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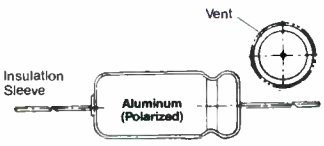

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EDITORIAL

HOPE AND GLORY

This month, **Popular Electronics** turns its attention once again to that semi-annual exercise in electronics excitement known as the Consumer Electronics Show. But while the winter show, held as always in Las Vegas, had its usual complement of celebrities, perky demonstrators, and general hype, there was something else in evidence—a genuine feeling of optimism that had been decidedly missing in the recent past.

Why? There were several factors at work. Most manufacturers had a decent holiday season. There was also the general excitement that surrounded the change in the U.S. government.

But to us, the real excitement surrounded several new products. Previously, pen-based computers, widescreen TV's, digital-audio recorders, RBDS receivers, and the like existed only as "vaporware," but now real, working units were either in the pipeline or had already begun shipping. And proposed new products from Pioneer and a new company called 3DO (with backing from, among others, AT&T and Matsushita) could finally kick-start the nascent multimedia industry, if they live up to their advance billing.

However, that's a big if, and therein lies the tale of CES. Electronics manufacturers, here and abroad, are searching for something to lead them out of their recent doldrums. They are looking for the next "VCR" or "CD player," and are hoping that one of the aforementioned products or product categories fills the bill.

Only time will tell if that will happen. In the meantime, however, you can get a first-hand report on all the goings on at the show in this month's **Gizmo**; the story starts on page 5.

Carl Laron
Editor

LETTERS

EXCELLENT EMF TESTER

Popular Electronics and John Iovine should be commended for the informative construction feature, "Electromagnetic Fields and Your Health" (March 1993). What a great article! It gave a candid, yet thorough, look at a health hazard about which many of us were uninformed. The circuit could be built cheaply, with off-the-shelf parts from Radio Shack.

Once completed, I immediately checked out the EMF tester on the first thing at hand, my soldering iron. Whew! I'm glad I don't hold on to one of those all day. The tester would not shut off within six inches of it! The investigation did not stop there. Those wall-type power supplies and a can opener were the biggest EMF producers that I found. Some of the devices indicated unsafe levels up to 2½ feet away! After testing the TV and computer monitor, the whole family could be warned to keep to a safe range, *now that I have a better idea of what that range is.*

Sweeping the EMF tester back and forth around the suspected offender seems to make it more receptive. Since wire (the pickup coil) passing through a magnetic field produces electricity, I believe this made my readings even more accurate, especially with the tester held at 90° from the first pass. First thing Monday morning, the tester is going to work with me, to identify "hot spots" so I can try to reduce my exposure there.

I assembled my EMF tester on a printed-circuit board and would gladly share the pattern and parts-placement diagram with other hobbyists who wish to keep assembly neat and easy. Send a self-addressed, stamped envelope to me at P.O. Box 344, Marysville, MI 48040.
Mike Giamportone

FUEL MISER EFFICIENCY?

I found the "Fuel Miser" (**Popular Electronics**, March 1993) to be an interesting and novel way to reduce the fuel-consumption rate in a heating system. But most heating systems are complicated, and it is doubtful whether the Miser actually can save any useful amount of fuel without degrading the system.

For best comfort, the system should be designed so that it is running near 100% of the time during cold-weather conditions. Normally, that results in somewhat less comfortable conditions during mild weather, especially with forced-air systems. I have heard that described as feast-or-famine operation. To counter that, some systems use an outside thermostat to reduce the gas flow to a hot-air furnace in mild weather. However, to maintain comfort it is necessary to also reduce the air flow by reducing the fan-motor speed. The Fuel Miser will reduce gas flow, but it doesn't take care of the fan-speed reduction.

In a properly designed and balanced hot-air system, the total air flow through the furnace should be just the right amount to remove all the heat available from the burner and at the same time maintain about 140°F air at the outlet vents. If the outlet temperature deviates much from 140°F, the heat level will be uncomfortable. Some people refer to heat-pump systems as "cold heat" since they usually have lower than usual outlet temperatures.

Most furnaces have a bonnet thermostat that keeps the fan from coming on until a certain temperature is reached, so that there's no blast of cold air from the vents. Some even cycle the burner on and off to maintain a desirable range of bonnet temperatures. When the room thermostat is satisfied, the burner is cut off. In some systems, the fan might keep on running until the bonnet temperature drops low enough, and in others the fan cuts off along with the burner. The heat remaining in the furnace might dissipate to the surrounding space or drift upward through the ducts, but there is not a great amount of actually energy loss in most installations. If the Fuel Miser is used, you still have the exact same situation during the time it has the burner cut off. If the Miser was installed so that it would cycle just the burner on and off, while maintaining proper outlet temperatures, it could be useful, but otherwise I see no value in it.

The article says that the Fuel Miser can be used with any kind of heating system—hot air, hot water, steam, etc. I don't see any useful application for it in hot-water systems. In most of them, the room thermostat just turns on a circulating pump, and a zone valve in a zoned system. The burner is basically cycled on and off by a thermostat that keeps the water reservoir hot within certain limits. Sometimes there is an interaction between those systems to reduce the time it takes get the burner on after a zone calls for heat. Installation of the Fuel Miser in this kind of system would merely result in turning the circulator on and off, reducing the amount of heat to the room. Hot-water systems usually do not produce uncomfortable conditions when operating in mild weather, so there would be no benefit in cycling the circulator, and certainly no fuel savings. Further, in any type of heating system, if you use the programmable thermostats to drop the temperature during the night or when the house is empty, you will want the system to run at maximum rate to get a fast recovery when the setback ends. The Fuel Miser would seriously interfere in that case.

There might be some improperly designed heating systems that could benefit from the Fuel Miser, but it would take a very comprehensive study to determine that. The device is cheap enough that one could experiment with it without losing his shirt, but I think your readers should know what they are getting into when they start messing with their heating systems.
K.E.S.
Cherryvale, KS

KIT BUILDER'S CHALLENGE

Among older readers (born before 1952), those who never built a Heathkit project must be in the minority. I (born in 1939) personally built three of them.

But, did I hear the story ("Kit Building Lives," Editorial, **Popular Electronics**, December 1992) completely and correctly? As far as I am concerned, Heathkits were not for true kit-builders!

As I heard the story, Heath never marketed a kit until it could be successfully completed by a non-hobbyist—often a secretary employed by Heath. If she could put it together, so could "dim-wit" hams, I suppose.

Heathkit's exit may bring sorrow to non-kit-builders. But for us hobbyists, can we now hope to see kits not designed for secretaries?
E.J.
Vero Beach, FL

HAVES AND NEEDS

Thanks so much for printing my request for an analog delay chip, and thanks to the many readers who responded. Even before I received my copy of **Popular Electronics**, I had a handful of responses!

Now I have another request. I just received a Modular Circuit Technology EPROM burner card for a PC-based computer, and I need both the documentation and the software to make it work. If anyone knows where I can obtain those items, I would greatly appreciate hearing about it. Thanks again.
Richard J. Marshall
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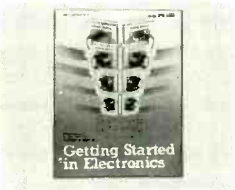

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MAY 1993

VOLUME 6, NUMBER 5

Wet and Wild Winter CES

A rundown of the 1993 Winter Consumer Electronics Show with product highlights

Something seemed different at January's 1993 Winter Consumer Electronics Show. No, it wasn't the weather—although a week of rainy days certainly is unusual for the Las Vegas desert. Rather, it was a change in attitude. We sensed a feeling of optimism that ranged from cautious to unbridled, which not even the soggy weather could dampen. With the economy on the upswing, a new president about to be inaugurated, and the latest EIA figures showing that 1992 was the biggest growth year for consumer electronics since 1985 (with factory sales up 7.9%), manufacturers and retailers alike had high hopes for the coming year.

Perhaps the wet weather was an inspiration to some, judging by the watery language used in two of the opening speeches. Gary J. Shapiro, group vice president of the Electronic Industries Association's Consumer Electronics Group (EIA/CEG), urged industry cooperation with the Clinton administration's new economic policies, reminding attendees that "a rising tide raises all ships." And IBM President Jack Kuehler, referencing the once separate fields of computers and consumer electronics, declared, "Technology has allowed our two streams to form a very powerful river."

Those two seemingly disparate remarks represent one major trend at this year's WCES: As the boundaries between computers and communications, and audio and video, become increasingly blurred, strong alliances that often cross the lines between various industries and technologies are being formed. The audio industry has already experienced a boom in sales thanks to consumer demand for home theater; now even high-end audio manufacturers have begun adding video capabilities to their equipment. In a newly developing trend, computers are being integrated into all areas of consumer electronics to create devices that are, in the words of Kuehler, "people literate." (An easier task, perhaps, than creating a public that is computer literate).

A strong feeling of optimism could be felt at the 1993 Winter Consumer Electronics Show.

To that end, IBM announced its involvement in joint projects with Polaroid (to create a camera/PC system), with Texas Instruments (to develop the MWAVE Multimedia system), with Blockbuster (for a retail format in which customers can preview digitally compressed audio and video material and have copies of their selections made up as they wait), with NBC and NuMedia (for an on-demand multimedia news service), and with Bell Atlantic (for the telephone-based Video On Demand system). And IBM is by no means the only company that's formed partnerships to broaden its consumer-electronics horizons, as you'll see below.

All that corporate wheeling and dealing aside, what were the hot items on the floor at WCES 93? The buzzwords were pen-based portable computer/organizers (PDA, PC, PIP), multimedia (3DO, L.I.F.E., CD-ROM), digital recording formats (MD, DCC), digital radio data (RBDS), and 16:9 TV's. If you feel like you're drowning in a bowl of alphabet soup, read on. We'll spell it all out for you below.

PEN-BASED POCKET COMPUTERS

If any one new product category is striving for a "people-literate" image, it's the first generation of hand-held, pen-based personal computing/communicating devices, known as personal digital assistants, or PDA's. The concept is innately appealing, offering consumers and business people a complete, intuitive, easy-to-use, computing/note-taking/communications package. Since the announcement of Apple's Newton during the 1992 Summer Consumer Electronics Show, the competition has been heating up. At WCES 93, AT&T showed the Personal Communicator 440, and Tandy and Casio demonstrated a working prototype of the Zoomer Personal Information Processor (PIP).

The AT&T Personal Communicator 440 is a good example of cooperation between manufacturers. Designed by EO, Inc. around AT&T's own Hobbit chip and GO Corporation's PenPoint operating system, the device is being manufactured at Matsushita's assembly plant in Illinois. The Hobbit runs at 20 MHz, giving the Personal Communicator the power to provide an immediate response to any form of user input. The PenPoint operating system

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This month in GIZMO®

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and applications software are stored in ROM, which means that the device is ready to use out of the box. No hard drive is required (although one is available as an option). The 440 measures 11 × 7 × 1 inches and weighs less than 2½ pounds. Its rechargeable battery provides two hours of use; an optional long-life battery lasts for seven hours.

In its basic configuration, the Personal Communicator 440 can be used as an appointment calendar, a notebook, and a phone/address book. You can jot down information in your own (printed) handwriting, and then for the sake of neatness convert the writing to text. Voice comments can be added to documents, thanks to the built-in microphone and digital recorder. Built-in software allows connection to a PC via cables or by an optional modem, which also allows the user to send and receive electronic mail (using AT&T's EasyLink Services, with no monthly fee) and faxes. By adding the cellular-phone option, the user can also make voice calls over regular telephone or cellular networks and perform wireless transfers of E-mail and fax transmissions. The fully-equipped 440 is priced at $2899.

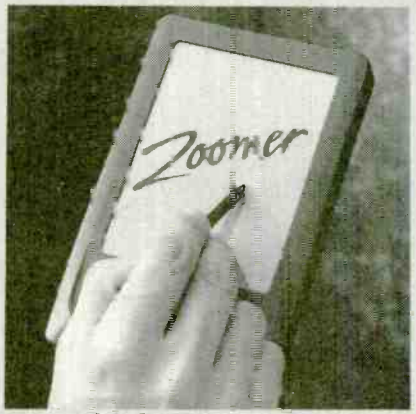
In terms of practical applications, the 440 allows users to add drawings to written entries. So, for a relatively simple example, beneath a reminder to "Meet Joe at Mary's office, Tues. 9 AM" you could

The AT&T Personal Communicator 440 is a pen-based, hand-held device that integrates computing and communications capabilities.

draw a map of how to get to Mary's office. Later, you might decide to leave a vocal reminder: "Don't forget to bring the Jones file!" And if Joe doesn't know where Mary's office is, you can fax the map to him.

From Casio Computer Company, Ltd. and Tandy Corporation comes the Zoomer Personal Information Processor. The suit-pocket-sized device uses an operating system from GeoWorks and bundled applications software and handwriting recognition software from Palm Computing, which also will develop an array of add-on products for the Zoomer. America Online will include a special ROM version of its interactive communications and consumer online services. Intuit, the developer of Quicken financial software, will support the Zoomer platform with specialized software.

The Zoomer is intended to deliver convenient information access and communications capability. While the developers were closemouthed about the latter, they hinted at PC, fax, and E-mail communications. The device allows users to write and draw on screen, or to input data using an on-screen pop-up keyboard. By pressing on icons, users can move between various applications, including reference functions, games, note taking, phone/address



The pocket-sized Zoomer from Casio and Tandy is a pen-based information-access and communications tool.

book, appointment calendar, calculator, and forms. The Zoomer is said to get up to 100 hours usage from ordinary alkaline batteries. The first-generation PIP will be available this summer, at a price that's yet to be revealed but is expected to fall "between $600 and $1000."

Apple and Sharp provided a technical update and demonstration of the Newton personal digital assistant, which features handwriting-to-text conversion, cursive-handwriting recognition, and fax capabilities. The first Newtons are expected to ship this summer for significantly less than $1000, including some built-in software applications.

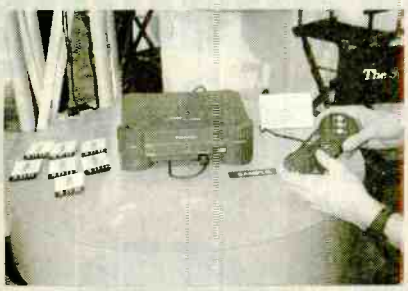
On a somewhat smaller scale, Sharp exhibited a pen-based version of their Wizard personal organizer. The $649 OZ-9600 has a touch-sensitive screen and a pen-input system, and can store notes entered in "digital ink" form. Unlike any of the other pen-based devices we've discussed, the OX-9600 is available *now*.

This Newton prototype from Apple represents the first PDA to be announced.

It remains to be seen whether PDA's "represent a completely new direction for telecommunications" or if in the future "almost everyone will use devices like this to communicate easily and effectively with voice, data, handwriting and pictures, regardless of where they are," as John Hanley, AT&T Consumer Products group vice president predicts for the Personal Communicator 440. But at this show, we got the feeling that the products—while not yet here—are for real. It's certainly worth keeping a close eye on the emerging PDA field.

MULTIMEDIA MAYHEM

Just as PDA developers forecast major changes in the way people work and communicate, multimedia manufacturers expect their products to change the way folks learn and play. If you're a regular **Gizmo** reader, you know all about Philips' CD-I, Atari's CDTV, multimedia PC's (MPC), and CD-ROM drives, and you'll be reading our review of Tandy's VIS in the near future. Although many applications are available for each multimedia format, CD-I and VIS are TV add-ons meant strictly for use in the family room, MPC and CD-



The 3DO Interactive Multiplayer will provide higher-quality video games and interactive learning experiences, and it's optional add-ons will allow full-motior video, MIDI, home-video editing, and access to network services.

ROM are computer products, and CDTV though originally marketed as a TV adjunct, has found its niche with Atari computer users. The verdict isn't in yet on CD-I or VIS, but CD-ROM has been continually gaining acceptance and is expected to really take off this year.

Now, into the fray leap two new interactive multimedia contenders: The 3DO Company's Interactive Multiplayer and Pioneer's Laser Interactive Family Entertainment (L.I.F.E., or LaserActive).

3DO, a 32-bit computer/game platform has several things going for it: power, upgradability, backing by a team of major players, and a unique licensing arrangement. The first version of the Interactive Multiplayer, expected to be available this fall for about $700, is a CD version that attaches to a television and can play audio CD's and Photo CD's as well as game CD's and cartridges. Not just a "souped-up version of traditional technology," the 3DO system is based on a custom graphics/animation processor designed with fast animation and graphics in mind. Other system components include a memory-management system, a custom audio digital signal processor, a video processor, a 32-bit RISC (Reduced Instruction Set Computer) processor, and a double-speed CD drive. The result, according to The 3DO Company is a device that has 50 times the power of today's 16-bit games and fast enough to allow real-time interaction without jerkiness or interruption. The system can be upgraded with the addition of separate expansion modules that enable such options as home video editing, MIDI, and MPEG-compatible full-motion video. A module planned for 1994 introduction will allow 3DO users to access network services.

Partners in The 3DO Company include representatives from the hardware, software, motion-picture, and cable and broadcast communications, and networking industries: Matsushita, MCA, Time Warner, Electronic Arts, and AT&T. Yet the company is not interested in monopolizing the new technology, but in setting a standard and then acting as a catalyst to licensees. Under their rather unique licensing plan, hardware licensees pay no royalties, and software licensees pay $3 per unit shipped. 3DO won't compete with their licensees, and they will supply software licensees a library of 170 CD's containing sound effects, music, photos, and video clips that can be used without fear of copyright infringement.

The 3DO graphics are quite impressive when compared to today's video-game systems, and the developer's tools that are promised appear quite powerful. In a simulated demonstration, images could be seen on all six sides of a transparent cube. As that cube rotated, the perspective changed naturally. Another example showed how shadows can change as characters move, or as the sun crosses the sky. Thanks to the 3DO's RISC-based graphics processor, those effects were achieved by applying special effects to a single image. To accomplish the same on current systems would require creating a new image for each change. 3DO promises to save time and money for the software developer and use up less memory in the game or playback device.

The bottom line: better-looking games. But that's just the beginning. The future? Quality video in a highly compressed format. Why is AT&T involved? They'll be able to download that compressed video over phone lines to provide video on demand.

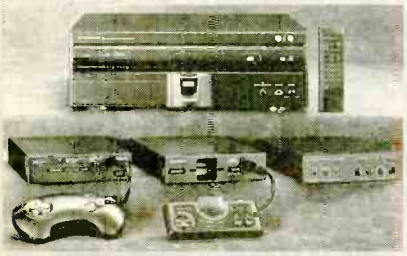
Meanwhile, Pioneer was unveiling their L.I.F.E., or Laser Interactive Family Entertainment, system, dubbed LaserActive. Pioneer is positioning LaserActive as a higher-quality alternative to CD-ROM and CD-I systems, because it contains the same quality video as found on laserdiscs. The system also can store 108,000 still pictures (compared to CD-I's 7000-picture capacity), FM audio, and still have the same 450-megabyte data area found in CD-I and CD-ROM multimedia systems free.

Like 3DO, the LaserActive system consists of a main unit and optional add-ons. The main unit, however, isn't interactive; it plays back only CD's, CDV's, and LD's. Interactivity is achieved by plugging in optional control packs that include the Sega-manufactured MEGA-LD pack, the LD-ROM² pack from NEC, and Pioneer's own Karaoke pack. The pack of choice is inserted into the main unit and, in the case of the game packs, operated via dedicated control pads. The MEGA-LD pack plays back 8- and 12-inch LaserActive Mega-LD discs, SEGA-CD discs, Genesis-ROM cartridges, and CD+G discs. The LD-ROM² pack plays back 8- and 12-inch LaserActive LD-ROM² discs, TurboGraphics CD-ROM discs, and CD+G discs. The Karaoke pack plays only Karaoke LaserDiscs. While remaining close-mouthed about U.S. pricing, Pioneer did say that at their summer 1993 American introduction, the units would be similarly priced to those currently selling in Japan, where the main unit is fetching the equivalent of $720 and the add-ons $480 each. (At those prices, we'd be tempted to buy a laserdisc player, a Sega Genesis, a karaoke machine—and go out to dinner several times!)

In Pioneer's simulated demonstration of a LaserActive game, in which the user piloted a spaceship through the inside of a pyramid on a distant planet, the animated background graphics were broadcast-quality. In a travel/foreign language application, the user could stroll through the streets of Paris, enter shops and cafes, and interact with the shopkeepers and patrons inside, conversing in French (with help from on-screen captions) or English. Another possible application is interactive movies, in which the player could assume the role of a main character and make

A panel of industry insiders gave updates on the state of Digital Comapct Cassette and Mini Disc.

Sony was exhibiting both play/record and playback-only Mini Disc units.



LaserActive, Pioneer's entry in the multimedia field, consists of a main unit that plays laserdiscs and CD's and optioanl add-ons that play game discs and cartrigdes from Sega and NEC.

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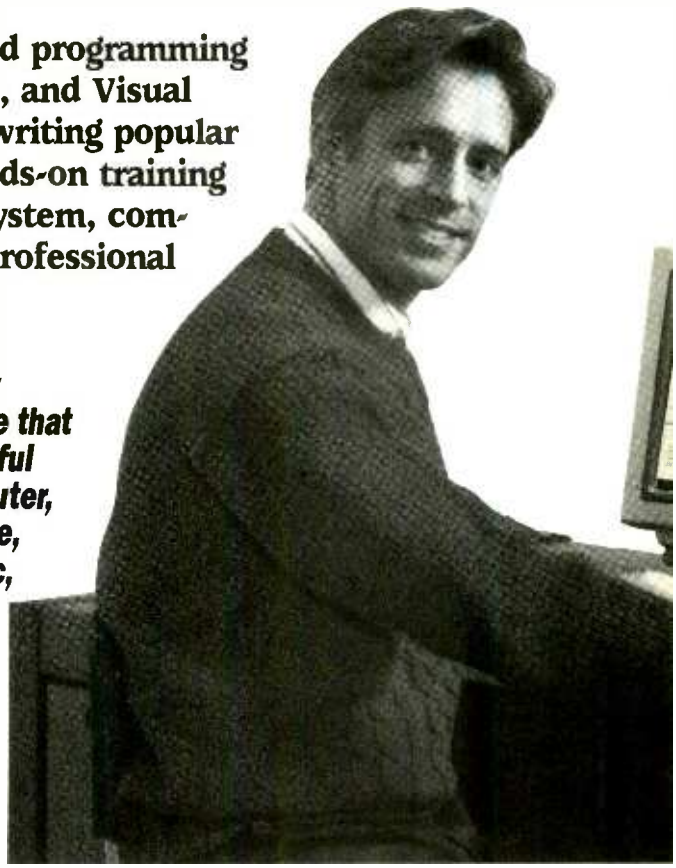

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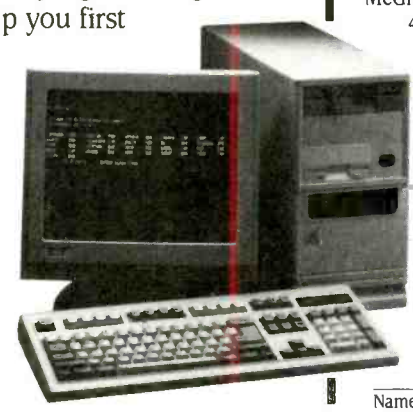

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Sanyo's MDX-P1 portable MD player is the smallest and lightest on the market.

