating, the device provides protection against AC power loss. It also provides a level of online protection through metal-oxide varistor (MOV) surge suppressors. Power line "noise" on the AC source is filtered and attenuated before being supplied to the equipment. The Intelligent Line Disconnect protects PCs by controlling the AC power and modem telephone-line connections. It can also protect home-entertainment components by controlling the AC-power, coax, and telephone/data-line connections for a TV, receiver, CD player, VCR, and cable or satellite receiving system.

The Intelligent Line Disconnect costs $99, plus $9.95 s/h.

RABUN LABS, INC.
P.O. Box 818
Plant City, FL 33564-0818
Tel: 1-800-788-1824
Fax: 813-752-4632
Web: http://www.rabunlabs.com

Soldering-Iron Temperature Controller

The Hot Tools Dial-Temp Controller is a compact, easy-to-use temperature controller that regulates the tip temperature of soldering irons and other devices such as melting pots or hot plates. It plugs into any 117-volt AC outlet, accepts a three-prong plug, and features a dial on top for adjusting the tip temperature of soldering irons from 150° to full heat. By allowing users to regulate the tip temperature of fixed-temperature irons, the low-cost controller can eliminate the need for elaborate temperature-control stations. Providing a 15-amp capacity, the Dial-Temp is well suited for lowering the tip temperature of soldering irons to protect sensitive electronic devices.

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The Dial-Temp Controller has a list price of $39.95.

HOT TOOLS
24 Tioga Way
P.O. Box 615
Marblehead, MA 01945
Tel: 617-639-1000
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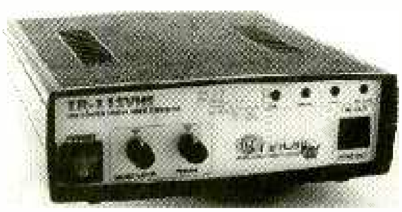
Multisystem Digital Video Converter

According to TenLab, its TR-11SVHS is the first consumer digital video converter that features S-VHS input/output connectors—real Y/C separation—for better conversion quality. It will convert PAL, NTSC 3.58, NTSC 4.43, and SECAM video signals to PAL or NTSC, and features TBC (time-base correction) for better signal synchronization.



CIRCLE 24 ON FREE INFORMATION CARD

The stand-alone converter can be used to convert tapes received from abroad and recorded in a different TV system. To convert tapes from PAL to NTSC, for instance, you would connect the TR-11SVHS between a PAL VCR (or camcorder) and an NTSC VCR. The device also allows you to use your video equipment in a country with a different video system. It is available for 117- or 220-volt power.

The TR-11SVHS multisystem digital video converter has a suggested retail price of $745.

TENLAB MULTISYSTEM VIDEO PRODUCTS USA
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Fax: 310-441-1807
E-mail: info@tenlab.com
Web: http://www.tenlab.com

Digital Multimeter

Wavetek's Model 25XT digital multimeter with built-in capacitance meter measures volts, ohms, amps, and full capacitance ranges from 200 pF to 20 mF, as well as transistor testing and frequency to 40 kHz. In addition to core measuring capabilities, the 25XT offers a combination of TechPreferred features including max/data hold, stray-capacitance zero adjustment knob, easy-to-read oversized characters, auto-off, wide measuring ranges, fully-fused current inputs, safety test leads, and input warning beepers.

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The Model 25XT handheld DMM costs $99.95.

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NEW LITERATURE

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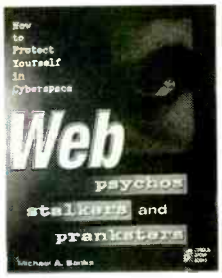

CIRCLE 338 ON FREE INFORMATION CARD

If you send and receive e-mail, post messages in public bulletin-board systems, enter an online chat room, or even just browse Web pages, you put yourself in the path of a new breed of criminals. Simply by being online, you expose your finances, your privacy, and perhaps even your physical well-being to risk. This book, written by an expert on the Internet and privacy issues, reveals the threats that lurk online, and explains how people can protect themselves and avoid becoming victims. If you've already been, or currently are, being victimized, the book will show you how to put a stop to it.

The book provides step-by-step instructions on how to protect sensitive, personal information and how to avoid becoming an online target. It shows readers how to track down those who might be harassing, abusing, or defrauding them. The book alerts the reader to the presence of many kinds of online hazards and violations of privacy, including compromises of passwords and chat-room impostors. Using real-life examples of Cyberspace crimes—as well as the author's personal, candid, and entertaining tales—the book describes how stalkers, con-artists, and pranksters cause problems. It then teaches Internet users how to use preventative and defensive methods to deal effectively with online threats.

Improvised Technology in Counter-Intelligence Applications

by Robert Ing, D.Sc., F.A.P.Sc.
Tiare Publications
P.O. Box 493
Lake Geneva, WI 53147
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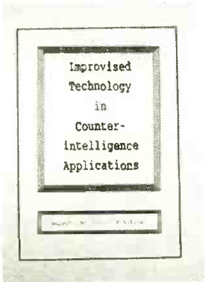


CIRCLE 339 ON FREE INFORMATION CARD

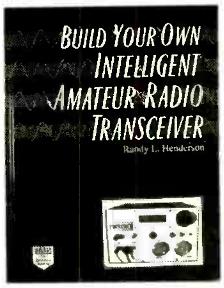
Industrial espionage is a serious, and escalating, problem. An increase in unemployed intelligence officers since the end of the Cold War and the proliferation of advansced technology have made corporate spying much easier. A survey conducted by the Canadian Security and Intelligence service found that 43% of American corporations have had an average of six incidents involving industrial espionage. And many of those incidents have gone unreported, because even a rumor of a security breach can cause a company's stock to drop.

To reduce losses due to espionage, field-investigative and corporate-security personnel must be able to detect and neutralize electronic surveillance devices. Unfortunately, notes the author of this book, who conducts workshops for field personnel of U.S. and Canadian government agencies, the required equipment is expensive and hard to come by, and its very presence might draw unwanted attention.

The book shows readers how to get around those obstacles. It provides practical methods for electronic "bug" detection without the need for expensive equipment or previous technical knowledge. Written specifically for non-technical field staff and intelligence officers, the book presents improvised methods for the effective detection of telephone taps, hidden radio and infrared transmitters, video cameras, and vehicle tracking devices.

Build Your Own Intelligent Amateur Radio Transceiver

by Randy L. Henderson
McGraw-Hill, Inc.
11 West 19th Street
New York, NY 10011
Tel: 1-800-822-8158
$39.95 hardcover; $29.95 paperback



CIRCLE 340 ON FREE INFORMATION CARD

This complete guide to the entire process of building, using, and enjoying a sophisticated radio transceiver is aimed at amateur-radio operators, and anyone else who is interested in how modern radio transceivers work. It thoroughly explains how to build a multiband, multimode HF transceiver, using a building-block approach that starts at the speaker and microphone and heads toward the antenna. The book provides easy-to-follow descriptions of how the finished radio works and tells where to get parts for the project. It also presents plans for smaller projects, such as a simple frequency synthesizer and a spectrum analyzer.

The book not only examines construction techniques, but also describes the operation and purpose of each circuit. It shows that, unlike some home projects, the main transceiver calls for techniques that are very similar to those for contemporary commercially produced equipment. With an emphasis on the how and why of frequency synthesis, the book covers everything from interfacing digital and analog circuitry to keeping digital switching noise out of sensitive analog circuits; from anticipating the real-world behavior of RF circuits to interfacing a microcontroller to various input/output devices; and from mastering the intricacies of circuit-board fabrication to performing assembly programming of the Intel 80C31 microcontroller.

Interconnection Solutions Catalog

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Advanced Cable Systems Division
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CIRCLE 341 ON FREE INFORMATION CARD

This 32-page catalog covers AMP's full lines of standard cable assemblies. It includes descriptions, part numbers, and prices for hundreds of cables, connectors, and switches; and features details on new products for the Universal Serial Bus (USB), Fibre Channel, SCSI-3, and CAT-5 markets. Many of the selections are available in either commercial grade or AMP Gold versions, which meet exacting specifications for durability and contact plating.

The catalog also describes how AMP Engineered Systems can solve tough design and engineering problems. The company's engineers routinely work with customers to generate custom solutions to special challenges, whether related to speed and distance, shielding, weight, latching, or even appearance.

The USB Handbook

by Kosar Jaff
Annabooks
11838 Bernardo Plaza Court
Suite 102A
San Diego, CA 92128
Tel: 619-673-0870 or 1-800-462-1042
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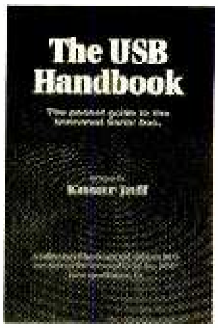

CIRCLE 342 ON FREE INFORMATION CARD

This pocket-sized guide for Universal Serial Bus (USB) hardware and software design is based upon USB Specification 1.0 and covers physical devices, client software, system software, and host controllers. The reference guide is divided into seven main subject areas:

The USB Overview includes USB implementation and topology. Transfer Types covers communication flow paths, bulk and data transactions, and control and isochronous transfers. Mechanical Requirements include dimensioning and tolerances, physical cable requirements, connectors, contact numbering, ratings, cable voltage-drop requirements, grounding, and propagation delays. In Electrical Requirements, USB driver characteristics, signal termination, data signaling, and bit stuffing are discussed. The Device Framework section covers USB device requests, standard driver requests, and USB device descriptors. USB Hub Information includes architecture, connectivity, repeater states, port I/O driver and receiver model, frame timing, and endpoint organization.

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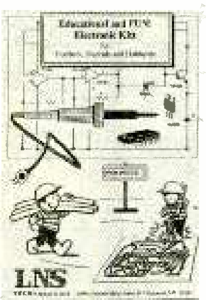

CIRCLE 343 ON FREE INFORMATION CARD

This 15-page catalog (#701) is filled with electronic kits that are designed to be both fun and educational. There are projects to appeal to builders of every skill level, from beginner to experienced. Skill levels for every kit are noted in the catalog. A small sampling of the featured kits include a laser, a solid-state recorder, a voice changer, a digital compass, a microcontroller, and an anti-gravity levitator.

Every kit comes with a drilled glass-epoxy printed circuit board and clearly identified parts, and many also include attractive plastic enclosures to give the projects a finished look. Manuals feature easy-to-follow instructions, plenty of illustrations, circuit diagrams, trouble-shooting pointers, and manufacturer's data sheets when new or unusual components are used.

Packet: Speed, More Speed and Applications: 2nd Edition

compiled by Rich Roznoy, K1OF
The American Radio Relay League
225 Main Street
Newington, CT 06111-1494
Tel: 860-594-0200
E-mail: ead@arl.org
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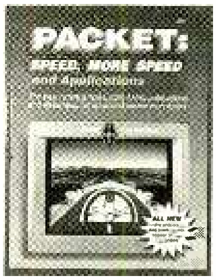


CIRCLE 344 ON FREE INFORMATION CARD

This book presents a collection of timely articles from a variety of authoritative sources. All of the most recent advances in packet can be found in this entirely new second edition, which contains none of the articles found in the original book.

The book includes articles from *ARRL Digital Communications Conference Proceedings*, *QEX*, *QST*, *The ARRL Satellite Anthology*, and the Internet. The article on APRS (Automatic Packet Reporting Service) helps you keep abreast of the latest advances in software and applications, including weather tracking and improved mapping databases. Speed is the name of the game in the piece on digital modulation: 9600 bits-per-second, 56-kilobits-per-second data links. There's an article that shows how to track meteors and use the first user-friendly 1200-baud satellite BBS on Fuji-29. Another makes TNC interfacing easy with wiring diagrams for all popular rigs. You'll also learn how to modify your rig for improved performance, build a "totally accurate clock," and construct a low-cost modem.

BY SAM GOLDWASSER

More About Microwave Ovens

LAST TIME WE TOOK A QUICK LOOK AT REPAIRING MICROWAVE OVENS, AND PROVIDED A HANDY GUIDE WITH COMMON SYMPTOMS AND THEIR LIKELY CAUSES. HOWEVER, BEFORE WE PROCEED FURTHER, WE NEED TO STEP BACK AND look at the basics behind microwave cooking, the magnetron, and microwave-oven electronics.

Microwave Cooking

The typical microwave oven uses between 500 and 1000 watts of microwave energy at 2.45 GHz to heat food. That heating is the result of the microwave energy vibrating the water molecules in the food. That's why plastic, glass, and even paper containers are heated only by the conduction of heat from the food. There is little direct transfer of energy to those materials. This also means that the food does not have to be a conductor of electricity (you can test this by heating a glass of distilled water in your microwave—you'll find that it does get hot even though distilled water is not a conductor).

Since the oven-chamber cavity is a good reflector of microwaves, nearly all of the energy generated by the oven is available to heat the food and heating speed depends only on the available power and how much the food is being cooked. Ignoring losses through convection, the time it takes to heat food is roughly proportional to its weight. Thus two cups of water will take about twice as long to bring to a boil as one cup.

Heating is not (as is popularly assumed) from the inside out. The penetration depth of microwave energy is only a few centimeters, so the outside does indeed cook faster than the inside. However, unlike a conventional oven, the microwave energy does penetrate those few centimeters, rather than being totally applied to the exterior of food. The misconception probably occurs when sampling something like a pie filling just out of the microwave. Since the pie can only cool from the outside, the interior filling seems to be much hotter than the crust and will remain that way for a long time.

One interesting note; since 30 to 50 percent of the power goes out the vents in the back as heat, a microwave oven is really only more efficient than a stovetop or conventional oven for heating small quantities of anything. With a normal oven or stovetop, wasted energy goes into heating the pot, the oven, the air, and so on. However, that waste heat is relatively independent of the quantity of food and may be considered to be a fixed overhead. Therefore, there is a crossover point beyond which it is more efficient to use conventional heat than microwaves.

How Microwave Ovens Work

A microwave oven is really a very simple device. It consists of two main parts;

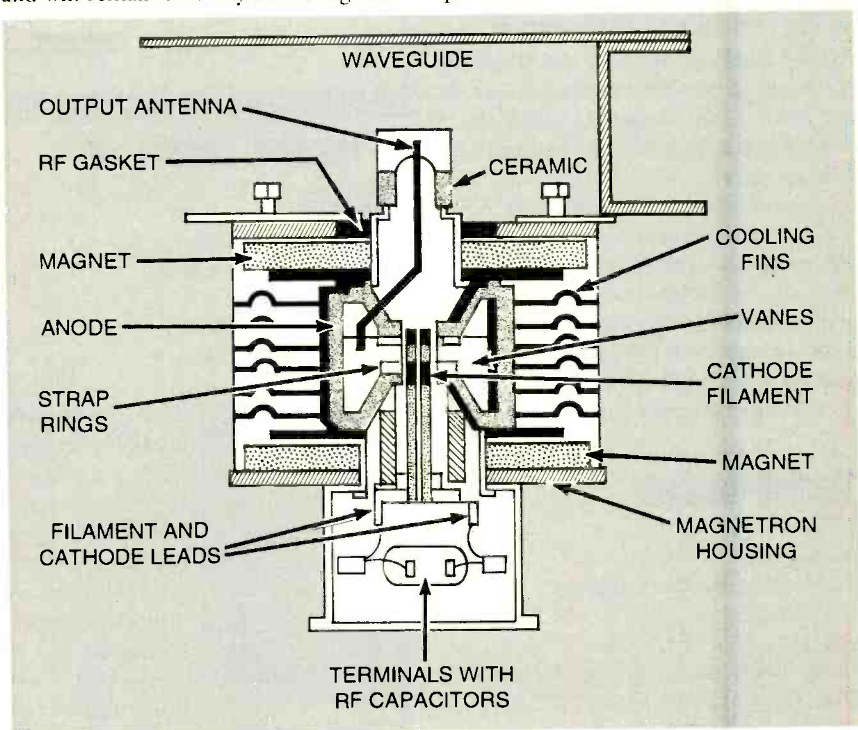


FIG. 1—A CROSS-SECTIONAL VIEW of a typical microwave-oven magnetron. This device is little changed since its invention shortly after WWII.

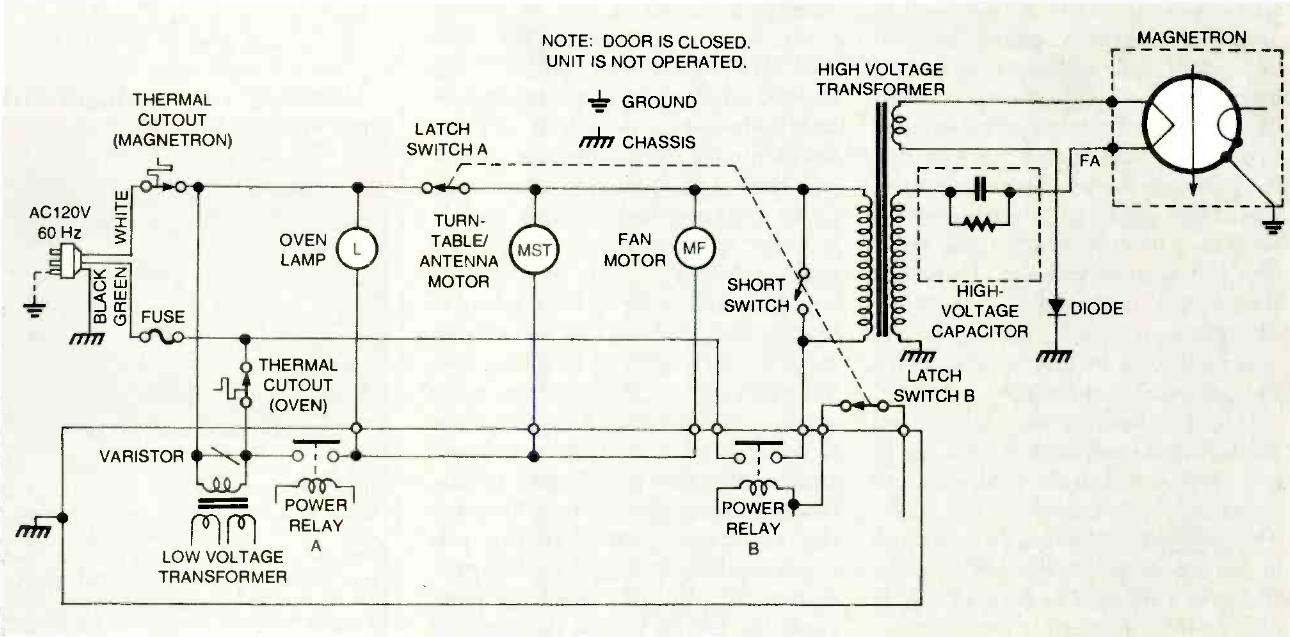


FIG. 2—THIS SIMPLIFIED SCHEMATIC DIAGRAM shows only the oven's power circuits. It is similar to the one you will likely find pasted inside your unit's cabinet.

the controller and the microwave generator. The controller is what times the cooking by turning the microwave energy on and off. Power level is determined by the ratio of on time to off time in a 10- to 30-second cycle. The microwave generator takes AC-line power, steps it up to a high voltage, and applies that to a special type of vacuum tube called a magnetron—a device that is little changed from its invention during World War II (for radar).

The controller section usually includes a microcomputer, though very inexpensive units may simply have a mechanical timer (which ironically, is probably more expensive to manufacture in today's world!). The controller runs the digital clock and cook timer; sets microwave power levels (via pulse-width control of the microwave generator); runs the display; and in high-performance ovens, may even monitor the moisture or temperature sensors.

There are also various door interlock switches that prevent the oven from producing microwaves if the door is not closed completely. At least one of these will be directly in series with the transformer primary so that a short in the relay or Triac cannot accidentally turn on the microwave generator when the door is open. The interlocks must be activated in the correct sequence when the door is closed or opened. There is another interlock across the AC line. It is there to blow the main fuse if the switches are activated out of sequence, as might happen with a damaged door or switch mechanism. Failed door interlocks account for the majority of microwave oven problems—perhaps as high as 75 percent.

The microwave generator is the subsystem that converts AC-line power into microwave energy. It consists of four major parts:

• High-voltage transformer—featuring a secondary of around 2000-volts rms at 0.25 amp and a low-voltage high-current winding for the magnetron's filament.

• High-voltage rectifier—usually rated 12,000 to 15,000 PIV at around 0.5 amp.

• High-voltage capacitor—0.65 to 1.2°F at a working voltage of around 2000-volts AC.

• Magnetron—the microwave producing tube including a heated-filament cathode, multiple resonant cavities with a pair of permanent ceramic ring magnets to force the electron beams into helical orbits, and an output antenna.

Magnetron Construction and Operation

The cavity magnetron was invented by the British before World War II. It is considered by many to be the invention most critical to the Allied victory in Europe. The story goes that shortly after the War, a researcher at the Raytheon Corporation, Dr. Percy Spencer, was standing near one of the high-power radar units and noticed that a candy bar in his shirt pocket had softened. In the typical "I have to know why this happened" mentality of a true scientist, he decided to investigate further. The Amana Radarange and today's microwave oven industry were the result.

Figure 1 shows a cross-sectional diagram of a typical magnetron (this diagram comes from John Gallawa's www.yup.com/microtech/ Web site). The filament and cathode are one and the same, and are made of solid tungsten wire in the form of a helix about $^{5}/_{32}$-inches diameter by $^{3}/_{8}$-inches in length. The cathode is fed a pulsating negative voltage with a peak value of up to 5000 volts. The anode is a cylinder made with an inside diameter of $1^{3}/_{8}$ inches (35 mm) and a length of about 1 inch (25.4 mm).

Rather than cylindrical cavities, as you would find in most descriptions of radar magnetrons, there is a set of ten copper vanes brazed or silver soldered to the inside wall of the cylinder facing inward toward the cathode. Copper shorting rings at both ends, near the center, join alternating vanes. That structure results in multiple resonant cavities that behave like sets of very-high-quality, low-loss L-C tuned circuits with a sharp peak at 2.45 GHz. A connection is made near the middle of a single vane to act as the output-power takeoff.

The entire assembly is placed in a powerful magnetic field—several thousand gauss compared to the Earth's magnetic field of about 0.5 gauss—provided by a pair of really powerful ceramic ring magnets placed against the top and bottom covers of the anode cylinder. A set of thin aluminum fins act as a heat sink for removing the significant amount of wasted heat produced by the microwave generation process, which is only about 50 to 75 percent efficient. There will always be a cooling fan to blow air through the assembly. The anode and magnetron case are at ground potential and connected to the chassis.

The gap between the cathode and anode, and the resonant cavities, are all in a vacuum. When powered, electrons stream from the cathode to the anode. The magnetic field forces them to travel in curved paths in bunches like the spokes of a wheel. The simplest way to describe what happens is that the electron bunches brush against the openings of the resonating cavities in the anode and excite microwave production in a way analogous to what happens when you blow across the top of a Coke bottle or through a whistle.

The frequency/wavelength of the microwaves is mostly determined by the size and shape of the resonating cavities—not by the magnetic field as is popularly thought. However, the strength of the magnetic field does affect the threshold voltage (the minimum anode voltage required for the magnetron to generate any microwaves), power output, and efficiency.

Microwave Generator Circuit

Nearly all microwave ovens use the same basic design for the microwave generator. That has resulted in a relatively simple, low-cost system. The typical circuit is shown in Fig. 2 (in this case from a Panasonic unit). That figure is a simplified schematic similar to the type you are likely to find pasted inside the metal cover. Only the power circuits are likely to be included. Unless it is a simple motor driven timer, the controller details are usually not shown. Since most problems will be in the microwave generator, your unit's simplified schematic may be all you need for servicing.

Note the unusual circuit configuration—the magnetron is across the diode, not the capacitor as in a "normal" power supply. This is a half-wave voltage doubler. The output waveform looks like a sinusoid with a peak-to-peak voltage equal to the peak-to-peak voltage of the transformer secondary, with its positive peaks at chassis ground. **BE EXTREMELY CAREFUL HERE!!! Up to 5000 volts at real amperage is present!!! Also, never attempt to view this waveform on an oscilloscope unless you have a commercial high-voltage probe and know how to use it safely!**

Other types of power supplies have been used in some ovens. Those include high-frequency inverters. But it is hard to beat the simplicity, low cost, and reliability of the very common half-wave doubler configuration. Note that there is also usually a bleeder resistor as part of the high-voltage capacitor. **However: do not assume that this is sufficient to discharge the capacitor. Always discharge the capacitor yourself before you touch anything in the microwave generator after the oven has been powered.** The bleeder may be defective and open without you realizing it as it does not affect the operation of the oven, or its discharge time might be long—up to several minutes. And some ovens might not have a bleeder at all.

Other parts of the switched primary circuit include the oven interlock switches, thermal protector bolted to the magnetron, thermal fuse near the transformer, cooling fan, turntable motor (if any), oven light, etc.

Wrap Up

Next time we will dive into the safe testing of the various components in the microwave generator. Until then, if you really are curious or have a pressing need to get your microwave going again, check out my Web site (http://www.paranoia.com/~filipg/REPAIR/) for general information or the Microtech Web site http://www.yup.com/microtech/) for more on magnetron operation and specific tech-tips that may apply to your model. And don't forget, if you have specific questions, you can contact me directly at sam@stdavids.picker.com

And a final note—the sci.electronics.repair FAQ hompage is on the move to a new and expanded site. Look for it in the near future at http://www.repair-faq.org/ EN

BY JEFF HOLTZMAN

A Hybrid Digital Camera

NO, I DIDN'T JUST BUY A DIGITAL CAMERA, SO THIS IS NOT GOING TO BE ANOTHER "MY-NEWEST-GADGET-AND-HOW-COOL-IT-IS" SESSION. HOWEVER, SEEING ONE ALTERED CERTAIN VIEWS OF MINE AND GOT ME THINKING. SO THIS IS REALLY going to be a "Gee, I wish I had something that could . . ." session.

The ELPH

Figure 1 shows an image of the new ELPH camera, introduced earlier this year by Canon. I happened to see one while browsing in a camera store after dropping off my trusty old Nikon for some routine preventive maintenance.

The ELPH is a super miniature camera, about the size of a pocket calculator. However, its diminutive size is about the only thing it has in common with its disposable plastic brethren (Instamatics, disk cameras, etc.). The ELPH has a brushed metal case and a heft that clearly says there's something different here. It sells for about $400.

The ELPH uses a new cartridge film about 25% smaller than a 35mm cartridge. The cartridge contains both film and digital data stored on some sort of magnetic medium. You don't have to thread a winder to load film. In addition, you don't have to deal with negatives. Instead, after submitting the roll for processing, you get back a contact sheet and the original cartridge, which acts as a permanent storage container. There is also a capability for time- and date-stamping each image.

It has built-in flash (with red-eye correction), 2× zoom lens, and a control that allows you to vary the format of a print (normal, wide, and telephoto). According to the sales clerk, the camera always takes the wide-view image, but the digital storage tracks the format setting. Later, when you get the contact sheet back, an overlaid rectangle shows the crop you would get by printing at the selected format. If desired, you can override the initial setting for actual printing. Table 1 summarizes the detailed specs.

FIG. 1—CANON'S ELPH is a marvel of electro-mechanical miniaturization, but there's no computer interface. What gives?

The sample prints I saw looked good. There were obviously better than 110-size images. Without doing a detailed comparison using my own subjects, I don't know whether they could really compete with 35mm, but results were encouraging.

It's Cool

The ELPH is cool. It has a high-tech look and a quality feel that together say something new, and that also points out future directions.

The ELPH is a hybrid or a mongrel, depending on how you look at it. It's neither fully analog nor fully digital. An optimist (or a marketing person) would say it combines the best of both. I don't know; let's think about that.

Certainly for image quality, analog is still king. Affordable digital image capture still has a long way to go. However, the ELPH leans heavily in the mass-market direction, so you don't get the range of control over aperture and shutter-speed settings you would with a comparably-priced 35mm device. And in digital capabilities, the ELPH falls short, primarily because it has no external interface for controlling image capture or data upload/download.

So maybe it does fall in the "toys-for-yuppies" category. It's smaller and sleeker and cooler than entry-level 35mm devices, but at more than twice the cost, it's hard to see twice the benefit.

What would it take to satisfy me? For one, I wholly agree with the hybrid approach. Regarding image quality, analog is still light years ahead of digital, so stick with film. But don't sacrifice control. Let me set the shutter speed and aperture diameter if I want to. And sure, provide auto settings for those who don't.

As for digital capabilities, Canon totally blew an opportunity by not providing some sort of interface into the system. I'd like to be able to snap pictures on command. I'd like to programmatically vary settings while snapping the same image over and over to "calibrate" the system. I'd like to take a series of identical images at some periodic rate (or even an aperiodic rate) under program control. I'd like to edit, modify, and annotate the (currently limited) digital information stored on the film cartridges. I'd also like to have a digital thumbnail image stored in the cartridge—yes, in addition to the

TABLE 1-ELPH SPECIFICATIONS

Type: IX 240 fully automatic lens shutter camera with built-in zoom lens and magnetic IX functions.

Lens: 24–48mm f4.5-6.2,6 elements in 6 groups (with 2 aspherical glass lenses).

Viewfinder: Real-image zoom finder covers approx. 82% of actual picture area. 0.31× magnification in wide; 0.62× in telephoto.

Shutter: Combination aperture and program electromagnetic-drive shutter.

Autofocus: Passive and active autofocus using 1/IRED skimming CCD sensor as a distance-measuring element.

AF Mode: Single point measurement only.

Focusing Range: 1.5ft./0.45m to infinity, 150 focusing zones.

AF Control: Program AE; AE lock upon completion; three-segment measurement with SPC light sensing elements.

Metering Range: (at ISO 100) Flash On/Flash Auto: WIDE EV9.5-EV17 (1/35 sec at f/4.5 to 1/500 sec at f/16); TELE-EV 11.5-EV19 (1/70 sec at 6.2 to 1/500 sec at f/32); Flash Off/Slow Sync: WIDE-EV3.5-EV17 (2 sec at f/4.5 to 1/500 sec at f/16); TELE-EV4.5-EV19 (2 sec at f/6.2 to 1/500 sec at f/32).

Film Speed Setting: ISO 20-10,000 automatically set in 1/3 step increments by reading data disk.

Film Loading: Manual drop-in loading. Fully automatic advance and rewind. Mid-roll rewind possible.

IX: Date, Print aspect ratio, Cartridge loading direction, Strobe On/Off, Subject brightness, and Title area recorded on film using a single track, write-on magnetic recording head.

Flash Exposure Controller: Determined by film speed and AF distance.

Red-eye Reduction Mode: Activated via Auto flash button.

Flash Recycling Time: Approximately 5 sec.

Flash Coupling Range: WIDE: 1.5ft–9.8ft/0.45–3m; TELE: 1.5ft–7.2ft/0.45m–2.2m (with ISO 100 color negative film.)

Self-Timer: Electronically controlled with 10-second delay.