Technics' first home DCC deck is the $999 Model RS-DC10.

decisions that affect the way the plot unfolds.

Both LaserActive, with its high-quality video and 3DO, with its powerful graphics capabilities, look promising. Of course, at this point, both are still "vaporware"—there's no real product yet. Both face the challenge of creating a demand for interactive multimedia in a public that has shown little interest to date. Multimedia is a hard sell, requiring in-store demos and a patient, well-trained sales force. Yet, in a survey of buyers at the Consumer Electronics Show, when asked what advanced products their customers are aware of and/or have asked about, 50% replied multimedia computers and games. And, according to 3DO, there's a whole generation of "VidKids" out there who, upon reaching adulthood, are going to be looking for a more sophisticated replacement for their old Nintendos. The price tags of the 3DO Interactive Multiplayer and the LaserActive system are much too steep for any rapid mass-market acceptance, however. (But remember that the first CD players cost more than $1000.)

CD-ROM, on the other hand, is a well-established technology whose time has come, according to many industry experts. Although the PC-based format has a much smaller prospective-buyers' base than does TV-based multimedia devices, it will rise along with today's rapidly growing PC sales—an estimated 7.1 million PC's were sold last year, and sales are expected to rise by 10% this year. CD-ROM hardware and software exhibitors made a strong showing at WCES 93. And the arrangement between multimedia publisher Compton's New Media and retailer Major Video Concepts to start renting CD-ROM's certainly can't hurt.

A short aside: Continuing the blurred-boundary trend, Sony has announced that they will be marketing Mini Discs formatted for use in computers. The 2.5-inch recordable optical discs will hold more data than many of today's hard drives: 130 megabytes. Sony also plans to develop a drive that can store video images.

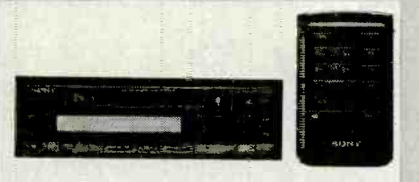
Now let's take a look at the showing made by audio MD's, and their competitor, DCC, at the show.

MD/DCC: A REPORT FROM THE BATTLEFRONT

Remember that old Vietnam-era bumper sticker that read "What if they gave a war and nobody came?" Well, that about sums up the preliminary skirmishes in the MD/DCC conflict. The big-wigs are all in place and raring to do battle. Each side has lined up an impressive array of allies. But, as in any format battle, the ultimate winner is determined by the foot soldier—Joe Consumer—and he simply hasn't turned out in sufficient numbers yet to give either camp a decided edge.

At a WCES workshop titled "Digital Recording Formats: DCC and Mini Disc" the entire panel (Mike Vitelli, senior vice president and general manager for Sony Personal Audio Products; Andy Nelkin, assistant general manager for the Technics division of Panasonic; Mike Grubbs, senior marketing director for Tandy; Ken Furst, vice president of marketing for Denon America; and Bud O'Shea of Capitol/EMI Music) blasted the press for being obsessed with the battle instead of playing up the good points of each respective format. The panelists made up for that omission, each using most of his floor time to sing the praises of his own technology, with Furst citing MD's "high level of coolocity" and Nelkin citing DCC's backward compatibility with analog cassettes. When asked the inevitable question—would DCC and MD cancel each other out or could there be peaceful coexistence between the two—Nelkin did remark somewhat wistfully, "It would be great both formats succeeded instead of having a winner/loser situation." And while one panelist pointed out that at least the well-publicized conflict was getting consumers back into the stores, Furst wryly countered that folks might be coming back to the stores due to the same instinct that makes them slow down to look at an accident on the highway!

Panasonic's Model RQ-DP7 portable DCC player is due out this summer.



Sony's MDX-U1 automotive MD player lived up to its anti-skipping claims in the Jaminator simulator on the show floor.

Sanyo introduced the first in-dash three-disc MD changer, the MD-300.

On the shown floor, both camps were pressing hard. The DCC Group of America, a trade association formed to foster consumer awareness and understanding, was giving away T-shirts and caps and holding daily drawings for a DCC deck, with one day's prize presented by rock star Meatloaf. Sony was demonstrating the skip-resistance of MD by offering rides in the "Jaminator"—a 12-seat motion simulator equipped with a 650-watt Sony sound system that included the world's first car Mini Disc player, the MDX-U1. As the vehicle rocked and rolled, a video display showed an even-more-hair-raising-than-usual drive through the streets of Manhattan, and the music played on without a hitch.

For the first time at CES, actual digital-recording products abounded. In the MD camp, Aiwa was showing the AMD-100, an $800 player/recorder; Sanyo displayed their $599 MDX-P1 play-only model; and Sony was showing their $749 MZ-1 player/recorder and their $549 MZ-2P (each of which has been selling for $50 less than its suggested retail price). In the world of DCC, home decks were exhibited by Philips (the DCC900), Technics (the $999 RS-DC10), and Marantz (the DD-92); Tandy's Optimus DCT-2000 was shown at the DCC Groups booth.

Several others were showing products not yet available. Denon and Sharp were showing play-only MD models to be shipped in the first half of 1993. Panasonic and Philips each announced that they would begin selling a $549 portable DCC player this summer. Onkyo announced their prototype home DCC deck, while Carver, Aiwa, Fisher, Sharp, Panasonic, Sherwood, and Pioneer held back the shipping dates on their prototype home DCC units pending public reaction to the first-generation decks.

As for autosound products, Blaupunkt was showing working prototypes of both

Now an industry standard, the Radio Broadcast Data System could spur sales of a whole new generation of radios that can decode and display digital data transmitted by FM stations.

MD and DCC units, with the DCC deck priced a bit lower than the $999 MD player. Sanyo previewed the first in-dash, 3-disc MD changer ($999), which includes a CD-changer controller. Philips' AM/FM/DCC unit lists for $899, and Panasonic's DC-1 detachable-face DCC/tuner with CD-changer controls, Dolby B, and remote control (but no amplifier section) is expected to cost between $800 and $1000 when it becomes available in late spring.

In all fairness, it's misleading to say that consumers aren't turning out for MD and DCC. After all, the first units weren't even available until late last year. Even such smashing successes as color TV, the VCR, and the CD player took years to become established sellers. In fact, it took color TV 11 years to hit the one-million-unit-sales-per-year mark, six years for VCR's, and three years for CD players. DCC and MD are still in their infancy, and both formats show exceptional promise for future growth.

FINALLY, RBDS

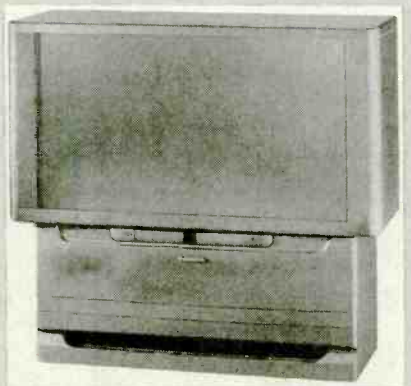
Another emerging digital format promises to pump new life into radio sales. The Radio Broadcast Data System, or RBDS, allows FM stations to send digital data over an inaudible SCA (Subsidiary Carrier Authorization) subcarrier. That data, which can include such information as station call sign, program format, and alternate frequencies, is then decoded and displayed at the receiver. FM broadcasters can also transmit traffic bulletins or emergency weather alerts that could even override the car's cassette player or CD when vital information is received. On home RBDS receivers, the display might be used to show additional information such as the name of the artist or recording being played, stock quotes, or weather forecasts. The textual data will be shown on an eight-character display. By the time you read this, about 50 FM stations should be broadcasting RBDS signals, and that number is expected to double by the end of 1993.

RBDS is not really a new technology. What *is* new, however, is the standard that will make it possible for real products to be manufactured and marketed. The industry standard was approved last September, and because RBDS falls under the FCC's existing SCA regulations, the system won't require any special FCC approval.

One snag that was holding up the standard-approval process was that AM radio, with its lack of SCA provisions, seemed to be precluded from RBDS participation. Because AM radio is having a hard enough time as it is, RBDS was opposed by the powerful National Association of Broadcasters (NAB). That problem was neatly sidestepped thanks to a technology called ID-Logic B, which is an option in the RBDS standard. With ID-Logic, a chip that holds format data for every U.S. and Canadian AM station is placed inside the AM receiver, allowing listeners to search for AM stations by program format. One FM station would then be able to update the programming information for all the AM stations in its geographical vicinity.

During WCES 93, ten Las Vegas radio stations were broadcasting on-the-air RBDS signals, and nine exhibitors were showing RBDS radios in their booths, including Axcess USA, Blaupunkt, Delco, Denon, Grundig, Kenwood, Onkyo, Philips Car Systems, and Sony. Denon showed the $600 detachable-face cassette deck with changer controller, Dolby B and C, and full RBDS capabilities, as well as the $450 DCR-720 that lacked Dolby C. Philips and Blaupunkt showed models that use the European RDS system, and Blaupunkt is leaving room in its RCM-43 Las Vegas unit for an RBDS circuit to be added later.

RBDS technology is fairly simple, and is expected to add only about $50 to a radio's retail price, so you're likely to see it in a good number of new receivers, including the OEM radio to be found in the next model of Pontiac Bonneville. There's hope that RBDS will spur a surge in radio sales.



Panasonic exhibited the only rear-projection 16:9 widescreen TV.

At Thomson's booth, attendees got a glimpse of CinemaVision's many viewing options, including split screen, and picture-outside-picture.

WIDESCREEN WONDERS

Television sales—particularly large-screen sets—don't need any stimulus, judging by 1992 sales figures. But with the coming of HDTV—and it *is* coming, sooner than you might think—widescreen 16:9 aspect-ratio sets just might be the sales leader in the early 21st century. Buyers polled as to what advanced products they wanted to see at WCES 93 put widescreen TV at the top of their wish list (65%); asked what advanced products interested their customers, 70% said 16:9 sets. Even without HDTV, widescreen sets are ideal for viewing movies that were filmed at that aspect ratio. More than 600 laserdisc titles and an increasing number of videotapes are available in 16:9 letterbox format.

At WCES, four companies were showing 16:9 sets. Sharp, Goldstar, and Thomson Consumer Electronics had direct-view sets, and Pansonic went with a projection model. Sharp was displaying 28-, 30-, and 34-inch widescreen sets, but no pricing was set and production has yet to begin. Goldstar has already shipped both 34- and 36-inch widescreen sets in Korea, and plans to hit the U.S. market next year. Panasonic's 50-inch, thin-profile, rear-projection PT-50WXF5 CinemaVision ($5499) contains two tuners, an icon-based menu system, and the company's Active Dome Sound system with subwoofer. It should be available this spring.

Thomson, long the leader in the U.S. widescreen field, plans to market its 34-inch direct-view CinemaScreen during the first half of the year. Two versions will be available: a console set will carry the RCA brand and a table-model will have the ProScan label. Each will cost about $5000. (According to Thomson, the price of widescreen sets is expected to drop—perhaps as much as 50%—with increasing customer demand.) The sets have a host of nifty features, including the ability to ex-

pand and adjust different-sized images to best fill the screen, to watch up to three picture-outside-picture (POP) images or a single PIP image, and to use an on-screen "channel guide" that displays nine channels at once. In addition, thanks to two separate tuners, the CinemaScreen sets' Split Screen feature lets you watch two programs at the same time, with the provision for separate audio reception. The sound system is no slouch either, consisting of a six-speaker audio system and a built-in, 10-watt-per-channel, Dolby Pro Logic surround-sound amplifier. An RGB input should provide HDTV-compatibility, when needed, according to Thomson.

NEAT NEW GIZMOS

Certainly not everything at WCES 93 involved complex, all-new technologies. As always, there were plenty of new products that represented interesting applications of existing technologies, or simply good ideas. Here are a few of our favorites for this year.

Panasonic has come up with an electronic solution to the perpetually unbalanced checkbook. Their KX-RC100 CPA Check Printing Accountant ($349.95) maintains two separate checking accounts, printing checks on demand. It also keeps track of credit-card purchases and other expenditures, can do simple calculations, and can remember up to 50 phone numbers. The CPA can be carried in a coat pocket or purse, and holds up to 25 checks. For making regular payments, as many as 25 payee names can be stored. A password is included for security. A "memo" function lets the user note if a transaction is tax deductible, or classify it as one of 50 common types of expenses (child care, property tax, auto loan, mortgage, entertainment, etc.) When a check is printed, the amount is automatically deducted from the account.

If your family owns a CD changer, there's a good chance that you've had the unfortunate experience of queuing up what you thought would be your favorite classical disc only to be blasted out of your seat by your teenager's Metallica CD. Addressing that problem, Fisher introduced its 24-disc CD Management System, dubbed Studio 24. The 24-disc changer stores and plays discs by names (input via an alphanumeric keypad) or by preset categories; each disc can be grouped in up to two categories (musical type, mood, occasion, disc or artist name). That allows each family member to store his own group of CD's in a subcategory. The device's vertical-loading, dust-free chamber minimizes wear and tear on discs. The Studio 24 changer is available in several different configurtions: as a separate component (DAC-167, $499.95); a mid-sized shelf

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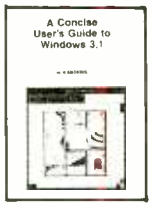

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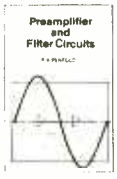

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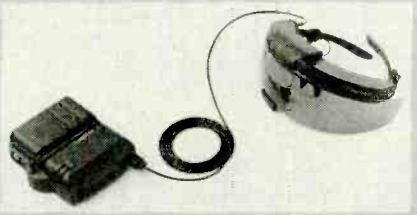


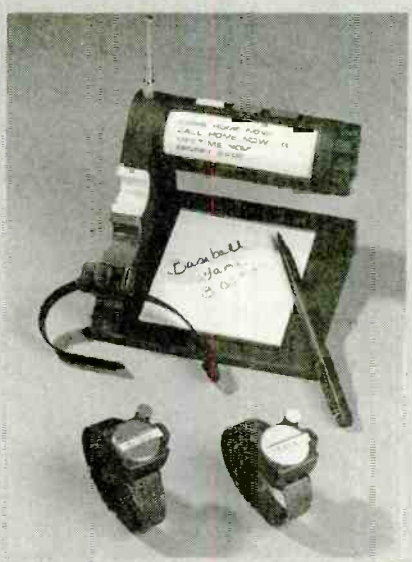
The Virtual Vision Sport is a widescreen TV in a pair of sunglasses. A special optical system makes a tiny, close-up image appear as if it's as far away as 15 feet and as large as 60-inches.

system (DCS994, $999.95) with Dolby Pro Logic surround-sound receiver, double cassette deck, 2-way bass-reflex speakers, and remote control; or a complete rack system (System 9335, $1499.95) with Dolby Pro Logic surround-sound amplifier, tuner, double cassette deck, floor-standing speakers, and remote control.

Now that fax machines have become essential ingredients in the modern office, and have made strong inroads into the home-office market, Sharp has decided it's time to position the fax as a real consumer product. Their NX-1 home fax ($495) lets the user avoid junk faxes by accepting only those sent from preset numbers, and offers a full-featured telephone, an answering machine hookup, and 20-number redial. It uses Sharp's Supreme Thermax paper, which, if not quite up to plain-paper quality, feels thicker and less slippery than standard thermal paper, and is suitable for long-term filing, according to Sharp.

It's easy enough to listen to the ball game on your personal stereo while you mow the lawn, but now you actually can watch a projection-screen-sized image and still get your chores done. The Virtual Vision Sport (less than $900) consists of a lightweight pair of goggles and a belt pack containing a TV tuner, battery and interface system to which you can connect a VCR, camcorder, or cable TV. Inside the goggles are surface-mount electronics and a special optical focusing system. The virtual image is generated by the video system in the eyeware, but appears to be as large as 60-inches diagonally, floating out 8 to 15 feet in front of you. Surprisingly, the sensation is only disconcerting for a few seconds before your eyes and brain allow you to accept the "large-screen" image as real.

A product that drew a lot of interest at WCES was KBA, Inc.'s Word Watch Child Alert Digital System, or C.A.D.S. ($79.95), system intended to help busy families keep in touch. The system consists of a Base Unit transmitter and as many as three Word Watches ($39.99 each). Parents can program up to four messages (come home now, call home now, etc.) that can be transmitted to be displayed on their child's watch/receiver. The base unit also acts as a charger for the watch's battery and has an internal clock that can be set to signal a child at a predetermined time. C.A.D.S. has a 1.5-mile range that can be extended to 5 miles with an optional antenna. In addition to the base unit, a remote unit (Available as an option) can be used to signal the watch from any remote location.



Send mesages to your kids via their wristwatches with KBA's Child Alert System.

The 50/50 Dual Desktop kit turns your PC into a PC/Mac hybrid!

For the ultimate in home theater, a THX sound system, certified by LucasArts, is a necessity. Unfortunately, THX-certified systems generally carry "ultimate" price tags, starting at $8000. But now Kenwood has teamed up with Altec-Lansing to create an under-$5000 THX system. Kenwood's side of the system includes a $1000 preamplifier/THX decoder/tuner and a six-channel, 600-watt amplifier priced at about $900. Then, for the relatively cheap price of $3000, the Altec-Lansing THX-approved loudspeaker system includes the AHT-2300 subwoofer, AHT-2200 left, center, and right speakers, and the AHT-2100 surround speakers.

Of the many computer products displayed at the CES, the most interesting one that we found was the 50/50 Dual Desktop from 50/50 Micro Electronics Inc. The plug-in board lets an IBM-PC compatible computer (AT or better) run Macintosh software! It contains a Motorola 68000 microprocessor running at 16 MHz, which puts it at about twice the speed of a Mac Classic. The Dual Desktop works with the PC's existing hard drive, treating it as a normal Mac hard disk. It also lets the PC's 3½-inch drive to read and write both 800K and 1.44-megabyte Macintosh-formatted floppies. A terminate-and-stay-resident program (or TSR) lets the Mac screen be called up with the push of a hot key. You can even run DOS and Mac software in a split-screen mode! It seems like the best of both worlds to us.

WCES WRAP-UP

From all we saw at WCES 93, the industry has good reasons to be feeling optimistic. New technologies fuel the industry, and there were several exceptional ones announced or exhibited at the show. But, it takes quite some time for those new formats to trickle-down to the mass-market level.

Meanwhile, the industry's bread-and-butter products are still TV's and VCR's, audio systems, and home-office equipment. Home theater continues to spur sales of big-screen TV's, stereo VCR's, laserdisc players, and the audio gear needed to complete the system. Home-office and PC sales are booming, and the car-audio industry in great shape. With the end of the recession said to be in sight, consumer confidence is on the upswing—and there's plenty of pent-up demand to be met. All in all, there's a lot out there to sustain the industry as it waits for DCC and/or MD to take off, for PDA's to become necessities, for HDTV standards to be set, and for todays media rooms to become multimedia rooms. ■

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CANON UCS2 Hi8 CAMCORDER. Manufactured by: Canon U.S.A., INC., 100 Jamesburg Road, Jamesburg, NJ 08831. Price: $1699.

Although camcorders haven't yet reached pocket size, they continue to shrink in both size and weight. "Purse size" might be a good way to describe today's crop of super-small camcorders. So what's the big deal about size and weight? Why are manufactures struggling so hard to win the title "smallest and lightest?"

After all, most users won't notice an extra ounce or an extra ⅛ inch when they're shooting their scenes, especially at home. But the extra size and heft do become noticeable while carrying the camcorder to where the action is; on the road—whether on a cross-country vacation or an across-town visit, size and weight *are* important.

On a vacation, a camcorder has to compete with all of the other gear that has to be packed and carried to your destination. Then it has to be toted to each exciting stop on your trip, up the stairs at the Statue of Liberty, for instance, or down—and back *up*—a steep trail at the Grand Canyon. And if you're bringing the baby across town to visit Grandma, a bulky, heavy camcorder runs the risk of being left behind in favor of extra bottles and diapers. And that defeats the whole reason of having a camcorder. The smaller and lighter the camcorder, the more often it will get used—and the better value you get for your money. And *value* is the most important factor in most people's buying decisions these day.

Canon has always been on the forefront of small and light. A little over a year ago (April 1992) we gave its UCS1—then the world's lightest and smaller Hi8 camcorder—a workout. This year, Canon brings out the *UCS2*, which, as you might have already guessed, is even smaller and lighter. Canon managed to shave almost six ounces off the weight, bringing it down to 1.2 pounds—just over 19 ounces—without the battery. It did the same thing with the dimensions, trimming 1/16 inch of the width, ⅛ inch off the length, and ½ inch off the height, bringing the camcorder's size to 3⅛ × 6 1/16 × 5 3/16 inches. As a result, the UCS2 wins the "smallest-and-lightest" title—at least this month—in the Hi-band 8mm category.

The chassis of the UCS2 is similar to the others in Canon's UC-Series. That means it uses a small-diameter video-head drum, multi-layer circuit boards, and stacked components. The layout was changed slightly to give the camcorder a slimmer profile, and the lens system was made smaller by changing the iris mechanism.

CIRCLE 75 ON FREE INFORMATION CARD

The 8× (6–48 mm) power zoom lens features two stepper motors and a new fuzzy-logic autofocus algorithm that is designed to eliminate hunting and blurring. One of the motors controls the zooming drive, while the other controls the focusing drive. The intent is to keep the image in focus when zooming in either the manual or automatic-focus mode. The focusing motor can move at one of 127 speeds in each direction. When focusing, large adjustments are made at high speed. As the correct focus is approached, the motor switches to the slower speeds, which prevents the lens from bypassing proper focus, and then having to correct.

In the wide-angle mode, the camcorder can focus at a minimum distance of less than half an inch. At full telephoto, that distance increases to about 28 inches. Two zooming speeds are offered.

The UCS2 is very easy and comfortable to use—and ease and comfort are two more factors that add significantly to the value of a product. The zoom and the record/pause controls are easy to reach, even for those with very small hands. Even the power switch is easy to reach with the fingers on the right hand. The left-hand side of the camcorder features only four controls, grouped together above the cassette compartment, near the front—just where you would want them to be when holding the camcorder with both hands.

The largest control is a four-position rotary exposure selector. The first selection is a full Auto mode, which provides the correct exposure for most situations. The Spotlight mode, intended for recording spot-lit scenes, sets the proper exposure to the brightest part of the scene. Normally, when shooting such a scene, the camcorder would properly expose the darker area, and the smaller, concentrated light source would appear overexposed.

A Portrait mode is intended to make a subject stand out against the background. It decreases the camcorder's depth of field so that the foreground and background are slightly blurred while the intended image is in focus. A Sand and Snow mode properly exposes scenes with excessively bright backgrounds, such as ski slopes or sunny white-sand beaches. Except for full auto, the chosen mode is displayed in the viewfinder.

At the center of the exposure control is a Fade button, which operates differently from any other that we've seen. To fade out a scene, you must push and hold the button, which fades the video to white, and fades out the sound. When your fade is complete, a push of the record/pause mode stops the recording. To fade in, you first hold the fade button until the scene disappears, then press the start/stop button, and release the fade button.

The UCS2 fade requires a little more work than other camcorders, but we felt it gave us a little more control over the fade. With other camcorders, we often find ourselves forgetting to push the fade button

before we hit the stop/start button—or having to take our eyes off the scene to find the button. The "manual" fade control seemed easier to remember. And its location was sensible and hard to miss. It is possible to make the fade feature operate like those on traditional camcorders, however; we'll see how soon.

Behind the exposure/fade control are two other buttons. First is the backlight compensation button, the purpose of which is to properly expose scenes that are backlit with bright light. It works only when the camcorder is in the full auto mode. The other button calls up the date and/or time display for recording.

The lack of buttons, and the sensible placement of those that are there, make the UCS2 a breeze to use even for people who have never used a camcorder before. As you might expect, though, there actually are more buttons. They're just hidden out of sight.

Underneath the viewfinder are four additional controls. As you swivel the viewfinder up to a 90-degree angle, four of them are revealed. First is an alternate start/stop button. If you have the viewfinder swiveled up, you're likely shooting a low-angle scene. The alternate button is conveniently located for such shots. Also under the viewfinder is a reset button for the tape counter, and a tape return button, which rewinds the tape and stops when the tape counter reaches zero. A wind-screen slide switch can reduce wind noise when recording outdoors.

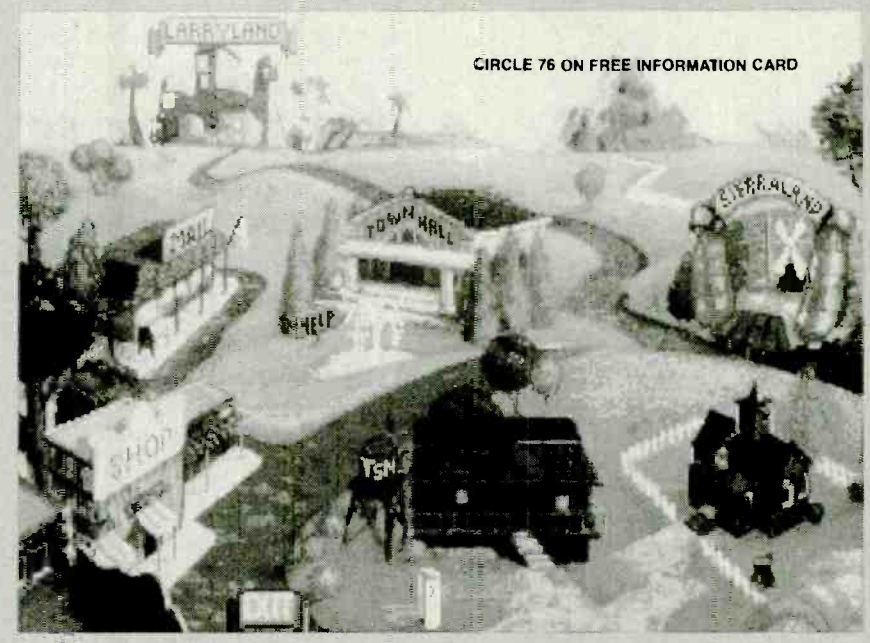
A flip-down panel on the right side of the UCS2 reveals nine more controls. Near the front are three focusing controls. The first turns auto focus on and off, and the two others control the focus direction. A group of four buttons each have two or three functions. In the camcorder's play mode, the serve as the play, stop, fast forward, and rewind controls. In the camera mode, however, they take on different roles.

The fast-forward and rewind buttons become the record-search controls, which let you review the scenes that you've recorded. The stop button becomes a quick review button, which rewinds and then plays back about the last three seconds that have been taped. The play button's dual function is to call up menus on the viewfinder.

The first push of the menu button calls up a four-entry menu: edit-erase, shutter, WB lock, and BTS. The + and − record search (also the fast forward and rewind) buttons scroll through the menu. The record review (also the stop) button makes the selection. Because all of the controls are sensibly labeled, the multi-function buttons are not confusing.

The edit-erase control lets you quickly return to the point where you started shoot-

(Continued on page 24)



Use Your ImagiNation

THE SIERRA NETWORK ON-LINE SERVICE. From The Sierra Network, 41486 Old Barn Way, Oakhurst, CA 93644. Price: $12.95 per month.

There are all kinds of reasons for having a home computer. Some people earn all or part of their living from a home PC. Some people have a computer as a status symbol, but aren't really sure what to do with it. Others are hobbyists, who love to sit in front of a computer for hours every evening, turning their spouses into "computer widows." Those are the computer buffs about whom sociologists worry, citing an unhealthy level of isolation from other human beings.

But for about the past year, some people have actually been making new friends—and in several cases, have met their future spouses—via their home computers. No, we're not talking about a new computer-dating service. Matchmaking is just one unexpected offshoot of an interactive on-line service called *The Sierra Network (TSN)*, where users can meet new people and play games in real time. Socialization, not isolation, is the key, as users of all ages and interests get together for an on-line evening of games and gabbing.

The Sierra Network is located in an old barn in the foothills of the Sierra mountains. But you can access the network through a local phone number and a 1200, 2400, or 9600-baud modem. (SprintNet is the public data network used by TSN, so about 97% of the U.S. population can access the network via a local telephone call.)

What else is required to get on The Sierra Network? As a minimum, you need a 286-based machine running at 16 MHz that offers either EGA or VGA graphics. High-density floppy disk drives are required to install the software onto your hard disk; you'll need about 7 megabytes free. A mouse is also required. Your PC must have at least 640 kilobytes of RAM installed. Specifically, you need 583K free to run the software, so DOS version 5.0, which lets you load device drivers and the like into high memory, is the best bet for getting up and running without any problems.

The Sierra Network itself runs on 50-MHz 486-based PC's. Each machine can support about 2000 members, or about 200–300 simultaneous users. During our review of the system, 20 host computers were up and running, which gave the network a capacity of 4000–5000 simultaneous users. TSN can be expanded by simply by adding more 486's, and hooking them into the LAN and telephone network. That apparently happened during our trial period. The available space was increased, making it easier to gain access to some of the areas.

TSN doesn't really have a user's manual, although some help files are included with the software. For the most part, you're on your own. And that's part of the fun. Once you get on-line, you can ask anyone—whether or not they're TSN Help people—for assistance. If you have trouble getting to the point where you can ask for help on-line, TSN does provide a toll-free help line. Although you can expect to spend some time on hold waiting for a live person, the quality of the help is excellent.

When you're connected, you find yourself at a map of TSN ImagiNation. You can gain access to the buildings and towns

The FaceMaker program lets you create your new image.

pictured by simply clicking the them. For example, when you click on the Post Office, you find yourself in a very basic E-mail system. You can send notes to other TSNers, or you can ask for help from a TSN host. Click on Town Hall, and you find yourself in the administrative area, where you can get billing information, newsletters, and other information. Click on the Mall, and you can order goods and services.

The real fun begins in the other sections: the SierraLand amusement park; the Clubhouse for card and table games; and MedievaLand, which holds a fantasy role-playing game. And then there is LarryLand, home of adults-only gambling halls.

We would guess that the games are what bring most people onto the network. But the interactive nature of the games is what will keep them coming back. Often the games become merely an excuse to get together to chat, just as when friends visit your home to play cards, half the night is spent talking and laughing. In fact, 50% of the traffic on the network has nothing to do with games, but with social interactions.

It's not always easy to know just who you're really socializing with, however. That's because you get to create your own on-screen persona—called a "toon" by most TSNers—before you enter any of the lands. To that end, the FaceMaker program provides a wide selection of eyes, noses, mouths, face shapes, hair styles, clothing, and accessories that you can mix and match in endless combinations. To help other users get to know you better, you can also select from a list of your hobbies and interests. The sets of physical attributes and personal interests change depending upon which land you're in, to reflect the ambience of each place. In the SierraLand amusement park, you can't help but look like a kid, for example, and your interests generally are restricted to such activities as playing, surfing, talking, video games, etc. Obviously, if you're a 50-year-old businessman, your SierraLand persona won't bear much resemblance to the real you.

Further complicating the issue—or making game-playing much more interesting—is the fact that in each area of ImagiNation, you can create up to four different 'toons. A family of four, for example, could have one persona for each family member. Alternatively, a single person could be one of four different people depending on what role he wanted to play. Not only can each persona look different, but each can have a different name, age, and interests. You can never be quite sure who you're talking to on-line!

To help handle potential crowds, each area of ImagiNation features a number of "rooms," each of which has a maximum capacity of 50 players. When you first enter a room, a list of the players already "inside" comes on screen. To talk to a specific person, you can click on his name and then on "talk." To say something to the whole crowd ("Anyone interested in a game of miniature golf?"), you can click on "all" and then "talk," and then key in your message.

Click on a player's name, and you can see her personna, including interests, age, and what she is interested in playing.

The same games are available in all the rooms in a given area. For instance, every room in the SierraLand amusement park, has games ranging from Sneak-A-Tac, a three-dimensional four-in-a-row tic-tac-toe game, to PaintBall, a strategy game that we never learned how to play. A miniature-golf game is available for playing solo or against another TSN'er, and Red Baron lets you shoot other players out of the sky in an interactive dogfight. Rocket Quiz is, in our opinion, an annoying arithmetic quiz game. (Maybe just because we never found anyone who was slower than we were at doing long multiplication problems—we're certainly out of practice!). A Graffiti "game" lets you use computer tools to draw and save colorful pictures.

The Clubhouse also has a number of different rooms with the same games available in each one. As in SierraLand, the names help to keep people of similar interests together. Teens will likely gravitate to teen scene, while singles hoping to meet someone will go to the singles club. People who like playing bridge will go to the bridge club—even if they happen to feel like playing Go (the ancient board-control game) that evening. Other games that are available in the Clubhouse include the board games chess, checkers, backgammon, and flip-flop (an Othello play-alike). Besides bridge, other card games available are hearts and cribbage.

Medieval Land contains only a single game: Shadow of Yserbius. But the Dungeons and Dragons-like fantasy role-playing game is currently the most popular game on the network. The Sierra Network's parent company, Sierra On-Line is best known for its graphic adventure games—they currently hold about 60% of the market for IBM-PC compatibles.

Not being adventure-game players ourselves, we ignored the area except for a brief look at the interesting graphics. But that, in itself, points out one of the strengths of TSN. We had a lot of fun doing the things that appealed to us and ignoring the rest. And we're sure that the people in MedievaLand were doing the same. That factor also helps players meet like-minded users, with whom many form fast friendships.

We must admit that the Shadow of Yserbius sounds quite interesting, even to us non-adventure-game players. One reason is that, although you can play alone, it makes more sense to play with other characters. A team that is made up of a character with magic powers teamed with one who has great physical strength and another who has great intellect will have a better chance of survival during the encounters with the dragons, monsters, and other dangers within the maze of dungeons. Hmmm. Maybe we *will* play the game after all. (But not until we've met the deadline for this article!)

LarryLand, where we ended up spending most of our time (we're slightly embarrassed to admit), is a completely different story. It gets its name from the popular "Leisure Suit Larry" adult-oriented games from Sierra On-Line. LarryLand is an "anything goes" kind of place. When you enter one of the gambling areas (Las Vegas, Lake Tahoe, Monte Carlo, etc.) you are presented with an announcement stating that adult language and behavior is accepted in the area, but that abusive or harassing behavior will not be tolerated. Minors are informed that they are not to enter. (Parents can password-protect LarryLand). Adults who want to gamble without being subjected to other members' adult language and behavior can check into Polite Place, where normal TSN community standards are enforced.

In the LarryLand gambling halls, poker, blackjack, roulette, and slot machines are available for playing. If you wish, you have the option, as in other areas, to play without being disturbed by other users. If gambling is not your thing, you might want to retire to Lefty's Bar for "a drink" and

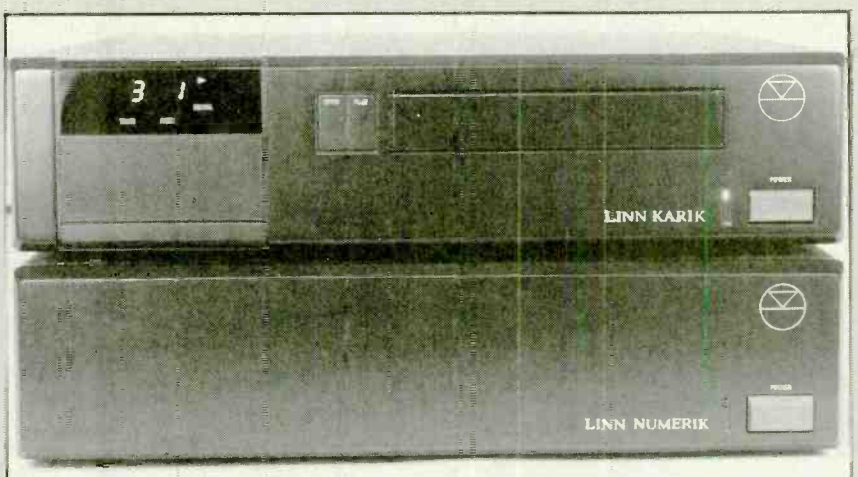
Although you can play blackjack against the house, playing with real people is a lot more fun!

some bar games, or just to chat with a group of friends. As with "chat rooms" in other areas, groups of people can talk simultaneously while looking at each other's personae. If you wish to say something so that only one person "hears" you, you can choose to "whisper" to him.

As you might expect, people on TSN are real people. And the percentages of jerks on TSN is about the same as in real life. Although we never encountered any abusive behavior or language on the network, we're sure that it happens on occasion. To combat that potential, TSN offers a reactive form of "censorship." If someone says something that offends you, simple click on the Complain button in the chat box that pops up to show messages. The message, along with your comments (which you are asked to type in) are sent to a sysop (system operator). If the comment is deemed offensive, TSN will contact the offender—usually not using the E-mail system, but with a phone call. And if you simply don't like someone who insists on talking to you, it's possible to "mute" that particular person so that he can no longer communicate with you. (Those two features alone make TSN a more enjoyable, safer meeting spot than your local singles bar!) Members who want to play without being disturbed by others can click on a do-not-disturb option.

We learned a few interesting things from interacting with other users. For instance, if we created a somewhat sexy female persona, a lot more people wanted to talk to us than when our 'toon was a thirty-something man with glasses. We learned from on-line gossip that not only have there been about a half-dozen TSN-inspired marriages and about the same number of engagements, but there's also been at least one divorce due to a married player falling in love with another TSN user!

TSN had more than 18,000 subscribers when we first logged on. By the time you read this, they expect to more than 40,000, and by the end of the year, 150,000. We can understand why. All in all, TSN is *fun*. And trying it for three hours is free! Just call 1-800-Sierra-1 and get your starter kit. Why not give it a try! ■



CIRCLE 77 ON FREE INFORMATION CARD

High End Defined

LINN KARIK/NUMERIK CD PLAYER. Manufactured by Linn Products, Ltd., Glasgow, Scotland. Distributed in the U.S. by Audiophile Systems, 8709 Castle Park Drive, Indianapolis, IN 46256. Price: $5800.

The compact disc was such an important development in audio not only because it offered a new, convenient, and rugged way to distribute music. Perhaps the most important aspect of the CD format is that it brought high-fidelity down in price and made it available to the masses. Because even inexpensive CD players could offer superb sound, people learned what quality audio can be. As a result, the demand for high-quality sound has increased.

Not everyone saw the CD as a step forward, however. Many audiophiles criticized the "harsh, sterile" sound of CD's. How could any process that broke music up into millions of pieces and then reassembled them result in anything close to natural sound?

Even today, not everyone is convinced that converting audio to digital data permits accurate reproductions. Linn Products, a highly regarded Scottish maker of high-end turntables—you remember, those machines that play vinyl LP's—has, for the first time, put its name on a CD player. The *Linn Karik/Numerik* is not your everyday CD player, though. First there's the almost $6000 price. Second, the player is actually two separate components: a CD transport (the Karik) and a D/A (digital-to-analog) converter (the Numerik).

In the world of high-end audio, $6000 isn't an unreasonable price for a CD player. In fact, Linn's top-of-the-line record player costs almost $7000! But, we wondered, is there any justification in paying such a high price? Could we tell the difference between the Linn Karik/Numerik and a CD player costing a small fraction of its price? Before we get to our listening tests, let's see what the developers at Linn were trying to accomplish.

Why is the CD player housed in two boxes? Because separating the transport and the converter allowed Linn "to achieve both optimum performance and user flexibility." Both boxes are totally screened from each other to avoid interference, and each contains its own power supply. The Karik and the Numerik can be used independently, if desired. The Numerik can decode other digital sources, and the Karik can feed other D/A converters. Both boxes are available separately. But only if the pair is used in combination can you use the "Sync-Linc," which forces the transport to lock to the processor's clock. (An accurate clock signal is essential to reproducing the digitally stored data.) Usually, CD players operate in the opposite way; the transport sends the clock in the data. Linn's method, where the processor sends a clock to the transport on a separate cable, is said to reduce or eliminate clock jitter. Jitter is potentially audible and can reduce the dynamic range of a system.

The D/A converters in the Numerik are 20-bit, 8× oversampling chips manufactured by Burr-Brown. Why use 20-bit converters when the data on a CD are stored in 16-bit words? And why oversample the data that was recorded at a sampling rate of 44.1 kHz?

All sampled waveforms contain extraneous high-frequency information in the form of images. That quantization noise is a natural consequence of digital sampling. Although the noise is far above the range of human hearing—the first image occurs at 88.2 kHz, more than four times the top limit of what we can hear—they must be

eliminated from the output signal for numerous reasons. They could, for example, interfere with other equipment, damage tweeters, or cause amplifier instability. One way to remove the quantization noise is to use a very sharp analog "brickwall" filter to band-limit the output audio. Such analog filters were used in first-generation CD players. They are expensive, bulky, prone to drift, and have undesirable characteristics, adding ringing and phase non-linearity to the audio.

In an oversampling CD player, digital filters do most of the work. The Linn Numerik, an 8 × oversampling player, generates seven intermediate samples between each input sample. Since eight times as many samples are present after oversampling, the sampling frequency is increased by a factor of eight, from 44.1 kHz to 352.8 kHz. That pushes the unwanted quantization noise much higher in frequency; only a simple, low-order analog filter is required to remove it. Although it's a common misconception, oversampling doesn't somehow increase the accuracy of the audio signals played back. It's just a more dependable and efficient way to ensure the accuracy.

A real-world 16-bit converter cannot reproduce 16-bit audio from a CD without error. By definition, because the quantization levels are spaced 1 LSB (least-significant bit) apart, the quantization uncertainty is ±½ the LSB. An 18-bit D/A converter has four times as many output levels as a 16-bit converter; the Numerik's 20-bit converters have four times as many output levels as a 18-bit converter. That reduces the nonlinearities. The error is still ±½ the LSB, but the LSB is one sixteenth the size of that of a 16-bit converter.

From the outside, the Karik/Numerik looks clean and simple. The two units are housed in cases that are the same size. Both feature a power button on the lower right corner of the front panel. A bright, green LED is alongside the switch. The transport box has a digital display on the upper left, a slide-out CD tray, and two buttons: OPEN and PLAY. Other customary CD controls are hidden behind a flip-down door. You can skip tracks, search for index points, or change the time display, for example. Missing from the controls are any programming functions. This isn't surprising to us; it forces people to use the player much in the same way they used to listen to LP's: Put the record on, sit back, and listen. (We agree that that is the way discs should be listened to, and hardly ever use programming.) The remote control provided with the player is designed to be used with other Linn components such as its preamp and tuner.

The rear panel of the Karik contains something we've never seen on a consumer CD player: a 9-pin "D" connector labeled "diagnostic output." The port does not follow the RS-232 standard, so we couldn't examine it. It's intended to be connected to Linn-specific test equipment. Among other things, the diagnostic port allows a properly equipped dealer to monitor the performance of the laser pickup. (The pickup assembly was designed to be replaceable within ten minutes.) It also lets error rates be checked.

We weren't sure what to expect from the Karik/Numerik. On the one hand, we've always been happy with the sound of CD. That is, the sound of the format itself. We've heard plenty of poor-sounding discs, though, especially in the early days of CD when recording engineers didn't appreciate the required differences between mastering a compact disc and an LP. On the other hand, a $6000 CD player *must* sound better than a garden-variety CD player, right?

We've always thought that some of the self-proclaimed golden-eared audiophiles were full of little more than hype. Many of their explanations just don't make sense. But who's to say that they can't hear what they claim to hear? We will admit that we couldn't hear the difference when we disconnected the Sync-Linc, yet a high-end reviewer called the sonic difference "dramatic." Perhaps he really could hear what is inaudible to everyone else.

There is no doubt that the Karik/Numerik is a superbly designed machine. We would never argue with someone who thought that it is a good idea to overdesign servo motors, power supplies, and other CD-player subsections. Building a CD player for serviceability—rather than as a disposable item—is something we'd like to see more of. Quality is visible in the cabinetry, and is evident from the feel of the controls. The quality of the shielding is readily evident from its low RF interference. Perhaps all of the visible quality is one of the reasons why—despite our prejudiced beliefs that inexpensive CD players can perform as well as expensive models—we enjoyed auditioning it so much. Having pride in your audio system can, indeed, make it sound better ■

CANON CAMCORDER

(Continued from page 21)

ing the current scene so that you can re-record it. Lets assume that just after starting a recording, something happens to destroy the scene—a loud, unwanted noise, or someone walking in front of the camcorder. Choosing edit-erase lets you fix it up quickly; it works only during the first minute of each scene, however.