Remote Controller: Optional remote controller RC-5, 2 seconds delay shutter release; transmits up to 16.4 ft/5.3m when directly in front: up to 11.5ft/3.5m at periphery.

Data Imprint: Recorded magnetically and can be printed on either the front and back or only the back of print.

Power Source: Battery: One Lithium (3V).

Battery Capacity: Approximately 12–25 exposure rolls with 50% flash use.

Dimensions (inches): 3.6 (W) × 2.4 (H) × 1.1 (D)

Weight: Approximately 6.3 oz. without battery.

analog image on the film. All the digital information could be downloaded to a database application. A database might store a roll number, a print ID, a category, and descriptive text for each print, and likewise for the cartridge as a whole. With thumbnails available, annotating the images ("Johnny's first birthday") would be much simpler and more likely to get done.

Standards

It's ironic when you consider that, like the (PC portion of the) computer industry, the photography industry grew up around standards. Interchangeable film cartridges, flash units, lenses, mounts, and so on all contributed to the overall variety of choices.

Now it's time for a similar set of standards concerning digital photographic technology. We need a standard interface such as Universal Serial Bus (USB). But we need more than just a way of moving bitmaps down a wire.

We also need a standard set of data structures, communications protocols, and APIs. Putting a CCD behind a lens does not make a camera digital. To fully bring photography into the digital age, we need a comprehensive model of what is to occur, independently of how it happens. By analogy, we routinely place computer data on media with widely differing physical characteristics without a second thought. I want the same media independence from film, CCDs, and whatever may develop in the future.

Anyway, Canon's ELPH is a marvel of electro-mechanical miniaturization. It won't replace my Nikon, but it's a harbinger of things to come.

Pilot Redux

Last month I wrote about another high-tech gadget, US Robotics' handheld organizer, the Pilot, one of which I do happen to own—and use every day, I might add. I've been brainstorming several avenues for serious technological evolution of the Pilot, and thought you might be interested in these ideas.

But first, I should report two interesting developments. First, networking giant 3Com has just about completed its purchase of USR, and there are persistent rumors that the Palm division will be sold, as it seemingly—but see below—has little to do with telecommunications. Second, Xerox is suing USR, claiming that its Graffiti handwriting recognition is based on a prior technology called Unistrokes, invented and patented by Xerox, possibly as early as 1979.

Xerox, of course, has achieved fame for inventing but failing to deploy and profit from several of today's more popular computer technologies, including the GUI, Ethernet, and laser printers. Later, after said technology achieves widespread market acceptance, the lawyers get in the act, figuring that even if the marketing folks blew their chance, there's still an opportunity. So Xerox sues Apple, and Apple sues Microsoft, and . . . .

Some people suspect that the suit may represent a serious liability, thereby decreasing Palm's perceived market value, should it be sold. Does that say anything about Palm's (and the Pilot's) longevity?

But let's get back to technology. Here's my vision of the ultimate handheld organizer; call it a PDA or whatever you want.

Start with your basic Pilot: small, lightweight, handheld. Eliminate the dedicated app-launching buttons (except power) and the dedicated handwriting recognition area, making the whole screen programmable (like Apple's Newton). Then add the following (the biggie is the first one):

(1) Full telecommunications capability, including voice, data, and fax transmission over EIA232, IR, V.34 modem (or better), some form of cellular, USB or FireWire, possibly Ethernet. Data communications must include a credible e-mail system, net news reader, and Web browser. No, it doesn't have to do Shock-

Wave and RealAudio, just the basics. One DSP should be able to handle all those, though not necessarily simultaneously.

(2) Integrate a robust chargeable power system.

(3) Add an earphone jack and a microphone to handle voice communications and voice memos.

(4) Integrate a clever, robust, low-cost universal I/O connector, kind of like a laptop docking station or port replicator.

(5) Integrate text-to-speech to allow the device to read your e-mail to you while driving, riding the subway, or enduring a boring meeting. Don't bother with voice recognition.

(6) Integrate SmartCard technology to handle everything from ATM/debit cards to music and video playback, in effect turning the device into a miniature stereo/ entertainment/ information center. Choose your own in-flight entertainment. Of course, it will need audio and video I/O jacks.

(7) Integrate a television tuner.

(8) Integrate an AM/FM tuner. Make it digital and totally software controlled so it can receive on any (reasonable) band. Add another connector for an external antenna.

(9) Strategically locate the IR device (and add the appropriate software) so it can function as a remote control.

(10) Integrate a vibrator (like some pagers have), and allow built-in and external (e.g., cellular) alarms to activate it.

(11) Make the screen two-way optical. In other words, allow it to function as a scanner for capturing business cards, passages from books or magazines. May as well throw in OCR. Perhaps even give it a snapshot lens and CCD. Or combine it with an ELPH?

(12) The current plastic case is well-done, but could be beefier. Provide a super lightweight metallic case, with flip-up cover housing the telephone earpiece. Provide foam or other padding for comfort and to protect the screen when closed.

(13) Provide robust GPS implementation.

(14) Provide sensors for temperature, relative humidity, and air quality.

Basically I want something to integrate and replace my wallet (including credit cards, cash, and identification) and my telephone, and to supplement all other data-gathering and enhancement functions. It's not intended to compete with either a laptop or desktop computer, but to function as an adjunct, and to provide a complete personal identification and information system. I don't want it to do anything computationally intensive, so CPU speed and RAM availability are not major issues. I'd rather keep power usage to a minimum to keep the size down.

Is that a crazy idea or what? Until next time, you can stay in touch via e-mail at jkh@acm.org **EN**

"Let me get this straight, you were watching Lassie and . . . "

CIRCLE 270 ON FREE INFORMATION CARD

JULES RYCKEBUSCH

BUILD THESE *NOISE-CANCELING* *HEADPHONES*

Muzzle the din and relax to the sounds of silence with headphones that combat the uproar with "anti-noise."

In today's hectic and noisy world, we are all searching for a little peace and quiet. Well, you might not be able to slip off to a tranquil forest for an hour or two, but you can block out background noise with the Noise-Canceling Headphones. The theory behind this project is that by picking up ambient sound with a microphone and reproducing it out of phase, we can actively cancel or "null" out background noise. In fact, several commercially available devices perform the same function. However, by building your own headset, you can add features not otherwise available and have fun while doing it! Along with noise-canceling features, the Active Noise-Canceling Headphones let you mix in an auxiliary line-level signal from a CD or tape player. That allows you to minimize background noise while quietly listening to music. The project also has a phase switch that will let you keep the microphone signals in phase, thus amplifying background sound. In addition, the design of the Noise-Canceling Headphones lends itself to several other interesting functions, which we will look at later.

How It Works. The electronics consist of three op-amp circuits; each built around one half of an NE5532 dual op-amp. Each circuit uses that op-amp in a different configuration. The first circuit is a non-inverting pre-amp, the second is a unity-gain phase-inverter, and the third is an inverting headphone amplifier. Since the Noise-Canceling Headphones is a stereo device, the circuit is actually two identical circuits side-by-side. Only one channel will be described; the second channel works in exactly the same way.

The schematic diagram in Fig. 1 shows the design of the electronics portion of the project. A headset-mounted microphone is connected to J1,

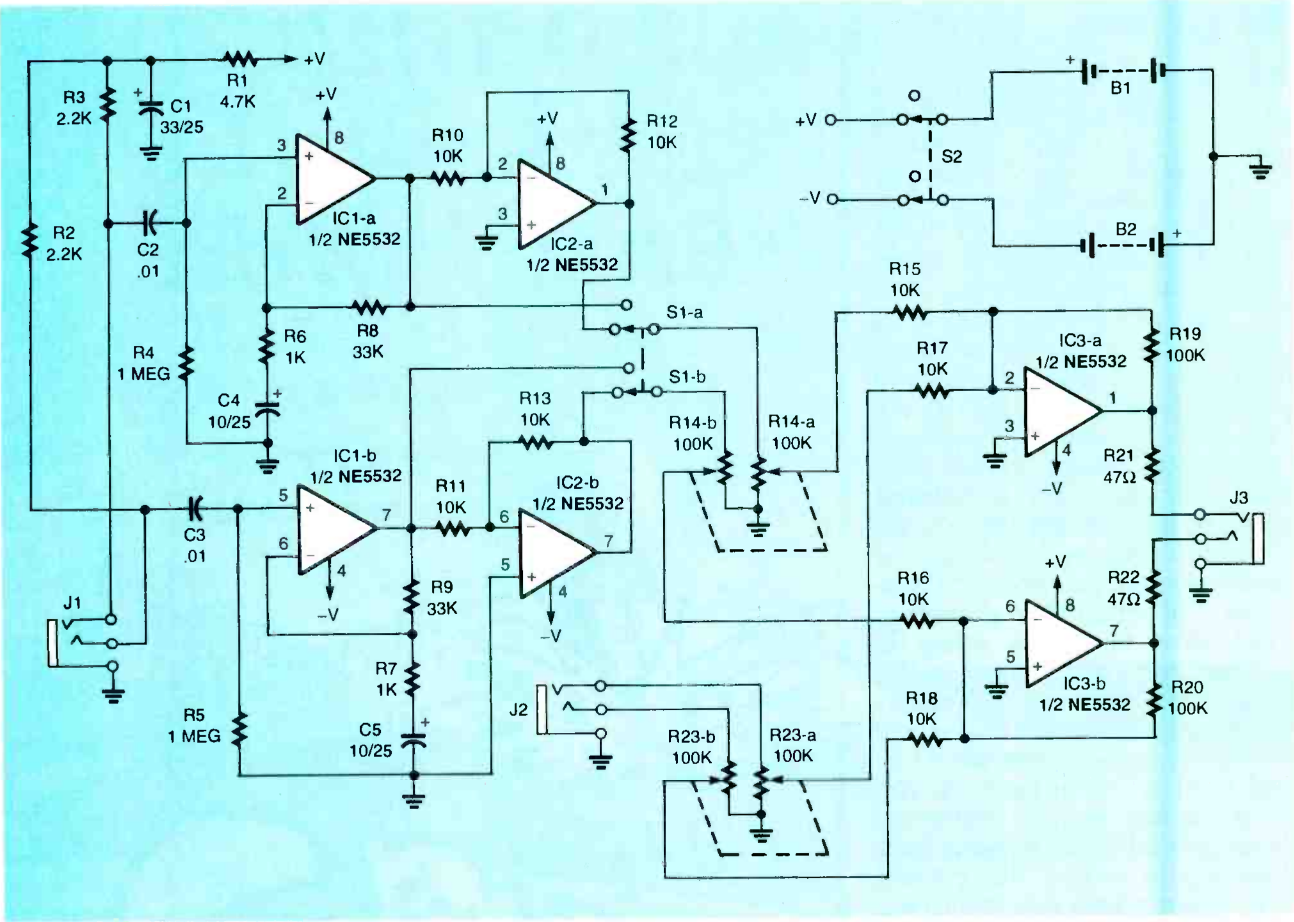


Fig. 1. The Noise-Canceling Headphones is a simple phase-inverting amplifier. All inverted sounds played back through the headphones cancel out the original sounds, leaving nothing but silence. The amount of canceling can be adjusted for different situations. A CD player or cassette tape can be listened to if you want to "fill the quiet."

a 1/8-inch stereo jack. Electret-condenser microphones need a 2- to 10-volt bias voltage for their internal FET pre-amps. That is supplied by R2. A voltage-dividing network, which also decouples the bias voltage from the power supply, is provided by R1 and C1. That is necessary due to the high gain of the entire signal chain.

The signals from the microphone then go to IC1-a, an NE5521 set up as a standard non-inverting pre-amp. The gain is set to one plus the ratio of R8/R6 in the feedback path. The total gain for that stage is about 31 dB. Resistor R4 provides a ground reference for the pre-amp. A pair of high-pass filters is formed by C2/R4 and C4/R6. Those filters block any DC that tries to slip through the pre-amp.

From the output of the pre-amp, the microphone signal is sent down two different paths. It feeds both one pole of S1-a and the phase-inverter. The phase inverter is nothing more than a second NE5532 configured as a unity-gain inverting op-amp (IC2-a). The output of IC2-a is connected to the other pole of S1-a. That way, S1-a can select either the inverted or the non-inverted signal. The selected signal on S1-a's common pole goes to potentiometer R14-a.That potentiometer sets the level of the microphone signal feeding the headphone amplifier.

The headphone amplifier is built around IC3-a, a third NE5532 wired as an inverting op-amp stage. The gain here is set by the ratio of R19/R15. That type of op-amp configuration can be easily modified to add a summing feature by the inclusion of R17. The second input comes from an auxiliary line-level input that is attenuated by potentiometer R23-a.

There is a reason why 10,000 ohms was chosen for the value of R15 and R17. Besides keeping the values of R19 manageable, the 10,000-ohm resistors interact with the 100,000-ohm linear potentiometers. The potentiometers then behave in a logarithmic fashion. This is how that feature works: One end of the potentiometer is tied to ground because we are using it as a voltage divider. Because the summing junction of an op-amp is at a virtual ground, the 10,000-ohm resistor is also essentially tied to ground. That affects the response of the potentiometer. As the potentiometer is rotated, there is a more pronounced increase in the output as the end of the potentiometer's travel is reached. That causes a smooth increase in perceived loudness of the signal. Potentiometers with an audio taper are, of course, available, but a linear-taper unit is easier to obtain and costs less.

The output of the headphone amplifiers is coupled to output jack

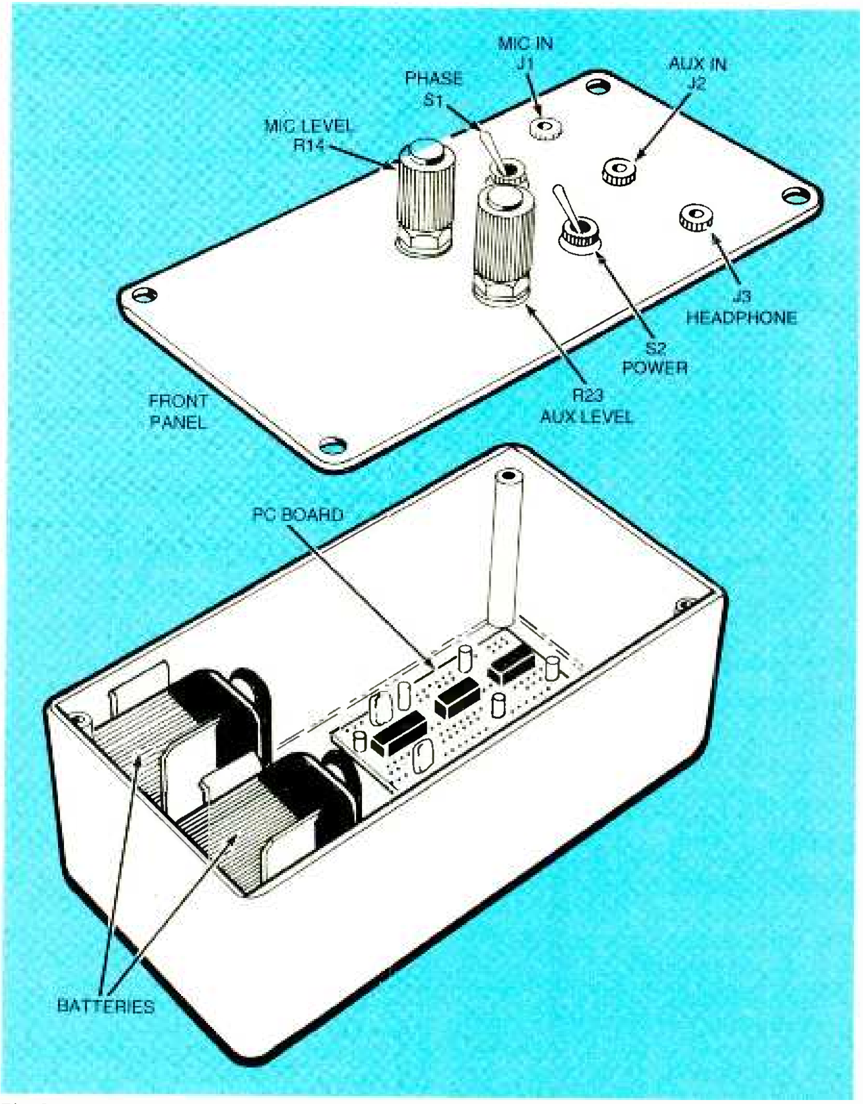


Fig. 2. The circuit board and batteries fit neatly into a simple project box. Keeping the wiring neat and following the layout shown here makes assembling the unit and changing the batteries easier.

J3 through R21. That resistor provides overload protection to IC3-a in case the output is shorted. If you have never used an op-amp for driving headphones before, you are in for a nice surprise. The NE5532 will supply a 10-volt rms signal into a 600-ohm load with very little distortion. That works out to 166 mW of power. Most personal stereos only supply 20 to 30 mW of power to headphones. A final note on using operational amplifiers as headphone amps: Most generic ones will not supply enough current to function properly. Some substitutes for the NE5532 that are known to work include the OP275 from Analog Devices, the OPA2604 from Burr Brown, and the LM833 from National Semiconductor. Those components are available from several sources, including Digi-Key, Allied Electronics, and Jameco.

Construction. There are two parts to this project: building the electronics and modifying a pair of headphones. The circuit is relatively simple and can easily be assembled on a perfboard. One style of perfboard that simplifies construction is one having a pre-etched copper pattern on its solder side that connects groups of holes together. One example of that type of perfboard is RadioShack #276-150. The etched pattern on that board has a pair of buses that run the length of the board. Those buses are very convenient for power distribution. If you use that type of board for the Noise-Canceling Headphones, it is best to start by spacing out the three ICs on the board so that they straddle the buses. Then attach the power supply leads from each chip to the buses. It is then a simple matter of point-to-point wiring the rest of the circuit.

Check your work often while building the circuit. A common mistake many hobbyists make is not checking their work thoroughly enough. Often a few components are accidentally wired in backwards. The usual result is that the circuit will probably not work, the ICs could be damaged, and the electrolytic capacitors might explode!

When wiring the jacks, it is a good idea to follow the audio industry standards as to which jack connection is for which stereo channel. Normal standards for stereo connections are to connect the right channel to the ring and the left channel to the tip.

The board and batteries are mounted in a suitable enclosure. A suggested layout for the components and control panel is shown in

PARTS LIST FOR THE NOISE-CANCELING HEADPHONES

RESISTORS

(All resistors are $^1/_4$-watt, 1% metal-film units unless otherwise noted.)
R1—4,700-ohm
R2, R3—2,200-ohm
R4, R5—1-megohm
R6, R7—1000-ohm
R8, R9—33,000-ohm
R10–R13, R15–R18—10,000-ohm
R14, R23—100,000-ohm potentiometer, dual-gang, linear-taper
R19, R20—100,000-ohm
R21, R22—47-ohm

ADDITIONAL PARTS AND MATERIALS

IC1–IC3—NE5532 dual audio op-amp, integrated circuit
C1—33-µF, 25WVDC, electrolytic capacitor
C2, C3—0.01-µF, Mylar capacitor
C4, C5—10-µF, 25WVDC, electrolytic capacitor
J1–J3—Audio jacks, $^1/_8$-inch, stereo
S1, S2—Toggle switch, double-pole, double-throw
B1, B2—Battery, 9-volt
Microphones (Digi-Key P9967-ND or similar), headphones, PC board, case, wire, hardware, etc.

Fig. 2. When selecting a case for the project, be sure that it is large enough to hold the circuit board and the two 9-volt batteries comfortably. After the front panel is laid out and drilled, check to make sure all the controls and jacks will fit. One method for labeling the front panel is to spray the entire panel with a flat color such as white or yellow. After applying transfer letters, seal the panel. Use several thin coats of a clear coating such as Crystal Clear by Krylon. The results are worth the effort. While the front panel is drying, we can start on the headphones.

Headphones with Ears. The headphones are a standard pair of aftermarket Walkman-type units. They sell for about $20 at most record or electronics stores. The headphones are modified by mounting two small electret-condenser microphones on the headphones, one on each earpiece. That modification is shown in Fig. 3.

The key to making the headphones wearable is to use thin wires running to the microphones. An excellent source of thin audio cable is to buy another set of cheap headphones—the cheapest you can find. Cutting the wire off them will yield a shielded stereo cable that is thin and flexible. As an added bonus, the wire will have a $^1/_8$-inch stereo plug molded on to it already!

The best way to strip that type of wire is to roll a razor blade very carefully over the insulation without cutting the wire underneath. Once the insulation is cut, carefully pull it away from the wire. That method works especially well on Teflon-insulated wire. After you have prepped the wire, mark the wire that is connected to the ring and the one that goes to the tip of the jack. An ohmmeter makes that task easy.

Carefully solder the wires to the microphone elements. The easiest way to do that is to pre-tin the wires and melt the little dab of solder on the microphone element with the tinned wire beneath the soldering iron tip. Look carefully at the microphone. As shown in Fig. 3C, the terminal that is connected to the case of the microphone is the ground connection. The other terminal is the actual microphone output. Holding the microphone element in an alligator-clip holder will make the job much easier. After soldering on the microphone elements, it is a good idea to test them prior to gluing them to the headphones. The wiring should follow Fig. 3B.

Mount the microphones on the headphones as shown in Fig. 3A. One way to attach the micro-

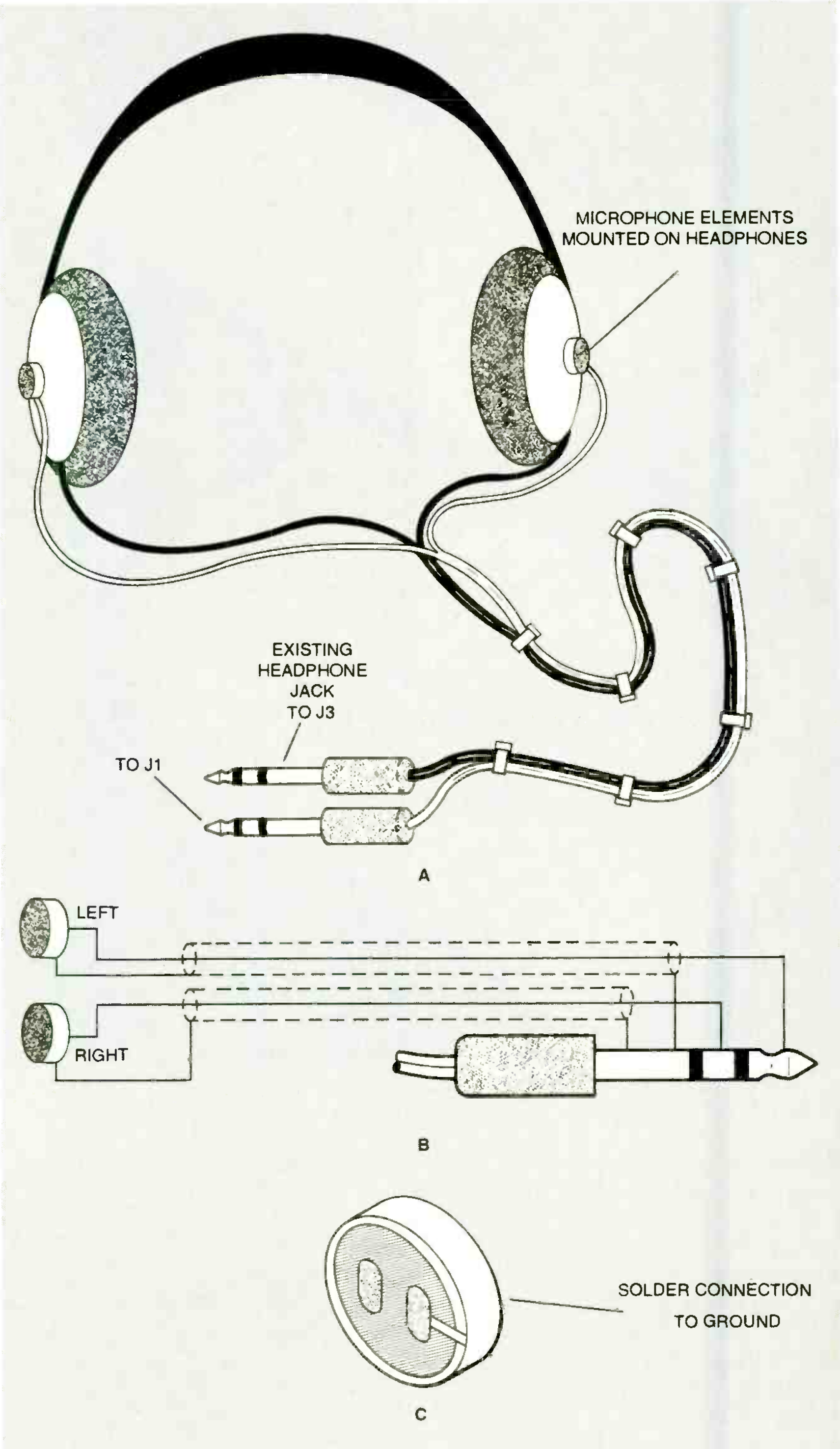


Fig. 3. The microphones are mounted on the earpieces of the headphones with a dab of silicone sealant. Tie both wires together in order to make the headphones more comfortable to wear (A). Follow the diagram in (B) when wiring the microphones. The left mic is connected to the plug's tip and the right is connected to the ring. The ground connection on an electret microphone cartridge is easily identified by the solder connection between the terminal and the mic's case (C).

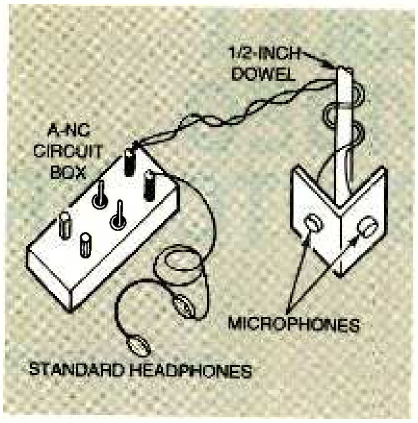


Fig. 4. Mounting both microphones angled apart at the end of a long stick makes an audio probe. It is very useful when you need to listen at a location that you can't reach.

phones to the headphones is to use a dab of silicone sealant. Using a toothpick or other suitable substitute, mold the silicone around the edges of the microphone element to smooth everything off. Be careful not to get any on the black felt surface—that is where the sound enters. Obviously, the left and right microphones should be attached to the left and right sides of the headphones, respectively. Trying to cancel out a sound on the right with a sound from the left will not work.

After the glue is dry, gather and bundle the wires together with several nylon tie wraps along the length of the wires. With the headphones complete, it is time to experiment with the Noise-Canceling Headphones.

Creating A Quiet Zone. For testing purposes, you should be in a quiet room with just a little background sound, such as a heater or air-conditioner fan. Plug in the microphone jack and the headphone jack, and put on the headphones. Turn both controls all the way down and turn the power switch on. Slowly turn up the microphone level. You should either hear the background sound increase or start to fade. If it increases, change the position of the phase switch. At some point, you should reach a "null" point where the background sound is at a minimum. If you adjust beyond the null, background sound will become louder as the out-of-phase signal exceeds the ambient sound level. Try talking aloud. If it sounds like you have a massive head cold and can barely hear yourself, the circuit is functioning properly.

Note that it is impossible to eliminate all incoming sound. Many things affect the ability to cancel out noise. The loudness of the incoming sound, the specific frequencies involved, and the position of the sound source all play a part in how well the headphones do their job. Feel free to experiment. If everything is working fine, try connecting a CD player to J2. You will need a 1/8-inch-to-1/8-inch patch cord similar to the ones used to connect portable CD players into a car stereo. After connecting the CD player, slowly turn up R23. It should sound clear with no distortion. Experiment with combining low levels on the CD player and canceling out room noise. The Noise-Canceling Headphones is the perfect device for environments that have a loud ambient sound level, such as rooms with loud ventilation systems.

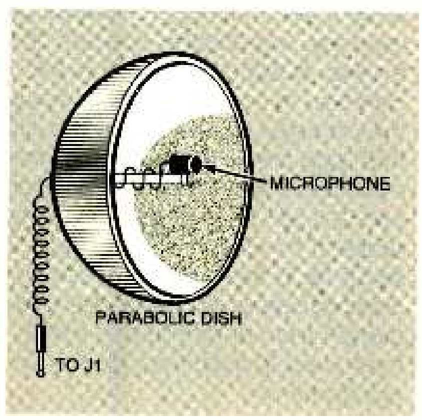


Fig. 5. A parabolic dish or lamp reflector makes a usable "Big Ear" microphone. The microphone is mounted at the focal point facing in towards the dish. Either one or two microphones can be mounted in the dish. If you build two, you can pick up stereo sounds.

Beyond Peace and Quiet. This project lends itself to many other uses. Several interesting applications will suggest themselves that do not require any additional hardware. For example, by switching the microphones to "in-phase," the unit can be used to assist hearing or improve hearing. Areas that can benefit include outdoor activities such as hunting or just observing nature.

Another unusual application for the Noise-Canceling Headphones is in binaural recording. Since we already have two microphones mounted in essentially the same place human ears are, all we have to do is send the headphone output to a tape recorder input. Binaural recordings put the listener directly in the sound field. The two microphones capture the exact phase and timing relationships of sound as we hear it. Those are the clues our ears use to determine the location of a sound. Try this little experiment: record a person talking to you while you are wearing the headphones and have them walk around you in a circle. Then listen to the recording on the headphones. You will hear the person walk around you! The microphone elements used in this project feature full 20-Hz to 20-kHz frequency response. They provide a signal with surprisingly high fidelity.

Other interesting tools can be created by building different types of housings for the microphones. If two microphones are mounted on the end of a length of ½-inch dowel, an audio probe is the result. It is wired similarly to Fig. 3B. That device lets you listen to things up close that you wouldn't normally hear. It can be used to "sniff" out problems in mechanical equipment or to record things like hamsters chewing on cardboard. With the microphones mounted at an angle between 90° and 120°, you will have a stereo image of the sound source too!

An extension of the shotgun-style microphone is a "Big Ear." The general arrangement is shown in Fig. 5. The main component is a small parabolic dish. Place one or both microphones at the focal point of the dish and experiment away. Sources for parabolic dishes can be as close as a local hardware store. A simple reflector for a light bulb can be found at a very reasonable price. Another source of true parabolic dishes is Edmund Scientific, 101 East Glouchester Pike, Barrington, NJ 08007. For some advanced experimenting, use two dishes (one for the left microphone, one for the right) and experiment with stereo reception of a distant sound. Ω

BUILD A VIDEO SWITCHER

FRANK MONTEGARI

Watch several cameras on one monitor with this simple device.

With the cost of security cameras going down, adding a surveillance system for your store, office, or home is becoming more practical all the time. However, you might be dismayed at the thought of having to buy a monitor for every camera that's installed. Dedicating a single monitor to a single camera also runs the risk of burning the camera's image into the phosphor screen of the CRT.