The shutter selection lets you manually set the shutter speed to one of eight speeds from 1/60 to 1/10000 second. Fast shutter speeds are useful for shooting sports scenes or other fast motion without blurring. Selecting WB lock lets you manually set the white balance. Normally, the camera automatically sets white balance, which allows the camcorder to record whites and colors properly under a variety of light sources. It can't, however, automatically set the white balance when you try to record subjects with a single dominant color (the sky or sea, for example), under rapidly changing lighting, or under certain types of artificial light. The manual control lets you get realistic colors even under such situations.

The final selection in the first menu, BTS, automatically searches for blank tape, a feature we find especially handy. It lets us stick a tape in, choose BTS, and sit back and wait—no more looking at what's on the tape and trying to remember where we stopped recording.

The second menu offers four more choices: fade trigger, line in, tally, and sensor. Fade trigger changes the way the fade control works. Instead of having to hold the fade control in, you can make it operate like a traditional fade. Line in permits recording from video/audio inputs rather than the camera. Selecting tally turns off the flashing lamp at the front of the camcorder that normally indicates that the camcorder is in the recording mode. It's useful if you're recording near glass or other surfaces that could cause unwanted reflections of the light. The sensor selection turns off the camcorder's remote-control sensor in the camera mode. It's useful if other Canon camcorder users are operating their units by remote control. The infrared remote control supplied with the UCS2 can be used during recording or playback.

Although it might sound complex, the menu system is actually a breeze to use—certainly much easier than it would be to hunt through all of the additional buttons that would otherwise be required to perform the same functions.

Considering everything that Canon managed to pack into the UCS2, did they leave anything out? The most obvious omission is that of an image-stabilization system. Canon has steadfastly refused to incorporate any such system into their camcorders until they come up with a reliable system that causes no image degradation. (Actually, their engineers already have. The ingenious system is built into Canon's UCS3, which we hope to report on in the coming months.) A couple of bells and whistles found on other camcorders—a title function, for example—are missing, as is an accessory shoe for mounting an external microphone or video light. (An accessory adapter bracket is available as an option, as are a host of other Canon accessories.) ■

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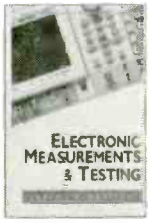

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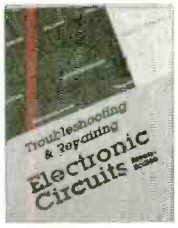

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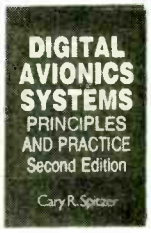

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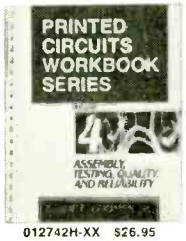

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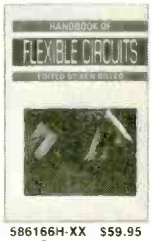

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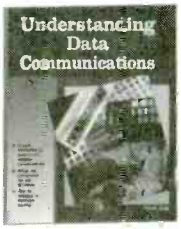

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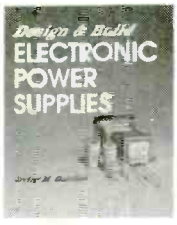

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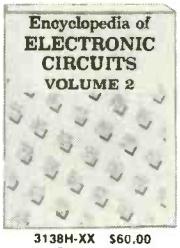

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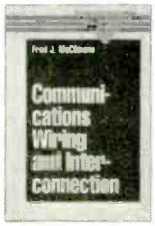

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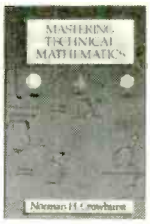

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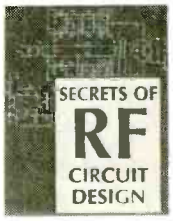

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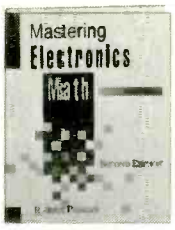

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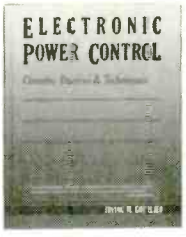

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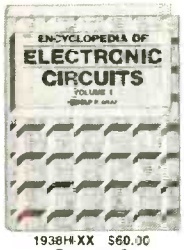

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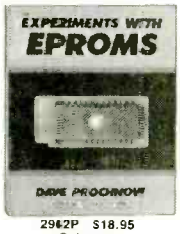

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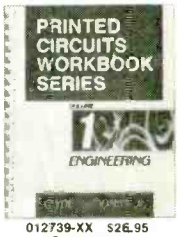

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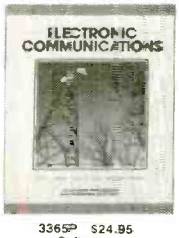

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A Hands-on Electronics REPORT

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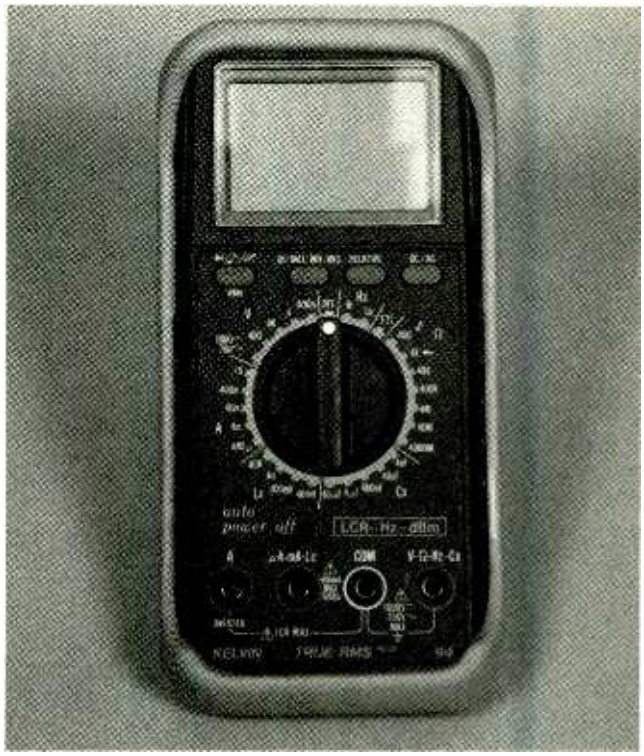

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Put an entire electronics-troubleshooting lab in your coat pocket with the Kelvin-94 digital multimeter.

Multimeters have certainly come a long way. It used to be that a handheld multimeter was good for checking voltage, resistance, and perhaps current. However, over the years, manufacturers were able to add new features to multimeters, while lowering prices. Now you can buy a multimeter containing more features than you could ever imagine, all for less than $200. That's what you get when you buy a Kelvin-94 digital multimeter, which sells for $199.95.

Not only does the Kelvin-94 boast a lot of features, but most of its features go the extra distance by having above-average quality, range, and accuracy. Although Kelvin is not yet known for their test equipment, they will be when this high-performance multimeter gets noticed.

Features. Since all of the Kelvin-94's features are worth mentioning, we may as well start with some very simple features that all multimeters should have, but usually don't. To begin with, the Kelvin-94 is claimed to be water resistant. Curious about what that meant, we opened up the meter. We were surprised to find that not only is there a rubber gasket between both halves of the case, but that all of the screws have a washer and gasket as well. The switches, LCD lens, and test-lead sockets are also gasketed. While you certainly would not use the meter under water, with that type of construction you could actually use it out in the rain.

While we had the meter open, we noticed that it is as ruggedly built inside as it is outside. A 9-volt battery compartment and spare-fuse holder (which did contain a spare fuse) are molded inside the case. A cushioned yellow rubber holster included with the meter adds to its durability.

As you would expect, there is a meter stand built into the back of the meter. There's also a pair of ribbed rubber feet that really keeps the meter from sliding, even on an incline. The foot toward the bottom of the meter is curved to keep the meter sure-footed when the stand in use. Although rubber feet are nothing exciting, no meter this reviewer has used up to now had feet that were useful when the stand was engaged. From years of troubleshooting, we know how extremely annoying a wandering meter is.

The Kelvin-94 has a 3¾-digit display. That ¾ digit is important. When a meter has only a 3½-digit display, as is common with most handheld units, it lets you see a maximum of 1999 in any given range, the "1" being the half-digit. By contrast, a 3¾-digit display lets you see a maximum of 3999 in any range, the "3" being the three-quarter digit. So, while the "ohms" ranges on 3½-digit multimeters are usually 200, 2K, 20K, 200K, 2 megohm, and so on, the Kelvin-94's ranges are 400, 4K, 40K, all the way up to 4000 megohm. The extra quarter-digit essentially doubles the maximum reading in any given range, and halves the average number of times you have to switch ranges while using the meter. It makes for much more friendly operation. The display also has a 40-segment bargraph display.

The Kelvin-94 can be used to mea-

sure resistance, capacitance, inductance, frequency, logic levels, dBm, and true-rms voltage and current. There's also the usual audible continuity test and diode checker. Pushbuttons enable other features such as data hold, relative measurement, and maximum-, minimum-, and average-recording modes.

The meter also has an auto power-off function and a low-battery indicator. The one thing we were surprised not to find on this meter is a transistor checker, but that is a seldom-used feature.

Use. Because we're all familiar with using common multimeter functions (measuring voltage, current, etc.), there's no sense in us going into the details of measuring such things. Instead, let's take a closer look at some of the more interesting features.

In many of the meter's modes, there's an audible readout option. That allows you to "hear" a measurement's relative amplitude in addition to seeing the reading on the display. A feature like that comes in handy when troubleshooting in dimly lit areas, and for quickly detecting a particular signal with a pair of trained ears without having to look at the display.

While there's nothing unusual about the way inductance is measured with the Kelvin-94, it is unusual to find a multimeter containing this feature at all. The meter has inductance ranges from 40 millihenries to 40 henries.

When the meter is set to measure AC voltages, and you press the "dBm" button, it enters the decibel mode. Normally 0 dBm corresponds to a voltage (0.7746 V_{rms}) that causes a 1-milliwatt dissipation in a 600-ohm load—which is the reference impedance in this mode. The meter can also be set to record minimum, maximum, and average readings. A beep will be heard each time a new maximum or minimum is recorded. You can then cycle through the recorded readings.

A data-hold function is especially convenient when you have to measure a voltage in one location, and read it in another. For example, if you measure a voltage under the hood of a car, you can then easily compare it to a chart in a shop manual without having to remember or write down the reading. It is also useful in taking measurements in hard to reach or see places.

A "relative" function is used to store the displayed reading as a reference value and display all subsequent readings relative to the stored value. This feature is also useful when measuring small capacitances or inductances because you can use it to negate the effects of the test leads and the meter itself on the reading.

The meter enters a sleep mode if it has been inactive for 30 minutes. It will then display a blinking symbol for an additional 60 minutes after which it shuts off completely. The auto power-off function can be disabled to prevent it from erasing any stored minimum or maximum values.

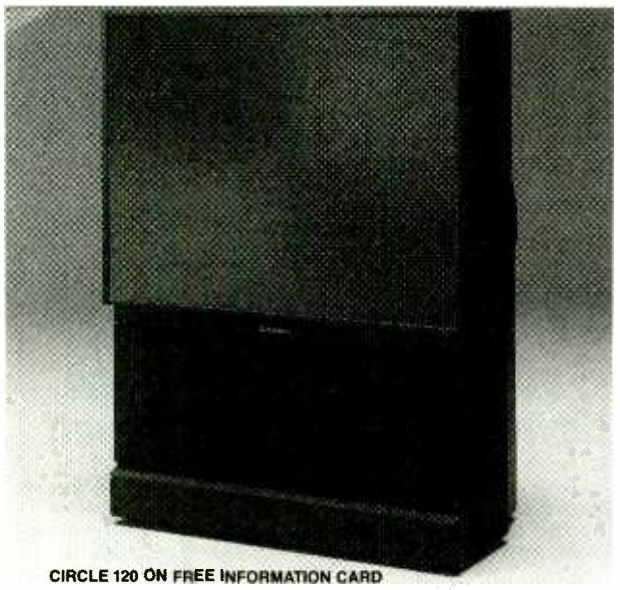
If we had to run into a burning building to do some emergency troubleshooting and could carry in only one piece of equipment, the Kelvin-94 would be it. For more information on the Kelvin-94 contact Kelvin Electronics, (10 Hub Drive, Melville, NY, 11747; Tel. 516-756-1750) directly, or circle No. 119 on the Free Information Card. ■

PRODUCT TEST REPORTS

By Len Feldman

Mitsubishi VS-4517S Rear Projection TV Receiver

If you haven't checked-out a rear-projection TV set in some time, you might be pleasantly surprised at the picture quality, brightness, and extra features found in today's units. An excellent example of that is the Mitsubishi (5757 Plaza Dr., Cypress, CA 90630) VS-4517S, a 45-inch (measured diagonally), ultra-thin (21 inches in depth) console that takes up little more space than a large-screen direct-view TV set. The receiver features picture-in-picture capability (using a second video program source such as a VCR or a videodisc player). The TV-tuner section is "cable ready" and can receive 181 channels and MTS-stereo audio. The unit provides two external video inputs, which can be either composite signals or S-video (Y/C). One of the video inputs is duplicated on the front panel for easy connection of a camcorder. In addition to the conventional audio and video outputs, there is a line-level subwoofer output and outputs for two external speakers. There are also two RF inputs for antenna and cable converter signals. An unusual fold-out tray on top of the unit is intended for housing a VCR, which must be held in place by means of a supplied strap.



CIRCLE 120 ON FREE INFORMATION CARD

Mitsubishi VS-4517S Rear Projection TV Receiver.

The unit also sports a most unusual feature for any TV set—a five-band graphic equalizer, which is set by using the remote control and on-screen menu/display. An "audio-expansion" setting is provided to enhance the sound of mono sources. Video features include a noise-reduction system (which can be switched on or off), a three-position color-temperature setting, a color-bias control for obtaining proper skin-tones, and a color-aperture improvement feature to improve color-edge definition. The rear-projection TV set is supplied with a universal "learning" remote control that can be taught the commands of other remote controls.

CONTROLS

Most of the user controls associated with this TV set's special features are accessed via the handheld remote control. The controls found on the set itself include a power switch, volume-adjustment controls, channel-scan up/down buttons, input-selector buttons, video- and audio-adjustment controls, an A/V-reset button, and a timer-reset button. Direct access to specific channels can only be accomplished via the handheld remote control. The same holds true for many of the other on-screen, menu-driven features mentioned earlier.

TEST RESULTS

As usual, the video and audio performance of this sample was carefully measured by the Advanced Product Evaluation Labs, under the direction of Frank Barr. APEL and we were particularly impressed by the maximum usable luminance, or brightness, which measured 149 foot-lamberts. That's bright enough so that the set can be comfortably viewed in a normally lit room, although, as with most projection sets, dim lighting is still recommended. That reading is substantially better than what we used to encounter with early rear-projection sets. However, if you move off-axis by a substantial angle, brightness diminishes quite rapidly. This is even more true if you try to view the picture from a standing position; Vertical brightness fall-off is even more severe than horizontal. We should point out, however, that this effect is true of most rear-projection sets and, in fact, this one is better than most

at least in terms of its horizontal brightness fall-off.

Horizontal resolution was superb, measuring 680 lines. That's better than the best resolution obtainable from any consumer video-program source, including S-VHS VCR's or videodisc players. There was only a slight amount of overscan, and that was apparent only in the horizontal direction when viewing a test pattern. It will probably not be sufficient to cause any visible distortion when viewing actual scenes of a program.

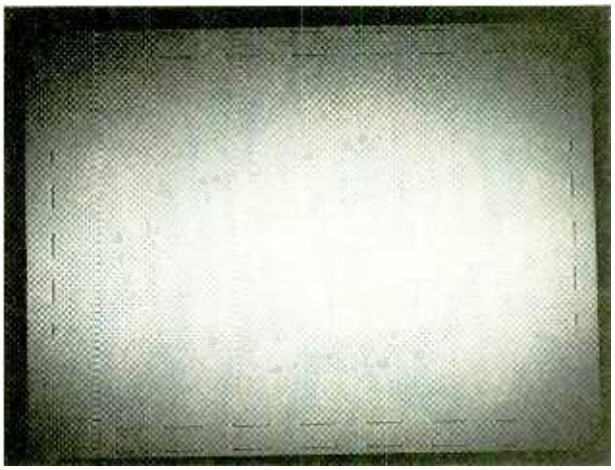
Convergence was very good, though there was a slight error of convergence in the lower left corner of the picture. Interlace was perfect, which means that you're not likely to notice TV scanning lines unless you sit very close to the screen. Tuner sensitivity was excellent.

Audio performance via the line-out jacks was excellent, with harmonic distortion at −10 dB levels measuring an inaudible 0.02%. The signal-to-noise ratio was a very high 79.4 dB and audio frequency-response extended from 23 Hz to 20 kHz. The speaker-out jacks delivered in excess of 19-watts-per-channel with less than 3% distortion and, if backed off to −10 dB below that level, distortion decreased rapidly to a mere 0.04%, with signal-to-noise measuring 50.5 dB. Even via the speaker-output terminals, response remained flat over the entire audio spectrum.

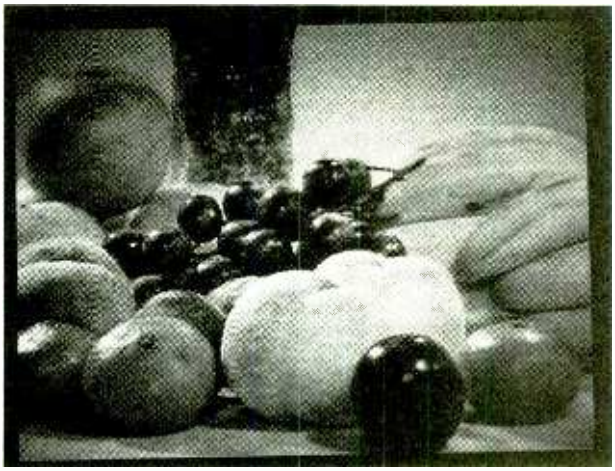
The built-in stereo decoder also performed well, delivering a signal-to-noise ratio of around 63 dB and stereo separation well in excess of 20 dB at all modulation levels. Harmonic distortion in the stereo mode measured 0.13% for the left channel and 0.11% for the right channel at levels of −20 dB (using a 1 kHz test signal). The signal-to-noise ratio was also excellent (nearly 69 dB) in the SAP (Secondary Audio Program) channel, which is increasingly being used for narration for the visually impaired, second-language dialog, and for other special programming.

TEST RESULTS—MITSUBISHI VS-4517S PROJECTION TV RECEIVER

Specification	PE Measured
Video Section	
Maximum usable luminance	149 ft.-lamberts
Luminance off-axis (horizontally)	
50 degrees	27-ft.-lamberts
70 degrees	3.5 ft.-lamberts
Horizontal resolution	680 lines
Overscan (vertical/horizontal)	0/2.0%
Black-level retention	100%
Interlace	50/50 (perfect)
Transient response	Excellent
Audio Section	
Audio output	
Line output	0.51 volts, 3.0% THD
Speakers output	19.2 watts, 2.6% THD
Distortion at 1 kHz, −10 dB	
Line output	0.02%
Speaker output	0.04%
Signal-to-noise ratio	
Line output	79.4 dB
Speaker output	50.5 dB
Frequency response	
Line output	23 Hz to 20 kHz
Speakers output	20 Hz to 20 kHz
Stereo signal-to-noise (L/R)	63.6/62.7 dB
Stereo harmonic distortion L/R, −20 dB	0.13/0.11%
Stereo separation	
100% modulation (L/R)	24.8/24.4 dB
−20 dB modulation (L/R)	22.2/21.2 dB
S.A.P. signal-to-noise ratio	68.9 dB
Additional Data	
Picture size	45 inch diagonal
Power requirements	240 watts
Weight	187 pounds
Dimensions (W × D × D, inches)	37¼ × 49¼ × 20⅞
Suggested price	$3299.00



There was only a slight amount of overscan, and that was apparent only in the horizontal direction when viewing a test pattern.



Tuner sensitivity was excellent, as evidenced by our "weak-signal" simulation (100 microvolts) shown in this photo.

HANDS-ON TESTS

Since the Mitsubishi VS-4517S weighs some 187 pounds, we traveled out to APEL's facilities for a hands-on evaluation of this rear-projection set. Color rendition was excellent, with reds actually looking red instead of the usual orange that is encountered on many sets—both direct view and projection. The three-position white-balance control is a very useful feature, especially since not everyone agrees on just what "white" should look like, some preferring a bluish tint with others favoring a reddish hue. We found the remote control extremely easy to use, and unlike some other similar remotes, there are no hidden buttons under

(Continued on page 93)

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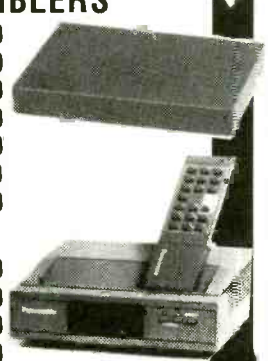
JERROLD 400	49.00	39.00



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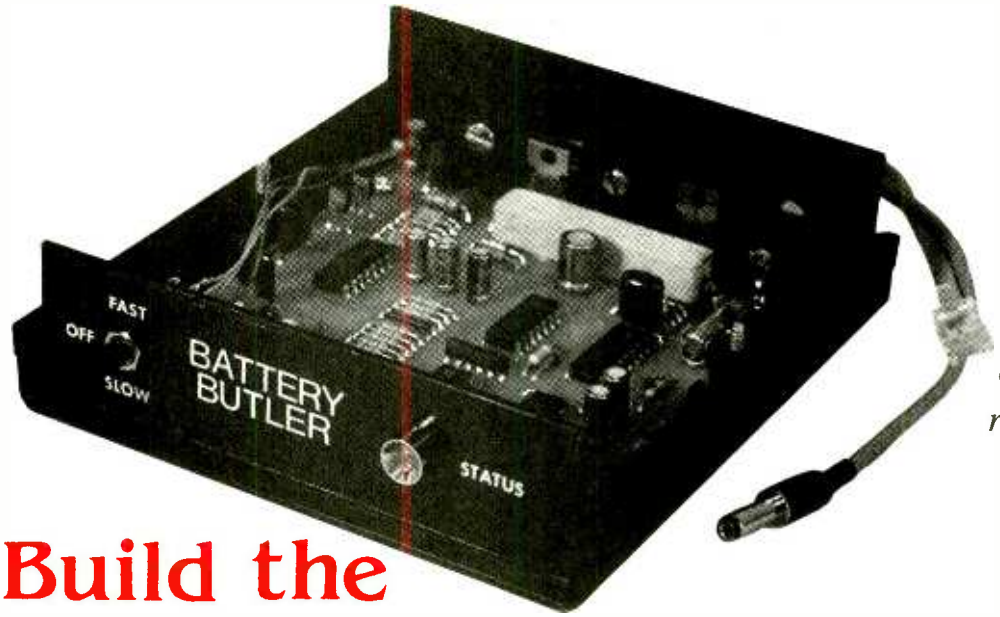


Eliminate frequent rechargeable Ni-Cd battery replacement with a charging circuit that can also restore batteries that have developed a "memory"

Build the BATTERY BUTLER

BY LARRY LANPHER

With the widespread use of fast-charging, nickel-cadmium (Ni-Cd) battery chargers supplied with many consumer products, many consumers have found that the convenience of rapid charging has not offset the high cost of replacing destroyed batteries in their telephones, handheld transceivers, remote-control model cars, and planes. The replacement cost of the batteries that power such portable and cordless gadgets can range from 25 to 75 dollars. On top of that, with regular use, some types of fast chargers can reduce the useful life of a rechargeable battery to 20% to 50% of its normal life.

Further reducing the useful life of their Ni-Cd batteries, consumers, especially portable cellular telephone users, fail to let their batteries fully discharge before recharging them. That can cause the battery to develop what is known as a "memory"—which is caused by repeated partial discharge of the Ni-Cd battery. Each time the battery is partially discharged, prior to a normal recharge cycle, the battery demonstrates an apparent loss of capacity. However, most of the incurred loss is recoverable by subjecting the battery to a few deep-discharge cycles.

Operating and charging Ni-Cd batteries at elevated temperatures also reduces their useful life. Most Ni-Cd batteries give their best performance at temperatures between 18°C and 30°C. The high internal temperatures of Ni-Cd batteries during fast charging, often near 50°C, accelerates cell electrolyte-seal and separator deterioration and increases the probability of internal shorting. Electrolyte venting, due to high internal pressures, occurs more often at elevated temperatures. The loss of cell electrolyte, due to continuous cell venting, results in a net loss of cell capacity.

The *Battery-Butler*, described in this article, solves the common problems associated with the maintenance and operation of Ni-Cd batteries. The Battery-Butler, by initially discharging a Ni-Cd battery to a preset point, reduces the possibility of the "memory" effect occurring. Once discharged, a battery is then usually charged at 25% or less of the fast-charge rate. Charging at a lower rate will typically reduce the internal cell temperature rise by 25% and reduce the internal cell pressure increase by 40% or more. Once the battery is fully charged, a trickle charge is provided to maintain the battery in a fully charged state. The Battery-Butler circuit can be bypassed, and the existing fast-charger used, if needed.

Circuit Description. A schematic diagram of the Battery-Butler is shown in Fig. 1. When power is first applied to the circuit and S1 is in the off position, C2 is held discharged. At the same time, pin 14 of U3-f is held low via R2, forcing U3-f's output at pin 15 high. The high output of U3-f divides along two paths. In one path, U3-f's output is fed to U3-b at pin 5 through D3, causing the output of U3-b at pin 4 to go low. The logical-low output of U3-b is fed to the base of Q4, keeping it turned off.

In the other path, the high output of U3-f is applied to the input of U3-c at pin 7, forcing its output low, which in turn holds C1 in a discharged state through R4 and D2. That keeps the output of U1-b (at pin 9) high, which keeps LED1 dark. The reset signal (taken from pin 6 of U3-c), being low, forces both R/S latches (comprised of U4-a/U4-b and U4-c/U4-d) to return to their respective reset states. Once in a reset state, pin 4 of U4-b and 10 of U4-c go high, and pin 11 of U4-d remains low, indicating a discharge cycle. The low output of U4-d at pin 11 forces pin 2 of U3-a high, turning Q2 on. That pulls the ADJ pin of U7 low, which holds the output off.

When S1 is flipped to the SLOW position, pin 15 of U3-f goes low, forcing pin 6 of U3-c high, while at the same time reverse biasing D3, so no current flows through that unit. With D3 reverse biased and pin 11 of U4-d low, pin 4 of U3-b goes high, turning on Q4. The battery then starts to discharge into R39 through Q4. Zener diode D7 provides overvoltage and reverse-voltage protection for Q4.

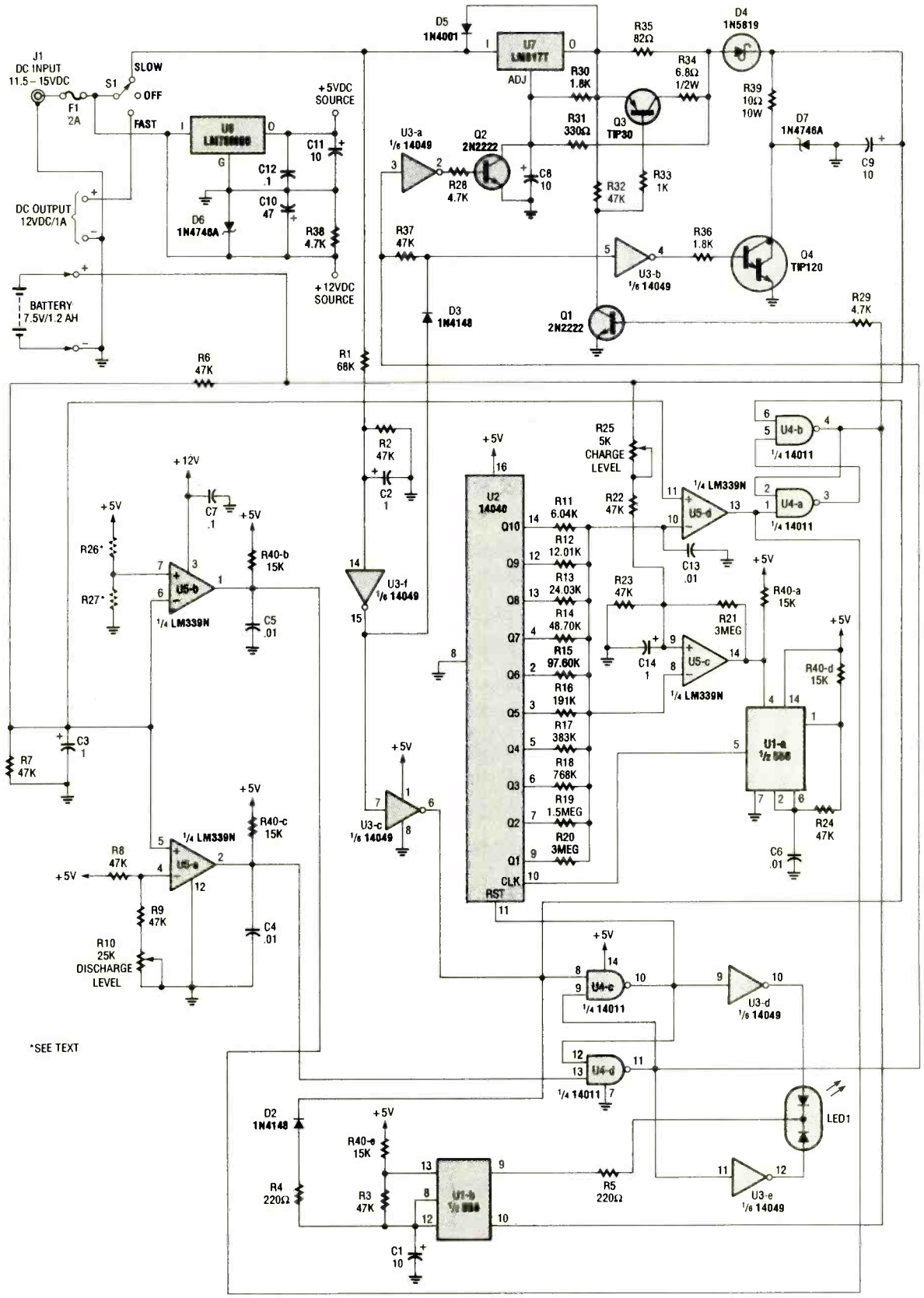


Fig. 1. The Battery-Butler is comprised seven IC's—an LM556 dual oscillator/timer, an MC14040 CMOS 12-stage binary counter, an MC14049 CMOS hex inverting buffer, an MC14011 quad CMOS NAND gate, an LM339N quad comparator, an LM78MO5 5-volt, 500-mA, voltage regulator, and LM317T 1-amp, adjustable voltage regulator—along with their support components.

Pin 6 of U3-c, which is now high, allows C1 to begin charging. The charge on C1 is applied to the threshold input of U1-b at pin 12. The high output of U4-b at pin 4 is applied to the reset input of U1-b at pin 10. Those two signals, being high, cause U1-b to begin oscillating, which in turn flashes LED1. The displayed color of LED1 is selected by the state of pin 10 of U4-c and 11 of U4-d. With pin 11 of U4-d low, LED1 flashes red.

The Ni-Cd battery's voltage is applied to the circuit and divided by R6 and R7, and is monitored by U5-a. When the voltage at a pin 5 of U5-a dips lower than the reference voltage at pin 4 of U5-a, pin 2 of U5-a goes low, indicating that the battery has been discharged. Note that the discharge cycle can last from seconds to hours, depending upon the type and condition of the battery. The low output of U5-a is fed to one input of an R/S latch (consisting of U4-c and U4-d), forcing pin 10 low and 11 high, which, in turn, causes the red section of LED1 to turn off and the green section to turn on, indicating that a charge cycle has begun. The high output of U4-d at pin 11 forces the output of U3-a at pin 2 low, turning Q2 off. That allows the ADJ terminal of U7 to float high, which turns the output pin on and allows current to flow to the Ni-Cd battery.

Since the initial reset cycle, pin 4 of U4-b has been high, generating the hi-rate signal. The hi-rate signal (in a high-logic state) turns Q1 on, which turns Q3 on. With Q3 conducting, R34 sets the regulator's constant-current output at the higher charging rate.

The Ni-Cd battery's charge voltage is divided by a resistor network comprised of R22, R23, and R25, and applied to a track-and-hold circuit, which is used to monitor the charge voltage. The track-and-hold action is initiated when the reset input of U2 at pin 11 drops low at the start of the charge cycle. That allows U2, clocked by U1-a, to begin counting. Once counting, U2, combined with R11–R20, produces a ramp voltage at pins 8 and 10 of U5-c and U5-d, respectively. That voltage continually increases until the voltage at pin 8 of U5-c is greater than that at pin 9, at which time, the reset input of U1-a at pin 4 goes low, inhibiting the clock.

As the battery continues to charge, the voltage at pin 9 of U5-c increases proportionately with the increase in battery voltage. When the voltage at pin 9 of U5-c is greater than that pin 8, the reset input of U1-a at pin 4 pulled high, causing it to oscillate. The output of U1-a at pin 3 is fed to the clock input of U2 at pin 10. As the charge cycle continues, the track-and-hold circuit tracks the battery's reference voltage at pin 9 of U5-c, which is slightly less than the $V_{BATT/2}$ voltage at pin 11 of U5-d. That difference can be adjusted via R25.

As the Ni-Cd battery approaches full charge, the voltage across the battery terminals begins to decrease. Since the voltage at pin 8 of U5-c and pin 10 of U5-d is held slightly below the peak $V_{BATT/2}$ voltage, the circuit can detect when the decreasing voltage crosses the lower limit, and hence detect that the battery is approaching full charge.

Once $V_{BATT/2}$ falls below the voltage at pin 10 of U5-d, pin 13 drops low, causing the high-rate signal at pin 4

PARTS LIST FOR THE BATTERY BUTLER

SEMICONDUCTORS

U1—LM556 dual oscillator/timer, integrated circuit
U2—MC14040 CMOS 12-stage binary counter, integrated circuit
U3—MC14049 CMOS hex inverting buffer, integrated circuit
U4—MC14011 quad CMOS NAND gate, integrated circuit
U5—LM339N quad comparator, integrated circuit
U6—LM78MO5 5-volt, 500-mA, voltage regulator, integrated circuit
U7—LM317T 1-amp, adjustable voltage regulator, integrated circuit
Q1, Q2—2N2222 general-purpose NPN silicon transistor
Q3—TIP30 PNP Darlington power transistor
Q4—TIP120 NPN Darlington power transistor
D1–Not used
D2, D3—1N4148 or 1N914 general-purpose silicon, switching diode
D4—1N5819 or equivalent Schottky diode
D5—1N4001 1-amp, 50-PIV rectifier diode
D6, D7—1N4746A 18-volt, 1-watt, Zener diode
LED1—Bi-color (3 lead) light-emitting diode

RESISTORS

(All fixed resistors are ¼-watt, 5% units, unless otherwise noted.)
R1—68,000-ohm
R2, R3, R6–R9, R22–R24, R32, R37—47,000-ohm
R4, R5—220-ohm
R10—25,000-ohm, cermet trimmer potentiometer (Bourns 3386P)
R11—6040-ohm, ¼-watt, 2%
R12—12010-ohm, ¼-watt, 2%
R13—24030-ohm, ¼-watt, 2%
R14—48700-ohm, ¼-watt, 2%
R15—97600-ohm ¼-watt, 2%
R16—191,000-ohm, ¼-watt, 2%
R17—383,000-ohm, ¼-watt, 2%
R18—768,000-ohm, ¼-watt, 2%
R19—1.5-megohm
R20, R21—3-megohm
R25—5000-ohm cermet trimmer potentiometer (Bourns 3386P)
R26—Jumper wire, see text
R27—No connection, see text
R28, R29, R38—4700-ohm
R30, R36—1800-ohm
R31—330-ohm
R33—1000-ohm
R34—6.8-ohm ½-watt, 5%
R35—82-ohm
R39—10-ohm 10-watt, 5% ceramic
R40—15,000-ohm × 5 SIP resistor network

CAPACITORS

C1, C8, C9, C11—10-µF, 25-WVDC, electrolytic
C2, C3, C14—1-µF, 25-WVDC, electrolytic
C4–C6, C13—0.01-µF, ceramic-disc
C7, C12—0.1-µF, ceramic-disc
C10—47-µF, 25-WVDC, electrolytic

ADDITIONAL PARTS AND MATERIALS

F1—2-amp, 125-volt, 5-mm × 20-mm fuse
J1—5.5-mm × 2.1-mm DC power jack
S1—SPDT center-off toggle switch
Printed-circuit board materials, 5½- × 5- X 1½-inch plastic enclosure, battery-output cable, DC-output cable, LED bezel, grommets, TO-220 heat-sink, fuse holder, wire, hardware, etc.

Note: A kit containing a PC board, plastic enclosure, and all parts for the Battery-Butler is available from Peripheral Products (P.O. Box 19278, Tampa FL, 33686-9278: Tel. 813-835-8088) for $49.95, plus $4.50 shipping and handling. Florida residents please add appropriate sales tax.

of U4-b to go low. That signal turns Q1 off, which, in turn, turns Q3 off. With Q3 turned off, R35 sets the regulator's constant-current output at the lower charging rate. The high-rate signal brings pin 10 of U1-b low, inhibiting LED1 from flashing; LED1 remains a steady green until S1 is returned to the OFF position or DC power is lost.

If the battery is disconnected during discharging or charging, the leakage current through U7 will cause $V_{BATT/2}$ to exceed the threshold voltage at pin 7 of U5-b, causing pin 1 of U5-b to go low. That low signal, which indicates a high level at the battery terminals, sets pin 1 of U4-a low, forcing the ready state as previously described. That function also detects overcharging conditions and functions as a safety feature.

Construction. The authors prototype was assembled on a double-sided, printed-circuit board. The foil patterns for the two sides of the board are shown in Figs. 2 and 3 for those who wish to etch their own board. The board is also available separately or as part of a complete kit from the supplier listed in the Parts List. Note that, in any event, it will be necessary to solder the circuit elements to both sides of the board.

Once you have the board and all the components, construction can begin. A parts-placement diagram for the project's double-sided board is shown in Fig. 4. It is wise to socket all of the DIP IC's, as some are CMOS devices and as such are static sensitive. Note: To make socket installation simpler, it is recommended that you use wire-wrap DIP sockets, elevating them slightly so that the leads can be soldered to the top, as well as the bottom, of the board. Once the sockets are in place, install the passive components (resistors, capacitors, fuse, etc.), followed by the active components (diodes, and non-socketed IC's). Be sure and use heat sinks on both U7 and Q4.

The Battery-Butler may be built with an internal DC power supply, allowing operation directly from the 117-volt AC line, or an external adapter may be used. The circuit, as described, requires 11.5–15.0 volts DC at 250 mA during charging, and less than 80 mA during discharging and when in the ready state.

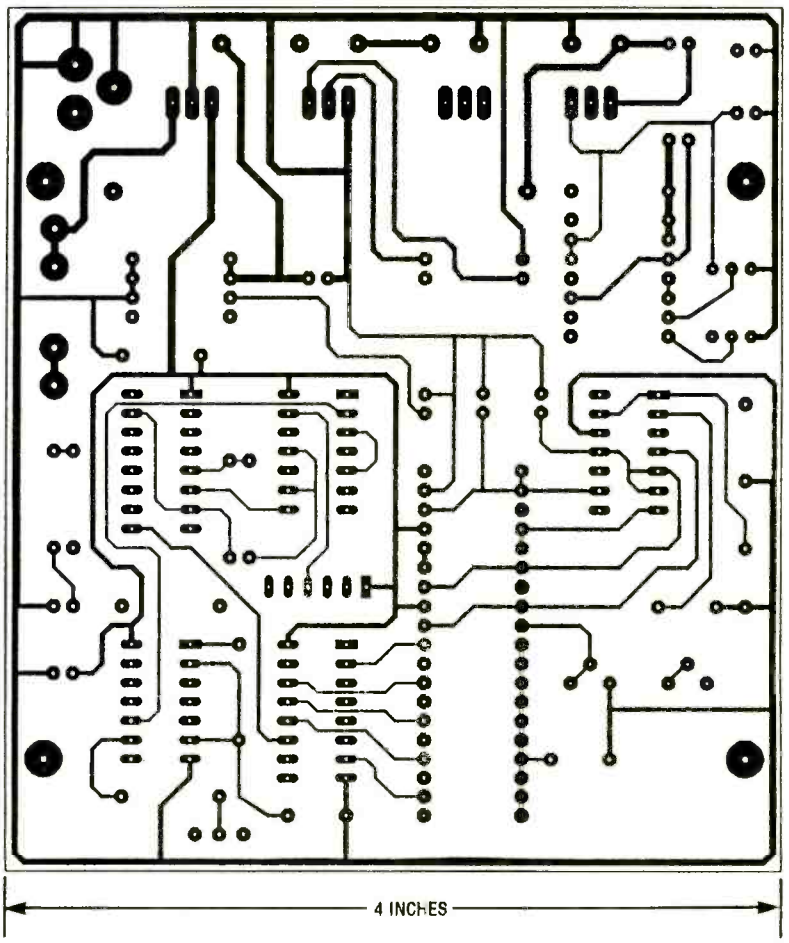
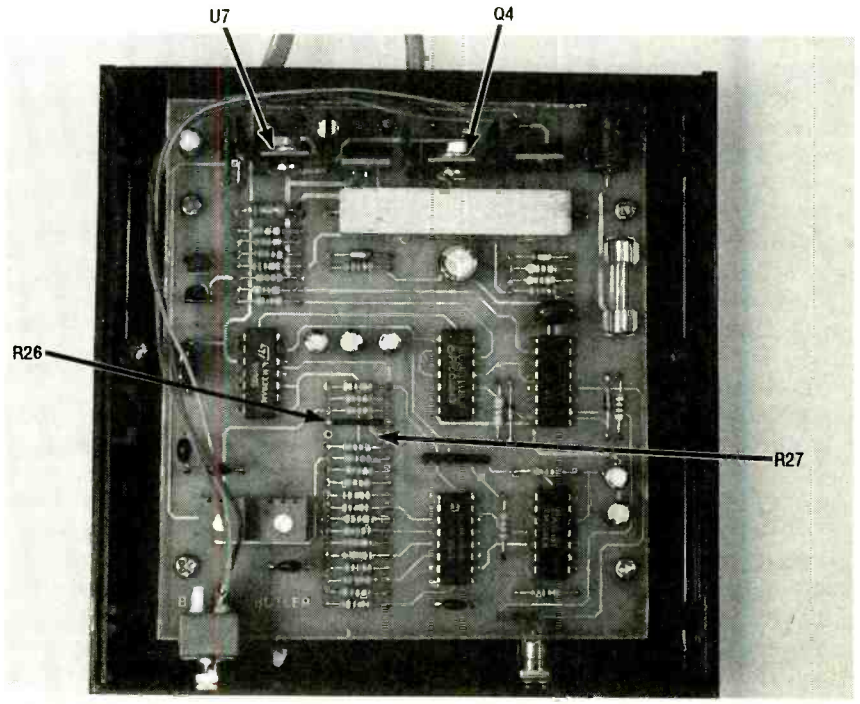


Fig. 2. The author's prototype of the Battery-Butler was assembled on a double-sided, printed-circuit board, measuring about 4 by 4½ inches. The foil pattern for copper side of the board is shown here full-scale.



Note that in the author's prototype, a jumper wire has been place in the R26 position and R27 (just below it) has been omitted. Also note that U7 and Q4 have heat sinks mounted to them.