If you prefer a single monitor instead of the "NASA-Mission-Control" look, you could buy a special monitor that has a video switcher built in. That type of monitor can automatically switch between several camera inputs in sequence. With that type of arrangement, you'd have to watch only one screen instead of having to scan a wall of CRTs. Switching between several cameras would also prevent image burn-in on the monitor. Those types of monitors, unfortunately, are also very expensive, offsetting the cost savings of even the cheapest surveillance camera.

Video switchers are also available, but the cost of a switcher and a monitor could be as expensive as a monitor/switcher combination unit. A viable alternative for a video switcher is to build your own. Thanks to some recently introduced ICs, the cost and effort of designing and building such a unit has become both quite affordable and easy.

The video switcher described here can display the output of two, three, or four cameras on a single monitor. The number of cameras is set by a DIP switch on the circuit board. That feature avoids blank displays if less than four cameras are used by sequencing through only the inputs that are connected to a camera. In the automatic mode, the cameras are switched at a rate that can be varied with a panel-mounted control. The switching rate can be set from about once per second to about once every 20 seconds. In the manual mode, one camera output is displayed continuously. A momentary-toggle switch is then used to step through the various cameras.

How it Works. The heart of the video switcher is a Maxim MAX454. That integrated circuit contains a four-way video multiplexer and an amplifier that operates as a low-impedance line driver. The resulting video output is high quality with very low phase distortion. The video inputs are selected by applying a binary number to the address inputs. The binary number is also used to light a series of LEDs that indicate which camera input is currently selected. The circuit is powered by a 9-volt AC wall-adapter transformer, two diodes, and two voltage regulators.

Circuit Description. Figure 1 is a schematic diagram of the video switcher. Multiplexer IC1 has four video inputs, two address inputs, one video output, one external amplifier input, and three power terminals. The video cameras connect to the video inputs through J1–J4. The inputs are terminated with 75-ohm resistors R1–R4. The gain of the internal video amplifier is set by a feedback network connected to pin 13 of IC1. That feedback network consists of R5–R8 and C3. The gain is set to 2 in order to compensate for any losses through the 75-ohm terminator resistor, R9. The resulting net gain is 1 at output J5.

The binary addressing circuit is built around IC2, a CD4017 decade counter. That chip produces one positive output at a time on each of its ten outputs in sequence for every clock pulse. The first four outputs at pins 3, 2, 4, and 7 are connected to transistors Q1–Q4. Those transistors drive LED1–LED4 through current-limiting resistor R15. The outputs from IC2 (pins 2, 4, and 7) are also decoded into binary logic by diodes D1–D4. The binary logic is sent to the address input lines of IC1.

The number of cameras connected to the video switcher is set with S1. Each switch in S1 is connected to an output from IC2. If, for example, there are only two cameras connected to the video switcher, S1-a is closed. That connects the third output to IC2's reset line. When IC2 advances to the third count, that output passes through S1-a to the reset, and IC2 resets to zero, activating the first camera. The sequence would be camera 1, camera 2, then back to camera 1. Closing S1-b or S1-c instead of S1-a will let the video switcher cycle through three of four cameras, respectively.

Clock pulses for the counter are generated by IC3, an LMC555 CMOS timer. The pulse rate and pulse width is controlled by C4, R10,

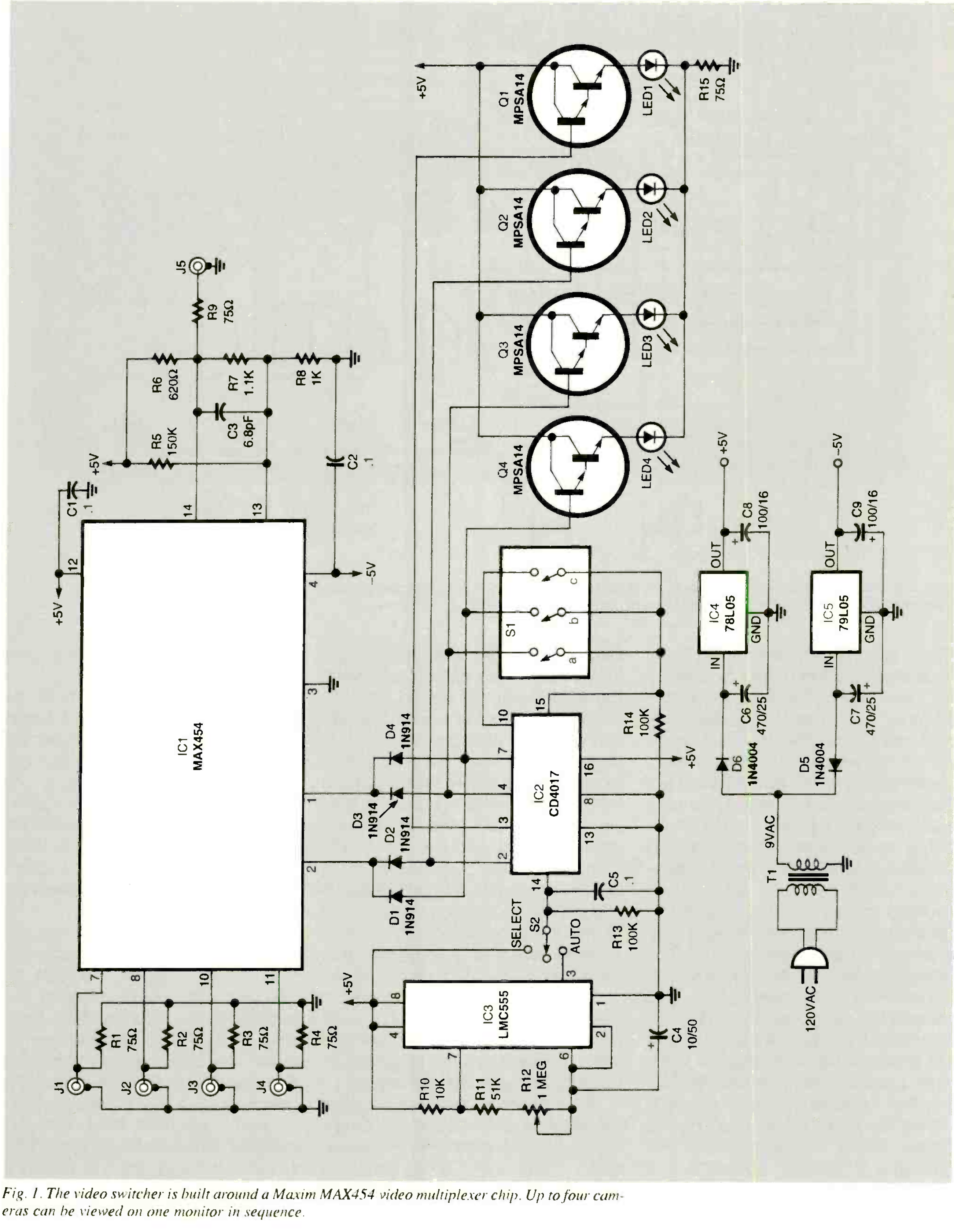


Fig. 1. The video switcher is built around a Maxim MAX454 video multiplexer chip. Up to four cameras can be viewed on one monitor in sequence.

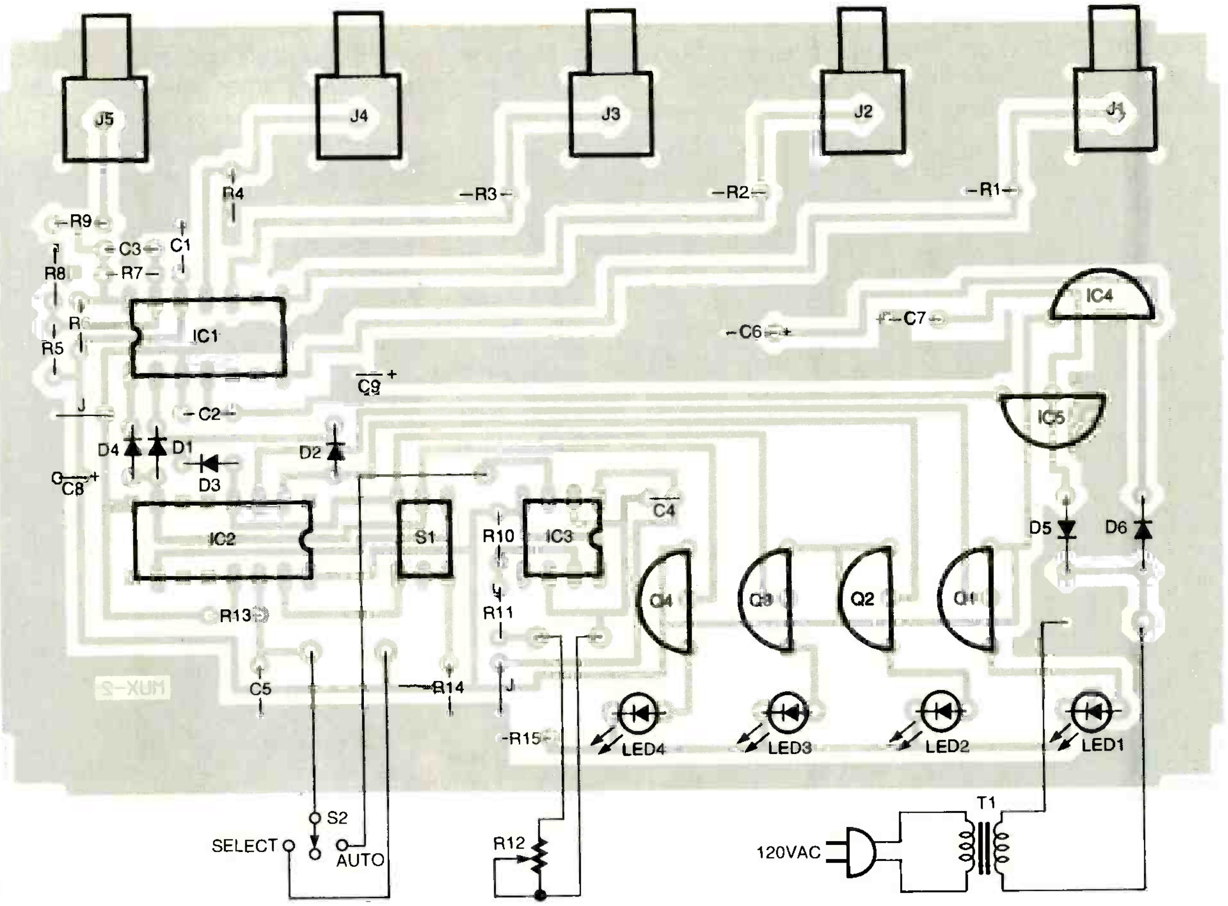


Fig. 2. Use this parts-placement diagram if you're building the video switcher with a board made from the foil pattern provided. Don't forget the two jumper wires, or the circuit won't work.

R11, and potentiometer R12. By adjusting R12, the output frequency of IC3 can be controlled between 1 Hz and $^1/_{20}$ Hz. The clock pulses from IC3 are connected to IC2 through S2, a three-position toggle switch. Switching S2 to the auto position lets the pulses from IC3 select the next camera at a rate set by R12. When S2 is in its center-off position, no switching takes place, and whatever camera input is selected is passed through to the output. The select position on S2 is a momentary contact. That position raises the clock input of IC2 to 5 volts, which increments the binary count and selects the next camera. When S2 is released, it springs back to its center-off position. The clock input of IC2 is then held at a low-logic level by R13.

The MAX454 requires ±5 volts while the other ICs require only +5 volts. Power is supplied by AC adapter T1, rectifier diodes D5 and D6, regulators IC4 and IC5, and filter capacitors C6–C9.

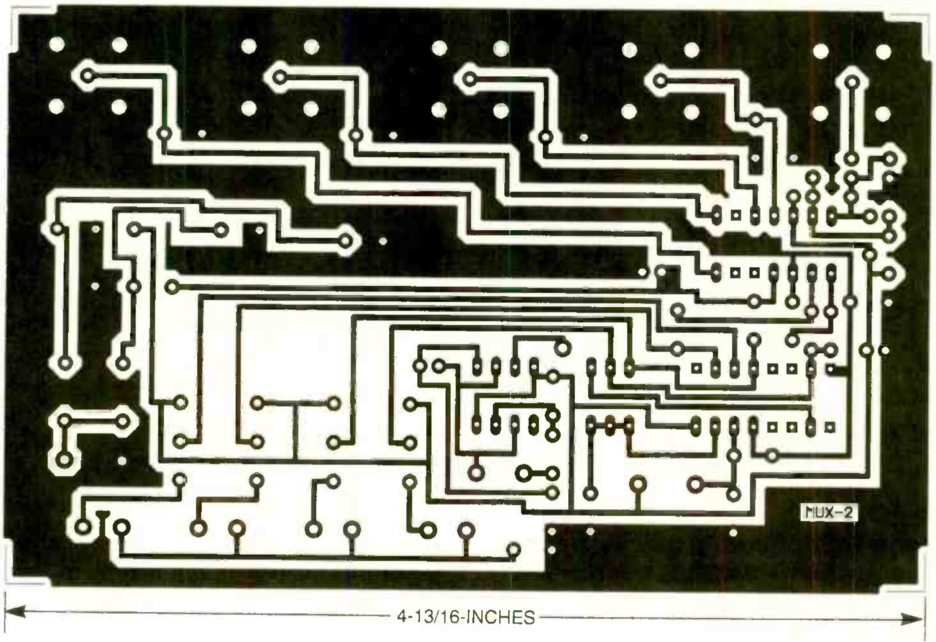
Construction. Because of the high-frequency video signals involved, the video switcher should be built on a printed-circuit board. The circuit is simple enough to fit onto a single-sided board with only two jumpers needed. A foil pattern is included for etching and drilling your own board. Alternatively, an etched board can be purchased from the source given in the Parts List. A feature of that board design is ground traces that run between all of the video signal traces in order to keep induced noise and crosstalk between the signals to a minimum.

Whether you etch a board from the foil pattern or purchase one from the source in the Parts List, use the parts-placement diagram in Fig. 2 for component placement.

It is easiest to install and solder the resistors and diodes first. Once those components are in place, scrap component leads can be used for the two jumper wires. Next, install S1 and sockets for IC2 and IC3. Do not use a socket for IC1, the MAX454 multiplexer.

When installing J1–J5, hold the connectors tight against the board while soldering the center pin. The assembly can then be placed on a heat-resistant surface and the ground pins soldered. Because of their size and mass, a larger soldering iron might be needed to solder J1–J5. Otherwise, the board might be damaged if heat is applied too long.

Once the connectors are soldered in place, Q1–Q4, IC4, IC5, and all the capacitors can be installed. The LEDs should be installed next, leaving their leads long so that they can be bent to reach through the front panel of the enclosure. Double-check the orientation of the polarized components, so that they are not installed backwards by accident. Once a component is soldered in place, removing it becomes much more difficult.



Here's the foil pattern for the video switcher. The circuit fits easily on a single-sided board. Ground traces around the video lines prevent noise and crosstalk.

Solder two 3-inch long wires onto the two terminals of R12 that are clockwise when viewing the potentiometer from the back. Connect those wires to the holes for R12 on the board. Three additional 3-inch long wires are soldered onto the terminals of S2. The center terminal connects to the hole near C5 and R13. The momentary-contact terminal connects to the hole near R14. The remaining terminal connects to the hole near IC3 and R10.

Solder IC1 directly onto the circuit board. That will result in the shortest possible lead length for the video signals. Plug IC2 and IC3 into their sockets, being careful to handle them as static-sensitive CMOS devices. Solder the T1 leads onto the board.

Examine the board for any wiring errors, bad solder joints, and incorrect components. Once the assembly is inspected, it can be tested.

Testing. Plug T1 into an AC outlet and measure the voltages across C8 and C9. The voltage across C8 should measure +5 volts. Across C9, the voltage should be −5 volts. To select two cameras, set S1-a on; to select three cameras, set S1-b on; and to select all four cameras, set S1-c on. Only one switch at a time should be on. When switch S2 is toggled to its momentary position, the LEDs should sequence to the next indicator each time S2 is toggled. The order of the LEDs should cycle from 1 through 4 and repeat. When S2 is set to automatic, the LEDs should sequence automatically at a rate that should vary as potentiometer R12 is adjusted.

Connect cameras to J1–J4 and

continued on page 45

PARTS LIST FOR THE VIDEO SWITCHER

SEMICONDUCTORS

IC1—MAX454 multiplexer, integrated circuit (MAXIM)
IC2—CD4017 decade counter, integrated circuit
IC3—LMC555 timer, integrated circuit
IC4—78L05 voltage regulator, integrated circuit
IC5—79L05 voltage regulator, integrated circuit
Q1–Q4—MPSA14, NPN transistor
D1–D4—1N914, silicon diode
D5, D6—1N4004, silicon diode
LED1–LED4—Light-emitting diode, red

RESISTORS

(All resistors are $^1/_8$-watt, 5% units unless otherwise noted.)
R1–R4, R9, R15—75-ohm
R5—150,000-ohm
R6—620-ohm
R7—1100-ohm
R8—1000-ohm
R10—10,000-ohm
R11—51,000-ohm
R12—1 megohm potentiometer, panel-mount
R13, R14—100,000-ohm

CAPACITORS

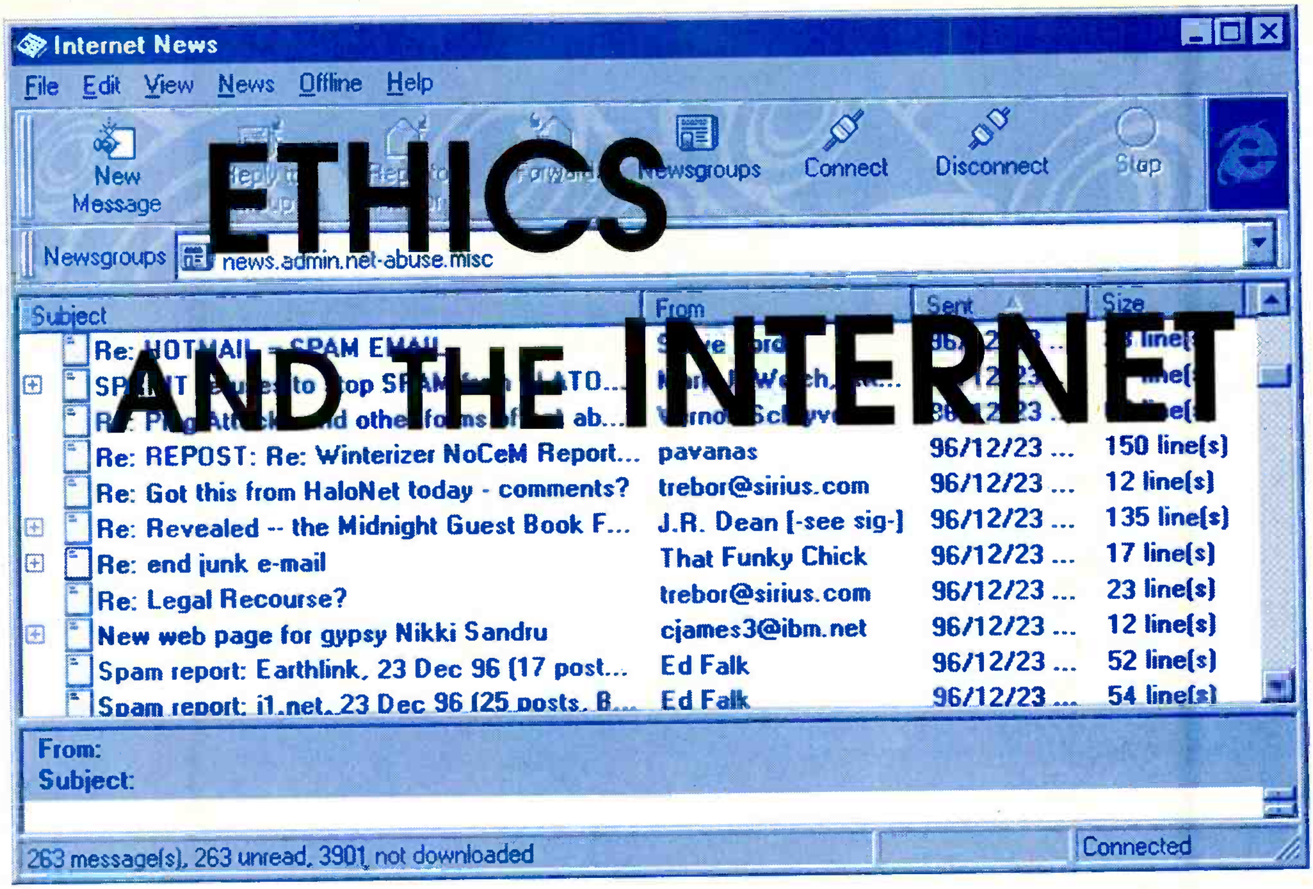
C1, C2, C5—0.1-µF, 50-WVDC, metalized film
C3—6.8-pF, ceramic-disc
C4—10-µF, 50-WVDC, low-leakage electrolytic
C6, C7—470-µF, 25-WVDC, electrolytic
C8, C9—100-µF, 16-WVDC, electrolytic

ADDITIONAL PARTS AND MATERIALS

S1—DIP switch, 3-position
S2—Toggle switch, single-pole double-throw, one momentary position (Digi-key CK1028-ND or similar)
J1–J5—Video connector, chassis-mount, "F"-type
T1—9-volt AC wall adapter
PC board, IC sockets, LED holders, 22-gauge hookup wire, knob, enclosure, hardware, etc.

Note: The following items are available from: American Electromechanical, Inc., 134 Van Voorhis, Wappingers Falls, NY 12590, e-mail: aei@vh.net: Complete kit of parts including etched and screened PC board and drilled enclosure, $70.00; PC board with assembly instructions, $22.00. Please include $5.00 for kit and $3.00 for board to cover shipping and handling. NY residents must add appropriate sales tax.

ETHICS AND THE INTERNET



How to avoid the highwaymen as you travel on the "information superhighway."

MICHAEL A. COVINGTON*

Will Rogers once said, "The trouble with the world is not ignorance. It's the things people 'know' that aren't so." That's certainly true of the Internet. To many people, it's a personal soapbox, a refuge from law and order, or a gigantic video game.

But the real Internet is none of those things. As its name implies, it's a network of networks. The Internet is not a company or organization, and it is not regulated by the FCC or any other government agency. It's a loose federation of computer sites that agree to link their computers together.

The Internet started in the 1960s as a Defense Department experiment, and until 1990 it was purely a network of universities and research labs. Nowadays, most people access the Internet through commercial access providers such as CompuServe and America OnLine, which were originally separate networks.

How the Internet Works. The Internet provides three basic services: electronic mail (e-mail) from individual to individual, open discussion forums (newsgroups) on almost 30,000 subjects, and the ability to publish "web pages" and file libraries for others to see. All of those services rely on the rapid forwarding of data from site to site. Crucially, the Internet has no headquarters; there is no central site that all messages go through. Messages take whatever path is convenient at the time. Because there's no central node, censoring the content of messages is physically impossible; the significance of that statement will become apparent as we continue this discussion.

Figure 1 shows how a message might go from site in Athens, Georgia, to a site in Phoenix, Arizona. The complete path involves 14 computers, 6 cities, and 3 long-distance carriers. Each site picks up each data packet and passes it on. Further, successive packets in the same session don't necessarily follow the same path.

In the early days of the Net, sites transmitted information for each other free of charge, voluntarily. Nowadays, most inter-site communication takes place over "backbones" set up for the purpose, but some of the costs are still hidden from the users. For example, all e-mail sent into The University of Georgia travels over a line leased at the University's expense, regardless of where it came from.

That's the key to Internet ethics: You never know exactly who's paying the bills, so *you are always someone else's guest.* The fees that you pay to America OnLine, for instance, only pay for America OnLine's equipment, not the rest of

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the network. That's radically different from the way telephone companies and post offices work. If you mail a letter or make a phone call to England, part of the postage or telephone charge will go to the British post office or telephone company. But the Internet doesn't work that way. When you send e-mail to a CompuServe user, CompuServe pays the cost of delivering it. Other sites along the way might also incur expenses.

Junk Mail And Spamming. The concept above partly explains the furor over junk mail and "spamming" (massive posting of ads in irrelevant discussion forums). It's not that people object to advertising; there are many places on the Net where ads are welcome. The problem with junk mail and spamming is that they impose enormous expenses on unwilling victims. It's as if pesky telephone solicitors were calling collect.

Spamming started in April 1994 when two Arizona lawyers, Laurence Canter and Martha Siegel, posted an ad on 8,000 newsgroups offering their services to help immigrants get "green cards." This provoked thousands if not millions of angry complaints as every news site in the world suddenly found 8,000 copies of Canter and Siegel's ad on its disks. The Internet community was frustrated at not having the physical or legal means to stop the spammers. About a year later, there was a wave of spamming from the Albuquerque area, but it ended as the perpetrators apparently realized that getting a million people angry at you is much worse than being sued or jailed.

Since then, those who oppose spamming have sharpened their weapons. Many argue that spamming and junk e-mail are illegal under 47 U.S.C. §227, the law that forbids "junk faxes;" that hasn't been confirmed in court, but if it's not true, it ought to be. And in a noteworthy court decision last November, America OnLine won the right to refuse to deliver unsolicited e-mail sent to its subscribers by a junk mailer, Cyber Promotions, Inc. The court ruled that mass mailers don't have a constitutional right to

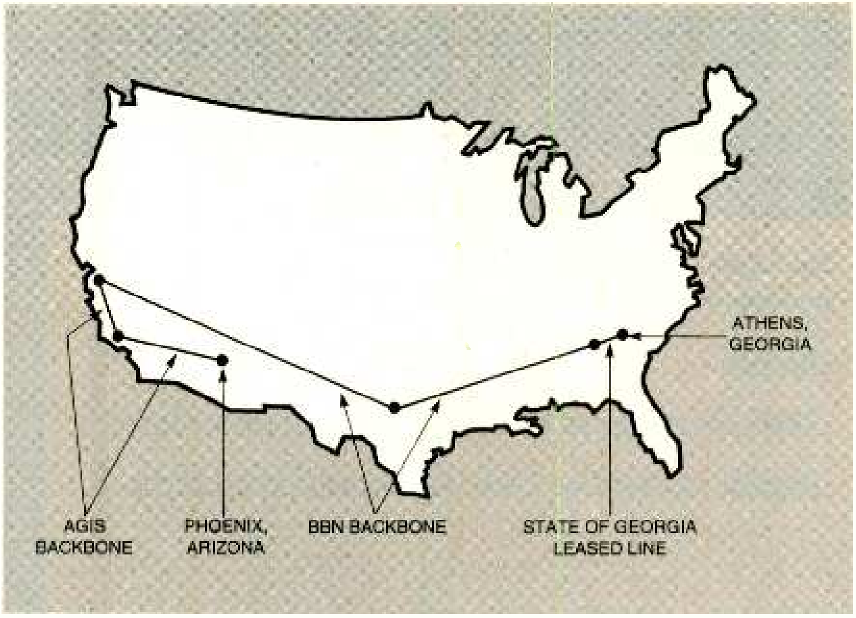

Fig. 1. To travel from Athens, Georgia, to Phoenix, Arizona, a data packet must travel through 14 computers, 6 cities, and 3 long-distance carriers.

clog up other people's computers.

Today, responsible service providers don't tolerate spamming; it is a violation of almost all acceptable-use policies, and the first incident almost always results in the termination of the offender's account. Aside from good manners, there's a practical reason for that—Internet providers realize that the resulting flood of complaints generated by a spam will render their own machines inoperative.

Even so, spamming still takes place. There are rogue sites that seem to exist for no other reason. Also, spammers have mastered the art of using fake addresses and other petty deceptions. Another trick used is to create an account with a fake name, send out a solicitation, and then move on to another unsuspecting provider

If you encounter unwelcome advertising in a newsgroup, discussion forum, or e-mail, *don't* post a reply in the same forum; that just compounds the problem. *Don't* reply to the "from" address, either; it's likely to be fake, and it may be the address of an innocent victim, or a site that the perpetrator wants to flood with complaints. Check the newsgroup news.admin.net-abuse.misc to see what others know about the incident. If the spamming appears to involve illegal activity or fraud, contact the National Fraud Information Center (http://www.fraud.org).

Scams and Pyramids. The most common Internet crimes are frauds and con games. One of those is the so-called "Make Money Fast" pyramid scheme: Send $5 to the first person on the list, take that person's name off, add yours at the bottom, and e-mail it to 100 of your friends. Thousands of dollars will supposedly pour into your mailbox.

There's no way this scheme could work; money doesn't come out of thin air, so there's no way everybody could receive more than they send out. That's why the law considers pyramid schemes to be theft or fraud. What usually happens is that a few people make money at the beginning, but thousands more, farther down the line, get nothing. Those schemes are illegal throughout the U.S.

If you need further proof of the foolishness of those schemes, consider the recent situation in Albania. There, with apparent government backing, thousands of individuals invested their life savings in these pyramid "investment" plans. When the plans collapsed, the ensuing unrest nearly broke out into civil war.

Naturally, business fraud and false advertising abound on the Internet. The type on your screen

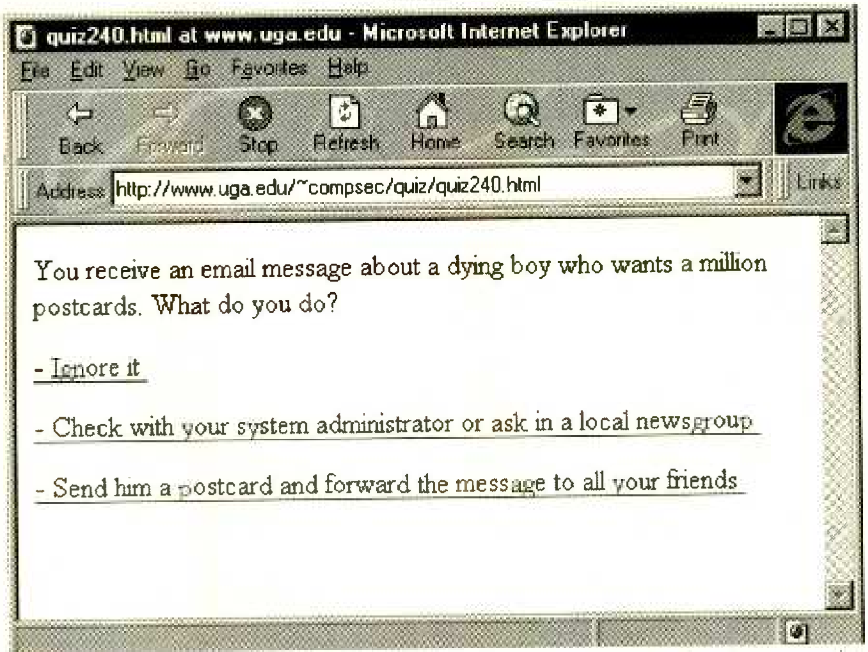

Fig. 2. Are you street-wise on the Information Superhighway? Try this quiz at http://www.uga.edu/~compsec/.

looks the same whether or not the words are honest, and people are easily taken in. The FDA has recently expressed concern about medical quackery on the Internet.

Hoaxes abound, too, as does out-of-date information. Every few weeks we hear (falsely) that the FCC is about to ban religious broadcasting, and a dying boy's appeal for postcards has been circulating, often with false addresses, since 1989. The University of Georgia forewarns people about these hoaxes, and many other net ethics issues, with an online quiz (Fig. 2).

Speaking of hoaxes, contrary to widespread rumor, viruses don't arrive in text-only e-mail, or by reading a message in a newsgroup (though you do have to be wary of programs or word-processor documents that are delivered as e-mail attachments). The only way for a computer to get a virus is for it to run (not just download or view) an infected program. A widespread hoax says that if you receive e-mail titled "Good Times" or "Deeyenda," your computer will be infected. That's not true, and the hoax has wasted lots of time and money.

That's not to say that computer viruses are not a problem, though much less of one than the media would have you believe. If you download programs from the Internet, common sense dictates that you check it with anti-virus software before running it.

Forgery on the Net. Forgery is presently a serious problem. Last September, an ad for child pornography appeared in thousands of newsgroups. It gave the name and address of a man in New York who turned out to be an innocent victim—somebody else was trying to frame him, or at least flood his computer with angry e-mail. That same month, students at the University of Georgia received, by e-mail, official-looking threats of disciplinary action that turned out to be fake.

If something on the Net looks like it might be fake, it probably is. There's no guarantee that an e-mail message or newsgroup posting actually came from where it says. Some software lets the sender give any name and e-mail address whatsoever.

Figure 3 shows one way to spot fakes. Each piece of e-mail or newsgroup posting arrives with a path indicating how it reached you. To see the path, you might have to set up your newsreader to show all headers. If your newsreader does not give you that capability, you might have to save the message to a file and view it with a text editor. If the message wasn't sent from the site it claims to have come from, something is amiss. That test isn't bulletproof; it's possible to fake part of the path, but it is hard to fake all of it.

Dirty Pictures? Unfortunately, no discussion on Internet ethics would be complete without a word or two on a topic that has gotten big publicity—online pornography. Because the Internet is a totally open communication system, it will inevitably contain some pornography along with everything else. It's not like a school library; it's more like a city street. Pornography does not intrude into other communications; you have to go looking for it.

Still, Internet users have to obey obscenity laws like everyone else. Enforcement so far has been lax, but would be easy to tighten up because web pages are easily traceable to their owners. Obscenity laws restrict what you publish or redistribute, not what you view, and they apply only to material that meets a legal test of obscenity—they do not ban all sexual content or bad taste.

The Communications Decency Act of 1996 muddied the waters by trying to prohibit "indecent" communications, not just obscene ones. That is a much heavier restriction, and parts of the law were immediately declared unconstitutional by a Pennsylvania district court. The problem is that the framers of the Act seem to have thought that service providers control the contents of the Internet. As we saw earlier, they don't, and they can't.

But decency remains a serious issue if the Internet is to be usable by schoolchildren, and private organizations are stepping in to do what government can't (and shouldn't): promoting voluntary standards of decency and rating the suitability of web pages and newsgroups for children. At least two companies, Cyber Patrol and Surfwatch, presently do this. Teachers and parents can set up their Internet software so that students can only access approved materials.

The Future. The two biggest problems with the Internet today are that the costs are too well concealed (which leads to the spam problem), and there is no proof that messages actually came from where they say (which makes financial transactions impossible). Fortunately, both problems are solvable.

Concealment of costs, of course, goes back to the days when the Internet was a subsidized research network. Now that the Net is commercial, too many things are still being paid for by the wrong people. Junk e-mail would disappear if the sender had to pay for the delivery of every single copy. This isn't a technological issue; it's just a matter of accounting. Telephone companies and post offices solved the same problem long ago.

Authenticating the origin of messages is harder, but several systems are being developed. They all rely on "public-key encryption"—that is, codes with two "keys" or passwords, one for encoding and the other for decoding. The idea is that you tell people your decoding password but keep your encoding password secret. Then, any messages that decode successfully with your decoding password must have come from you, because nobody else can encode messages that way.

Besides making it possible to send credit card numbers and even "digital cash" over the Net, reliable authentication will practically eliminate problems with spamming and forgery. After all, every message will be traceable to its origin, or at least, false addresses will be immediately recognizable. People who want to communicate anonymously can still do so, but it will be obvious that their addresses are being withheld, and some people might refuse to accept such communications.

But the real future of the Internet is probably unforeseeable. After all, no one predicted web pages, spamming, public-key encryption, or even word processing; these developments, good and bad, were sudden, unexpected developments. There's no telling what will come next. Ω

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Received: from mailhost.myisp.com
  (mailhost.myisp.com [204.180.128.167])
  by aisun1.ai.uga.edu (8.8.5/8.8.3)
  with ESMTP id LAA07898 for <mcovingt@ai.uga.edu>;
  Tue, 28 Jan 1997 11:10:13 -0500 (EST)
Received: from xyz01
  (alpha.myisp.com [204.180.128.141])
  by mailhost.myisp.com (8.8.4/8.8.4)
  with SMTP id LAA06952 for <mcovingt@ai.uga.edu>;
  Tue, 28 Jan 1997 11:10:10 -0500
Message-Id: <199701281610.LAA06952@mailhost.myisp.com>
X-Sender: doofus@somewhere.com
X-Mailer: Windows Eudora Version 1.4.4
Mime-Version: 1.0
Content-Type: text/plain; charset="us-ascii"
Date: Tue, 28 Jan 1997 11:11:59 -0600
To: Michael Covington <mcovingt@aisun1.ai.uga.edu>
From: doofus@somewhere.com (Get Rich Quick Guy)
Subject: Amazing wealth awaits you!
Status: RO

Join our mailing list and money and free phone cards will
pour into your mailbox.  It's perfectly legal and the police
don't know about it because blah blah blah...
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Fig. 3. In this maze of headers are the clues you need to spot a fake: The point where the message was mailed (in bold-face type and underlined) doesn't match sender's return address (in bold-face type and underlined).

VIDEO SWITCHER

(Continued from page 41)

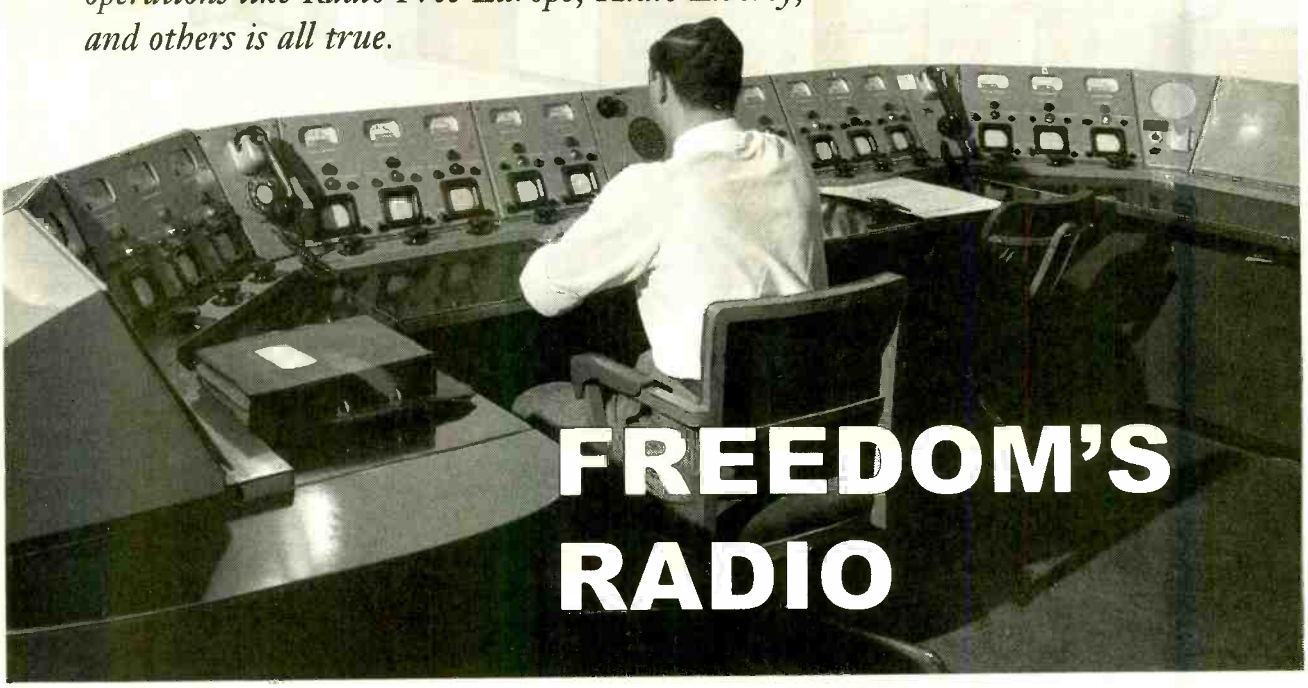
a monitor to J5. The video signal on the monitor should switch from camera to camera according to the LEDs.

After testing is completed, drill appropriate holes in a suitable enclosure for J1-J5, LED1-LED4, S2, and R12. Mount the board in the enclosure using the mounting hardware for J1-J5 to hold it in place. Mount R12 and S2 in the front panel and bend the LEDs so they fit through the holes in the panel. The hole for the T1 wire should be drilled at a point where the two halves of the enclosure meet. Tie a knot in the wire for strain relief and place the wire in the enclosure hole with the knot on the inside of the enclosure before closing the case.

That completes the project. If all has gone well, as is likely, your video switcher is now ready for use. Ω

It may read like a spy novel, but the story behind operations like Radio Free Europe, Radio Liberty, and others is all true.

STANLEY LEINWOLL



FREEDOM'S RADIO

An era has ended: The Berlin Wall has come down, and Communism in Europe is dead. We've won the cold war! A key element in that victory was America's "black-radio" operations. In light of that, it is a bit ironic that the future of the radio operations that enhanced U.S. policy for more than four decades is in doubt.

The success of black radio—broadcast operations that were funded clandestinely by the CIA and other intelligence organizations, whose purpose was to spread discontent, in some cases to disinform, to encourage counter-revolutionary activities, and, ultimately, to free the peoples who were under the yoke of Communist tyranny—was unprecedented. With major black-radio operations long since ended, and the survival of the broadcast organizations that succeeded them in jeopardy, it is appropriate to recall the early history of those broadcast operations, including the spying and counter-spying, dirty tricks, espionage and counter-espionage, poison plots, intelligence gathering, a bombing, and at least three assassinations. In short, to tell the story that, due to security reasons, could not be fully told before now.

Genesis. On July 4, 1950, a 7½-kilowatt, mobile shortwave-broadcast transmitter, code-named Barbara, went on the air with programs in Czech and Slovak from a secret location in the woods of southern Bavaria, near the Czech/German frontier. Calling itself Radio Free Europe (RFE), it was to become America's most successful black-radio operation. The station, which was funded by the newly formed Central Intelligence Agency, began a hard-hitting campaign intended to roll back the Iron Curtain and liberate the peoples of East Europe from Communist domination.

The decision to fund a clandestine anti-Communist radio station had been made a year and a half before, following the overthrow of the Czech government by the Communists. The CIA had come into existence during the summer of 1947, with the passage of the National Security Act. Originally envisioned as an intelligence-gathering organization, the role of the CIA quickly expanded to include other functions, one of which was the dissemination of disinformation.

In 1948 President Truman had appointed a three-man commission to evaluate the operation of the CIA. One of these men was Allen W. Dulles, a firm believer in broadly expanded operations for the CIA, including undercover political and military activities. After the presidential election of 1948, Dulles reported to President Truman, proposing the inauguration of covert radio operations beamed behind the Iron Curtain and aimed at counter-revolution within the Soviet bloc.

In February 1949, within weeks of Dulles's recommendation, preliminary discussions were held, which led to the formation, in May of that year, of the National Committee for a Free Europe (NCFE), and its subsidiary, Radio Free Europe. Allen Dulles, who in 1951 was to become the Deputy Director of the CIA, and its Director in 1953, was the first President of the NCFE. Exiled anti-Communist nationals from East European RFE-target countries were recruited. Among its first employees were high-ranking former government officials, ex-diplomats, statesmen, authors, and other prominent individuals.

Radio Liberty. In 1951 a sister organization was formed. Calling itself the American Committee for the Liberation of the Peoples of the USSR, AmComLib, as it would come to be called, was a lower profile operation from the outset. There were many reasons for keeping this service under wraps, including the vastness of the Soviet Union, the many ethnic divisions within it, and the fact that because the USSR lay at the very heart and soul of Communism, AmComLib was to be a much harder hitting organization.

Radio Liberation, the shortwave broadcasting arm of AmComLib, went on the air from a transmitter site in Germany in March 1953. Within minutes of its first broadcast, heavy jamming started, and it would not end for 35 years. Until RFE and Radio Liberation, later called Radio Liberty, then RL for short, merged in 1975, the two organizations were funded from the same CIA sources, and maintained as separate entities.

Radio Free Europe was the first secretly funded CIA political operation, and to assure adequate cover for the organization, a division of the NCFE, called the Radio Free Europe Fund, was set up to raise money from private contributions. In the almost 40 years the RFE Fund existed, private contributions never amounted to more than five percent of the total RFE budget.

The station was directed from CIA headquarters in Washington, D.C., in a division called Policy and Planning, East Europe (PPEE), and several dozen PPEE officials were transferred to RFE, both to its main office in Munich, Germany, as well as to its New York City headquarters. Radio Liberty was also directed from different locations in both Munich and New York City. The organizations maintained these headquarters for 21 years, during which period they expanded steadily. In 1971, what had been a poorly kept secret became public knowledge: CIA ties were well publicized, and pressure began to mount to terminate both RFE and RL, which were referred to by Senator William Fulbright as "relics of the cold war."

During the first six years of its operation, until the ill-fated Hungarian revolution in 1956, RFE hit hard and often at the twin themes of Communist oppression and tyranny. The station's first day of programming was chosen to coincide with America's Independence Day, to remind its listeners of the long history of man's struggle for freedom. On Bastille Day, July 14, 1950, RFE expanded its programming. This day is known to Europeans as a celebration of the spirit of freedom.

Radio Free Europe's first transmitter, a 7½-watt mobile transmitter code-named Barbara, operated on the Czechoslovak–West-German border.

Jamming. The Communists jammed Radio Free Europe Czechoslovak and Bulgarian broadcasts from the day they went on the air until the cessation of jamming in late 1988 and early 1989. All Radio Liberty broadcasts, including Russian, Ukrainian, and 15 other nationality languages of the Soviet Union were jammed from their first days in the early 1950s until the cessation of jamming of all languages of the Soviet Union on November 29, 1988.

In the field of international broadcasting, the term "jamming—causing deliberate interference to a broadcast by transmitting noise on the same frequency in order to make reception impossible—is well known to shortwave listeners, because even today some jamming continues. The People's Republic of China, for example, jams some broadcasts of the Voice of America, as well as those of Radio Free Asia. Jamming noises are intended not only to prevent reception, but also to make listening so annoying that even attempts to listen are discouraged. In the early days of jamming the noise was created mechanically and transmitted via recordings. As jamming, particularly from the Soviet Union, became more sophisticated, jammers transmitted "white noise," which was produced electronically, and covered the entire range of the audio spectrum. And with the increased sophistication of the system, the number of jamming transmitters increased, as well. At its peak, the Soviet jamming network consisted of between 2,500 and 3,000 transmitters, ranging in power from 20 kW to more than 100 kW.

Although jamming was clearly a means of censoring material that the Communists wanted to keep away from their people, it was recognized early in the development of the Soviet jamming system that it was also a potentially powerful military weapon. In the period after World War II, most military communications were carried on shortwave, and the Soviet jamming system, if turned against an enemy, could clearly disrupt communications between and among enemy military forces. It was therefore, decided that it was in the United States interests to learn as much as possible about the Soviet system.

Keeping East and West separate was deadly business for the East. Here border guards are laying mines along the Austria–Hungary border.

The Technical Evaluation Advisory Committee (TEAC). In the 1950s, after RFE and RL were established and expanding, the Soviet jamming system was growing exponentially. Radio Liberty carried Russian and 16 nationality languages, which many of us hadn't even heard of, including Tatar Bashkir, Turkmen, Kazakh, Kirghiz, Tadjik, Uzbek, and others. To cover those, the Soviets were required to build jamming-transmitter stations throughout the Soviet Union, as well as in some of its satellites. Furthermore, in order to provide an effective jammer network, they had to have extensive monitoring of the unwanted transmissions, as well as command and control centers that could call up jamming transmitters as they were needed to cover a particular language in a particular area. In order for them to know which jamming transmitters were being heard in any given target area, they developed a system of "Idents", two letter call signals in International Morse Code that were transmitted roughly every minute.

The "ident" AR, for example, was located in the Moscow area. How did we know this? Primarily by "df-ing"—using direction finding equipment to lock onto the jamming transmitter from at least two different distant locations, and triangulating onto the jammer site. In the 1950s we did not have satellite reconnaissance to spot large transmitter complexes from space, and the work had to be done by direction finding and triangulating, or by having people inside who drove around the countryside with a shortwave receiver trying to locate jamming stations.

Each jammer complex carried with it a unique "ident" that was specific only to a single location. Jamming centers in the East European satellite countries were identified by a letter-number or a number-letter "Ident." For example, the "ident" L7 was located near Sofia, Bulgaria.

The "idents" were required for Soviet monitors. Located at literally scores of crucial points within the Soviet orbit, they listened to every hostile frequency carrying broadcasts earmarked for jamming. If they were able to hear an unwanted program, they communicated with jammer locations thought capable of providing signals strong enough to interfere with the hostile programs. If one location was not providing enough jamming, they called in another, and, if necessary, another, until the program was obliterated.

Some of us in the West established technical monitoring stations to determine how well we were doing. Full-time technical monitoring posts were set up on the periphery of our target areas. They listened to our broadcasts, every language, every frequency, every hour of the day. In addition, those monitors, who were generally amateur-radio operators and knew International Morse Code, were required to report to us any interference to our broadcasts, whether it was from another broadcaster (unintentional interference),or jamming (deliberate interference). They were also required to log all "idents." Such logs provided extensive and very valuable information about the makeup and distribution of the Soviet and satellite jamming system.

In order to make the most of the information contained in those monitoring logs, the Technical Evaluation Advisory Committee (TEAC) was created. It consisted of a Chairman and Vice-Chairman (both CIA people), representatives from the broadcasters (VOA, RL, and RFE—the latter represented by the author), a team of radio-propagation specialists from the Commerce Department, and several observers. We met weekly at CIA headquarters, went over all the monitoring data that had been analyzed the previous week, and began to prepare "Top-Secret" maps of the jamming system. Each week or two we selected several "idents," and had monitoring stations with direction-finding equipment look at these idents every hour. Generally, at least three, sometimes many more, direction-finding stations reported regularly.

In a matter of a few years, we had detailed maps showing where each jamming complex was located. In the event of war, those locations were high on the list of priority targets. Later on, we also began to obtain aerial (low-altitude and earth-satellite) photos of those stations, and we were able to determine how many antennas were located at each complex, what their characteristics were, and in what direction their energy was being radiated.

Eventually, the Soviets got wind of what we were doing, and in the mid-1960s they began to change the "idents" every two weeks. By then it was too late; the direction-finding stations had increased, satellite photos were taken routinely, and we had pretty much precisely pinpointed every jammer complex throughout the Soviet empire.

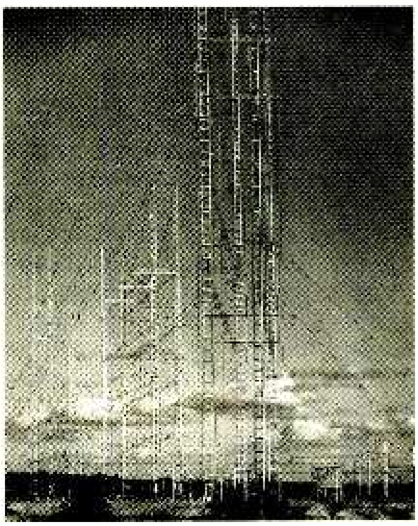
The Winds Of Freedom. The activities of the NCFE were not limited to radio broadcasting alone. In 1951, The Winds of Freedom project was inaugurated. Two thousand helium-inflated weather balloons, carrying more than two million leaflets, were launched into Communist territory from a location near the German-Czech border. The prevailing winds carried those balloons aloft over Czech territory. When the balloons reached an altitude of about 30,000 feet, they burst, releasing their cargo of leaflets.

The idea had been proposed by Allen Dulles, who had read of a similar exploit by the Russians over Yugoslavia in 1948. The operation was organized in a division of NCFE, the Free Europe Press, which was responsible for the dissemination of printed anti-Communist propaganda oriented toward RFE's East-European target countries. The first balloon was launched on August 13, 1951, and the first leaflets carried the following message to the citizens of Czechoslovakia:

To the People of Czechoslovakia:
A new wind is blowing.
A new hope is stirring.
Friends of freedom in other lands
have found a new way to
reach you.
They know that you also want
freedom.
Millions of free men and women
have joined together and
are sending you this message of freedom, which in
the upper air always blows
from West to East.
An oppressor has brought slavery to your proud country.
He has tried to cut you off
completely from your
friends in the free world. But
he has failed.
We are in touch with you daily
by radio.
Now, we take this new way of
extending our hand to you.
There is no dungeon deep
enough to hide the truth,
no wall high enough to
keep out the message of
freedom.
Tyranny cannot control the
winds, cannot enslave your
hearts.
Freedom will rise again!

The project was an enormous success, and by 1954 regular launching had been inaugurated into Czechoslovakia, Hungary, and Poland. Those leaflets were primarily small newspapers published twice weekly, giving news of the goings on in the Free World, and carrying anti-Communist propaganda.

Because of their vulnerability to the leaflet barrages, and the popularity of the leaflets among the populace, the Communists carried out violent attacks on the balloon operation. MIG jets were routinely sent up to shoot as many balloons down as possible; protests were sent by the Communist bloc through diplomatic channels; campaigns among the youth were organized to locate and confiscate the leaflets. Two sabotage missions were attempted. Communist agents were sent to blow up the balloon launching sites. But Western agents got wind of the plots and thwarted them. The Soviets even claimed that the balloons carried germs, explosive charges, and incendiary pellets.



To overcome jamming, high-gain, highly directional, curtain-antenna arrays like this one in Gloria, Portugal were used.

After making numerous veiled threats to RL employees, the Soviets acted: During 1954, two RL employees in Munich were assassinated. A Russian, Leonid Karas, was found drowned in a local river under mysterious circumstances. A little more than six months later the head of the RL Azerbaijan service was found shot to death. The perpetrators of these crimes have not been found to this day.

The turning point in the Winds of Freedom project came in the winter of 1955, when balloon-launched leaflets carried a message from the enormously popular President Eisenhower, which said, in part, that "the American people share your faith that right in the end will prevail to bring you once again among the free nations of the world."

The leaflets were hurting the Communists more and more, and something had to be done. In January 1956 the Soviets, who had thus far remained in the background, got into the act. They protested vehemently that Soviet air space had been violated by RFE balloons, and that unless something were done, retaliatory measures would be taken, since the balloons constituted a threat to commercial air traffic. Shortly afterward, a Czech airliner crashed in the Tarta mountains, killing 22 people. The Czechs immediately sent a strongly worded protest to Washington, blaming the crash on the balloons. Unconfirmed reports in some Western circles held that Soviet MIGs had shot down the Czechoslovak airliner to provoke a confrontation. The Czech government and the Soviets were planning to protest the balloons in the United Nations, and the CIA learned that there was a plan afoot to cut off all Berlin air corridors because of the claimed danger to air traffic from the balloons. There was a distinct possibility, therefore, that continued escalation could lead to World War III.

In February 1956, Secretary of State John Foster Dulles, brother of the CIA Director, reluctantly terminated all U.S.-sponsored balloon flights, but not before some heated debate within the National Security Council. The Winds of Freedom had been one of the most successful CIA operations, and it was not without considerable regret that the project was finally canceled.

In all, more than half a million balloons were launched toward the East. They had carried some 300 million leaflets and newspapers to readers behind the Iron Curtain. Approximately 40-million cubic feet of helium gas had been consumed during the project.

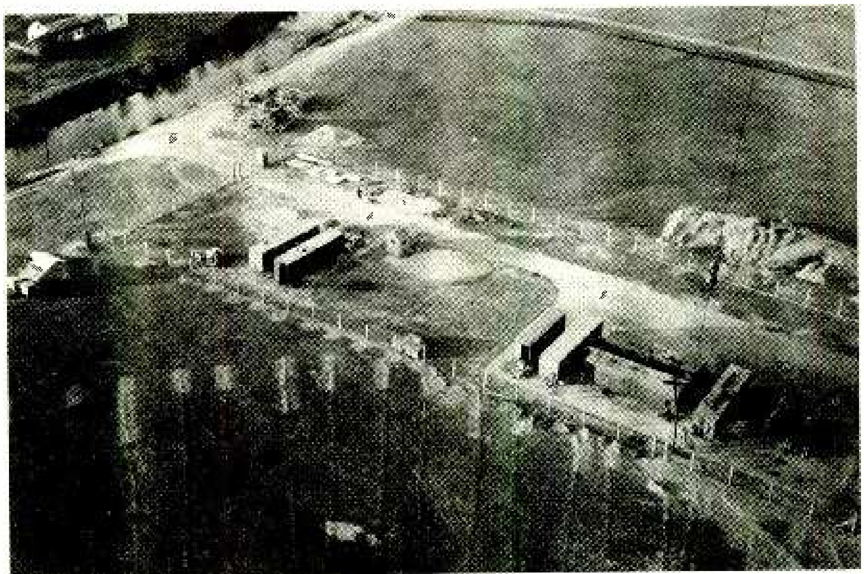
The Hungarian Revolution. The year 1956 marked another major turning point in the history of Radio Free Europe. In October, violent and widespread demonstrations broke out in Hungary, and in a short time, a full-scale revolution erupted. Ultimately, the Soviets sent in several armored divisions, and a blood bath ensued. The uprising was suppressed, but a storm of protests erupted. It was widely held that the broadcasts of Radio Free Europe had encouraged the Hungarian freedom fighters with promises of Western military assistance. After investigations by the German government, as well as an internal probe, RFE was exonerated, but a controversy continued about RFE's role in the ill-fated uprising. Crucial tape recordings of some of the RFE Hungarian programs carried during the revolution were never found.

A footnote to the enigma emerged in September of 1996, when documents were released in Budapest at a conference on historians' access to cold-war documents. Among the documents from Budapest, Moscow, and Washington was a memorandum from a CIA advisor which noted that a broadcast carried on October 27, 1956 "fairly clearly implied that foreign aid would be forthcoming if the resistance forces succeeded."

It was the failure of the Hungarian uprising that led to major changes both in RFE and RL broadcast policy, which ultimately led to making those stations among the most respected, authoritative, and effective broadcasters in the world. It had become apparent to CIA and Department of State policy makers that the Soviets would not tolerate the overthrow of Communism either within its own borders, or within those of its East-European satellites, and that carrying material that would in any way encourage overthrowing Communism would not be in the interests of the United States.

An official CIA paper issued directives to RFE and RL executives outlining guidelines that, in essence, dictated changes in programming objectives. Program policy would henceforth support change by reform rather than by revolution. The stations were to bring listeners comprehensive, accurate, uncensored news and commentary not available inside the Iron Curtain by any other medium. They were to become, in essence, home services in exile, and were referred to thereafter as surrogate broadcasters. As an adjunct to the changes made in the organizations, the name of Radio Liberation was changed to Radio Liberty.

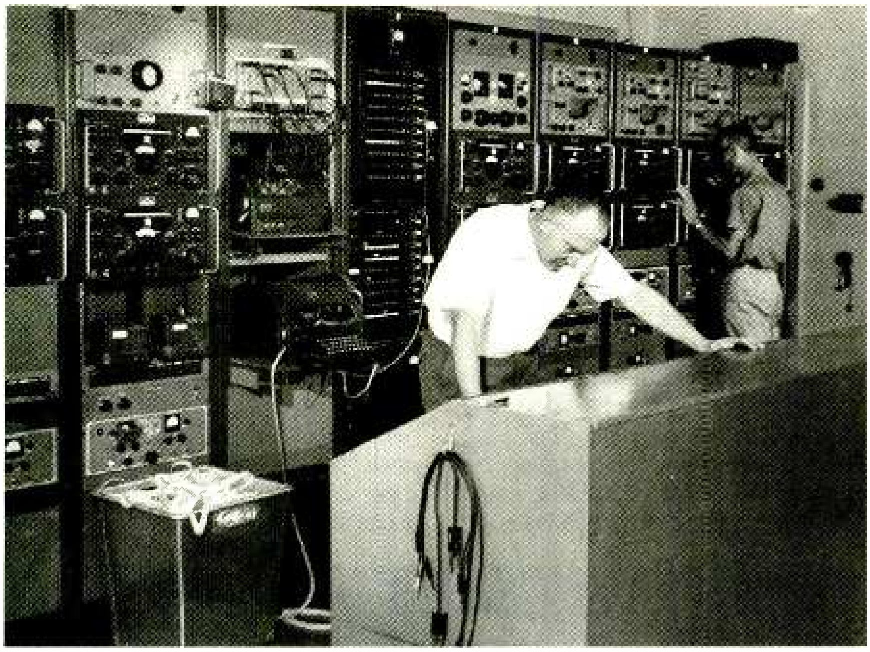
In their heyday, the stations were the most popular and most listened to Western broadcasters in their target areas, which included Russia, 16 Soviet Republics, and five East-European countries. (Bulgaria, Czechoslovakia, Hungary, Poland, and Romania). In the 1980s, long after the CIA connection had been severed, the RFE/RL network consisted of one medium-wave and 54 shortwave transmitters, at six sites in Germany, Spain, and Portugal. From the modest beginning of a single 7½-kilowatt transmitter, total power in its prime exceeded 12,500 kilowatts—enough to supply electricity to a medium-sized city.



This 50-kilowatt mobile transmitter, code named Eagle, failed in its mission in Europe, but was later used successfully to broadcast to Cuba, and in Vietnam.

The Eagle That Became A Swan. In 1953, Radio Free Europe put a 50-kilowatt, mobile, medium-wave transmitter on the air. That added to its growing complement of shortwave transmitters, which were now operating from two sites in Germany, and one near Lisbon, Portugal. There already was one medium wave transmitter operating near Munich, Germany. The second medium-wave transmitter was intended to give the organization more flexibility, because a mobile transmitter would be capable of moving along the border of Czechoslovakia, or could even be moved to another country.