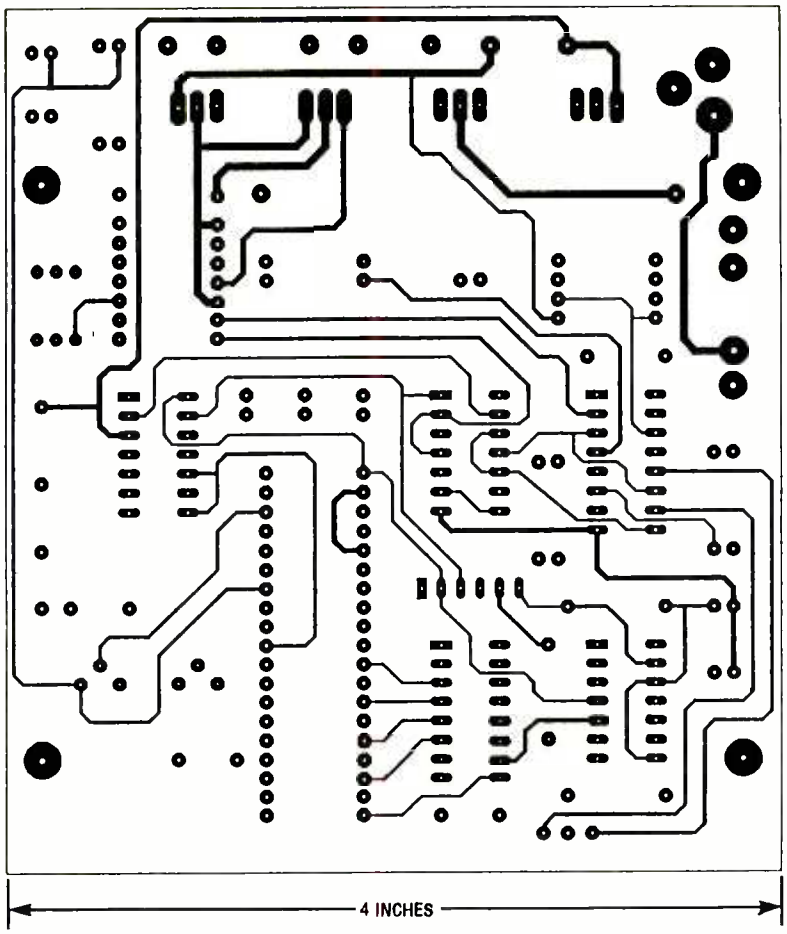


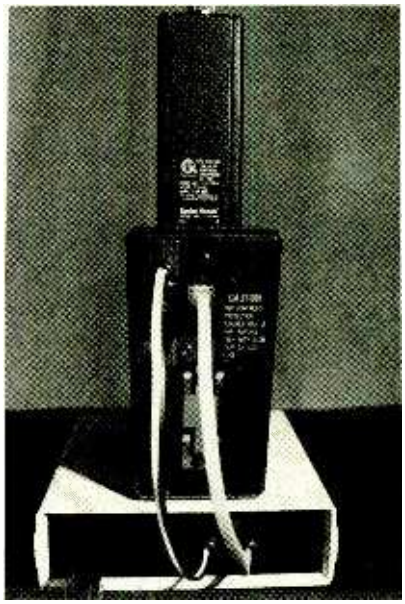
Fig. 3. This full-size template shows the circuit board traces for the components side of the Battery-Butler's double-sided, printed-circuit board. If you decide to etch your own board, be very sure that the two traces are properly aligned before the etching process is begun.

Modifications and Limitations. As described, the circuit has been designed to operate a six-cell—a 7.5-volt DC, 1.2 amp/hr Ni-Cd battery, commonly used in several models of portable cellular telephones. In the unit used by the author, access to the battery is provided through the hands-free interface modular telephone jack on the rear of the charging stand. When using a standard RJ-11 plug and four conductor wire, the red wire is the battery's negative lead, the black lead is the battery's positive lead, and the yellow and green wires are not used.

The charging stand may be used with the 12-volt DC auxiliary output of the Battery-Butler. By connecting that output to a 5.5 mm × 2.1 mm DC power plug (polarized for positive tip) and inserting the plug into the DC power jack on the charging stand, the fast charger can be used normally by placing S1 in the FAST position. Some users have reported good success even with occasional use of the fast charging mode.

The circuit may be adapted for use with any Ni-Cd battery within the range of from 4.8 to 8.8 volts at 500 mA with a capacity of up to 2 amp/hrs. The charge and discharge characteristics can be easily adjusted to suit the battery. The rate of discharge is set by the value of R39. The discharge level is set by the combination of R8–R10. The high-rate charge current is set by R34 and the low-rate charge current is set by R35. The output overvoltage limiter threshold is set by R26 and R27. (Note that in the version for the 7.5-volt DC/1.2-amp/hr battery described in this article, those resistors are replaced by a jumper and an open circuit, respectively; *i.e.*, the overvoltage limiter threshold is equal to 5 volts.)

The infinite range of battery types, voltages, and current ratings make it difficult to address all possible configurations, but by experimenting and



Shown here is the wiring interface between the battery-charging stand and the Battery-Butler.

using simple calculations, the proper setting for those resistance values can be determined.

Table 1 lists modifications to the circuit for various battery voltages and number of cells. For example, for a battery with two cells and a voltage ranging from 2.40 to 2.50 volts, R6 should be replaced by a jumper wire, R7 is not installed, R9 goes from 47k to 12k, R22 is replaced by a jumper wire, R23 goes from 47k to 82k, R26 (which, in the author's configuration, is a jumper wire) becomes 47k, and R27 (which is omitted altogether in the author's unit) is now 68k. In addition, the voltage measured at pin 4 of U5 should be around 1.80 volts, with no more than a 0.06-volt deviation.

The discharge rate can be controlled by changing the value of R39. If the battery's rated full-charge voltage and the desired discharge rate are known, the new value for R39 (in ohms) can be determined using the following formula:

$$R39 = (V_{batt} - 0.7)/I_{discharge}$$

where V_{batt} is the battery voltage, and $I_{discharge}$ is the discharge current in amperes. For example, if V_{batt} is 7.5 volts and $I_{discharge}$ is .68-amps (680 mA), then:

$$R39 = 7.5–.7/.68$$

$$= 6.8/.68 = 10 \text{ ohms}$$

which is the R39 value used in the author's prototype unit.

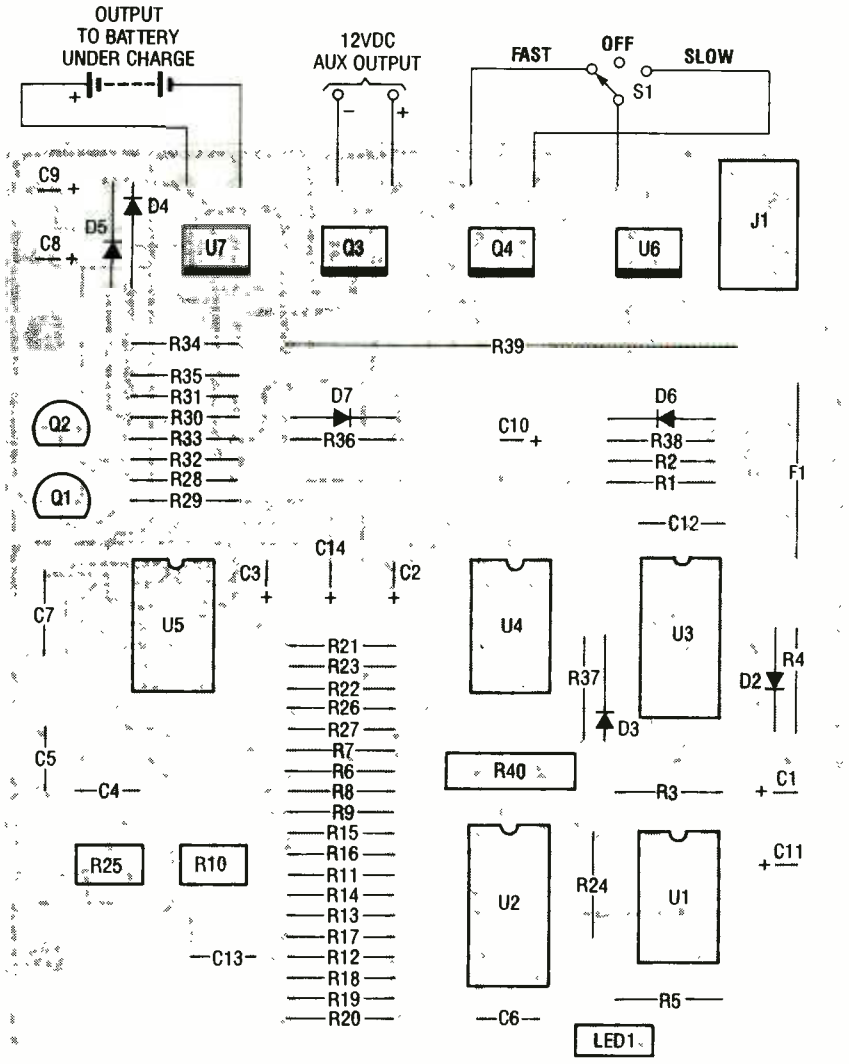


Fig. 4. Assemble the Battery-Butler's printed-circuit board guided by this parts-placement diagram. Note that whether you purchase a board or kit from the supplier listed in the Parts List or etch your own board, it will be necessary to solder the circuit elements to both sides of the board. It is also wise to socket all of the DIP IC's, as some are CMOS devices, and as such are static sensitive.

TABLE 1—RESISTOR VALUE CHANGES AND VOLTAGE ADJUSTMENTS

No. of Cells	Battery (V)	R6	R7	R9	R22	R23	R26	R27	Pin 4 U5 (V)	– dV
2	2.40 – 2.50	JW	NI	12K	JW	82K	47K	68K	1.80	0.06
3	3.60 – 3.75	JW	NI	43K	JW	82K	JW	NI	2.70	0.08
4	4.80 – 5.00	15K	47K	47K	15K	47K	JW	NI	2.70	0.08
5	6.00 – 6.25	33K	47K	47K	33K	47K	JW	NI	2.60	0.08
6	7.20 – 7.50	47K	47K	47K	47K	47K	JW	NI	2.70	0.10
7	8.40 – 8.75	68K	47K	47K	68K	47K	JW	NI	2.60	0.10
8	9.60 – 10.0	82K	47K	47K	82K	47K	JW	NI	2.60	0.10

JW = Jumper Wire NI = Not Installed

To charge seven- and eight-cell (8.40 – 10.0 volt) batteries, the circuit must be supplied from a 16–18-volt DC power source. That voltage must be regulated (via an LM317 or equivalent device). Resistor R34—which normally ranges from 2 to 47 ohms at ½ watt—sets the high-rate charge current. Resistor R35—which normally ranges from 47 to 120 ohms at ¼ watt—sets the low-rate (trickle) charge current.

Testing and Adjustments. Set S1 to the OFF position. Connect the completed circuit to a 12–15-volt DC supply. Measure the voltage at pin 3 of U5. That voltage should be at, or near, 5.0 volts DC. If either of those voltages are not within the specified ranges, remove the DC voltage source and recheck the connections.

Measure the voltage at pin 4 of U5 with a high input-impedance digital voltmeter (DVM). That voltage can be set by adjusting R10. The recommended voltage at pin 4 of U5 can be determined by the following:

$$0.90(V) \times (\text{number of cells})/2$$

For example, if a 6 cell, 7.5-volt Ni-Cd battery is used, the voltage at pin 4 should be adjusted to:

$$0.90 \times 6/2 = 2.70 \text{ volts DC}$$

That adjustment sets the level to which the battery will be discharged. Note that the battery will discharge to twice this present voltage:

$$\text{Battery Discharge Level} = \text{pin 4 of U5} \times 2$$

$$= 2.70 \text{ VDC} \times 2 = 5.40 \text{ VDC}$$

If the Ni-Cd battery is not discharged low enough, the battery will lose its ability to hold a full charge. If the Ni-Cd battery is discharged too low, it is possible that the cells within the battery may reverse and the battery will lose its ability to take a charge.

Connect a fully charged 7.5-volt, 1.2 amp/hr Ni-Cd battery to the proper terminals on the Battery-Butler. Be aware that reversing the battery connection will cause the battery to immediately begin discharging through D7 and R39; that should not damage the Battery-Butler.

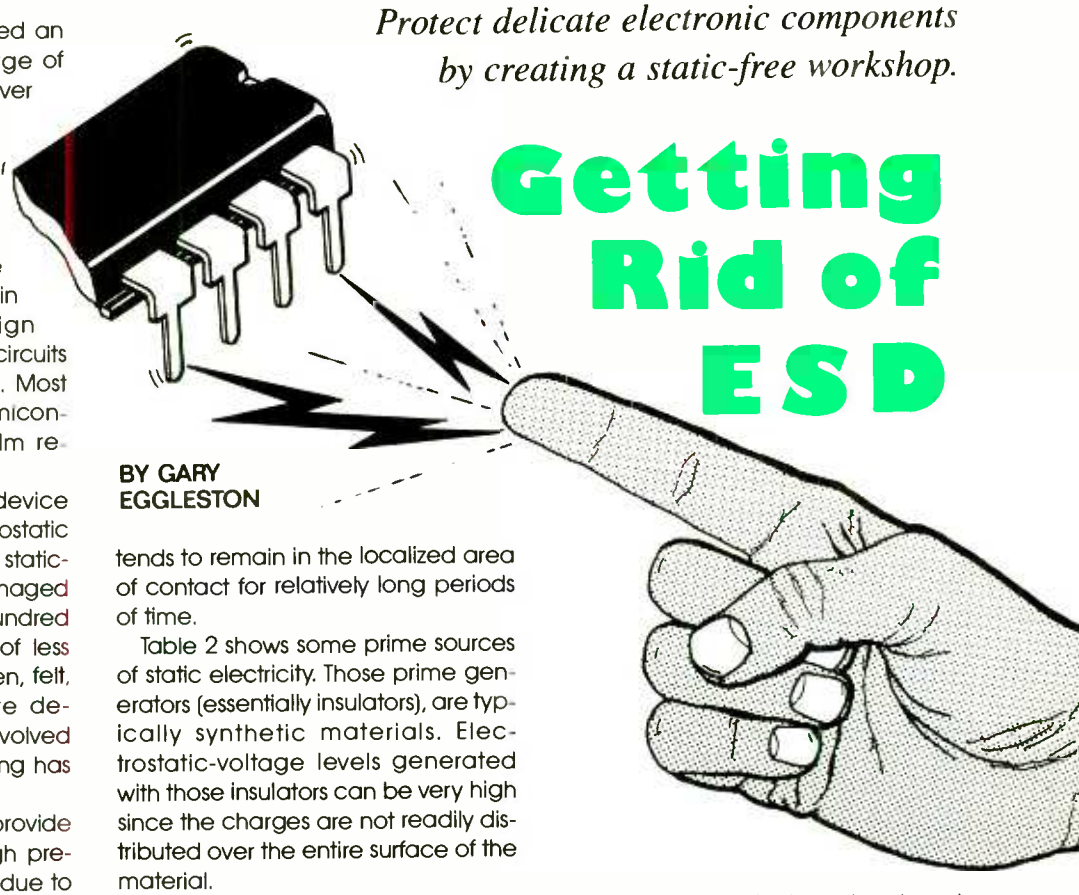
Again using a high input-impedance DVM, measure and record the voltage at pin 5 of U5. Measure the voltage at pin 9 of U5. The recommended voltage at that point can be determined by subtracting 0.10 volt DC from the voltage noted earlier at pin 4 of U5. The proper voltage can be set by adjusting R25.

If the voltage at pin 9 of U5 is within .02 volts, or greater than the voltage at pin 5 of U5, the circuit will return to the ready state too soon, and the Ni-Cd battery will not reach a full charge. Note: If the voltage at pin 9 of U5 is 0.30 volts less than the voltage at

(Continued on page 93)

Protect delicate electronic components by creating a static-free workshop.

Getting Rid of ESD



BY GARY EGGLESTON

We have all experienced an electrostatic discharge of some type. If you've ever walked across a rug, touched a door knob, and received a good jolt then you have been the victim of an electrostatic discharge or ESD.

However, people aren't the only victims of ESD; advances in electronic-component design have provided us with smaller circuits that are also sensitive to ESD. Most ESD-sensitive devices are semiconductors (especially chips), film resistors, or crystals.

Table 1 lists some typical device types that are sensitive to electrostatic discharge. Note that all of the static-sensitive devices can be damaged by ESD levels of only a few hundred volts. Since static discharges of less than 4000 volts cannot be seen, felt, or heard, many devices are destroyed without the person involved even being aware that anything has happened.

The only protection we can provide ESD-sensitive devices is through prevention. Since static builds up due to common device handling, special procedures must be followed when handling such devices. But before we discuss specific ESD-prevention techniques, it would be helpful to review some of the basic principals of static electricity. Let's do that now.

Principles of Static Electricity. A build up of electrical charge is typically produced when two objects are rubbed together or moved in close proximity to each other. Generating static electricity in this manner is called the triboelectric effect. In triboelectric charging, electrons are stripped from one object and added to another. The object that has lost electrons will be positively charged and the other object will be negatively charged. These charges are opposite but equal.

The magnitude of the charge depends on the size, shape, composition, and electrical properties of the two objects. For example, charges on conductors are rapidly distributed over the entire surface of the substance. That keeps conducting materials from developing high levels of electrostatic charge. In the case of non-conductors, any built-up charge tends to remain in the localized area of contact for relatively long periods of time.

Table 2 shows some prime sources of static electricity. Those prime generators (essentially insulators), are typically synthetic materials. Electrostatic-voltage levels generated with those insulators can be very high since the charges are not readily distributed over the entire surface of the material.

In addition to the materials involved, the relative humidity has a major influence over ESD. That is because humidity would tend to help dissipate electrostatic charges. During low-humidity conditions, simple activities or shop practices can generate tremendous electrostatic voltages. For instance, at 20% humidity, simply walking across a carpeted room or sitting on a polyfoam-padded chair can create static voltages of over 20,000 volts.

Types of Failures. ESD can cause total failure of electronic parts, intermittent failures, or erroneous signals. ESD can also cause latent or delayed failures; items partially damaged by an ESD can check out electrically fine on the repair bench, but fail in a project when subjected to wide temperature ranges or mechanical shock. When the damaged component later fails, it is usually written off as a random failure. If the failed component is analyzed in a laboratory, one would probably find that the real cause behind the failure was ESD over-stress.

There are two general failure modes resulting from ESD transients on semiconductor devices: hard and soft. Hard failures are usually immediate, devastating, and permanent. They occur in unmounted integrated circuits, transistors, diodes, and other semiconductor devices. A soft failure is generally latent, delayed, and temporary. It is generally the result of a variable of the device being shifted outside of normal specifications. Soft failures occur only during system operation and in the case of digital circuitry, can usually be cured by re-entering data, re-booting the system, or powering down to clear the glitch. Analog circuitry undergoing a soft failure usually returns to normal automatically.

Creating a Safe Area. All work with ESD-sensitive devices should be done in an "ESD-safe work area." A safe area should consist of a work bench, a personal wrist strap, a conductive floor mat, and tools and equipment all connected to a single-point ground. Let's look at some of those items, one at a time, starting with work benches.

Any work bench you use for the handling of ESD-sensitive items should be grounded. An effective grounding

TABLE 1—SUSCEPTIBLE DEVICES

Device Type	Range of ESD Susceptibility (Volts)
VMOS	30 – 1,800
MOSFET	100 – 200
GaAsFET	100 – 300
JFET	40 – 7,000
SAW	150 – 600
Op-amp	190 – 2,500
CMOS	250 – 3,000
Schottky diodes	300 – 2,500
Film resistors (thick, thin)	300 – 3,000
Bipolar transistors	380 – 7,000
SCR	680 – 1,000

TABLE 2—TYPICAL SOURCES OF STATIC ELECTRICITY

Work Surfaces
Waxed, painted, or varnished surfaces
Common vinyl or plastics

Floors
Sealed concrete
Waxed, finished wood
Common vinyl tile or sheeting

Clothes
Common stocks
Common synthetic personnel garments
Non-conducive shoes
Virgin cotton

Chairs
Finished Wood
Vinyl
Fiberglass

Packaging and Handling
Common plastic bags, wraps, and envelopes
Common bubble pack and foam
Common plastic trays, vials, and parts bins

Assembly/Cleaning/Repair
Spray cleaners
Common plastic solder suckers
Solder irons with ungrounded tips
Cryogenic sprays

method is to cover the work surface with a conductive anti-static sheet or mat, as shown in Fig. 1. The mat will constantly drain any static charges to ground. It should have a grounding cable, a series resistance of at least 250,000 ohms to ground (to protect the wearer by limiting current), and be connected to the common ground of the workshop.

Anyone handling ESD-sensitive devices should wear a conductive wrist strap. The wrist strap should be connected to the table mat at the point where the mat's ground lead is attached, and be long enough to permit the wearer freedom of movement. It should have a quick-release mechanism for emergency situations. It is important that the wrist strap have at least 250,000 ohms of resistance in series to ground.

The work station should have a grounded floor mat. As with the table mat, the floor mat provides a drain of static charge to ground. The floor mat should be equipped with a grounding cable to meet at a common ground point with the table mat. The floor mat should also have a resistance of at least 250,000 ohms in series to ground.

The work station should also be provided with grounded tools and equipment. Soldering irons should be hard grounded and isolated from the power line by a transformer. Other electrical equipment should be grounded, too. ESD-safe solder suckers should be used. The insulated handles of hand tools should be checked for static generation and periodically treated with an antistatic product if required. Such tools should be neutralized by contact with a grounded surface before and during use. This advice should be followed for probe leads, too.

The work area should be equipped with conductive parts trays, tote boxes, and carriers to store or transport ESD sensitive parts. Shorting bars, clips, or special shunts should be used to hold sensitive parts, leads, and hardware. Conductive foam can be used for shorting parts leads during handling.

As a further precaution, an ESD-safe area should be free of static generators. Styrofoam cups, plastic candy wrappers, common plastic bags, plastic equipment covers, and nonconductive tote boxes are all notorious static generators, so keep them away.

Smocks, gloves, or aprons of common plastic, rubber, nylon, or untreated cotton should never be used in an ESD-safe area. However, there is ESD-safe clothing such as smocks, gloves, and aprons that you can wear when performing critical work on static-sensitive components.

As we mentioned earlier, humid air helps to dissipate electrostatic discharges and lessens their generation. Relative humidity between 40% and 60% in ESD-protective areas is desirable as long as it does not accelerate the formation of rust or result in other detrimental effects in electronic assemblies.

In practice, all ESD-sensitive items must be protected from electrostatic fields and ESD with shunts such as bars, clips, conductive foams, or inside of conductive coverings during storage, shipping, and while transporting from parts storage to a grounded work bench. You should neutralize charges on all ESD packaged items by placing the packages on an insulated work surface prior to opening them. The ESD-protective covers and shunts should only be removed immediately before being installed into the circuit for which it is intended. By the way, as common sense would dictate, no power should be applied to an ESD-sensitive device during its placement or removal from a circuit.

This article should give you some idea of the potential harm of electrostatic-discharges and how to prevent them. It is hoped that you will use the information to keep electrostatic discharge from ruining any of your future projects. ■

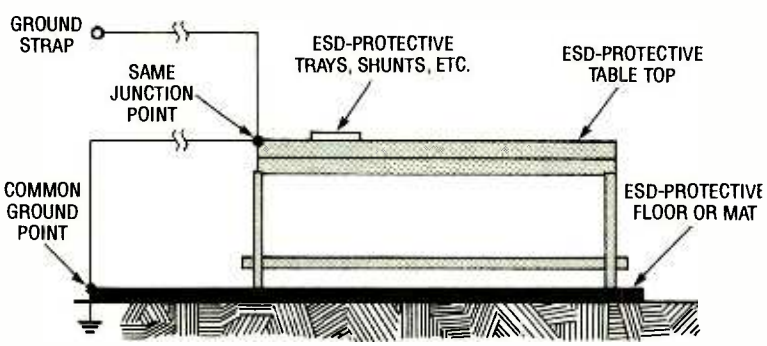


Fig. 1. A properly grounded ESD work bench uses a single ground point for everything except the wrist strap, which should be connected to the bench-top mat.