The transmitter was housed in a van, and its operation was ill-fated from the start. The frequency cho-



Monitoring stations, like this one in Schleissheim, Germany, kept tabs on the goings-on behind the Iron Curtain.

sen for its broadcasts was 854 kHz, which was the primary frequency of Radio Bucharest. That frequency had been used with low power by the Armed Forces Network (AFN) in Berlin, and some high-level negotiations were required to get the station to agree to dropping the frequency so that RFE could use it. AFN moved to another frequency, and almost immediately began complaining that coverage was not as good as it had been previously on 854 kHz.

Mutual interference between RFE and Radio Bucharest was severe, and what the powerful Bucharest transmitter didn't take out, jamming by the Czechs did. Sharp protests from the Romanian Government to the United States, and to Germany, which had recently signed a treaty with the United States, forced RFE to shut the transmitter down.

For a while it was hoped that the transmitter, code named Eagle, could be moved to another location outside Germany, but the prospects of finding another host government, or, for that matter, a suitable frequency, were hopeless, and the project was abandoned. In 1956, after the shutdown of Eagle, the transmitter was quietly shipped to the free port of Bremen, where it remained in storage for several years, until one of the chief Latin American policy planners in the CIA thought it would be useful to move the transmitter into the Caribbean and inaugurate a black-radio operation beamed toward Cuba. Thus, Radio Americas was born.

Eagle, still inside its van, was shipped to Swan Island, where it began operating against Castro's Cuba. It remained in service for some eight years, during which time it was a prime communications link into the Communist island, sometimes carrying messages to friends inside. The transmitter was then moved to Vietnam, where it conducted clandestine operations until the end of the war. While in Vietnam, the transmitter operated from an airplane, and was often referred to as The Blue Eagle.

ABOUT THE AUTHOR

Stanley Leinwoll has been involved in shortwave broadcasting for nearly half a century. He worked for the Voice of America from 1952–1957 when he joined Radio Free Europe. In 1975 he became Director of Engineering for both Radio Free Europe and Radio Liberty, continuing in that capacity until his retirement in 1993. Since then he was worked as a shortwave broadcasting consultant to private U.S. broadcasters.

Mr. Leinwoll has served on five United States Delegations to International World Administrative Radio Conferences; he has also written hundreds of technical articles, and his ten published books include *From Spark to Satellite—A History Of Wireless Communication*, *Shortwave Propagation*, *Space Communications*, and *Understanding Lasers and Masers*.

The Poison Plot. One of the more bizarre episodes involving RFE is generally referred to as "the poison plot." From the birth of the Radios onward, threats and intimidation were commonplace. The communists did everything they could to frighten RFE and RL employees.

The inside story of the "plot" was told by a former Major in Czech intelligence, who defected in 1968 when the Soviets invaded Czechoslovakia during the "Prague Spring." He had been involved in nearly 14 years of espionage activity. The idea had been dreamed up in the late 1950s by a vice consul in the Czech consulate in Salzburg, Austria. His scheme was to slip atropine into the salt shakers in the RFE canteen in Munich. Atropine can cause anything from diarrhea to death, depending on the quantity ingested.

What the Czechs did not know was that the man assigned the mission of putting atropine in the salt shakers was a double agent whose primary allegiance was to the CIA. Afraid that the atropine would harm some RFE employees, the agent blew his own cover by alerting RFE officials, who promptly advised German authorities. Although the agent had placed some atropine in the salt shakers, it was scarcely enough to cause more than mild stomach upsets in a number of RFE employees. The exposure of the plot resulted in a mad scramble by the Czechs to prevent the arrest of one of their most productive operatives in Germany, who happened to serve as contact man for the double agent.

One of Czechoslovakia's top intelligence officers entered Germany to bring his agent out. The agent was spirited out of the country in a wild automobile ride just as the German police were about to close in on him.

An RFE Scoop. The Radio Free Europe and Radio Liberty newsgathering structure was the most sophisticated and comprehensive in the West. Information gathering consisted of reports from various bureaus and news services throughout the world; the stations subscribed to newspapers and periodicals from all Communist capitals. Those were read and analyzed daily, reports were prepared and provided not only to each language service, but to the CIA representative in Munich as well. The average daily intake at the Central News Room in Munich was over one million words; in addition, close to 100 Communist radio stations were monitored daily, using advanced receiving antennas to pull in some of the more distant stations. Copies of RFE and RL analyses were also provided to other major broadcasting organizations including the BBC and VOA.

It was the work of the RFE monitoring network that led to major reforms in Poland late in 1970. A few minutes before midnight on December 15, 1970 a 52 year-old native of Poland was monitoring a Polish radio station at a site in Germany when there was a sudden interruption in the program and a bulletin announcing that rioting had occurred in Gdansk. What the RFE monitor heard was the first official word from Poland that violent demonstrations had taken place and that a curfew had been imposed by the Communists.

RFE immediately began carrying reports of the rioting, and by giving full and complete coverage to the stories during the days that followed, fueled further uprisings in other parts of Poland, which eventually led to the overthrow of the Polish Communist Chief, Ladislaw Gomulka. The Polish authorities were so desperate to keep the news of the riots from the people that they took transmitters normally used in Radio Poland's international shortwave service and re-scheduled them on RFE frequencies in an effort to jam the broadcasts. RFE's Polish programs had previously been clear of jamming.

An Ineffective Double Agent. The Communist governments to whom RFE/RL directed its broadcasts periodically attempted to infiltrate Munich headquarters with spies. By and large those missions failed, because very few RFE/RL employees were privy to the inner secrets of the organization. The employees who had such knowledge first had to go through detailed security checks, and were required to sign documents agreeing not to divulge any information about the organization. My own security checks included clearance up to and including "Top Secret." In addition, I received a special clearance after being briefed at CIA headquarters. The letters describing this clearance are themselves classified, and since they have no bearing on this story, will not be divulged here.

Radio Free Europe's central news room.

In the jargon of the CIA, a person who has been given detailed information is said to be "witting", and very few, if indeed any, foreign nationals working for the station were "witting." Consequently, spy missions by Communist agents infiltrating either RFE or RL frequently failed, and in the end they had to make up their own stories. In 1971, for example, one such spying mission was intended to get RFE and RL out of West Germany, where the Radios not only had their headquarters, but three transmitter sites, as well.

Andrei Czechowicz, a 34-year old Polish national, had been planted in RFE's news room since 1965. Czechowicz was actually a captain in Polish intelligence, but in six years in Munich, he learned nothing about the organization that had not already been printed in the newspapers.

Believing the time to be ripe for a campaign against RFE, the Polish spy was recalled to Warsaw, where he held a series of unconvincing news conferences and made three unimpressive appearances on Polish TV. The consensus among Poles who watched and listened to what Czechowicz had to say was that they didn't know what all the fuss was about, and, in fact, the publicity resulted in more than the usual number of listeners tuning in to RFE to determine for themselves what was going on.

The recall of the Polish captain was part of a big push against RFE, which included protests to the German government, and a threat by the Polish and Hungarian regimes that unless something were done about RFE they would withdraw from the 1972 Olympic Games, which were to be held in Munich.

The West-German government, which, under the leadership of Willie Brandt, had been attempting to build bridges to the East, was caught in the middle. What to do? Chancellor Brandt notified top U. S.

officials that he did not intend to renew the licenses of Radio Free Europe and Radio Liberty in Germany. President Nixon had been, and continued to be, a staunch supporter of the Radios, and he advised Brandt that if Germany failed to renew the licenses of RFE and RL he would withdraw all U.S. troops from Germany.

The licenses were renewed.

As a result of President Nixon's strong support, a secret compromise agreement was reached concerning the journalistic status of the Radios. During the 1972 Olympic Games, the Radios would carry only sports and music programs, and refrain entirely from anything that could be interpreted as political.

A Little Espionage On The Side. Communist charges of CIA involvement in RFE and RL were, of course, true, and the fact is that the organizations were engaged in activities that extended beyond the pale of surrogate radio. Station employees who were members of the CIA were involved in escape networks that aided Soviet and East-European residents who wanted to leave the Communist bloc. Employees in Munich maintained close contact with some residents inside to obtain information, and some members of the Communist press were on the CIA payroll, the purpose being, again, to obtain information.

Still another aspect of the organization's activities involved the questioning of Communist tourists while on holiday or business trips to the West. Trained CIA agents posing as poll takers, interviewed visitors from the East, ostensibly to determine their radio listening habits, but, in reality, they were highly attuned to the possibilities of defection, and, in cases where such tendencies were detected, to encourage such acts.

RFE And RL Officially Surface. In early 1971, Senator Clifford Case of New Jersey officially brought CIA financing of RFE and RL out in the open. Debate over the future of the Radios continued for several years, and two commissions were set up to study the effectiveness of the organizations.

The decision was made in 1973 to merge both Radios under a single Board—the Board for International Broadcasting (BIB), and by 1975 a single president of both Radios was named. Funding was to be through Congress, which would provide grants to the BIB, which would then be responsible for oversight of RFE/RL.

Another Assassination, And A Bombing. Although CIA funding of RFE and RL ended in 1971 the stations continued to grow in stature and were an increasing influence on Communist governments in East Europe and the Soviet Union. In 1969 a prominent Bulgarian writer, Georgi Markov, defected to Great Britain. The well-known novelist and playwright was a favorite of the Bulgarian President, Todor Zhivkov. On his arrival in London, Markov began to write his memoirs, which were broadcast weekly by Radio Free Europe, reaching an estimated half of the Bulgarian population. Those memoirs repeatedly called attention to the corruption within the Bulgarian Communist party, and of its President, who was totally controlled by Moscow.

Markov was repeatedly warned that if he did not stop writing for Radio Free Europe he would be killed. In 1978, while walking on a London bridge, he was attacked by an assassin who used the tip of an umbrella to inject a deadly poison, ricin, into his leg. He died four days later, but it was six months before a top-secret British chemical and germ warfare unit was able to determine the cause of death.

In early 1981, a group of Swiss, East-German, Hungarian, and Czech terrorists planted a powerful bomb consisting of plastic explosives along an outside wall near the RFE Czechoslovak service. The concussion was heard throughout Munich, and windows half a mile away were shattered. Fortunately, the bomb was set off in the late evening of a Saturday night, and casualties were kept to a minimum. Extensive investigations at the time failed to provide information about the bombing, and it was not until recently, after an examination of the files of the former East-German intelligence agency, known as "STASI", was conducted, that details of the bombing were unearthed. The bombing reflected intense Communist hostility toward Radio Free Europe, which continued until the fall of Communism.

To some extent, hostility toward RFE and RL continues to this day.

What The Future Holds. Toward the end of 1993, Radio Free Europe, Radio Liberty, and the Voice of America were combined within the United States Information Agency under a single Board of Directors. The combined entity is called the International Broadcasting Bureau (IBB). A power struggle ensued within the IBB almost immediately. Seventeen top engineers of RFE/RL resigned; three primary RFE/RL transmitter sites were either shut down entirely, or mothballed. A Voice of America transmitter site in the United States was shut down. Some languages were cut entirely, and all others were sharply cut back. Listenership has suffered, with sharp declines being observed in virtually all RFE and RL languages. VOA services have suffered, as well.

The keywords of the 1990s have become budget-balancing and downsizing. There are many who feel that those proud and historic Radios have served their purpose, and that there is no longer a need for surrogate broadcasting. Perhaps they are correct, and as listenership continues to decline in the face of more stringent economic measures the popularity of RFE and RL decreases almost daily, as they drift inexorably toward their place in history.

An era has ended. Ω

ALL ABOUT REMOTE EMISSIONS SENSING

BILL SIURU

See how technology is helping officials to identify polluting vehicles and get them off the road.

As engines on new cars and trucks burn fuel more efficiently, emitting far less pollutants, investing in new technology for further cleanup of future vehicles is reaching the point of diminishing returns. Therefore, focus is turning towards finding and then requiring repair or even the retirement of older, environmentally dirty vehicles.

A 1991 California study showed that only 7% of the vehicles emitted 50% of the carbon-monoxide emissions, and that just 10% contributed 50% of the hydrocarbon emissions. On a national basis, roughly 20% of the cars on the road are responsible for approximately 80% of automotive pollution.

Incidentally, old and gross polluting vehicles are not necessarily synonymous. Properly maintained 1970s and earlier cars, made before the days of the catalytic converter, can be cleaner than much newer vehicles whose high-tech emission systems are not working properly.

The focus is also shifting from detecting polluting vehicles during annual inspections to identifying them as they travel down the road. That not only forces gross polluters to make repairs or take their vehicles off the road much sooner, but also nabs owners who are driving illegally without getting the required inspections.

Since 1996, new vehicles must have the OBD II (Second Generation On-Board Diagnostics) emissions system that includes sensors that constantly monitor the emission equipment. Faults are recorded in the vehicle's on-board computer, and can be displayed on the instrument panel. While not now part of the OBD II systems, it would be relatively easy to transmit that information to a roadside receiver via an inexpensive vehicle-to-roadside communications system. Environmental monitoring agencies could then easily use the information to track down vehicles that need emission-system repairs.

Catching Older Polluters. Unfortunately, such a system would only catch the rare new vehicle that is polluting. As a result, much more emphasis is being aimed at real-time, roadside remote-sensing systems that can monitor all vehicles. An example of that is FEAT, or Fuel Efficiency Automobile Test, developed in 1987 by researchers at the University of Denver under

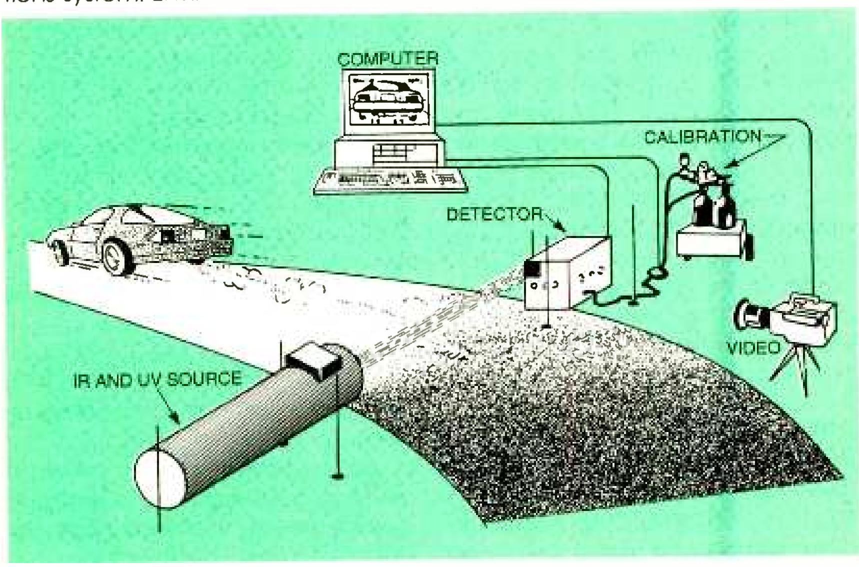


Fig. 1. The FEAT system, developed by the University of Denver, uses IR and UV beams to remotely measure vehicle emissions.

the direction of remote-emissions sensing pioneer, Dr. Ronald Stedman (see Fig. 1).

FEAT uses infrared and ultraviolet light absorption between a source and detector to determine the amounts of pollutants emitted by a passing automobile. As the vehicle crosses the light beam, the tires block the beam and tells the FEAT system to prepare to measure the exhaust plume. As the car passes through the beam, the light detectors across the road measure the amount of the exhaust by looking at the voltage drop that it produces within the detector.

The FEAT computer takes the voltage-drop measurements and calculates a ratio compared to the CO2 measurements. A ratio is used so that the results are accurate regardless of the position of the exhaust pipe, the intensity of the exhaust gases, or wind conditions. Within a second, the FEAT system can provide mass emissions in grams-per-liter or gallon of fuel, with a demonstrated accuracy of 15% and at vehicle speeds up to 150 mph. There is also the capability to record license plates simultaneously with the emission levels. Since 1987, FEAT has been used in numerous states and many foreign countries in test and demonstration programs.

Commercial Solutions. Two commercially available systems are being selectively used to identify vehicles that are out of compliance. Those are the RSD 1000 offered by Remote Sensing Technologies, Inc. and the Smog Dog Remote Emissions Sensor from the Hughes Aircraft, Santa Barbara Research Center.

With the RSD 1000, which is based on the University of Denver research, the IR source is placed next to the detector in a unit located in the monitoring van, or as a portable unit suspended from a tripod. A transfer module on the opposite side of the traffic lane, really a reflector, returns the IR beam after it passes through the exhaust plume.

Once a vehicle interrupts the beam, the system begins to make the measurements, the detector separates the beam into channels and filters it to determine the exhaust content. The detector can make 60 to 80 measurements in less than a second. The data is sent to a microprocessor, which averages the measurements, adjusts for any discrepancies, and calculates the emissions.

The system also features a high-resolution, high-speed camera that freezes an image of the vehicle and its license plate. The image is displayed on a computer monitor with the date, time, and measured emissions values superimposed on it. The information is then compressed, digitized, and stored for future use.

Fig. 2. How's the health of your car's exhaust? This sign in Denver, CO will let you know.

A Smart Sign. Denver motorists exiting I-25 at Speer Blvd. and heading towards downtown are greeted by the large, animated "Smart Sign," shown in Fig. 2. As they climb the exit ramp their vehicles pass through an optical beam, triggering a remote sensing system that measures carbon-monoxide emissions. Within two seconds, just as the driver faces the Smart Sign, the results are digitally displayed either as "Good", "Fair," or "Poor." A license plate reader, located behind the vehicle, is also triggered by the beam.

The system uses infrared-based, remote sensing technology. The IR source is located in a manhole on one side of the ramp and the Remote Sensing Technologies' RSD 1000 unit is located in a manhole on the opposite side. A periscope setup using mirrors focuses the IR beam across the right-of-way at a height of about a foot. While the RSD 1000 can measure CO, HC and CO2 emissions, only CO is measured in this demonstration.

Currently, the system is only for the motorist's information, with no enforcement involved. The license plate reader is used in a human-factors study being conducted by the National Center for Vehicle Emissions Control And Safety at Colorado State University. Using the license-plate data, CSU researchers contact a sampling of drivers to determine their response to the information on their car's health provided by the Smart Sign and the value of this purely voluntary program. About a thousand drivers receiving poor or fair ratings will be contacted to see if they had their engines checked because of the sign.

The Smart Sign project cost $567,000 and was jointly sponsored by the University of Denver, the Federal Highway Administration, Conoco, TSTi Tucson, Colorado Department of Transportation, and Colorado Department of Public

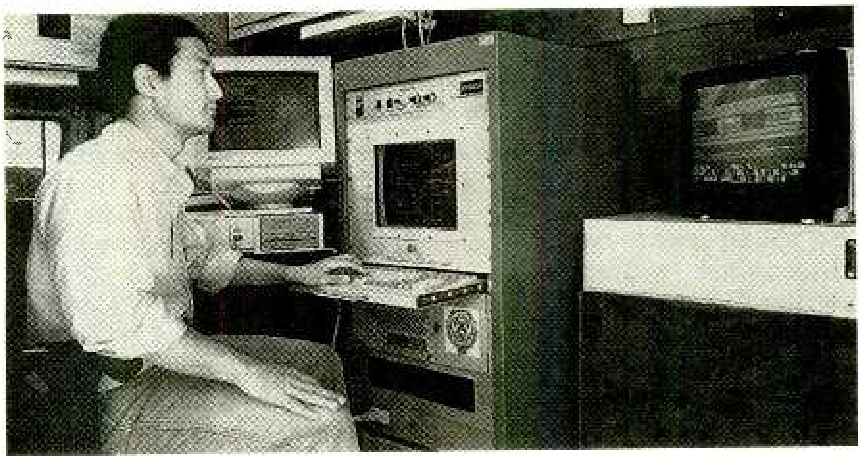


Fig. 3. A look inside the Smog Dog van shows results displayed on several monitors, including one that displays the vehicle's license plates integrated with its emissions measurements.

FOR MORE INFORMATION

Santa Barbara Research Center
75 Coromar Drive
Goleta, CA 93117

Remote Sensing Technologies, Inc.
2002 North Forbes Blvd.
Tucson, AZ 85745-1446

Smart Sign, Chemistry Dept.
University of Denver
2050 E. Iliff
Denver, CO 80208

Health and Environment. The sign was built by Skyline Electric Signs in Colorado Springs.

Smog Dog. Though the set-up resembles that used by the RSD 1000, the Smog Dog system is based on technology used to monitor chemically specific species aboard the STEPS (Space Technology for Environmental Protection Sensors) earth-resources satellite. The Smog Dog's ultra-sensitive, infrared sensor measures the selective absorption of polluting species (CO, CO2, HC, and NOx) by comparing the light intensities of the pollutants against the background light intensity.

The roadside setup includes placing an IR source on one side of the traffic lane and the remote emissions sensor (RES) on the other side. Emissions are measured as the vehicles pass through the IR light beam. Readings from the sensor are monitored on displays in a mobile laboratory that's in a van located at the side of the road (see Fig. 3). A high-speed video camera captures license plates. Image processing electronics add sensor data to the license plate image so emissions are identified with each individual vehicle. The combined image is shown on a display and recorded on a optical disk or VCR. An optional "Automatic License Plate Reader System" could save actual license plate images plus computerized readings of the digits and letters. Remote sensing can be done at speeds of up to 65 mph, and without any disruption to the normal traffic flow.

The system has been tested and used in prototype monitoring application in several states as well as in Canada and Australia. Arizona is the first state to use the Smog Dog in a continuing program, with a fleet of six mobile sensing vans to monitor emissions in the Phoenix area.

Owners of cars identified several times as high emitters will be notified to bring in their vehicles to a smog-check station for an inspection. Those that do not comply, or do not make required repairs (or obtain a waiver), could have their vehicle registrations suspended. Ω

continued from page 11

three years ago. The answer is apparently that BNC stands for "Bayonet Neill-Concelman," referring to the push-and-twist mechanism and the two people who invented it. But some say the B stands for "baby" because of its small size. We'd like to hear from readers who know more of the story.

Finding Transmitter Frequencies

Q *What test instrument do I need to use to find the frequency of a garage door opener, and what is the procedure? —M. A. G., Dallas City, IL*

A Use a frequency counter. Hold the transmitter close to the frequency counter's antenna and transmit. The display will show the frequency. This works with all types of radio transmitters, not just garage door openers.

Calling Pinball and Telephone Wizards

Q *I am interested in obtaining manuals and other information about pinball machines made by D. Gottlieb & Co. in the 1950s and 1960s and about a B. Kellogg hand crank wall phone.—*
L. M. Iannuzzelli, 1315 W. 53rd St., Davenport, IA 52806.

A We're publishing your full name and address, so readers can respond directly to you. Any pinball-machine wizards out there?

Dimmer Interference

Q *Can you suggest a 60-Hz, 117-volt power-line filter circuit to reduce or eliminate TV interference caused by a light dimmer switch in the house? When the dimmer is on about half brightness, it causes one or two lines of rolling horizontal dashes on the TV screen. —J. W. B., Midlothian, VA*

A That interference pattern indicates quite strong spikes at 60 Hz. Instead of a filter, get a new light dimmer. Newer ones have much better filtration built in. If the interference from the old one is that bad, a component in it may be starting to fail.

Separating Video From Audio

Q *Early-1980's video game and computer systems (Atari, Commodore, etc.) used an RCA plug to connect to a standard television set. Is there a way to separate the video and audio components of the signal so the audio could be sent to a separate amplifier?—P. M., Raiford, FL*

A Separating the audio and video components of the modulated signal is not easy. Fortunately, you can catch them before they get combined. Open up the video game and find the modulator (a small shielded box, probably made by Astec). It has four terminals: DC power, channel select, audio input, and video input. You can tap into the audio and video signals at the input to the modulator and route them directly to your amplifier and monitor. If you don't need TV-channel output, you can remove the modulator entirely and bring out external connections for video and audio.

Audio Transformer

Q *I'm running out of stamps trying to find a source for a printed-circuit-board-mountable transformer with a primary impedance of 100 ohms and a secondary impedance of about 17k ohms, about half an inch square (cube-shaped). I would appreciate any help you may be able to give me.—D. B. J., Panama City, FL*

A We assume this is for transforming the impedance of an audio signal. If so, the requirements of the circuit are probably not very critical; any transformer reasonably near your specifications will work. Also, what you're really looking for is an impedance ratio rather than a particular pair of impedances; anything that steps up the impedance by a factor of about 150 to 200 will probably work.

With that in mind, you might try using an 8-ohm-to-1.2-kilohm audio-output transformer mounted backward. That will step up a 100-ohm source impedance to 15k ohms. Many suitable miniature transformers are available; one supplier that has a good selection is Mouser Electronics (800-346-6873; http://www.mouser.com).

Laser Diodes: Why 3 Pins?

Q *I would like to build a diode laser, but all the laser diodes I have seen have three pins. What is the third pin for, and how can I use a laser diode in a circuit?—J. W., Houston, TX*

A The third pin is for monitoring the energy level of the diode. Laser diodes work only at a very narrow range of energy levels. If the diode current is too low, no laser action takes place and the diode acts like an LED; if the current is too high, the diode burns up.

The proper circuit for any particular laser diode is specified by the manufacturer on the data sheet. It involves a feedback loop to keep the diode operating at the correct level.

Changing Automobile Polarity and Voltage

Q *I have an old car that was originally 6 volts, positive ground. I converted it to 12 V, negative ground, and need a power supply for the engine instruments. I tried a RadioShack voltage converter, but it is ground referenced and would only provide +6V. Any ideas?—G. R. C., Phoenix, AZ*

A Many of the instruments will probably work quite happily on +6V instead of –6V without modification. Thermal gauges don't care about polarity. Neither do balanced-coil meters, as long as the sensor remains connected to chassis ground (which is now negative rather than positive). So the first thing to do is just try the instruments on +6V and see how well they work.

If some of the gauges read backward, your next step will be to see if they can be rewired. Try swapping the "hot" and "ground" connections to them.

As a last resort, you might run the 6-volt instruments on 5 volts, using 12-volt to 5-volt isolating DC-to-DC converters. Those are a common surplus item in the computer industry and are available for a few dollars each from All Electronics Corp. (P.O. Box 567, Van Nuys, CA 91408) and Marlin P. Jones (P.O. Box 12685, Lake Park, FL 33403). An isolating DC-to-DC converter has four terminals, two for input and two for output, allowing you to ground the negative input and the positive output without conflict. Each converter puts out a maximum of 1 amp, so you may need several, one for each instrument. Check the maximum ratings, bearing in mind that 12 volts, on a car, is really 13 to 16 volts with brief surges of even higher voltage. You may need to use a voltage regulator IC ahead of the converter to avoid exceeding its maximum input voltage.

Alarmed VCR?

Q *I need a device to control the record function of my VCR and make it start recording when a burglar alarm is tripped. It should not require any modification or soldering inside the VCR and consequently should use infrared remote control. Thanks for your help.—P. G., Riyadh, Saudi Arabia*

A Get a cheap replacement remote control for your VCR and open it up. Across the appropriate button switches (either "Rec" or both "Rec" and "Play"), connect relays tripped by your security system. Supply power in whatever way is convenient (perhaps using one of the regulator circuits in Fig. 4), and you're done.

Need Signal, or Maybe Noise

Q *I need a 400-600 MHz RF signal generator for antenna experiments. It does not have to be extremely accurate, just close to frequency. Can you suggest a circuit? —J. W. G., Bluff Dale, TX*

A Stable UHF oscillators are not especially easy to build. You might consider, instead, an untuned noise source plus a receiver tuned to the appropriate frequency. You probably already have a stable receiver for the frequencies of interest, and its AVC (AGC) voltage can serve as an accurate indication of signal strength.

For more information on noise testing of antennas and receivers, you can have a look at *The ARRL Handbook for Radio Amateurs*, published by the American Radio Relay League, Newington, CT 06111.

Digital Noise Suppression

Q *I have built, from scratch, a 137-MHz weather satellite receiver, but noise causes streaks in my pictures. I've heard about digital noise suppression, and that could be the answer to my problem. Unfortunately, I can find no information or circuits for such a filter. Can you provide one using standard parts? — H. J. K., Sacramento, CA*

A Digital noise suppression is more computer programming than electronics. The signal is digitized, then processed by a computer program that looks for certain waveform patterns and alters them. As far as we know, no one makes a generic digital noise reducer chip that you can use without programming. To learn more, see *A Simple Approach to Digital Signal Processing*, by Marven and Ewers, published by Wiley.

Reflect on It

Q *I have two incandescent lamps outside my house, controlled by a single light sensor. I can't change the location of the sensor, but it switches the lights on too early. I want it to be much darker before the lights come on. Is there an easy way to achieve that?—K. S., Prunedale, CA*

A Your sensor is probably aimed at some dark objects such as shrubbery or trees. Make a small reflector out of shiny metal or any white material and put it in front of the sensor so that light from the bright sky will be reflected into the photocell.

Writing to Q&A

As always, we welcome your questions. Write to "Q&A," **Electronics Now** Magazine, 500 Bi-County Blvd., Farmingdale, NY 11735. The most interesting ones are answered in print. Please be sure to include plenty of background information (we'll shorten your letter for publication). *If you are asking about a circuit, please include a complete diagram.* Due to the volume of mail, we regret that we cannot give personal replies. EN

BY DON LANCASTER

A New TV Typewriter, Hydrogen as a Fuel, and more

SOMEBODY ON THE INTERNET HAS JUST INVENTED A WATER-POWERED CAR. UNFORTUNATELY, THEY WERE LOUDLY BEMOANING THE FACT THAT NOBODY NOTICED. REPEATED CONTACTS TO UNIVERSITIES AND TALK SHOWS WERE totally ignored, as were newspaper letters and magazine inquiries. Why, even Detroit wasn't showering them with megabucks.

Golly gee Mister Science!

I was left with the feeling that they simply had not done their homework. There are lots of very good and very bad things about hydrogen-powered cars. And in fact, there has been a new hydrogen-storage discovery that could end up being rather interesting. So, it might be a good time for my . . . .

Thoughts on Hydrogen Power

Hydrogen-powered vehicles have some rather obvious advantages. The energy density by weight of hydrogen is three times better than gasoline. Hydrogen can power a fuel cell and thus might "beat" the thermodynamic Carnot efficiency limitations on heat engines—possibly by a factor of two or more. And the usual main product from hydrogen energy conversion is plain old water for potential (but by no means at all guaranteed) localized pollution reduction. Hydrogen can be made anywhere, totally trashing geopolitics. Lastly, those low voltages and high currents used in hydrogen production are very much solar compatible.

But here are the downsides . . . .

Hydrogen is not a fuel: I'll define a fuel as any substance that is able to produce net BTUs of energy at an economically reasonable cost. For instance, assume you fill your tractor with ten gallons of gasoline, plant some corn, and distill the corn into six gallons of grain alcohol. You could think of this process as a giant funnel. You'll pour gasoline into the top, and alcohol dribbles out of the bottom.

But the alcohol is not a fuel; it is simply an energy transfer medium for gasoline in disguise. You'll produce a fuel only when you have net deliverable BTU gains in the process. And your fuel might be competitive only if and when those gains are quite large.

Whenever you allow for "gasoline equivalents" for such things as labor, true costs, and interest, I know of no proven process for making alcohol that comes even remotely close to an energy break-even, let alone ending up economically competitive. Similarly, hydrogen usually comes from the electrolysis of water via the highly energy-intensive process shown in Fig. 1.

You first make the water conduct, perhaps by adding a weak acid. Then put the

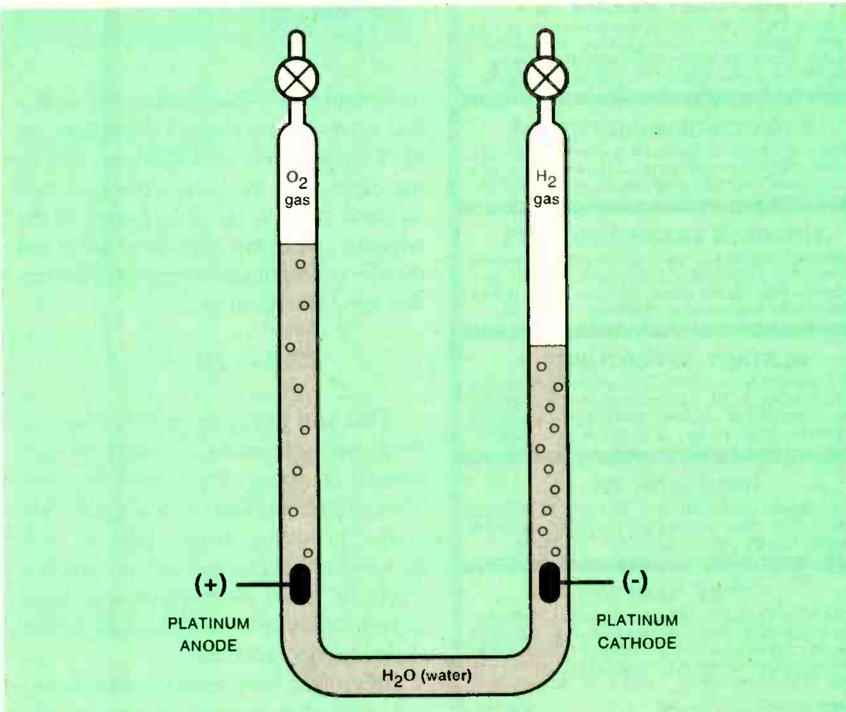


FIG. 1—HYDROGEN IS NORMALLY PRODUCED by the electrolysis of water. There is no known non-nuclear process for hydrogen generation that creates more energy than it consumes. Thus, hydrogen is definitely not a fuel.

NAMES AND NUMBERS

Analog Devices
PO Box 9106
Norwood, MA 02062
(617) 329-4700

Decade Engineering
5504 Val View Dr. SE
Turner, OR 97392
(503) 743-3194

Experimental Musical Instruments
1700 Old Rancheria Rd.
Nicasio, CA 94946
(415) 662-2182

Fair Radio Sales
PO Box 1105
Lima, OH 45802
(419) 227-6573

ISD
2045 Hamilton Avenue
San Jose, CA 95125
(408) 369-2400

ISSI
2231 Lawson Lane
Santa Clara, CA 95054
(800) 379-4774

Lindsay Publications
PO Box 538
Bradley, IL 60915
(815) 935-5353

Microchip Technology
2355 W Chandler Blvd.
Chandler, AZ 85224
(602) 786-7200

Parts Cleaning
84 Park Avenue
Flemington, NJ 08822
(908) 778-0343

Radio Research Instruments
584 N Main Street
Waterbury, CT 06704
(203) 753-5840

Rohm Corporation
2150 Commerce Drive
San Jose, CA 95131
(408) 433-2225

See Sharp Press
PO Box 1731
Tucson, AZ 85702
(520) 628-8720

Speleonics
Box 5283
Bloomington, IN 47407
(812) 339-7305

Synergetics
Box 809
Thatcher, AZ 85552
(520) 428-4073

water into a "U"-shaped tube and apply a DC current. Your current dissociates the H_2O water by way of electrolysis, liberating oxygen gas at the positive or anode side and twice as much hydrogen at the negative or cathode side. Your gases can then be collected and compressed for further use. The reaction is:

$$2H_20 \leftrightarrow 2H_2 + O_2$$

That is a nearly reversible reaction. Tremendous amounts of energy are consumed in going from left to right. Tremendous amounts of energy are liberated in going from right to left. Because of cell heating and related side reactions, more electrical energy input to your cell is always required compared to the energy returned.

You might have seen a recent exposé and criminal prosecution of a major pseudoscience hydrogen scam. As usual, the culprit started off with plain old had labwork that was not even wrong, combined with wishful thinking plus "too-good-to-be-true" results that got out of hand.

Other hydrogen-production ploys apply steam to existing hydrocarbons or use water to oxidize sodium. Since those gobble up your input products, such processes are even more energy consumptive than electrolysis.

In short, no non-nuclear means is currently known to generate hydrogen that can deliver more in energy BTUs than it consumes! Thus, at its best, hydrogen can only move pollution. It can never eliminate it. And it can only raise your cost of energy.

When you talk about a hydrogen economy, the total production costs must always be included. Total costs that are direct and indirect, obvious and hidden. We saw more on electrochemistry last month (Muse114.PDF on my www.tinaja.com Web site if you missed it) and in the Tech Musings reprints.

Hydrogen is quite hard to store: The energy density of hydrogen gas is an outstanding 38,000 kilowatt-hours-per-kilogram (kWh/kg). Compare that

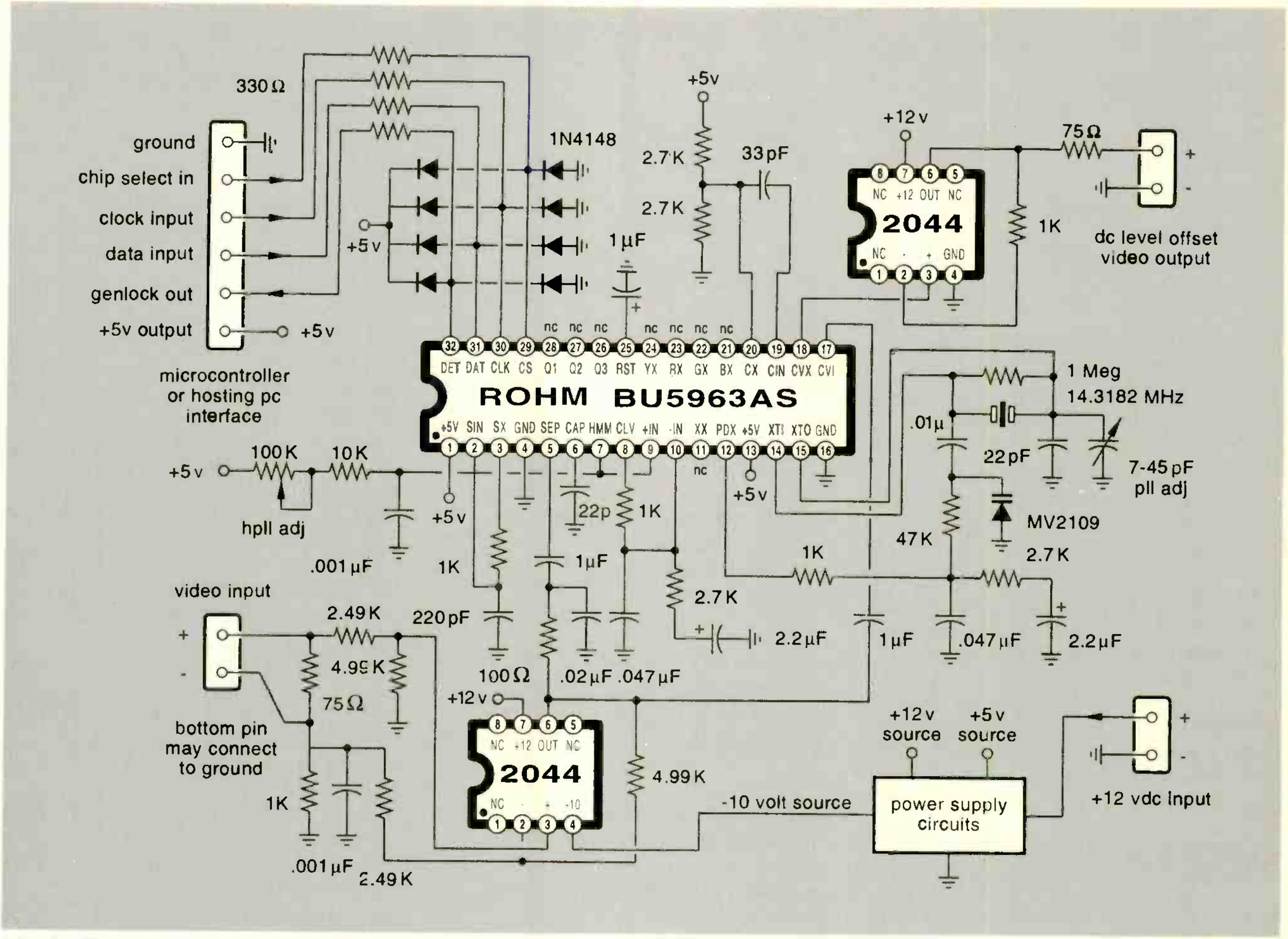


FIG. 2—THE SCHEMATIC FOR THE BOB-5L TV TYPEWRITER produces a 10 row × 24 character color display and generates its own NTSC baseband video or overlays an external input. Uses include PIC data displays, teleprompters, low-end titlers, large print aides, or budget point-of-purchase systems. There's an amazing variety of options.

to gasoline at 13,500 kWh/kg or lead acid at its 25 kWh/kg.

But a kilogram of hydrogen at standard temperature and pressure takes up 11,126 liters, for an utterly laughable energy density by volume of 3.4 kilowatt hours per liter (kWh/l). Compare that to gasoline at 9600 kWh/l or lead acid at 40 kWh/l.

One way to reduce the volume of a gas is to compress it. The pressures involved quickly get horrendous, and safety becomes a rather serious issue. Instead, processes are sought out to chemically bind hydrogen to another substance, creating a hydride.

The best storing hydride in nature is methane or CH_4. Methane can store 25 percent hydrogen by weight, and, until recently, the most promising of man-made carbon hydrides were way on down at 4 percent or so.

However, that might soon change. A new graphite nanofiber storage material was recently announced by Nelly Rodriguez and her research team at Northeastern University. It is a recyclable hydride that stores up to 75 percent of its weight as hydrogen. If verified and proven, this could give a 20:1 density improvement—as much as 30 liters of hydrogen can be stored per gram of nanofibers! In real-world terms, that means a recyclable cartridge the size and the weight of a tank of gasoline could run a car for 5000 miles.

An announcement on this ongoing development is in *New Scientist* for December 27, 1996 and is based on a Fall 1996 Boston paper at the Materials Research Society conference. Their full paper should show up in *Science* magazine "real soon now." A useful summary appears in the *Hydrogen and Fuel Cell Letter* for February, 1997.

While this new storage scheme is very exciting, we are merely talking highly preliminary lab work for now. Off-the-shelf products and systems to deliver them might be something else entirely, especially solutions that are safe and economically competitive.

Hydrogen rots metal: The hydrogen molecule is the smallest one known. Therefore, it easily diffuses through many common materials—it just waltzes right on by. Worse yet, hydrogen reacts with metals and causes embrittlement. That is, a metal in contact with hydrogen for a long time tends to lose most of its strength, ultimately stress cracking or shattering to failure.

That leads to severe safety, testing,

NEED HELP?

Phone or write all your US Tech Musings questions to:

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HYDROGEN ENERGY RESOURCES

Alternate Energy
901 N Columbus Street
Alexandria, VA 22314
(800) 469-2519

American Association for Fuel Cells
50 Mile Street
Greenfield, MA 01301
(413) 774-6051

American Hydrogen Association
216 S Clark Dr., Suite 103
Tempe, AZ 85281
(602) 921-0433

CA Selects: Batteries
PO Box 3012
Columbus, OH 43210
(800) 848-6538

CA Selects: Stress Corr.
PO Box 3012
Columbus, OH 43210
(800) 848-6538

ElectroChem
400 W Cummings Park
Woburn, MA 01801
(617) 938-5300

Energy Research Corp.
3 Great Pasture Road
Danbury, CT 06813
(203) 792-1460

EPRI Journal
PO Box 10412
Palo Alto, CA 94303
(415) 855-2000

Fuel Cell Association
PO Box 65481
Washington, DC 20035
(301) 681-3532

Home Power
PO Box 520
Ashland, OR 97520
(916) 475-3179

Hydrogen & Fuel Cell Letter
Grinnell St. PO Box 14
Rhinecliff, NY 12574
(914) 876-5988

International Fuel Cells
195 Governors Hwy.
South Windsor, CT 06074
(860) 727-2348

International Journal of Hydrogen Energy
Box 945
New York, NY 10159
(212) 633-2730

Materials Research Society
9800 McKnight Rd. #327
Pittsburgh, PA 15237
(412) 367-3003

National Hydrogen Association
1800 M Street NW, Suite 300
Washington, DC 20036
(202) 223-5547

Natl. Renewable Energy Lab
1617 Cole Blvd.
Golden, CO 80401
(303) 231-7681

New Scientist Magazine
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New York, NY 10159
(212) 633-7300

Rocky Mountain Institute
1739 Snowmass Creek Rd.
Snowmass, CO 81654
(970) 927-3851

SAE
400 Commonwealth Dr.
Warrendale, PA 15096
(412) 776-4841

Science/AAAS
1333 H St. NW
Washington, DC 20005
(202) 326-6400

and lifetime considerations when you are talking about a hydrogen-powered anything.

Hydrogen is dangerous: Even after you get past the Hindenberg and Three Mile Island, hydrogen is still nasty stuff. The flammability range of hydrogen in air is one of the broadest known, ranging from 4 to 74 percent. Inside most of that range, hydrogen is violently explosive.

Hydrogen normally burns with an invisible flame. A stunt that fire-department hazardous-materials teams use is to tie a rag onto a pike pole and then attempt to "joust" with the invisible flame front. Do not try that at home!

Anyway, hydrogen storage systems should be designed such that any total and catastrophic release of all contained energy is extremely unlikely. Sort of like a flywheel that could expend its failure energy by tearing itself apart rather than violently ejecting pieces. Hydrides would seem better at slow release than a pressure-tank hydrogen-gas system would be.

Fuel cells are expensive: Just like the Volkswagen van heaters, "significant improvements" in the fuel cells have been claimed every year for the past three decades, and in fact, they have been demonstrated. But my feet are still cold.

The appeal of fuel cells is obvious: Beat Carnot at his own game, flush thermodynamics, and approach 100% efficiency by routing air and hydrogen to an electrochemical cell that directly generates electricity and outputs (mostly) water as a byproduct.

Sadly, we flat out "ain't" there yet. Expensive catalysts are involved. The cells remain large, costly, and offer limited life. Output voltages are very low. Many cells have to run at higher temperatures. They sometimes can be slow to start or change power levels. Claimed efficiencies are often fudged by assuming you can use your waste heat for something else.

But sharply increased funding for next year's grant will magically cure all of this. Just ask any researcher.

For this month's resource sidebar, I've gathered together a few places to go to get more hydrogen information. Ground zero on all this appears to be *Hydrogen & Fuel Cell Letter*. There is also a pair of quality books—*Fuel Cell Handbook* by Appleby and Foulkes (1989 from Van Nostrand), or *Fuel Cell Systems* by Blomen and Mugerwa (from the Plenum Press).

There is tons of stuff on the Web. Start off with all the fuel cell links on www.uni-kassel.de/fb18/elch/fuelcell.htm or the summary on www.getnet.com/charity/aha/ahafcell.html Two useful newsgroups include sci.energy.hydrogen and alt.energy.renewable Also try sci.chem.analytical

For alternate wishful thinking on all this, visit the Keelynet, or any of those dozens of mesmerizingly awful sites found using the Pseudoscience Web links page of my http://www.tinaja.com

Build the TV Typewriter

Hmmm—It's *deja vu* all over again. For those of you that came in late, my **Radio-Electronics** TV Typewriter (September 1973) is widely regarded as having been the opening shot fired in the personal computer revolution.

Well, there's now a brand new TV Typewriter, called the BOB-5L from Decade Engineering. Listing at $79 in quantity and double that price in singles, that smallish card can provide either gen-

0	0	1	not used	not used	not used	not used	not used	set address msb	set address bit #6	set address bit #5	set address bit #4	set address bit #3	set address bit #2	set address bit #1	set address lsb

Typical word to set auto-indexing address for forthcoming data

0	0	0	super-impose flag	set character color blue	set character color green	set character color red	display reverse on-off	not used	character select msb	character select bit #5	character select bit #4	character select bit #3	character select bit #2	character select bit #1	character select lsb

Typical data word for display screen position addresses #0 through #239

0	0	0	not used	not used	not used	horiz size lines 2-10 msb	horiz size lines 2-10 lsb	horiz size line 1 msb	horiz size line 1 lsb	horiz position setting msb	horiz position setting bit #4	horiz position setting bit #3	horiz position setting bit #2	horiz position setting bit #1	horiz position setting lsb

Data word for control address #240

0	0	0	not used	not used	not used	vertical size lines 2-10 msb	vertical size lines 2-10 lsb	vertical size line 1 msb	vertical size line 1 lsb	vertical position setting msb	vertical position setting bit #4	vertical position setting bit #3	vertical position setting bit #2	vertical position setting bit #1	vertical position setting lsb

Data word for control address #241

0	0	0	not used	not used	not used	not used	set outline color blue	set outline color green	set outline color red	set charsize color blue	set charsize color green	set charsize color red	set backgnd color blue	set backgnd color green	set backgnd color red

Data word for control address #242

0	0	0	Port #3 data output on pin 26	Port #2 data output on pin 27	Port #1 data output on pin 28	character charsize on-off	character outline on-off	blink reverse -vs- blank select	blinking enable select	blinking duty cycle msb	blinking duty cycle lsb	blink frequency set	super-impose on-off	mono color off-on	interlace off-on

Data word for control address #243

FIG. 3—ADDRESS MAP FOR BOB-5L. The low 240 locations hold on-screen display characters and their individual attributes. The high four locations hold global formatting information. If an incoming bit B13 is a one, the 16-bit word sets an auto-indexing address. If B13 is a zero, data gets placed into the previously set address.

locked overlay video or a stand-alone data display for a PIC, PC, or any other similar device.

The schematic appears in Fig. 2. Up to 10 rows of 24-characters-per-row could be either generated or superimposed over your input NTSC video. An optional output fader can be added for variable transparency.

Although their 128-character set is fixed, there's a surprising variety of color, outline, overlay, background, and size options, all brought about mostly by the Rohm BU5963AS chip whose original intended use was as a VCR/ TV remote display. A single +12 volt power supply at 60 milliamps is needed, typically from a wall-mount module.

Data-Format Details

Your host computer or micro can communicate with the unit using three input lines, and possibly a fourth output line. The inputs are chip-select, clock, and data lines, while the optional output returns genlock information. When chip select is low, the input data gets transferred on the positive edge of the clock. Data transfer could go as high as 2.5 megabaud, which might process up to 150,000 characters-per-second or as many as 650 full-screen refreshes-per-second—far more than can possibly be viewed.

There is an internal RAM memory stashing 244 bytes of 12-bit words. The lower 240 bytes hold the screen character-content data. Addressing starts with zero at the upper left and progresses rapidly left to right and slowly top to bottom.

The upper four control bytes give you all sorts of fancy display options, using the command set of Fig. 3. There are always sixteen bits in a word received from the host PC or controlling micro. Most significant bits B14 and B15 are always zero.

Bit B13 is the mode bit. If B13 is a one, the rest of the bits are treated as an address as shown. If B13 is a zero, the rest of the bits are treated as data and get entered into the previously stored or next available address.

All sequential data words will auto increment into your next available address. Thus, you only have to set an address once at the beginning of a sequential data stream. For random access, you'll have to individually set each address and data value.

There's an unimplemented feature on the BOB-5L that just might come in handy. You can directly write data to unconnected pins 26, 27, and 28 of the BU5963AS by using the bits shown in data word 243. That gives you up to eight more functions. One obvious trick here would be an eight-level fader or a transparency setter using a CMOS 4051. More details can be found in my *CMOS Cookbook*.

By a special arrangement, lower BOB-5L pricing is available only to readers of this column. Contact Mike Hardwick at Decade Engineering for more details. Use "tinaja" as your "top secret" code request for this special offer.

A BOB-5L Contest

What can you create with a third-generation TV typewriter—especially a very easy-to-use one that opens true low-cost genlocked color NTSC video-overlay character displays to even the simplest and cheapest of micros?

Decade is conducting an ongoing applications contest where they'll award several BOB-5Ls and a few development systems to their choice of the better entries. Just tell them a new or unusual use for their BOB-5L—or simply tell them why you want one. Submit all your written entries to Decade Engineering per their address in the Names & Numbers sidebar, or you could fax them at 503-743-2095, e-mail to decade@worldnet.att.net, or visit their Web site at http://decadenet.com

New Tech Lit

Microchip Technology has recently gathered all of their PIC papers (and everything else) together into a single free CD ROM. It is called the *1997 Technical Library, First Edition.* Also check out the free *Designer's CD Reference Manual* from Analog Devices.

There are two new electronic-speech resources: *Instant Voice ROM Products* from ISSI, and *ISD ChipCorder Data Book* from ISD. A few ISD products are also now available from RadioShack.

Musical Instrument Design is the new Bart Hopkin book that's got all sorts of simple construction projects. It's mostly acoustical instruments, including a few made from his bizarre collections of found materials. It consists mainly of excerpts and reprints from *Experimental Musical Instruments* magazine. It is published by See Sharp Press; they also have a Web site at http:// echonyc.com/70/0/Music/MO/EMI.

There's a "new" old book from Lindsay on *Finishes for Aluminum.* This one is primarily old Reynolds anodizing formulas.

After a few missed issues, Frank Reid's *Speleonics* is back in print. This one is my favorite labor-of-love newsletter. Frank uniquely reports on "underground" subjects such as cave communications, super-bright LEDs, and lamp batteries.

Surplus WWII military electronics remains available if you know where to look. For the small stuff, try Fair Radio Sales, and for those really big monsters (such as fifty foot tracking dishes and complete radars), try out Radio Research Instruments. Both have free catalogs.

Two great online electronic magazines are at http://www.poptronix.com and http://www.emags.com/electron/htm.

For most individuals or small-scale startups, patents are virtually certain to end up as a total waste of time, energy, money, and sanity. Find out why in my *Case Against Patents* package, as per my nearby Synergetics ad. Included are lots of tested and proven real-world alternatives and workarounds.

A reminder that my new Guru's Lair Web site (http://www.tinaja.com) is now going great guns. You will find bunches of reprints and preprints, surplus bargains, tinaja quests, a consultant's net, and lots of annotated links there. Because we can now deliver nearly 120,000 hits per month, advertisers are newly welcome.

That's all for now; until next time, let's hear from you! EN

BY FRANKLIN J. MILLER

Putting The Audio Generator Together

LAST TIME, WE TOOK AN OVERALL LOOK AT A WIEN-BRIDGE AUDIO GENERATOR THAT WOULD MEET MOST OF THE MORE COMMON NEEDS OF BOTH THE AUDIO AMATEUR AND THE PROFESSIONAL. THIS TIME WE WILL PUT IT ALL TOGETHER.

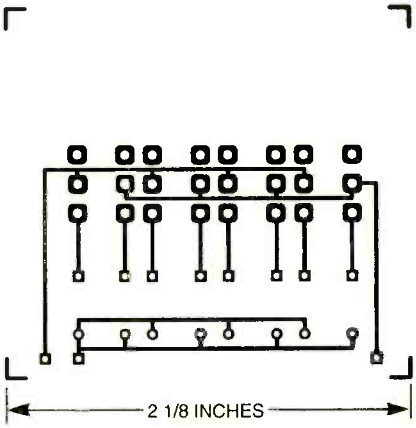
Circuit Description

We covered most of the circuit last time, but there are a couple of points we should go over before moving on to the actual construction. The full schematic shown in Fig. 1 should prove helpful as we proceed.

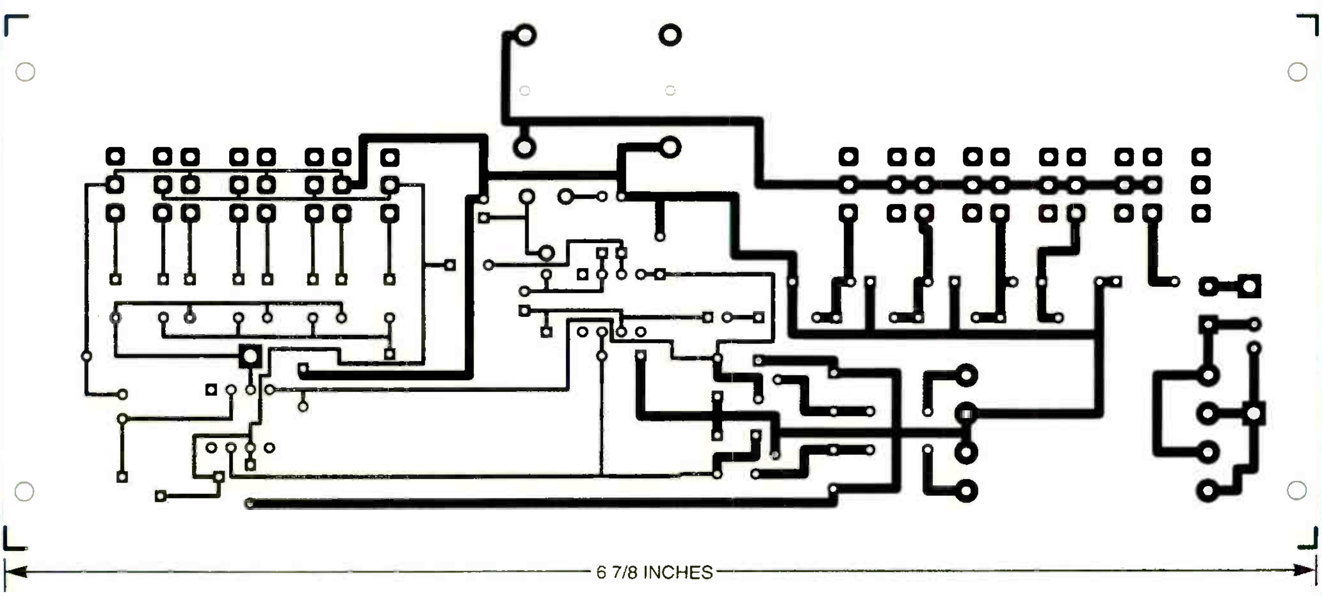
First of all, note that the schematic includes a dual power supply. It delivers the ±15 volts required by the op-amps. Also note that I have used a standard incandescent lamp as the stabilizing element of the Wien bridge. As the bulb was chosen for its current consumption and total resistance in the circuit, it is important to follow the specifications for it given in the Parts List.

Adjustment potentiometer R21 is used to reduce the oscillator's distortion. The oscillator's output is then fed into an op-amp. The gain of the op-amp acts as the output driver. That signal is then fed to a constant-impedance attenuator circuit, whose levels are set at +18 dBm, +4 dBm, –10 dBm, and –56 dBm. The levels are selected by the user using S1, a bank of pushbutton switches; we'll discuss those switches in more depth in a moment, when we get to the construction of the unit.

Those levels were chosen as they are the typical levels used in most audio-test-



USE THIS FOIL PATTERN to create the sub board on which S2 and its associated precision resistors are mounted.



HERE'S THE FOIL PATTERN for the oscillator's main board.

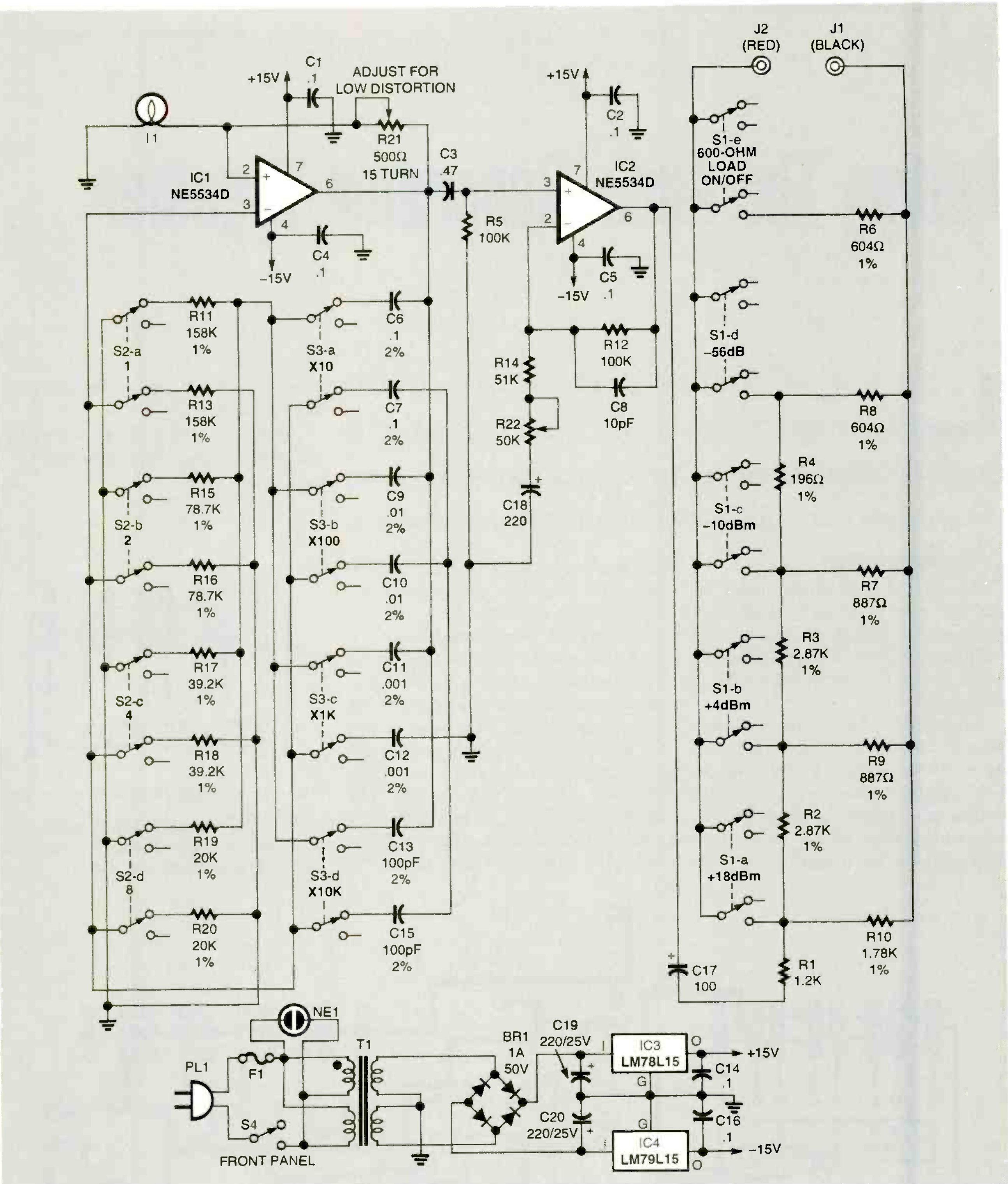


FIG. 1—HERE'S THE COMPLETE SCHEMATIC, including the power supply, for the Wien-bridge audio oscillator.

ing procedures. In particular, the +18 dBm output is the clipping level of most professional equipment. The +4 dBm level is the nominal operating level in pro equipment and is the clipping level in semi-professional or consumer types of gear. The -56 dBm level is the general value used for microphone input circuits.