Build an Ion Detector

BY VINCENT VOLLONO

This simple circuit lets you track down sources of high-voltage leakage, static build-up, and more

Ions are defined as electrically charged atoms. Positively charged ions have a deficiency of electrons, and negatively charged ions have a surplus of electrons. An ion can also be classified as an atom or molecule with an electrostatic charge. Another classification of an ion is a charged particle that is formed when one or more electrons are taken from or added to a previously neutral atom or molecule.

The *Ion Detector* described in this article can be used to detect the presence, and indicate the relative amount, of free ions in the air. The Ion Detector, a handheld unit about the size of a pack of cigarettes, is designed to indicate ion emissions from ion generators, high-voltage leakage points, static-electricity sources, electric-field gradients, and in other situations where the presence of ions or a measurement of their relative flux density is required.

The front cover features, a sensitivity control with on-off switch, a high-flux indicator lamp, and a panel meter. An antenna, mounted on the top of the unit, serves an external ion collector. A strip of metallic foil on the outside of the plastic enclosure touches the users hand and is used to ground the unit. For fixed applications, the strip can be replaced by a wire connected to ground.

Circuit Description. Figure 1 shows a schematic diagram of the Ion Detector—a rather simple circuit consisting of three transistors, (two PN2907 PNP units, and a single PN2222 NPN unit), three resistors, an antenna, and an LED.

In that circuit, a telescoping antenna is used as the pickup. In the presence an ion field, ions accumulate on the antenna, causing a minute negative current to flow to the base of Q1. Capacitor C1 and resistor R1 form an RC network, whose function is to eliminate any rapid fluctuations. Once the negative current becomes large enough, it causes Q1 to turn on, connecting the negative terminal of battery B1 to the base of Q2. That forward biases Q2, causing it to turn on. That, in turn, couples the base of Q3 to the positive terminal of the battery, forward biases Q3—whose collector is in series with current-limiting resistor R2 and meter-sensitivity control R3—causing it to conduct.

With Q3 turned on, meter M1 indicates (in a non-linear manner) the relative level of ion flux, while LED1 (which is connected in series with Q3's emitter) lights to give a visual indication of strong ion fields. It should be noted that in order for the unit to operate properly, some sort of ground is usually required.

Metallic tape is used in the prototype to provide a convenient contact for the users hand, thereby providing a partial ground. If possible, such as when the unit is used as a monitor at a permanent location, the detector should be grounded to a water pipe, or some other convenient grounding point.

The detector is set up to detect negative ions. It can be made to detect positive ions by simply reversing the polarity of the transistors that comprise the circuit; *i.e.*, PNP units become NPN units, and the NPN transistor is replaced by a PNP unit. It should note that the performance of the detector is seriously affected by high humidity. Damp or moist air tends to impair the circuit's ability to detect ion flux.

The Ion Detector can be used to give a quick indication of the presence of a negative ion field, aid in identifying its source, and indicate its relative strength, but it is not designed to provide an absolute measurement of flux intensity. The circuit can also be used to aid in making adjustments to ion sources, by noting the meter's needle deflection as you attempt to increase or decrease ion emissions. The Ion Detector can also be used to ferret out residual ion fields, check for ion leakage (in shielding tests, for example), or to test for static charges (in people's clothes, fluorescent lighting,

The author's prototype of the Ion Detector was housed in a small plastic enclosure, measuring about 4⅜ by 2⅜ by 1⅜6 inches. Note the strip of tape running along the side of the enclosure, which is used to ground the circuit via the user's hand contact. The strip can be supplemented or replaced by a wire connected to the same point in the circuit and terminated at the other end with an alligator clip.

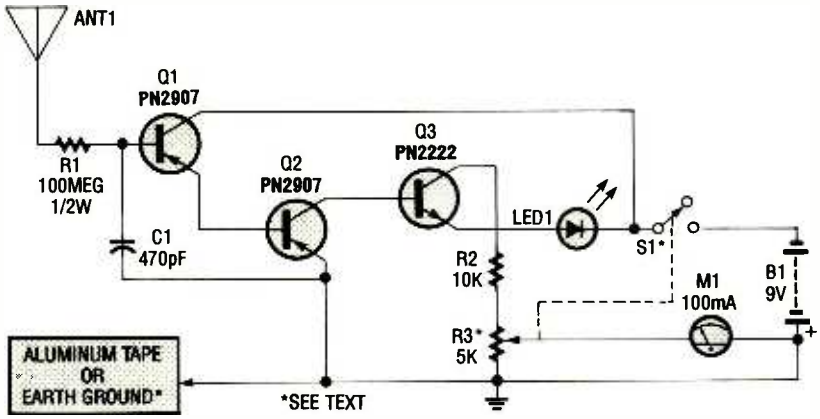


Fig. 1. The Ion Detector is a rather simple circuit consisting of three transistors, (two PN2907 PNP units, and a single PN2222 NPN unit), three resistors, a telescoping antenna (which is used as the ion pickup), and an LED.

PARTS LIST FOR THE ION DETECTOR

Q1, Q2—PN2907 general-purpose PNP silicon transistor
Q3—PN2222 general-purpose NPN silicon transistor
LED1—Light-emitting diode
R1—100-megohm, ½-watt, 5% resistor
R2—10,000-ohm, ¼-watt, 5% resistors
R3—5000-ohm potentiometer (see text)
C1—470-pF, ceramic-disc capacitor
M1—100-mA panel meter
B1—9-volt transistor-radio battery
S1—see text

ADDITIONAL PARTS AND MATERIALS

Perfboard materials, plastic enclosure, 9-volt battery holder and connector, wire, solder, hardware, etc.

plastic containers, certain winds, etc.), along with a host of other applications.

Construction. The author's prototype of the Ion Detector was assembled on a section of perfboard, using point-to-point wiring for inter-component connections. Pay close attention to the orientation of the polarized components (diodes, transistors, electrolytic capacitors, etc.), as well as the polarization of the DC source that will power the circuit, when assembling the circuit. It is very important that you verify all your interconnecting wiring.

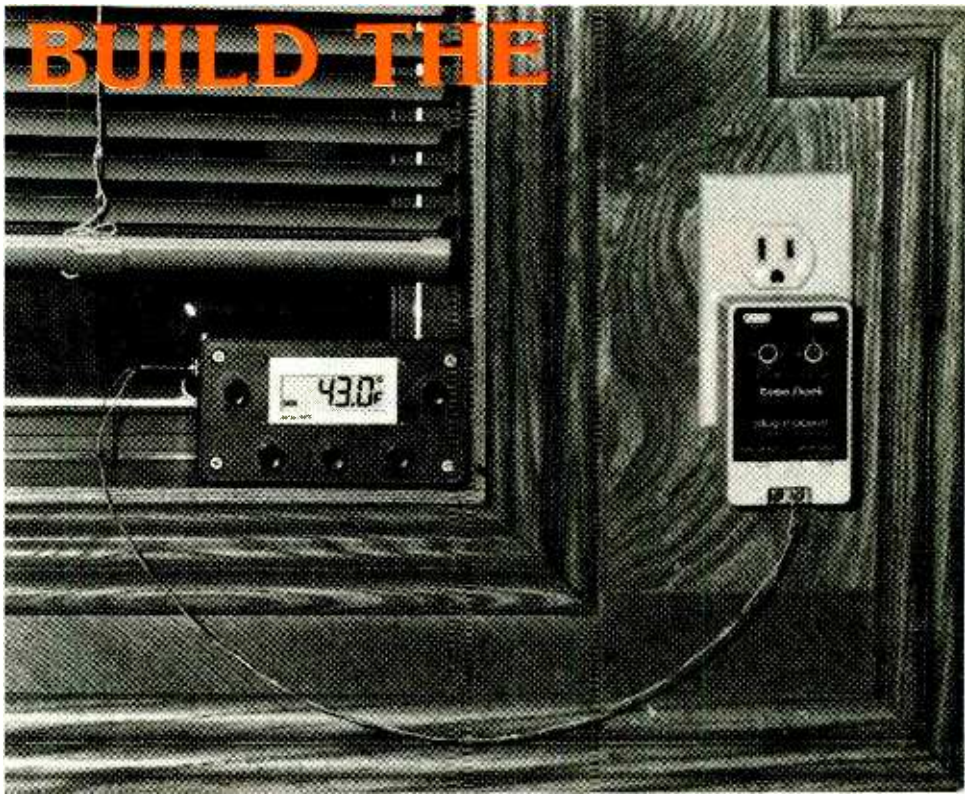
It is highly recommended that the circuit be enclosed in a plastic project box. Once the circuit is completed, a ½-inch wide strip of aluminum is attached to the side of the enclosure, and is then connected to the circuit board (at the junction of C1, the positive lead of the panel meter, and the positive terminal of the battery) as shown in Fig. 1. The aluminum strip serves as the circuit's grounding point. That grounding strip can be replaced or supplemented by a wired alligator clip for connection to a "true" earth ground (a water pipe, for instance).

The author used a telescoping antenna as the ion pickup in his prototype unit; however, a piece of stiff wire (a wire hanger, for example) would also work. In either case, the antenna must be electrically isolated; *i.e.*, it should not be connected to ground in any way. Note that S1 (the on-off switch) is piggy-backed to potentiometer R3 (a 5k potentiometer that serves as a the meter's sensitivity control). You can also use a potentiometer with a piggy-back switch or use two separate components.

For meter M1, the author used a small 100-mA panel meter; using a meter with a rating other than that specified may effect the performance of the unit. It is also important to remember that any leakage around the input of Q1 will reduce the circuit's sensitivity. To help prevent (or at least reduce) leakage, the circuit can be coated with a high-quality varnish. If you decide to coat the circuit, make sure that the unit is completely clean and dry before applying the varnish.

Use. To demonstrate the unit's sensitivity, run a plastic comb through your hair, and place it near the antenna of the Ion Detector. Making sure that the unit is grounded (either by the user touching the aluminum strip or by connecting an earth ground to the circuit), bring the comb near the antenna. As the comb is brought near the antenna, you'll note a needle deflection on the meter (indicating the presence of ions), and LED1 lights. As the detector is brought closer to the ion source, the meter needle should deflect harder. If the needle deflects too hard (pegs), R3 can be adjusted to bring the meter reading on scale.

That's all there is to it. While the Ion Detector is not a precision instrument, it can come in handy in your workshop or laboratory. ■



FREEZE FIGHTER

Keep your outdoor faucets warm in cold weather, and control your air conditioner in the summer.

BY DAVID H. PENROSE

A broken water pipe can be an expensive repair job. The repair leaves you with walls torn apart, floors ripped up, and we haven't even mentioned the water and construction damage to rugs and furniture. In Texas where I live, the number of times during the winter it freezes hard enough to break pipes can be counted on the fingers of one hand. However, only one mishap is enough to cost significant money. Also, since freezing weather is something we Texans normally let the folks up north deal with, most of our houses (and the plumbing in them) are not really designed to withstand the week-long plunges below 20 degrees. For example, I have a few outside faucets that insist on freezing at every opportunity. Putting covers over them works for a short time, but in extended freezes, they freeze-up solid. Letting them drip is often a sure cure, but after a week of dripping, a lot of water is wasted and some mighty respectable ice cones have built up.

While there are many things you can do to winterize your house in general (see the boxed text entitled "A Winter Arsenal") I wanted a solution to this yearly nuisance in particular. The solution had to be simple, reliable, and able to work totally unattended. My solution was to build a circuit called the Freeze Fighter that automatically warms outdoor faucets once the temperature drops to the freezing point.

The Design Process. I wanted to go on vacation, leave the house, and let the system handle any "blue norther" that might blow in. Therefore I needed a device to sense temperature and take appropriate action. Fortunately, National Semiconductor makes an integrated circuit that is designed to sense temperatures and turn devices on or off with changing temperatures. This IC is the LM3911; an 8-pin device containing a voltage reference, a temperature sensor, and an op-amp. With the addition of a few resistors, this IC can be configured into a complete temperature controller that will switch an external load with rising or falling temperatures. Now I had to figure out how to take the on/off signal generated by the controller and use it to keep the faucets warm.

Luckily, very little energy is needed to keep a faucet from freezing. A few watts of power should keep most faucets cheerfully warm. I decided to strap a 50-ohm, 10-watt resistor to the faucet using a hose clamp, and then apply enough voltage to produce about five watts of heat. I determined that a 13-volt, AC-to-AC adaptor, which will result in about 4 watts when terminated in the 50-ohm resistor, would be adequate. A 50-ohm resistor with 13 volts across it is going to pull about 300 milliamps. The adaptor is rated at 800 milliamps so the adapter was chosen with that current rating. I do not recommend using a DC adaptor for any extended period, since in a wet environment, a plating effect could occur which would eventually destroy the connections at the resistor.

The only problem left to solve was how to take the small control voltage available from the controller, and use it to turn the 13-volt supply on and off. The application notes on the LM3911 show a method of controlling a relay or similar device using a transistor switch. This would work fine if there was just a single faucet to protect, but my house has three that are vulnerable to freezing. I didn't want to string wire from one to another and use multiple control relays, nor did I want to produce three copies of the control circuit.

Radio Shack's universal interface for their "Plug'n Power" home controllers provided a solution. The interface will accept almost any kind of signal on its input, and will activate any number of remote modules through the house wiring when the signal is received. Adding a matching remote-controled appliance module or a special wall outlet (both available from the same source) completes the system. Figure 1 illustrates the major components of the system and how they might be used to protect two faucets. Note that both a controled outlet and

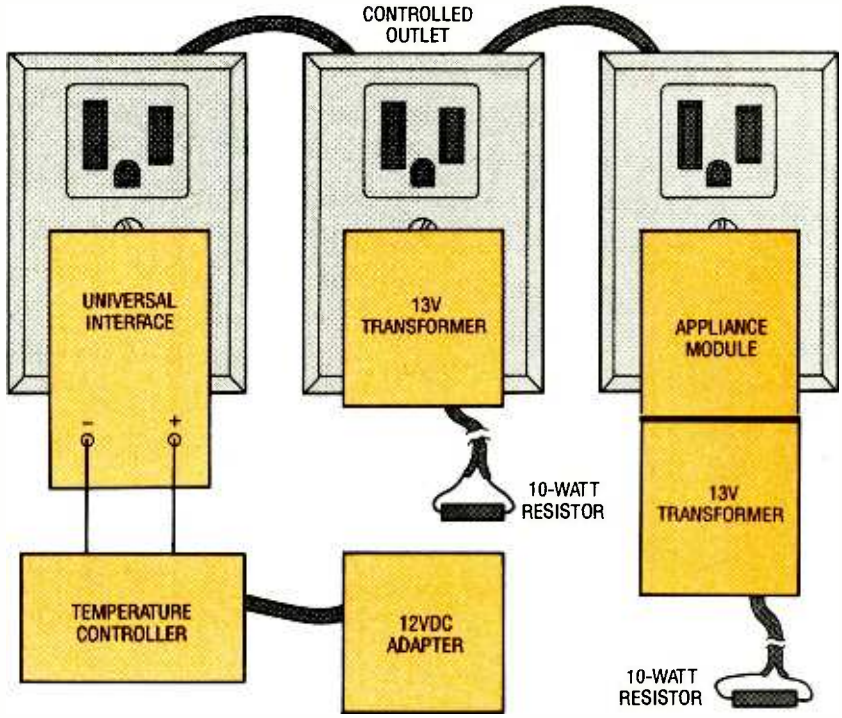


Fig. 1. A few components must be added to the temperature controller to complete the Freeze Fighter. This illustration shows two options for the remote devices: a remote-controled outlet and a plug-in controller.

an appliance module are shown to indicate how both are connected. Before discussing the Freeze Fighter contro! circuit, it would be wise to explain a little about the operation of the LM3911 and the interface modules, so I'll deal with them next.

All-in-One Temperature Controller. As mentioned, the heart of the Freeze Fighter is an LM3911 Temperature Controller IC. As you can see in Fig. 2, this clever IC incorporates a voltage reference, a temperature sensor, and an op-amp all in one 8-pin package. The voltage reference allows this chip to operate over a wide temperature range and also allows the unit work with accuracy over a wide power-supply range. The reference is a 6.8-volt active shunt regulator connected between pins 1 and 4 of the IC. In order to operate properly, this reference must be wired in series with an external current-limiting resistor. The selection of this resistor and the input voltage determines in part how much power is dissipated by the package. The application information on the LM3911 recommends values ranging from 3.5k to 12k depending on the application.

The sensor incorporated in the IC produces an output voltage that is directly proportional to temperature in degrees Kelvin at 10mV/°K. The sensor is powered by the internal reference and feeds the positive input of the on-board op-amp. If the output of this op-amp is tied back to the feedback input on the package, the 10mV/°K will be available for external use.

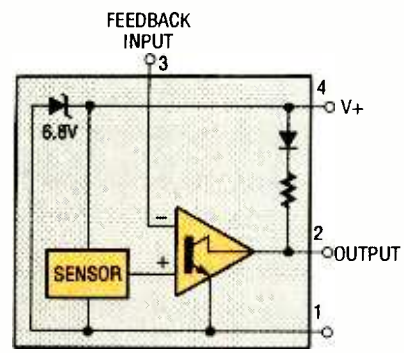


Fig. 2. There are only a few building blocks inside the LM3911: a voltage reference, a sensor, a comparator, and a pull-up network.

The internal op-amp can also be configured as a comparator. This is the mode used for the Freeze Fighter. To use this mode, the feedback input pin is supplied a voltage that corresponds to the desired temperature setting. The internal op-amp then compares this voltage to the voltage being generated by the sensor and switches high or low if the temperature is lower or higher than the set point. The passive output of the op-amp is pulled high by an internal resistor and series diode.

Remote-Control Using House Wiring. The universal interface controller and the remote-controlled outlet or appliance module used in the Freeze Fighter are only a few selections from a wide array of different home-automation devices available from Radio Shack, Heathkit, and other suppliers. The devices all use an interface adhering to the X-10 standard to send control signals over a home's AC-power lines. These devices have existed for a number of years and have gone through a number of refinements to make them more reliable and flexible.

The universal interface controller is a remarkable device in that it allows almost any type of control input to generate command signals to other devices in the house. The controller can accept a switch closure, or a low-level AC or DC signal at its input. It can then turn on one or more devices that match the address set through switches on its faceplate. The control inputs can be momentary or continuous, and the controlled devices can be turned on or flashed.

This device was obviously designed as an interface for alarm circuits, but it is also perfect for computer control. A computer can easily generate the output signals required to control remote devices. Granted, the device can only address devices corresponding to its switch settings, but this is usually not a major limitation. For the purposes of the Freeze Fighter, the Controller works perfectly.

The remote-control devices come in a number of different packages with a variety of functions. The devices recommended in this article are designed to be used to turn an appliance on and off. Other units that are designed for incandescent lights can vary the brightness of the light over a number of steps. These devices are not appropriate for the Freeze Fighter, and can cause the user significant problems if accidentally connected to fluorescent lights or other devices that allow only on/off control.

Little difficulty should be encoun-

tered in using the devices, since most of them just plug in. In some cases, devices plugged into different legs of the house's power line may not be able to communicate with each other. However, some means do exist to correct this problem. One method is to place capacitors across the different legs of the power line at the house's junction box. If you encounter this problem, I would recommend that you search around for outlets that do share a common supply leg, rather than paying an electrician to install the capacitors. I would never recommend attempting to install these capacitors yourself.

Winterizing.

The Freeze Fighter is only one weapon in the war against winter. A homeowner should be prepared with both active and passive defenses against freezing temperatures.

One of the best passive tools is pipe insulation. Sections of foam tubes can be bought that easily wrap around exposed pipes. This wrap helps trap the heat of the water and thus prevent freezing during mild freezes. A properly designed house will have all exposed pipes covered with this tubing or some other form of pipe insulation. Houses designed to withstand the killer freezes of the northern climates will have all the pipes protected within the warm core of the house. Faucet extensions allow the water carrying pipes to be inside the insulated walls while the controls and outlets are on extensions that are accessible from outside the house. An ideal configuration has a separate system for pipes that are in danger of freezing so that this system can be turned off and drained during winter. In milder climates, these precautions are overkill, and most of the time a foam bonnet on the exposed faucets prevents disaster.

Active defense systems consist of the Freeze Fighter described in this article and the electrical heating tape that can be wrapped around pipes. This tape is powered by house current and can be purchased in a number of different lengths, with or without built-in thermostats. This tape is an excellent defensive measure for those houses with exposed pipes that are prone to freezing. This tape should be used in accordance with all the instructions that come with it. Tape which is improperly used can destroy plastic pipes or even cause fires. The tape should not be placed in walls or other enclosed spaces, nor should it be overlapped on itself. Power consumption is minimal—the cost of warming pipes is considerably less than that of replacing them after they break. ■

The Circuit. The LM3911 requires very few external components to implement a full-function temperature controller. Figure 3 illustrates the simplicity of the Freeze Fighter circuit. The resistor network consisting of R1, R2, and R3 is used to provide the set-point voltage for the feedback input of the LM3911.

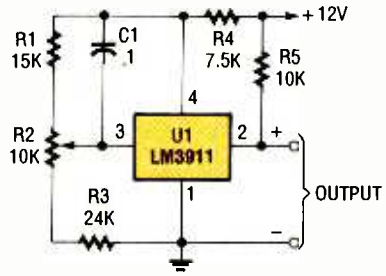


Fig. 3. The LM3911 requires only a few resistors and a capacitor to turn into a full-function temperature controller.

PARTS LIST FOR THE FREEZE FIGHTER

RESISTORS

(All fixed resistors are ¼-watt, 5% units.)

R1—15,000-ohm
R2—10,000-ohm miniature trimmer potentiometer
R3—24,000-ohm
R4—7,500-ohm
R5—10,000-ohm

ADDITIONAL PARTS AND MATERIALS

C1—0.1μF, ceramic or Mylar capacitor
U1—LM3911 temperature controller, integrated circuit (Digi-Key LM3911N)
Universal interface module (Radio Shack 61-2687), a 12-volt DC adaptor, a case with perfboard, jacks and plugs if desired, wire, solder, etc. For each faucet you'll also need a 13-volt, 800-mA power transformer, a 50-ohm, 10-watt resistor, a hose clamp, and an appliance controller (Radio Shack 61-2681 or 61-2684) or remote-controlled outlet (Radio Shack 61-2685).

Resistor R4 limits the current through the internal voltage reference of the LM3911 and can be selected from a wide range of values. I chose 7.5k, which is specified in most of the application notes.