The output impedance of the oscillator is set for 600 ohms. That might not be correct for every device that you may test, but is correct for most. Remember, this oscillator is designed to give us readings on a need-to-know basis. Also, we will use it to give us relative readings to set up equipment. A few dB up or down will not harm the system or the other equipment we will be using.

Construction

As mentioned earlier, switch S1 along

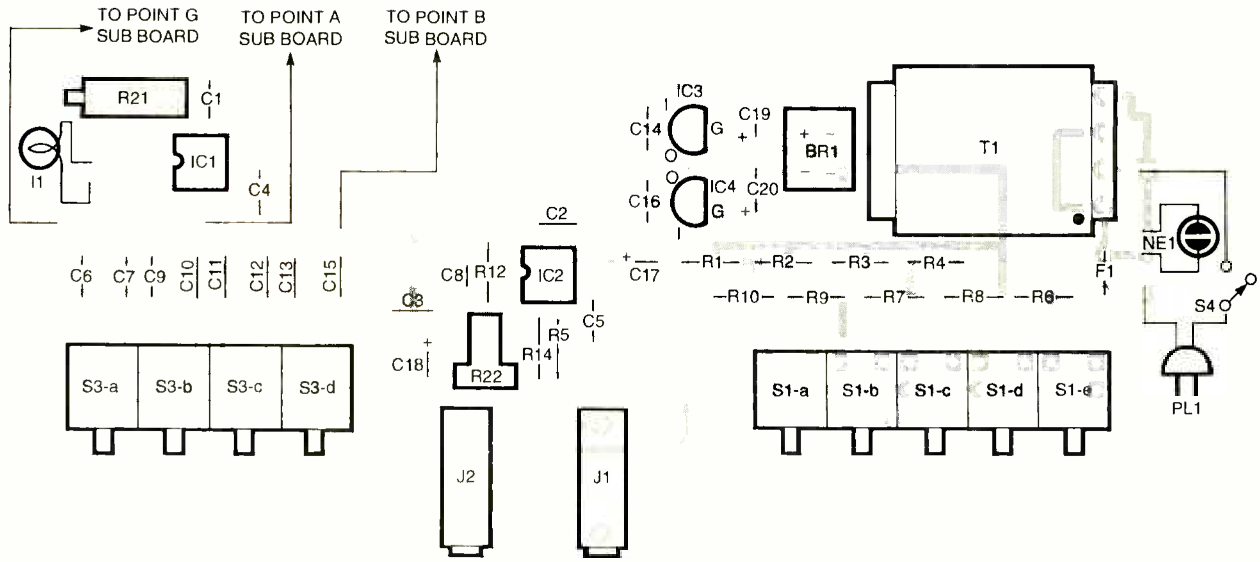


FIG. 2—WHEN MOUNTING COMPONENTS on the main board, use this parts-placement diagram.

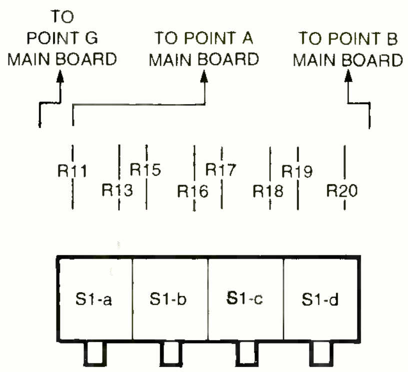


FIG. 3—SWITCH S2 and 12 precision resistors mount on the sub board.

with switches S2 and S3 are rather special pushbutton-switch assemblies. The Parts List shows how to obtain those switches as a part of a complete or partial kit for building this unit, and they do make it possible to put together a rather professional looking instrument. However, if you do not purchase the kit, or do not want to use those switch assemblies, there are alternatives. Switch S2 can be replaced with four 4PDT toggle switches, switch S3 could be a 2P6T rotary switch, and switch S1 could be replaced with a 2P4T switch together with a single SPDT toggle switch. Those changes will also require you to redesign the front panel, but that's not a difficult chore.

For those who want to tackle the pro-

PARTS LIST FOR THE WIEN-BRIDGE OSCILLATOR

SEMICONDUCTORS

IC1, IC2—NE5534N, op-amp, integrated circuit
IC3—LM78L15, voltage-regulator, integrated circuit
IC4—LM79L15, voltage-regulator, integrated circuit

RESISTORS

(All resistors are 1/8-watt, 1% metal-film units unless, otherwise specified.)
R1—1200-ohm, 1/8-watt, 5% carbon-film
R2, R3—2870-ohm
R4—196-ohm
R5, R12—100,000-ohm, 1/8-watt, 5% carbon-film
R6, R8—604-ohm
R7, R9—887-ohms
R10—1780-ohm
R11, R13—158,000-ohm
R14—51,000-ohm 1/8-watt, 5% carbon film
R15, R16—78,700-ohm
R17, R18—39,200-ohm
R19, R20—20,000-ohm
R21—500-ohm, 15-turn, trimmer potentiometer, PC mount
R22—50,000-ohm, potentiometer, PC-mount

CAPACITORS

C1 C2, C4, C5, C14, C16—0.1-µF, ceramic-disc
C3—0.47-µF, ceramic-disc
C6, C7—0.1-µF, 2%, polypropylene or similar
C8—10-pF, ceramic-disc
C9, C10—0.01-µF, 2% polypropylene or similar
C11, C12—0.001-µF, 2%, polypropylene or similar
C13, C15—100 pF, 2%, polypropylene or similar
C17—100-µF, 50-WVDC, electrolytic
C18—220-µF, 50-WVDC,electrolytic
C19, C20—470-µF, 50-WVDC, electrolytic

ADDITIONAL PARTS AND MATERIALS

F1—100-mA fuse
BR1—1-amp, 50-PIV, full-wave bridge rectifier
I1—6-volt, 20-mA, incandescent lamp
NE1—Neon lamp, NE-2 type
J1—Banana jack, red, PC mount
J2—Banana jack, black, PC mount
PL1—AC plug and cord assembly
S1—5 push-button switch assembly, DPDT, non-interlocking, see text
S2—4 push-button switch assembly, DPDT, non-interlocking, see text
S3—4 push-button switch assembly, DPDT, interlocking, see text
S4—SPST toggle switch
T1—Power Transformer, Primary 110-220 volts, two 7-volt, 25-mA secondaries, Signal DPC-34-25 or equivalent
Case, front-panel label, PC boards, hardware, wire, solder, etc.

Note: The following items are available from Franklin J. Miller, 2100 Ward Drive, Henderson, NV 89015. A complete kit of all parts including prepunched case, circuit boards, and front-panel label—$110.00; a partial kit of essential parts including circuit boards, three pushbutton switch assemblies, prepunched case, and front-panel label—$45.00. Shipping inside the continental US is included.

ject on their own, the circuit is built on two boards; full-size foil patterns for both are provided elsewhere in this month's column. The corresponding parts-placement diagrams are shown in Figs. 2 and 3.

Assembling the oscillator is relatively easy, assuming you can solder carefully and place the components where they belong. Nothing can destroy a project faster than solder bridges on a circuit board, reversing a capacitor, or reading a resistor value incorrectly and placing it in the wrong spot.

As in all construction projects, the first step is to make sure you have all of the parts you are going to need by checking them off against the Parts List. Begin with the smaller sub board. Twelve precision resistors and S2 go on that board.

Once the sub board is done, set it aside and start stuffing the main board. I like to mount components in order of ascending height, so the jumpers are installed first, then the precision resistors. The two IC sockets and the full-wave bridge rectifier are next, along with the trimmer potentiometers and all of the capacitors in the multiplier region. Next come the power-supply components. Finish up with jacks J1 and J2 and the switch assemblies for S1 and S3. Average construction time should run about four hours and an ordinary complement of hand tools should do the job.

The next step is to deal with the cabinet. If you are proceeding on your own, simply select one that is large enough to accommodate the main board and the off-board components—the S2 sub-board assembly, I1, NE1, and S4—comfortably. Note, as indicated, that the S2 sub-board assembly is intended to be front-panel mounted. For your convenience, a full-size front panel template is included in Fig. 4. The available kit includes a custom, pre-drilled cabinet that is ideal for the unit.

Regardless of the cabinet you use, the last step is to mount the front-panel components and to connect them to the appropriate points on the main board. Use shielded cable for the connections between the S2 sub board and the main board.

If you've got it all right, and the chances are that you have, the unit will be ready to go. Next time we'll look at how to calibrate your oscillator. It's a simple matter of adjusting two potentiometers, R21 and R22. Then I'm going to show you an assortment of tests you can perform with your new instrument. I'll cover checking an amplifier's frequency response, and measuring its input impedance. Cheers, until next we meet. **EN**

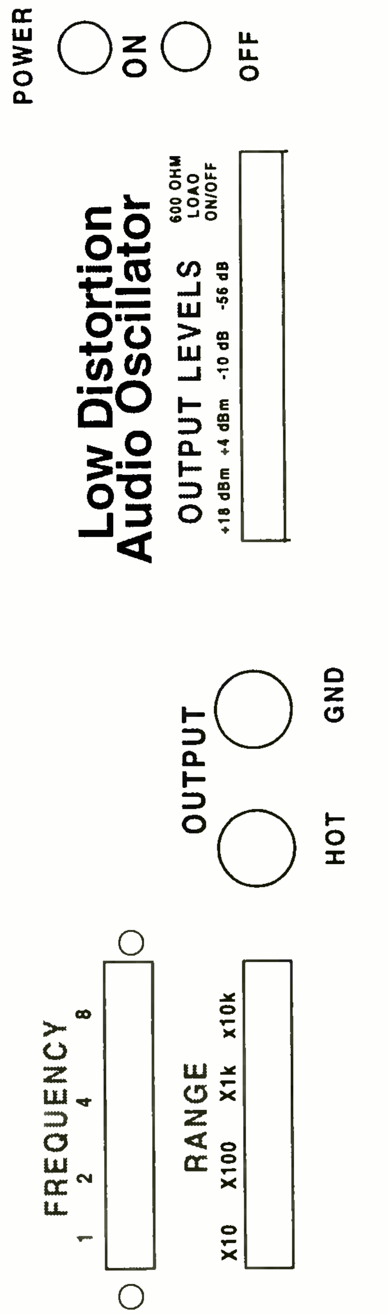


FIG. 4—HERE'S A FRONT-PANEL LABEL you can use to give your project a professional look.

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BAL 6127B..SCOPE CALIBRATOR...$3995
ENI 2100L...POWER AMPLIFIER......$2395
TEK 7104......1 GHz SCOPE M/F....$1895
TEK 2245..100 MHz 4 CH.SCOPE.$1250
TEK 11A72.....1 GHz PLUG-IN.......$1295
TEK 576.......CURVE TRACER.........$2395
DATRON 1081..7.5 DIGIT DMM....$1295
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TAS 112...NETWORK SIMULATOR....$2995
HP 16515A..1 GHz TIMING CARD.$1495

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ANALOGIC 2410..FUNC.GEN...$495
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HP 6940B.....MULTIPROGRAM.....$195
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TEK PS5010....POWER SUPPLY....$795
TEK 7L5....SPEC. ANALYZER.......$1095
TEK TR503....TRACKING GEN....$995
TEK 2465.....300MHz SCOPE....$2750
HP 3325A..SYNTH./FUNC. GEN.$1995
WAV 801...50MHz PULSE GEN..$795
TEK DC504A..COUNTER/TIMER.$450

EDC MV105.....DC VOLTAGE STD....$295
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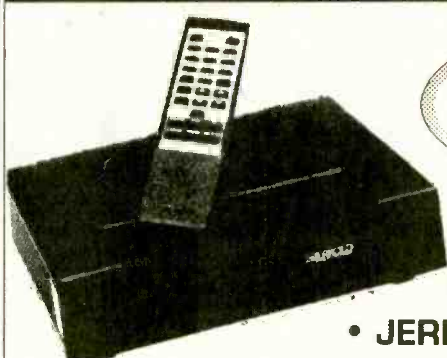

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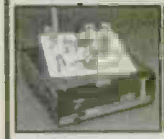
FM-25, Synthesized FM Stereo Transmitter Kit $129.95

Tunable FM Stereo Transmitter



A lower cost alternative to our high performance transmitters. Offers great value, tunable over the 88-108 MHz FM broadcast band, plenty of power and our manual goes into great detail outlining aspects of antennas, transmitting range and the FCC rules and regulations. Connects to any cassette deck, CD player or mixer and you're on-the-air, you'll be amazed at the exceptional audio quality! Runs on internal 9V battery or external power from 5 to 15 VDC, or optional 120 VAC adapter. Add our matching case and whip antenna set for a nice finished look.

FM-10A, Tunable FM Stereo Transmitter Kit $34.95
CFM, Matching Case and Antenna Set $14.95

RF Power Booster Amplifier

Add some serious muscle to your signal, boost power up to 1 watt over a frequency range of 100 KHz to over 1000 MHz! Use as a lab amp for signal generators, plus many foreign users employ the LPA-1 to boost the power of their FM Stereo transmitters, providing radio service through an entire town. Power required: 12 to 15 volts DC at 250mA, gain of 38dB at 10 MHz, 10 dB at 1000 MHz. For a neat, professionally finished look, add the optional matching case set.

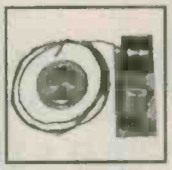
LPA-1, Power Booster Amplifier Kit $39.95
CLPA, Matching Case Set for LPA-1 Kit $14.95
LPA-1WT, Fully Wired LPA-1 with Case $99.95

Micro FM Wireless Mike

World's smallest FM transmitter. Size of a sugar cube! Uses SMT (Surface Mount Technology) devices and mini electret condenser microphone, even the battery is included. We give you two complete sets of SMT parts to allow for any errors or mishaps-build it carefully and you've got extra SMT parts to build another! Audio quality and pick-up is unbelievable, transmission range up to 300 feet, tunable to anywhere in standard FM band 88 to108 MHz. 7/8"w x 3/8"h x 3/4"h.

FM-5 Micro FM Wireless Mike Kit $19.95

Crystal Controlled Wireless Mike



Super stable, drift free, not affected by temperature, metal or your body! Frequency is set by a crystal in the 2 meter Ham band of 146.535 MHz, easily picked up on any scanner radio or 2 meter rig. Changing the crystal to put frequency anywhere in the 140 to 160 MHz range-crystals cost only five or six dollars. Sensitive electret condensor mike picks up whispers anywhere in a room and transmit up to 1/4 mile. Powered by 3 volt Lithium or pair of watch batteries which are included. Uses the latest in SMT surface mount parts and we even include a few extras in case you sneeze and loose a part!

FM-6, Crystal Controlled FM Wireless Mike Kit $39.95
FM-6WT Fully Wired FM-6 .... $69.95

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A truly professional frequency synthesized FM Stereo transmitter station in one easy to use, handsome cabinet. Most radio stations require a whole equipment rack to hold all the features we've packed into the FM-100. Set frequency easily with the Up/Down freq buttons and the big LED digital display. Plus there's input low pass filtering that gives great sound no matter what the source (no more squeals or swishing sounds from cheap CD player inputs!) Peak limiters for maximum 'punch' in your audio - without over modulation, LED bargraph meters for easy setting of audio levels and a built-in mixer with mike and line level inputs. Churches, drive-ins, schools and colleges find the FM-100 to be the answer to their transmitting needs, you will too. No one offers all these features at this price! Kit includes sharp looking metal cabinet, whip antenna and 120 volt AC adapter. Also runs on 12 volts DC.

We also offer a high power export version of the FM-100 that's fully assembled with one watt of RF power, for miles of program coverage. The export version can only be shipped outside the USA, or within the US if accompanied by a signed statement that the unit will be exported.

FM-100, Professional FM Stereo Transmitter Kit $299.95
FM-100WT, Fully Wired High Power FM-100 .... $429.95

Speech Descrambler Scrambler

Decode all that gibberish! This is the popular descrambler / scrambler that you've read about in all the Scanner and Electronic magazines. The technology used is known as speech inversion which is compatible with most cordless phones and many police department systems, hook it up to scanner speaker terminals and you're in business. Easily configured for any use: mike, line level and speaker output/inputs are provided. Also communicate in total privacy over telephone or radio, full duplex operation - scramble and unscramble at the same time. Easy to build, all complex circuitry contained in new custom ASIC chip for clear, clean audio. Runs on 9 to 15VDC, RCA phono type jacks. Our matching case set adds a super nice professional look to your kit.

SS-70A, Speech Descrambler/Scrambler Kit $39.95
CSS, Custom Matching Case and Knob Set $14.95
SS-70AWT, Fully Wired SS-70A with Case $79.95
AC12-5, 12 Volt DC Wall Plug Adapter $9.95

Tone-Grabber Touch Tone Decoder / Reader

Dialed phone numbers, repeater codes, control codes, anywhere touch-tones are used, your TG-1 will decode and store any number it hears. A simple hook-up to any radio speaker or phone line is all that is required, and since the TG-1 uses a central office quality decoder and microprocessor, it will decode digits at virtually any speed! A 256 digit non-volatile memory stores numbers for 100 years - even with the power turned off, and an 8 digit LED display allows you to scroll through anywhere in memory. To make it easy to pick out numbers and codes, a dash is inserted between any group or set of numbers that were decoded more than 2 seconds apart. The TG-1 runs from any 7 to 15 volt DC power source and is both voltage regulated and crystal controlled for the ultimate in stability. For stand-alone use add our matching case set for a clean, professionally finished project. We have a TG-1 connected up here at the Ramsey factory on the FM radio. It's fun to see the phone numbers that are dialed on the morning radio show! Although the TG-1 requires less than an evening to assemble (and is fun to build, too!), we offer the TG-1 fully wired and tested in matching case for a special price.

TG-1, Tone Grabber Kit $99.95
CTG, Matching Case Set for TG-1 Kit $14.95
TG-1WT, Fully Wired Tone Grabber with Case $149.95
AC12-5, 12 Volt DC Wall Plug Adapter $9.95

Mini-Peeper Micro Video Camera

Super small, high quality fully assembled B & W CCD TV camera the size of an ice cube! Provides excellent pictures in low light (2 lux), or use our IR-1 Infra-Red light source to invisibly illuminate an entire room on a pitch black night! Imagine the possibilities... build it into a smoke detector, wall clock, lamp, book, radio. Exact same camera that's in big buck detective catalogues and stores. Kit includes: fully assembled CCD camera module, connectors, interface PC board kit with proper voltage regulation and filtering, hook-up details, even a mini microphone for sensitive sound! Two models available: Wide Angle Lens 3.6mm/f2, adjustable focus lens, 92 degree view; Pinhole Lens 5.5mm/f4.5, 60 degree view. The Pinhole Lens is physically much flatter and provides even greater depth of focus. The camera itself is 1.2" square. The Wide Angle Lens is about 1" long, Pinhole Lens about 1/2", interface PC board is 1" x 2" and uses RCA jacks for easy hook-up to VCRs, TVs or cable runs. Power required is 9 to 14 VDC @ 150 mA. Resolution: 380 x 350 lines. Instruction manual contains ideas on mounting and disguising the Mini-Peeper along with info on adding one of our TV Transmitter kits (such as the MTV-7 unit below) for wireless transmission!

MP-1, Wide Angle Lens CCD TV Camera Outfit $169.95
MP-1PH, Pin-Hole Lens CCD TV Camera Outfit $189.95

MicroStation Synthesized UHF TV Transmitter

Now you can be in the same league as James Bond. This transmitter is so small that it can fit into a pack of cigarettes - even including a CCD TV camera and battery! Model airplane enthusiasts put the MTV-7A into airplanes for a dynamite view from the cockpit, and the MTV-7A is the transmitter of choice for balloon launches. Transmitter features synthesized, crystal controlled operation for drift-free transmission of both audio and video on your choice of frequencies: Standard UHF TV Channel 52 (which should only be used outside of the USA to avoid violating FCC rules), and 439.25 MHz or 911.25 MHz which are in the amateur ham bands. The 439.25 MHz unit has the nifty advantage of being able to be received on a regular 'cable-ready' TV set tuned to Cable channel 68, or use our ATV-74 converter and receive it on regular TV channel 3. The 911.25 MHz unit is suited for applications where reception on a regular TV is not desired, an ATV-79 must be used for operation. The MTV-7A's output power is almost 100 mW, so transmitting range is pretty much 'line-of-sight' which can mean many miles! The MTV-7A accepts standard black and white or color video and has its own, on-board, sensitive electret micorphone. The MTV-7A is available in kit form or fully wired and tested. Since the latest in SMT (Surface Mount Technology) is used to provide for the smallest possible size, the kit version is recommended for experienced builders only. Runs on 12 VDC @ 150 mA and includes a regulated power source for a CCD camera.

MTV-7A, UHF TV Channel 52 Transmitter Kit $159.95
MTV-7AWT, Fully Wired Channel 52 Transmitter $249.95
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MTV-7A4WT, Fully Wired 439.25 MHz Transmitter $249.95
MTV-7A9, 911.25 MHz TV Transmitter Kit $179.95
MTV-7A9WT, Fully Wired 911.25 MHz Transmitter $269.95
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ATV-79, 911.25 MHz Converter Kit $179.95
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- **DMM-20** ($74.95): AC/DC (V, A), Freq, cont., Capac, Induct., Ω, hFE, diode, duty cycle
- **DMM-22** ($89.95): 4000counts, bar graph, Freq, AC/DC(V,A), Ω, Capacitance, diode, contin
- **DMM-23T** ($99.95): 4½ digit, high resol. (10uV, 10nA, 10mΩ), hFE, diode, contin., true rms
- **DMM-89S** ($179.00): true rms, AC/DC (V,A), Ω, bar graph, freq, capac., dBm, logic, diode
- **DMM-113** ($24.95): Pocket Size, DC/ACV, Ω, diode, Continuity beeper
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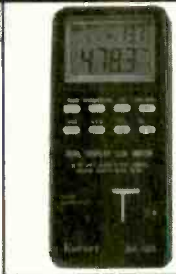
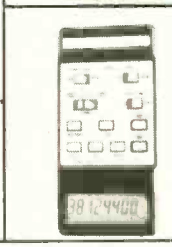
- **DMM-125C** ($54.95): Autorange + bar graph, DC/ACV, Cap,Ω, diode, continuity beeper





LCR METER

- **CAP-15** (*$49.95*): 3½ digit, 0.1pF-20mF, 9 Ranges, 0.1pF resolution zero adjustment.
- **LCR-195** (*$89.95*): 1uH-200H (induct.), 0.1pF-200uF(Capac.), 0.01Ω-20M Ω(resistance)
- **LCR-814** (*$189.95*): 0.1uH-200H, 0.1pF-20mF, 0.1Ω-20MΩ, Q Factor, dissipation, zero adjust
- **LCR-131D** (*$229.95*): autorange, 0.1uH-10kH, 0.1pF-10mF, 1mΩ-10MΩ, Q Factor, serial/parallel, 120Hz/1kHz testing mode

FREQ. COUNTER

- **FC-1200** (*$129.95*): 1.25GHz Handheld, 8 digits display, 10ppm accuracy, sensitivity 5mV (130-350MHz), 30mV (440MHz), 22m (800MHz), batteries or 9V adapter.
- **FC-2500** (*$179.95*): 2.5GHz Handheld, 8 digits display, 4ppm accuracy, sensitivity <50mV, batteries or 9V adapter.
- **FC-5270A** (*$149.95*) 1.2 Ghz bench type, 8 digit, 10 ppm, 35mV sensitivity, 10Vp-p max. input, power by 9V adapter.
- **FC-5700** (*$329.95*) 1.3GHz bench type, 8 digit, 1 ppm accuracy, 20mV sensitivity, period 0.1us to 100ms. Ideal for test & repair of audio instrument.

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76-II	$175.00	**863E**	$469
77-II	$155.00	**867E**	$659
79/29-II	$175.00		
87	$287.00		

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- High Voltgae Probe $59.95
- pH Meter $79.95
- Light Meter $80-$90
- Light Adapter $49.95
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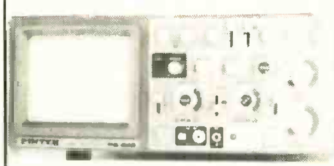


- PS-200 20 MHz Dual Trace $339.95
- PS-205 20 MHz Dual w/ Delay Sweep $429.95
- PS-400 40 MHz Dual Trace $494.95
- PS-405 40 MHz Dual w/ Delay Sweep $569.95
- PS-605 60 MHz Dual w/ Delay Sweep $769.95
- PS-1000 100MHz Dual Trace $999.95

Digital Scope:

- DS-303 30MHz Digital, 20 Samples/sec $849.95
- DS-303P RS-232 interface, 30Mhz $1,049.95

Scope Probe:

HP-9060 (60MHz) $15, HP-9150 (150MHz) $22, HP-9250 (250MHz)$29, HP-9258 (250MHz,100:1)$39

AUDIO/RF/FUNCT. GENERATOR

RF Generator

- **SG-4160** ($124.95) 100kHz-150MHz sinewaves in 8 ranges, 100mV at 35MHz
- **SG-4162** ($229.95): Generate same signal as SG-4160, but with int. counter (150MHz).

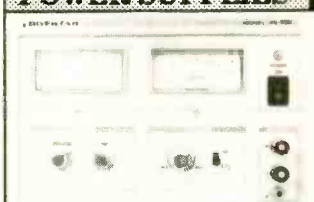
Audio Generator

- **AG-2601** ($124.95)10Hz-1MHz, 0-8Vpp sine, 0-10Vpp squarewave
- **AG-2603** ($229.95): Same as AG-2601, but with additional counter and digital display.

Function Generator

- **FG-2100A**($169.95).2Hz-2MHz,5mV-20Vpp
- **FG-2102AD** ($229.95) same as FG-2100A, but with int. counter and TTL, CMOS output.
- **FG-2103** ($329.95) *Sweep* 0.5Hz-5MHz, linear/log, VCG, GCV, and int. counter

POWER SUPPLIES



Single Output DC Power Supplies

- Short Circuit and overload protected
- Constant current, constant voltage mode
- 0.02%+2mV line regulation; 0.02%+2mV load regulate

Analog Meters Display

PS-303 ($159.00) 30V/3A
PS-305 ($219.95) 30V/5A
PS-8110 ($289.95) 60V/5A
PS-8112 ($399.95) 60V/5A
PS-1610 ($289.00) 16V/10A
PS-8107 ($399.95) 30V/10A

Digital Voltage, Analog Current

PS-8200 ($179.95) 30V/3A
PS-8201 ($239.95) 30V/5A

Digital Volt & Current Display

PS-8300 ($199.95) 30V/3A
PS-8301 ($259.95) 30V/5A

Dual Tracking

- Short Circuit & overload protected
- Constant current & constant mode
- Independent or Tracking

Dual Tracking (Analog V & I Displays)

PS-303D ($314.95) 30V/3A/30V/3A
PS-305D ($399.95) 30V/5A/30V/5A
PS-8108 ($549.95) 60V/3A/60V/3A
PS-8109 ($699.95) 60V/5A/60V/5A

Triple Output

- One fixed 5VDC, 3 Amp output
- Parallel to double current output (PS-8102 & PS-8103 only)

Triple Output (Analog displays)

PS-8102 ($399.95) 30V/3A/30V/3A
PS-8103 ($489.95) 30V/5A/30V/5A

Digital Displays

PS-8202 ($499.95) 30V/3A/30V/3A
PS-8203 ($549.95) 30V/5A/30V/5A

INSTEK® Test & Measuring Instrument

ISO 9002 Cert. #934163 (2 Years Warranty)

OSCILLOSCOPE

OS-653 $699.95 — 50MHz Triggering

- Dual CH / Delay sweep
- ALT trigger, trigger lock
- 1mV/div sen., delay line
- Zaxis input,CH1 output
- Hold off, TV syn.
- 2 probes (x1, x10)

OS-622B $399.95 — 20 MHz Oscilloscope

- Dual CH/X-Y operation
- 1 mV/div sensitivity
- Z-axis input,CH1 output
- TV syn., trigger level lock
- 2 probes (x1, x10)

OS-305 ($209.95) - 5 MHz One Channel
OS-310 ($324.95) - 10 MHz One channel

DC POWER SUPPLIES

Triple Output

- 2 variable out 0-30V,0-3A
- One fixed 5V,3A output
- Auto track, serial, parallel
- Const. volt, current mode
- 4 analog or 2 digital display

PC-3030 ($499.95)
PC-3030D ($549.95)

Single Output

- Const voltage, current mod
- Voltage regulation ≤0.01%
- Current regulation ≤0.2%
- PS: 2 analog or 1 digital dis
- PR: 2 analog or 2 digital dis

Analog Meters Display

PS-1830 ($209.95) 18V/3A
PS-1850 ($219.95) 18V/5A
PS-3030 ($224.95) 30V/3A
PS-6010 ($209.95)60V/10A
PR-3060 ($314.95)30V/6A
PR-6030 ($314.95)60V/3A

Digital Meters Display

PS-1830D($219.95)18V/3A
PS-1850D($244.95)18V/5A
PS-3030D($254.95)30V/3A
PR-6030D($399.95)60V/3A

Programmable

- High stability, low drift
- One fixed 5V,3A output
- 100point program(PPS ser)
- 50point program(PPT ser.)
- Auto serial/parall.(PPT ser)
- Auto track (PPT series), IEEE-488.2 and SCPI compatible command set (optional)

PPS-1860G ($1,099.95)
PPS-3635G ($1,099.95)
PPS-6020G ($1,099.95)
PPT-1830G ($1,399.95)
PPT-3615G ($1,399.95)

FUNCTION GENERATOR

FG-8015G($189.95)Sweep
- 0.02Hz-2Mhz,no counter
- Sine/Squ/Tri/Pulse/Ramp

FG-8016G ($239.95)
- 0.02Hz-2MHz w/ counter
- Pulse, function generator

FG-8017G($249.95)Sweep
- Sine/Tri/Squ/TTL/CMOS
- 0.02Hz-2Mhz, FM mod.

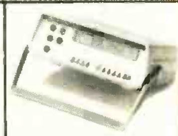
FG-8019 ($399.95) Sweep
- 0.02Hz-2MHz w/counter
- INT/EXT AM/FM mod

FG-8019 ($209.95)
- 0.02Hz-2MHz w/counter

FG-8050 ($499.95) Sweep
- 0.05Hz-5MHz w/counter
- INT/EXT AM/FM mod

FG-830 ($1,499.95) 30MHz Synthesized Function Gen.
- Output: sine, tri., square, sync out, arb. waveform
- 20mHz Freq. resolution
- Linear/log sweep
- Arbitrary modulation
- RS232; IEEE-488(option)

BENCHTOP DMM



DM-8034($179.95) 3½ dgt
- AC/DV(V,A),C,Ω,diode
- 1000V, 20A, 0.5% accu.

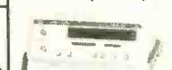
DM-8040($339.95) 3½ dgt
- ACV to 50kHz, true rms

DM-8055($649.95) 5½ dgt
- 0.006% basic accuracy
- 1uV,1mΩ,1nA resolution
- dBm,auto,REL, min/max

DM-8055G($889.95)GPIB
- Same funct. as DM-8055

Frequency Counters

FC-8131 ($469.95)1.3GHz
FC-8270 ($629.95)2.7GHz
UC-2010G ($294.95)



Programmable Electronic Load (PEL-300)

(Patent No 81011/81324)

**** NEW **** ***$1409.95***

- Operating Rating: voltage 3-60V, current 6mA-60A, power 300W, temp 0-40C(operate)/-10-70C (store)
- Over voltage, over current, over power protection
- Operation mode: constant voltage, current, resistance
- Transient Gen. Frequency 1Hz-1kHz; duty 10-90%
- High Resolution: 20mV, 0.2mA, 0.3mΩ
- Self-Test and Software Calibration
- Meet UL CSA IEC Safety regulation

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Don't let the price fool you. This meter is a digital multimeter designed for engineers and hobbyists. Equipped with 5 functions and 19 ranges. Each test position is quickly and easily selected with a simple turn of the FUNCTION/RANGE selector rotary switch. *Rubber Boot Included*

Our Best Offer Ever on a High Quality Full Sized DMM

General

Display: 3-1/2 Digit LCD, 21mm Figure Height with Automatic Polarity

Overrange Indication: 3 Least Significant Digits Blank

Temperature for Guaranteed Accuracy: 23°C±5°C RH<75%

Temperature Ranges:
Operating: 0°C to 40°C (32°F to 104°F)
Storage: -10°C to 50°C (14°F to 122°F)

Power: 9V Alkaline or Carbon-Zinc Battery(NEDA1604)

Low Battery Indication: BAT on Left of LCD Display

Dimensions: 188mm long x 87mm wide x 33mm thick

Net Weight: 400g

$19.00 any qty

DC Voltage (DCV)

Range:	Resolution:	Accuracy:
200mV	100μV	
2000mV	1mV	
20V	10mV	±(1%rdg+2dgts)
200V	100mV	
1000V	1V	

Maximum Allowable Input: 1000V DC or Peak AC.

DC Current (DCA)

Range:	Resolution:	Accuracy:
200μA	100nA	
2000μA	1μA	±(1.2%rdg+2dgts)
20mA	10μA	
200mA	100μA	
10A	10mA	±(1.2%rdg+2dgts)

Overload Protection: mA Input. 2A/250V fuse.

AC Voltage (ACV)

Range:	Resolution:	Accuracy:
200V	100mV	±(1.2%rdg+10dgts)
750V	1V	

Frequency Range: 45Hz-450Hz

Maximum Allowable Input: 750V rms

Response: Average Responding. Calibrated in rms of a Sine Wave.

Resistance (Ω)

Range:	Resolution:	Accuracy:
200Ω	100mΩ	
2000Ω	1Ω	
20KΩ	10Ω	±(1.2%rdg+2dgts)
200KΩ	100Ω	
2000KΩ	1KΩ	
20MΩ	10KΩ	±(2%rdg+10dgts)

Maximum Open Circuit Voltage: 2.8V

Diode Test

Measures forward voltage drop of a semiconductor junction in mV test current of 1.5mA Max.

ohFE Test

Measures transistor hFE.

CAT NO	DESCRIPTION	PRICE
9300G	Rugged High Quality DMM with Rubber Boot	$19.00

Switchable Scope Probe Sets

(Selectable X1/Ref/X10) These high quality scope probe sets are for oscilloscopes up to 60MHz (model HP 9060) or 50MHz (model HP9150). Both sets include a handy storage pouch and include an IC test-hook adapter for the probe. The BNC connector rotates to avoid cable tangle or kink. Cable length is 1.4 meters.

CAT NO	DESCRIPTION	PRICE EACH 1	10	100
HP-9060	Scope Probe Set DC~60MHz	$16.49	$14.49	$11.58
HP-9150	Scope Probe SetDC~150MHz	24.95	21.95	18.62

Etching Chemicals/Ferric Chloride

A dry concentrate that mixes with water to make 1 pint of etchant, enough to etch 400 sq. inches of 1oz board.

CAT NO	DESCRIPTION	PRICE EACH 1	5
ER-3	Makes 1 pint	$3.50	$2.75

Positive Photo Resist Pre-Sensitized Printed Circuit Boards

These pre-sensitized printed circuit boards are ideal for small production runs. They provide high resolution and excellent line width control. High sensitive positive resist coated on 1oz. copper foil allows you to go direct from your computer plot or art work layout. No need to reverse art.

Single-Sided, 1oz. Copper Foil on Paper Phenolic Substrate

CAT NO	DESCRIPTION	PRICE EACH 1	10	50
PP101	100mm x 150mm/3.91" x 5.91"	$2.55	$1.90	$1.70
PP114	114mm x 165mm/4.6" x 6.6"	2.98	2.45	1.98
PP152	150mm x 250mm/5.91" x 9.84"	5.40	3.98	3.60
PP153	150mm x 300mm/5.91" x 11.81"	6.15	4.48	4.10
PP1212	305mm x 305mm/12" x 12" NEW!	12.78	10.65	8.52

Single-Sided, 1oz. Copper Foil on Fiberglass Substrate

CAT NO	DESCRIPTION	PRICE EACH 1	10	50
GS101	100mm x 150mm/3.91" x 5.91"	$ 3.90	$2.98	$2.60
GS114	114mm x 165mm/4.6" x 6.6"	4.80	3.49	3.20
GS152	150mm x 250mm/5.91" x 9.84"	8.69	5.98	5.78
GS153	150mm x 300mm/5.91" x 11.81"	10.20	7.20	6.80
GS1212	305mm x 305mm/12" x 12" NEW!	18.88	15.73	12.59

Double-Sided, 1oz. Copper Foil on Fiberglass Substrate

CAT NO	DESCRIPTION	PRICE EACH 1	10	50
GD101	100mm x 150mm/3.91" x 5.91"	$ 5.07	$3.68	$3.38
GD114	114mm x 165mm/4.6" x 6.6"	5.95	4.29	3.99
GD152	150mm x 250mm/5.91" x 9.84"	10.47	7.39	6.98
GD153	150mm x 300mm/5.91" x 11.81"	11.95	8.69	8.30
GD1212	305mm x 305mm/12" x 12" NEW!	22.09	18.35	14.68

Developer

This product is used as the developer on our positive photo-resist printed circuit boards. Includes instructions. 50 gram package, mixes with water, makes 1 quart.

CAT NO	DESCRIPTION	PRICE EACH 1	10	25
POSDEV	Positive Developer	$ .95	$ .80	$ .50

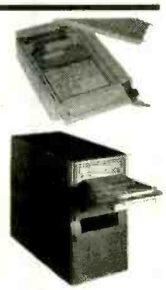
Etching Tank

This handy etching system will handle PC boards up to 8"x9", two at a time. Ideal for etching your PCB's! System includes an air pump for etchant agitation, a thermostatically controlled heater for keeping etchant at optimum temperature and a tank that holds 1.35 gallons of etchant. A tight fitting lid is also supplied to prevent evaporation when system is not being used. Typical etching time is reduced to 4 minutes on 1oz. copper board!

REDUCES ETCHING TIME!

CAT NO	DESCRIPTION	PRICE
12-700	Etch Tank System	$37.95

Removeable Hard Drive Racks



The ideal solution for protecting highly sensitive data. Or, buy one computer and allow individual users to keep their hard drive with their own applications and set-ups. Just turn the system off, lift the handle and the hard drive pops right out. Key lock included to avoid accidental or unauthorized removal. Includes hard drive activity LED's. Rack includes mounting hardware, keylock, front panel LED, convenient pull out handle. Made from high impact ABS plastic. Fits in 5.25" bay.

Features: *• Ideal for Hard Drive Portability • Solve Software Data Security Issues • Carry Your Hard Drive Between Home and Office • Each User Can Have His or Her Personal Hard Drive*

CAT NO	DESCRIPTION	PRICE
SpecialHDRACK-IDE	For IDE Hard Drive	$14.95

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CIRCLE 332 ON FREE INFORMATION CARD

Digital Panel Meters (LCD & LED)

Don't let the prices fool you. These digital panel meters are not surplus, so even if you design them into an ongoing manufactured product, you can be assured of continued availability. These high quality digital panel meters are decimal point selectable with guaranteed zero reading at zero volts input.

Applications Include:

- Voltmeter
- Thermometer
- pH Meter
- dB Meter
- Watt Meter
- Current Meter
- Capacitance Meter
- LUX Meter
- LCR Meter
- Other Industrial & Domestic Uses

PM-128: 3-1/2D LCD Digital Panel Meter

PM-129: 3-1/2D LED Digital Panel Meter

Features

- 200mV Full Scale Input Sensitivity
- PM-128 - Single 9VDC Operation
- PM-129 - Single 9VDC Operation
- Decimal Point Selectable
- PM-128 - 13mm Figure Height
- Automatic Polarity Indication
- Guaranteed Zero Reading for 0 Volt Input
- High Input Impedance (>100Mohm)

Specifications - PM-128/PM-129

Maximum Input	: 199.9mV DC
Maximum Display	: 1999 counts (3-1/2 Digits) w/Automatic Polarity Indication
Indication Method	: PM-128 - LCD Display PM-129 - LED Display
Measuring Method	: Dual-Slope Integration A/D Converter System
Overrange Indication	: "1" Shown in the Display
Reading Rate Time	: 2-3 Readings per sec.
Input Impedance	: >100 Mohm
Accuracy	: +-0.5% (23+-5°C, <80% RH)
Power Dissipation	: PM-128 - 1mA DC PM-129 - 60mA DC
Decimal Point	: Selectable w/Wire Jumper
Supply Voltage	: PM-128 - 9V DC PM-129 - 9V DC
Size	: 67mm x 44mm

3-1/2 Digit LCD 3-1/2 Digit LED 4-1/2 Digit LCD

PM-328: 4-1/2D LCD Digital Panel Meter

Features

- 200.00mV Full Scale Input Sensitivity
- Single 9V DC Operation
- Decimal Point Selectable
- 11mm LCD Figure Height
- Automatic Polarity Indication
- Low Battery Detection and Indication
- High Input Impedance (>100 Mohm)

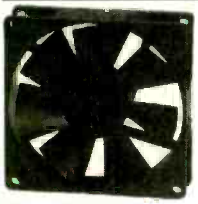
Specifications - PM-328

Maximum Input	: 199.99mV DC
Maximum Display	: 19999 counts (4-1/2 Digits) w/Automatic Polarity Indication
Indication Method	: LCD Display
Overrange Indication	: "1" Shown in the Display
Input Impedance	: >100 Mohm
Accuracy	: +-0.05% (23+-5°C, <80% RH)
Power Dissipation	: 1mA DC
Decimal Point	: Selectable w/Wire Jumper
Supply Voltage	: 9V DC
Size	: 67mm x 44mm

AS LOW AS $5.25 ea.

CAT NO	DESCRIPTION	PRICE EACH 1	10	25	100	250
PM-128	3-1/2 Digit LCD Panel Meter	$ 9.90	$ 7.09	$ 6.40	$ 5.86	$ 5.25
PM-129	3-1/2 Digit LED Panel Meter	11.49	9.54	8.67	7.95	6.95
PM-328	4-1/2 Digit LCD Panel Meter	19.88	16.40	14.90	13.66	11.93

Ball Bearing 12V DC Fans



These High Quality Fans feature Ball Bearings and Brushless DC Motors. All of them are designed to meet UL, CSA & VDE Standards. Design these fans into power supplies, computers or other equipment requiring additional air flows for heat removal. These fans are regular Circuit Specialists stock items — they are not surplus.

INDUSTRY BEST PRICING!

CAT NO	PRICE EACH 1	10	25	100
CSD 4010-12	$ 9.88	$ 6.38	$5.48	$4.87
CSD 6025-12	9.38	5.91	5.41	4.71
CSD 8025-12	8.88	5.85	5.19	4.49
CSD 9225-12	8.95	6.14	5.29	4.59
CSD 1225-12	11.45	8.96	7.82	6.85

Specifications

CAT NO	DIMENSIONS (MM)	RATED VOLTAGE (V)	START VOLTAGE (V)	INPUT CURRENT (A)	AIR FLOW (CFM)	STATIC PRESSURE (INCH-H_2O)	SPEED (RPM)	NOISE LEVEL (dB)	WEIGHT (g)
CSD 4010-12	40x40x10mm	12	7	0.06	5.1	0.19	5,500	26	20
CSD 6025-12	60x60x25mm	12	5	0.13	13.7	0.165	4,500	28	65
CSD 8025-12	80x80x25mm	12	5	0.16	37.8	0.177	3,000	31	80
CSD 9225-12	92x92x25mm	12	5	0.32	42	0.18	2,800	37	95
CSD 1225-12	120x120x25mm	12	5	0.35	62	0.180	2,500	42	135

• SOLDER • SOLDER • SOLDER • SOLDER • SOLDER • SOLDER •

We stock high quality 60/40(Sn%/Pb%), .031" and 63/37, .031" diameter. This is prime JIS certified solder that we maintain as a regular stock item (It is not "Left-overs, Rejects or Surplus") and you can buy it from us at a fraction of the price that you are used to.

Tired of Paying Inflated Prices for Solder?

CAT NO	DESCRIPTION	PRICE EACH 1	10	25
RH60-1	1-lb. Spool, .031", 60/40	$ 6.90	$ 5.96	$ 5.30
RH63-1	1-lb. Spool, .031", 63/37	6.95	6.10	5.41
RH60-4	4.4-lb. Spool, .031", 60/40	24.00	21.90	17.92
RH60-TUBE	6-oz. Tube, .031", 60/40	.99	.89	.79

CCD Camera - IR Responsive

As Low As $85!!

This black and white monochrome CCD Camera is totally contained on a PCB (70mm x 46mm). The lens is the tallest component on the board (27mm high from the back of the PCB) and it works with light as low as 0.1 lux. It is IR Responsive for use in total darkness. It comes with six IR LED's on board. It connects to any standard monitor, AUX or video input on a VCR or through a video modulator to a TV. Works with a REGULATED 12V power supply (11V-13V). Hooks up by connecting three wires: red to 12V, black to ground (power & video) and brown to video signal output.

Power Supply Regulating Kit for CA-H34 This simple kit is designed to fit onto the back of the CA-H34 CCD camera. It resolves the problem of hooking up the camera to an UNREGULATED supply (which damages the camera) by providing safe regulated power from any 12V-14V DC supply. It also provides regulated 12V DC from a 12V AC source.

CAT NO	DESCRIPTION	PRICE EACH 1	5
CA-H34A	PCB Mounted IRCCD Camera	$99.00	$85.00
A34	Power Supply Regulating Kit	$6.95	-----

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- Optima-6s

$53.80

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- 30 Watts Power
- Bakelite Construction • 1/8" Tip

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HOT PRICES ON POPULAR SEMI'S

Order #	Brand	Min	Price
BU-208	TESLA	10	$1.49
BU-208/O	TOSHIBA	1	3.49
2N-3055	TESLA	10	0.29
2N-3773	TESLA	5	1.20
2SD-1398	SANYO	10	1.39
2SD-1650	SANYO	5	0.99
STR-30130	SANKEN	1	2.66
TA-7777N	TOSHIBA	1	5.25
TDA-2005	SGS	5	1.49

SOLDER PASTE
- For soldering and tinning
- net/content 50g

Order № 51-1920

92¢

UNIQUE REALTIME OSCILLOSCOPE BUILT-IN FUNCTION GENERATOR 2-CH DUAL TRACE
1 MHZ FUNCTION GENERATOR

Features: • Wider than specified frequency response • High deflection factor of 1mV/div. • Wide dynamic range up to 30MHz without waveform distortion • Algebraic sum of CH1 and CH2 • Low drift with compensation circuit • Superb trigger sensitivity • Maximum sweep rate of video signals with internal TV sync. separator • Jittless trigger circuitry • CH1 signal output terminal available • Variable trigger hold-off • High precision X-Y phase difference measurement up to 50kHz • Built-In function generator with BNC output of 50Ω and TTL • Three kinds of waveform are available with 50Ω output • Flat output waveform frequency up to 1MHz

Specifications: Vertical deflection: • Bandwidth: DC coupled (DC to 20MHz normal), AC coupled: (10Hz to 20MHz normal) • Deflection factor: 5mV/div to 5V/div in 10 calibrated steps of 1-2-5 sequence • Rise time: 17.5ns or less
Horizontal deflection: • Time Base A: 0.2μs to 0.2S/div In 19 calibrated steps. 1-2-5 sequence • Uncalibrated continuous control between steps of at least 1: 2.5.

20 MHZ
Manuf # OS-9020G

$450.00

Order № 50-820

The most popular VCR ALIGNMENT TOOL KIT
- VCR Head pulley
- Retaining ringremover
- Spring hook
- Micro screwdriver
- Hex key set
- Fitted vinyl
- Soft zippered case
- 7 Assorted head & guide aligners
- Dimensions: 91/2"(W) X 121/4"(L)
- 3 Reversible screwdrivers (Small-Flat-Fillips)

$24.99

Order № 50-888

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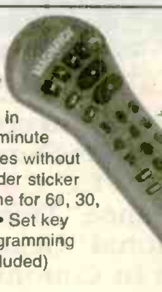
MAGNAVOX Smart. Very smart

- Controls basic functions of TV, VCR, cable box, and CD or laser player
- Ergonomic designl Main buttons are in line with natural thumb motion • Two-minute memory allows time to replace batteries without reprogramming • Programming reminder sticker inside battery compartment • Sleep time for 60, 30, or 15 minutes (according to your TV) • Set key recessed to prevent accidental deprogramming
- Requires four AAA Batteries (not included)



$9.95

- Cable (11 brands)
- VCR (68 brands)
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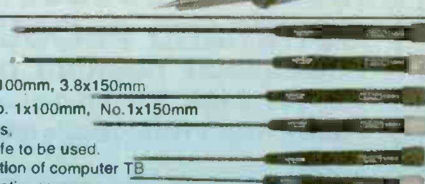

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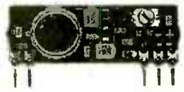

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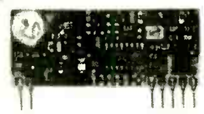

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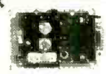

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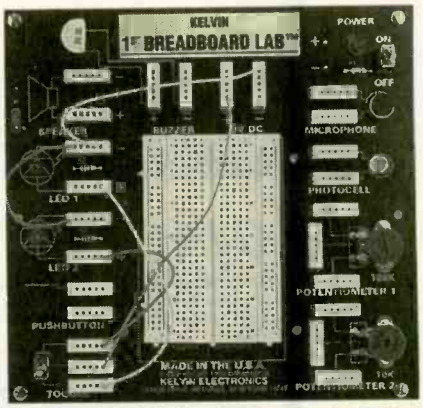

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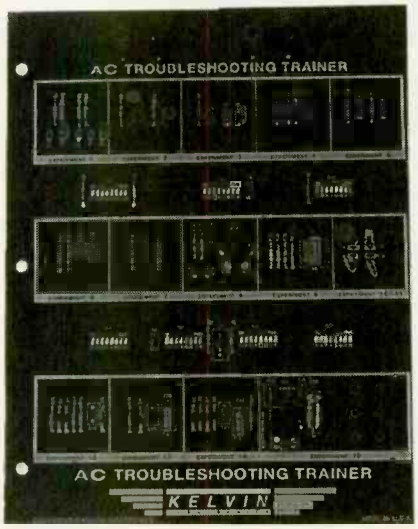

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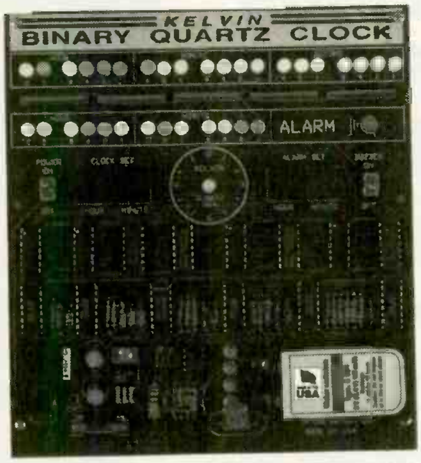

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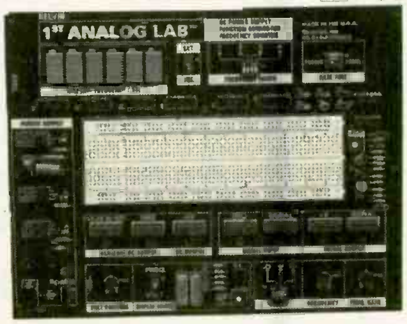

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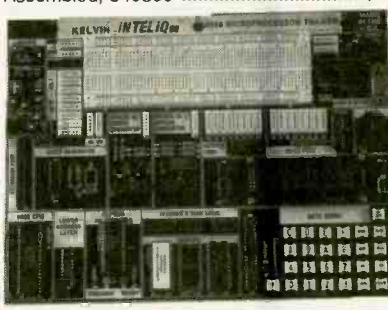

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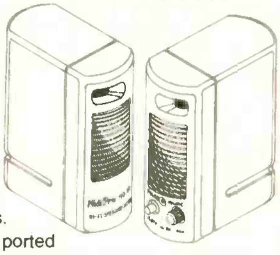

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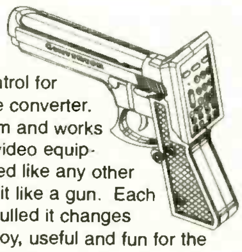

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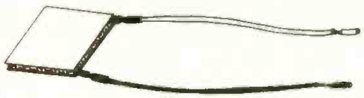

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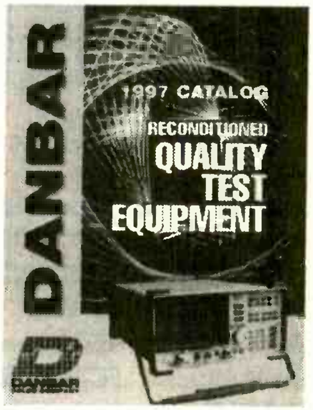

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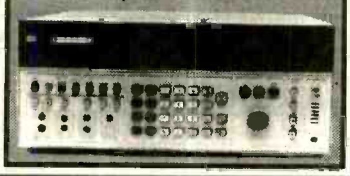

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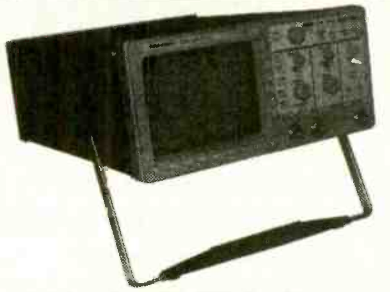

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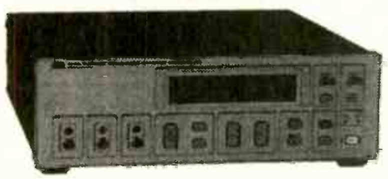

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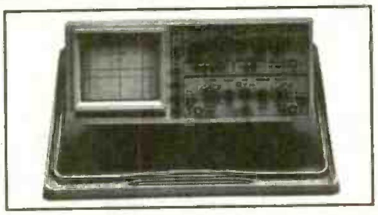

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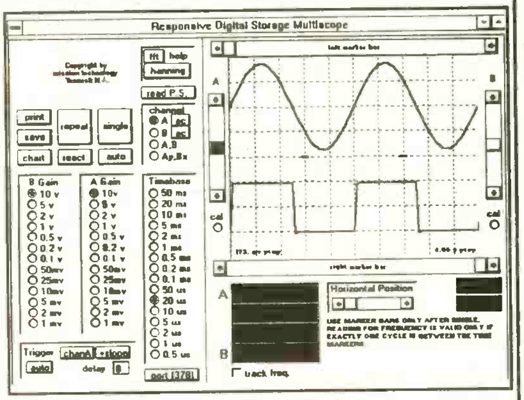

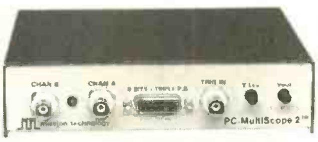

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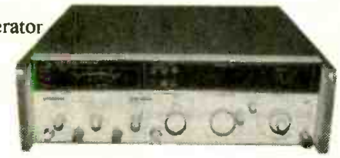

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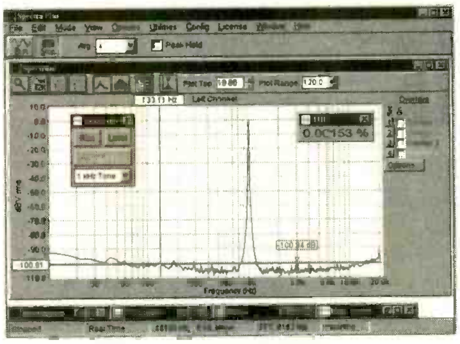

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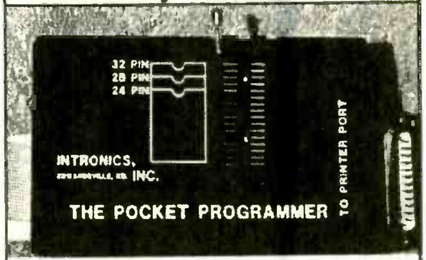

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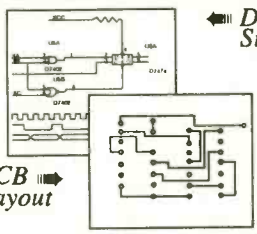

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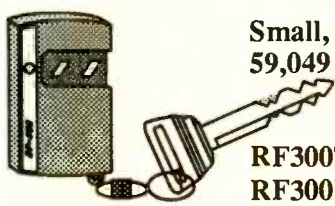

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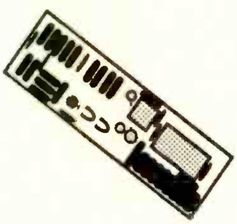

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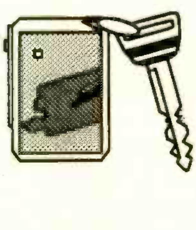

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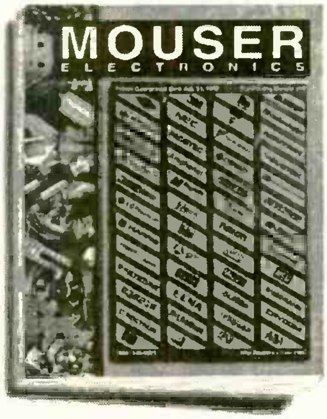

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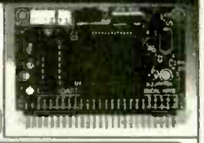

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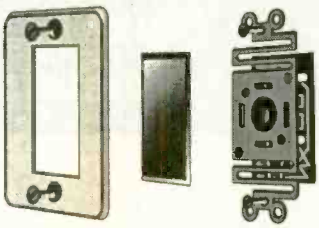

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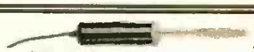

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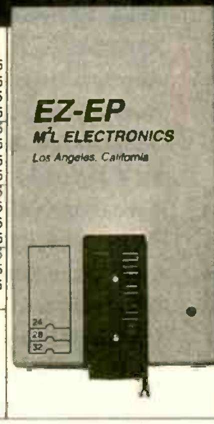

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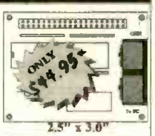

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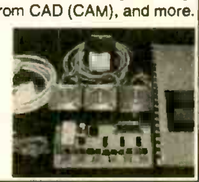

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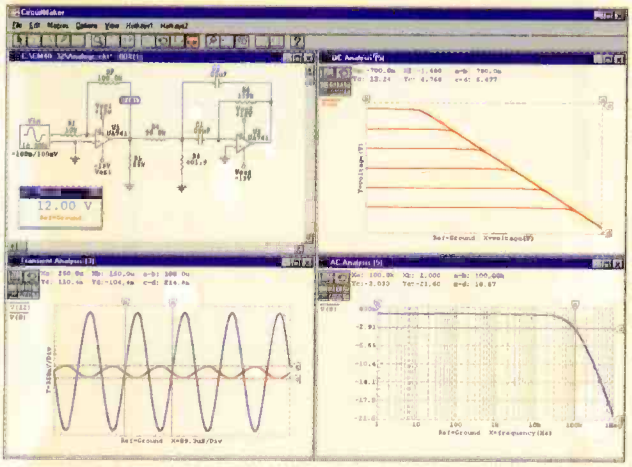

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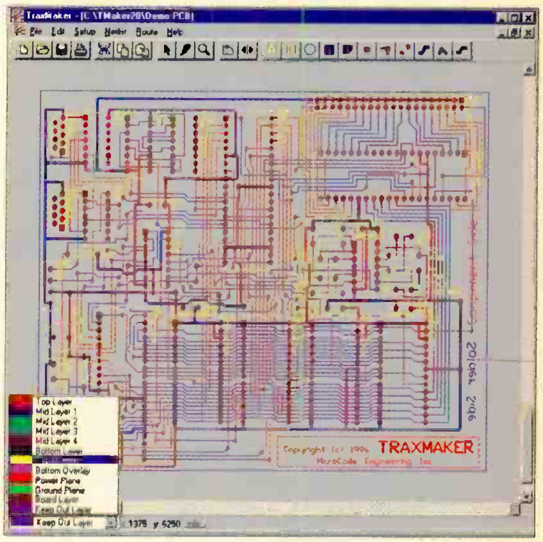

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