Resistor R5 pulls the output of the IC high when the temperature is below the set-point. The internal 50k resistor probably would have been sufficient for this project, but I included the external 10k resistor just to be safe. The internal resistor is in series with a diode that allows a switching voltage up to 35 volts to be used with the device. For the Freeze Fighter, 12 volts is adequate.

If ultimate reliability is required, dispensing with R2 is a good idea. To do that you should wire the circuit as shown, calibrate R2 with the procedure that follows a little later, remove R1–R3 from the circuit, and install larger values for R1 and R3 to account for the absence of R2 based on the calibration setting of R2.

Capacitor C1 is placed across the wiper of the variable resistor to limit noise that may be present. These few components complete the circuit and provide the interface required by the universal interface module. If the application had required switching a voltage on with a rising temperature, an additional transistor would have been required on pin 2 of the IC to invert the output.

Construction. Any typical method of construction (point-to-point wiring, wire-wraping, or PC-board mounting) is suitable for this project. I chose to use point-to-point wiring on a perfboard that comes with its own plastic case. If you choose to do the same, clean the perfboard well with some steel wool or other cleansing agent to insure that the copper pads are free of all oxidation. I soldered the IC directly to the board rather than using a socket to avoid the potential corrosion problems that may develop when the circuit is used outside over extended periods.

One additional caution when working with this IC: the positive voltage is attached to the bottom leg of the package (pin 4) where most other IC's have the ground attached. The ground on this IC is attached to pin 1 which is the top pin. Confuse these pins and the temperature-controller IC becomes a fuse.

Once you have your own temperature controller mostly built, you must decide on a power source. I powered my circuit from an AC adaptor I had available. If you don't have one in your junkbox, purchase a small 12–15 volt DC unit. The circuit draws very little current, so any adaptor rated at a suitable voltage will do.

I mounted the perfboard in the case with the components facing the plastic rather than the aluminum face plate, and drilled a number of holes in the side of the box to insure that the sensor was exposed to ambient air. Use caution when drilling these holes so as to not drill through the supports for the PC board, which are at the corners of the box. Power is supplied through a DC coaxial jack and the output is terminated in a 2-conductor miniature phone jack. These jacks are not necessary and could be replaced with direct connections. I included them because it makes it easier to string the power and signal connections through small openings.

Calibration. Now it's time for calibration. The relationship between the voltage at pin 3 of U1 and the desired temperature set-point is 10mV/°K. Since absolute zero Kelvin is equal to −273.4°C, a temperature of 0°C will result in an output voltage from the sensor of 2.734 volts. The resistor network values were chosen so that the same amount of voltage is obtained with the wiper of variable resistor R2 near its mid-point, so start by setting R2 to its middle position.

You will be required to check the voltage set by R2 shortly. However, be careful when measuring this value because the IC is not looking for a voltage referenced to ground, but instead is looking at the difference between the voltage at pin 4 and this set-point voltage. That seems simple enough until you fall back on old habits of connecting the black lead of the multimeter to ground and then measuring the voltage at pin 3. It took me a few minutes to realize that the circuit was working properly but that I wasn't.

That said, connect the black probe of your meter to pin 3 and the red probe to pin 4. Apply power and adjust R2. As you adjust the voltage you should find a point at which the circuit just switches on or off. At normal room temperature that should happen at about 2.98 volts, which is 250 millivolts above the zero point of 2.73 volts. The presence of 250 millivolts at 10mV/°K would indicate a room temperature of about 25°C. Now adjust R2 until you get as close as possible to 2.734 volts. This should calibrate the unit for the freezing point.

You can verify the calibration with just a little extra work. First place the sensor in your refrigerator and verify that it does not switch on, move it to your freezer and in a few minutes it should switch on.

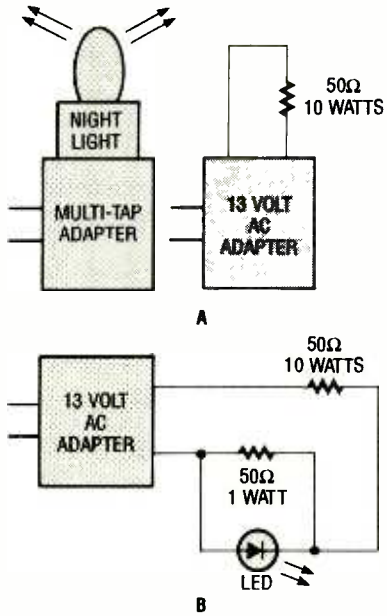


Fig. 4. If you want to monitor the operation of one of the faucet stations you could augment it with a cube adapter and a night light (A), or a resistor and LED (B).

Set Up. On the Plug'n Power interface connect the terminal labeled "+" to the output from pin 2 on the temperature controller. Connect the "−" terminal to the ground connection of the temperature controller. Make sure you have set the mode switches on the interface for an on/off control of the addressed device ("input select" to 1 and "mode select" to 3), then select the house code and unit code settings you wish to use for all the devices. The remote units must be set to the same house and unit codes.

I placed the controller outside near a window and ran the wire between the window and the frame. The seals on my windows allowed this. If this won't work on your window, you'll have to find some other way of exposing the controller to the outdoor temperature. If you must drill through the wall, plug the opening with caulk to keep the bugs out, and put a loop in the portion of wire that is outside to keep the rain from following it in.

Plug a 13-volt transformer into each remote module and run its leads outside as you did for the temperature controller. Use common sense in placing the resistor's transformers (and thus the remote modules); they can get warm when operating and should not have any drapes or flammable material near them. Connect each transformer output to its intended high-wattage resistor and cover the joints with high-temperature tubing. Avoid plastic that could melt at the elevated temperature. Physically attach each 10-watt resistor to its faucet with a hose clamp and you are done.

Improvements. I put foam covers over the faucets and taped a temperature sensor from an electronic thermometer (Radio Shack 63-842) to the faucet to monitor the effect of the heater until I was comfortable with it. You might do the same, and then adjust R2 until the desired effect is achieved. If a you wish to have an operation indicator for each faucet station, you can put a multi-tap adaptor on the remote unit and include a small night light to indicate when the unit is activated (see Fig. 4A). An even more fool-proof device is illustrated in Fig. 4B. There, the current flowing through the load resistor induces a voltage drop in a monitoring resistor. The voltage drop can be used to power an LED. Make sure the wattage of the monitoring resistor is large enough so if the load resistor shorts-out, the full load current will not cause any damage.

Summertime. This same controller with minor modifications can be used in the summertime to help control the air conditioner in your house. To use the controller in that way, rewire it to include an inverting transistor on the output lead. Mount the heating resistor under the air conditioner's thermostat and set the thermostat to a high temperature. Now when the outside temperature exceeds the maximum you program via R2, the heating effect of the resistor will turn on the air conditioner. This will take some careful adjustment of the resistor because eventually you want the air conditioner to turn off.

The Freeze Fighter can be used in many more applications around the home and in the car. Let your imagination work, and see what you can come up with. ■

CMPX-CAL: The Complex Number Calculator Program

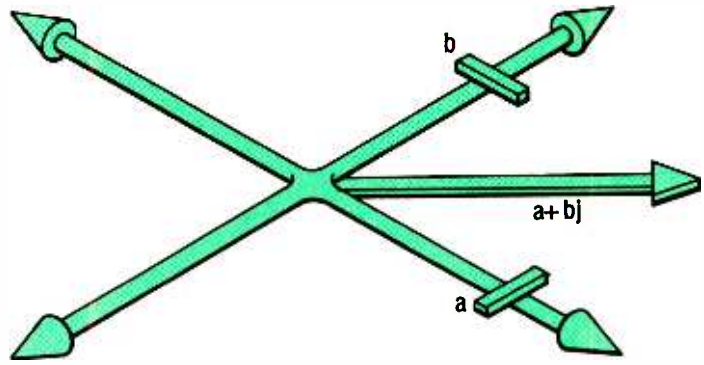
With the aid of complex numbers, AC circuit analysis is nearly as simple as DC analysis. That's because all of the well established mathematical tools used for DC analysis can be carried-over into the world of alternating current if you have a knowledge of complex math (which we'll assume for the rest of this article). That includes the big three: Ohm's Law, Kirchoff's Current Law, and Kirchoff's Voltage Law.

Unfortunately, while the analysis methods may be precisely the same, the calculations are a little more involved. The calculations are not necessarily difficult, just time consuming. This fact becomes more obvious when you consider that complex addition and subtraction must be done in one coordinate system, while multiplication and division are more easily done in another. As much as fifty percent of the calculations required during an AC analysis are performed merely to convert numbers into the proper coordinates for further processing.

A calculator can certainly be helpful, especially if it can handle complex numbers. However, even the most expensive calculators are generally limited to storing a single complex number at a time, so pencil and paper must serve as a "storage medium." A calculator dedicated to operating on complex numbers, with enough storage to eliminate the need to write down intermediate results, would be more helpful.

The complex-number calculator program, CMPX-CAL.BAS, presented in Listing 1, was designed to act as such an aid. It is a BASIC program for IBM-compatible computers that turns a PC into a "four-function-plus calculator" for dealing with complex numbers. Up to five complex numbers can be stored in memory at any one time, eliminating the need to jot down intermediate results. Also, numbers can be entered in either rectangular or polar coordinates and are always displayed in both notations, so no time needs to be wasted on trivial conversions.

As presented in Listing 1, CMPX-CAL will operate on any IBM PC-compatible computer with either the BASICA or GWBASIC programming language. Because the program does not rely on any machine-specific statements, it could easily be converted to any machine that supports an implementation of BASIC.



BY JAMES E. TARCHINSKI

Key-in a program that makes short work of AC-circuit analysis by making complex numbers easy to work with.

Typing-in the Program. Before you can use the Complex Calculator, you must enter it into your computer's memory and then save it to disk for subsequent use. There are several methods of accomplishing this. If you are unfamiliar with the process, however, it is suggested that you follow the method outlined in your DOS or BASIC manual. The process should run something as follows.

First, load the BASIC language into your computer. This can usually be done by executing one of two common commands at the DOS prompt, either "BASICA" or "GWBASIC." If you have a hard drive, one of these files should be present in the DOS sub-directory. If you have only a floppy-disk-based system, one of the two should have been included with the disks that originally came with your computer.

After loading BASIC, an "OK" prompt should appear on the screen. At this point, enter CMPX-CAL into your computer's memory by typing it in exactly as it is presented in Listing 1. You may want to use the LLIST command to copy your version of the program to the printer, allowing you to check for those inevitable typos.

Finally, when you've finished entering the program, save it to either your hard-disk or a preformatted floppy disk with the command:

SAVE "CMPX-CAL"

Screen Layout. When you type the RUN command in BASIC, the program will begin execution and should display the screen shown in Fig. 1. Note

that the screen is divided into three distinct sections.

The left side of CMPX-CAL's screen is the output display area; it shows the results of all data entries and operations. The letters A through E listed in this area signify the five memory storage locations utilized by the program. The complex number at each location is displayed in both rectangular and polar coordinates. For example, if the complex number 12 – j12 (or, equivalently, 16.97056 at –45°) were stored in memory location A, the program would display:

A: REL: 12 IMG: -12
MAG: 16.97056 ANG: -45

The lower section of the screen is the user-input section. In that area of the screen, you will be prompted to enter all data and commands for the program.

Finally, the right side of the program's screen is the command reference section. That area is essentially a permanent help screen, summarizing all of the program's available commands.

Using the Calculator. The best way to learn to use any new computer program is to dive right in and try it out on a real-world problem. In this case, we'll solve for voltage V2 in the circuit show in Fig. 2. This exercise will serve not only as an example of how to use the CMPX-CAL program, but also as a review of how complex numbers are used in AC analysis.

Because of the circuit's simplicity, V2 can be calculated by repeated application of Ohm's Law. First, we'll calculate the total impedance of the circuit by starting with the impedance of R2, and then adding in the effects of C1, L1, and finally R1. Once the total impedance is known, the current I1 will be calculated by dividing the total impedance into the value of the supply voltage. Finally, the voltage V2 will be calculated by multiplying I1 by the combined impedance of C1, R2, and, of course, L1.

Run the program and begin by entering an "A" at the "Command:" prompt; doing that informs CMPX-CAL that we want to enter a value into memory location A. The program then prompts us to enter the real and imaginary parts of the complex number (in this case, the 20 + j0 impedance of resistor R2):

Command: A
Enter the value of A.
Real part: 20
Imaginary part: 0

It then up-dates the results section of the screen as follows:

A: REL: 20 IMG: 0
MAG: 20 ANG: 0

Next we need to enter the value of capacitor C1 into another memory location. We need to do this because CMPX-CAL can only perform mathematical operations on the numbers currently stored in its memory. For example, you can't tell the program to add –6 – j11 to the value stored in memory location E. That may seem rather limiting, but as you work with the

LISTING 1

```
1000 '****************** COMPLEX CALCULATOR PROGRAM ********************
1010 '************** (C) 1990 BY JAMES E. TARCHINSKI ******************
1020 '
1030 WIDTH 80 : SCREEN 0,0,0,0 : COLOR 11 : KEY OFF
1040 CLS : CLEAR : COLOR 11 : DIM R(5,1) : PI=3.141593
1050 J1$=STRING$(79,196) : SP$=STRING$(14,32)
1060 PRINT J1$
1070 LOCATE 2,22 : COLOR 14 : PRINT "C O M P L E X   C A L C U L A T O R"
1080 LOCATE 3,25 : PRINT "(c) 1990 by James Tarchinski"
1090 COLOR 11
1100 PRINT J1$
1110 PRINT "                                                          |"
1120 PRINT "A: REL:              IMG:                 |  OPERATIONS: (Format: E=A*B)"
1130 PRINT "   MAG:              ANG:                 |    +  Add"
1140 PRINT "                                          |    -  Subtract"
1150 PRINT "B: REL:              IMG:                 |    *  Multiply
1160 PRINT "   MAG:              ANG:                 |    /  Divide
1170 PRINT "                                          |    #  Calculate the equivalent"
1180 PRINT "C: REL:              IMG:                 |       parallel impedance"
1190 PRINT "   MAG:              ANG:                 |"
1200 PRINT "                                          |"
1210 PRINT "D: REL:              IMG:                 |  COMMANDS:"
1220 PRINT "   MAG:              ANG:                 |    A    = enter value for A"
1230 PRINT "                                          |    ZA   = zero value A"
1240 PRINT "E: REL:              IMG:                 |    ZERO = set all values to zero"
1250 PRINT "   MAG:              ANG:                 |    QUIT = exit program"
1260 PRINT "                                          |"
1270 PRINT J1$
1280 'PRINT : PRINT : PRINT
1290 LOCATE 24,1:PRINT J1$;
1300 '
1310 '
1320 FOR I=1 TO 5 : GOSUB 2330 : NEXT I : GOTO 1410   'print initial values
1330 '
1340 '
1350 '***** TOP OF MAIN LOOP *****************************
1360 '
1370 GOSUB 2330  'go update alterend number
1380 GOTO 1410     'skip past error beep
1390 '
1400 BEEP    'jump here after an error, then continue
1410 LOCATE 22,1 : PRINT STRING$(158,32) 'clear command lines
1420 COLOR 15 : LOCATE 22,1 : INPUT "Command: ",CD$
1430 IF CD$="" THEN 1400
1440 '
1450 '
1460 '***** CLEAN UP CD$ **********************************
1470 '
1480 J1$=""
1490 FOR I=1 TO LEN(CD$)
1500   J2$=MID$(CD$,I,1)
1510   IF J2$=" " THEN 1540                          'remove spaces
1520   IF ASC(J2$) >= 97 THEN J2$=CHR$(ASC(J2$)-32)  'make upper case
1530   J1$=J1$+J2$                                   'add to new cd$
1540 NEXT I
1550 CD$=J1$
1560 '
1570 '
1580 '***** INTERPRET CD$ **********************************
1590 '
1600 IF CD$="QUIT" THEN CLS : SYSTEM
1610 IF CD$="ZERO" THEN GOTO 1040
1620 IF CD$="A" THEN I=1 : GOTO 2120
1630 IF CD$="B" THEN I=2 : GOTO 2120
1640 IF CD$="C" THEN I=3 : GOTO 2120
1650 IF CD$="D" THEN I=4 : GOTO 2120
1660 IF CD$="E" THEN I=5 : GOTO 2120
1670 IF CD$="ZA" THEN R(1,0)=0 : R(1,1)=0 : I=1 : GOTO 1370
1680 IF CD$="ZB" THEN R(2,0)=0 : R(2,1)=0 : I=2 : GOTO 1370
1690 IF CD$="ZC" THEN R(3,0)=0 : R(3,1)=0 : I=3 : GOTO 1370
1700 IF CD$="ZD" THEN R(4,0)=0 : R(4,1)=0 : I=4 : GOTO 1370
1710 IF CD$="ZE" THEN R(5,0)=0 : R(5,1)=0 : I=5 : GOTO 1370
1720 '
1730 IF LEN(CD$)<3 OR MID$(CD$,2,1)<>"=" THEN 1400
```

LISTING 1 (cont.)

```
1740 '
1750 I=ASC(LEFT$(CD$,1))-64
1760 J=ASC(MID$(CD$,3,1))-64
1770 IF I<1 OR I>5 OR J<1 OR J>5 OR J=I THEN 1400
1780 '
1790 IF LEN(CD$)>3 THEN GOTO 1820
1800 R(I,0)=R(J,0) : R(I,1)=R(J,1) : GOTO 1370
1810 '
1820 IF LEN(CD$)<>5 THEN 1400
1830 K=ASC(RIGHT$(CD$,1))-64
1840 F$=MID$(CD$,4,1)
1850 IF K<1 OR K>5 OR K=I THEN 1400
1860 '
1870 IF F$="+" THEN R(I,0)=R(J,0)+R(K,0):R(I,1)=R(J,1)+R(K,1) : GOTO 1370
1880 '
1890 IF F$="-" THEN R(I,0)=R(J,0)-R(K,0):R(I,1)=R(J,1)-R(K,1) : GOTO 1370
1900 '
1910 IF F$<>"*" THEN 1950
1920  R(I,0)=R(J,0)*R(K,0)-R(J,1)*R(K,1)
1930  R(I,1)=R(J,1)*R(K,0)+R(J,0)*R(K,1) : GOTO 1370
1940 '
1950 IF F$<>"/" THEN 2000
1960  M=R(K,0)^2+R(K,1)^2 : IF M=0 THEN GOTO 1400
1970  R(I,0)=(R(J,0)*R(K,0)+R(J,1)*R(K,1))/M
1980  R(I,1)=(R(J,1)*R(K,0)-R(J,0)*R(K,1))/M : GOTO 1370
1990 '
2000 IF F$<>"#" THEN 2090
2010  W=R(J,0)*R(K,0)-R(J,1)*R(K,1)
2020  X=R(J,0)*R(K,1)+R(J,1)*R(K,0)
2030  Y=R(J,0)+R(K,0)
2040  Z=R(J,1)+R(K,1)
2050  M=Y^2+Z^2 : IF M=0 THEN 1400
2060  R(I,0)=(W*Y+X*Z)/M
2070  R(I,1)=(X*Y-W*Z)/M : GOTO 1370
2080 '
2090 GOTO 1400
2100 '
2110 '
2120 '***** ENTER VALUE ROUTINE **************************
2130 '
2140 LOCATE 22,1 : PRINT "Enter the value of ";CHR$(I+64);"."
2150 GOSUB 2260 : INPUT "Real part:      ",RL
2160 GOSUB 2260 : INPUT "Imaginary part: ",IG
2170 IF RL<>0 OR IG<>0 THEN R(I,0)=RL : R(I,1)=IG : GOTO 1370
2180 '
2190 GOSUB 2260 : INPUT "Magnitude:      ",MG
2200 GOSUB 2260 : INPUT "Angle:          ",AG
2210 R(I,0) = MG*COS(AG*PI/180)
2220 R(I,1) = MG*SIN(AG*PI/180)
2230 GOTO 1370
2240 '
2250 '
2260 '***** CLEAR INPUT LINE AND POSITION CURSOR **********
2270 '
2280 LOCATE 23,1 : PRINT STRING$(79,32); : LOCATE 23,1 : RETURN
2290 '
2300 '
2310 '***** UPDATE VALUES ROUTINE ***********************
2320 '
2330 COLOR 10
2340 LOCATE 3*I+3,8  : PRINT SP$
2350 LOCATE 3*I+3,8  : PRINT R(I,0)
2360 LOCATE 3*I+3,27 : PRINT SP$
2370 LOCATE 3*I+3,27 : PRINT R(I,1)
2380 LOCATE 3*I+4,8  : PRINT SP$
2390 LOCATE 3*I+4,8  : PRINT SQR(R(I,0)^2+R(I,1)^2)
2400 LOCATE 3*I+4,27 : PRINT SP$
2410 IF R(I,1)=0 AND R(I,0)>=0 THEN AG=0   : GOTO 2470
2420 IF R(I,0)=0 AND R(I,1)>0  THEN AG=90  : GOTO 2470
2430 IF R(I,1)=0 AND R(I,0)<0  THEN AG=180 : GOTO 2470
2440 IF R(I,0)=0 AND R(I,1)<0  THEN AG=270 : GOTO 2470
2450 AG=(ATN(R(I,1)/R(I,0)))*180/PI
2460 IF R(I,0) < 0 THEN AG = AG + 180
2470 LOCATE 3*I+4,27 : PRINT AG
2480 RETURN
```

program you will see that it's really not. Entering the value of C1 into memory location B would be accomplished by the following sequence:

Command: B
Enter the value of B.
Real part: 0
Imaginary part: −10

Now that both C1 and R2 are stored in memory, we can add them together and place their sum into memory location C. This is accomplished with the command "C = A + B." Note that all of the mathematical operations utilize this same command format, as indicated on the reference side of the computer's screen. The letter before the equal sign indicates the memory storage location where the result will be placed. The two operands for the command are listed on the right of the equal sign, and separated by the symbol of the operation you wish to perform. For our example, the command line would look like the following:

Command: C = A + B

After completing this command, the value of memory location C is updated:

C: REL: 20 IMG: −10
MAG: 22.36068 ANG: −26.56505

but both A and B maintain their values.

Next, we proceed to enter the value of the inductor L1 into memory location D. The fact that L1 is given in polar coordinates will not cause any problems—the program can handle numbers in either system. To enter a number in polar coordinates, simply press the return key when prompted for real and imaginary parts of a number, and the program will assume you wish to enter the number in polar coordinates. It will then prompt you to enter the magnitude and angle of the number to be entered. The sequence would be as follows:

Command: D
Enter the value of D.
Real part:
Imaginary part:
Magnitude: 5
Angle: 90

When the program updates the value of D, it will display:

D: REL: 0 IMG: 5
MAG: 5 ANG: 90

Please note that entering zeros for the real and imaginary parts of a number does not perform the same function as just pressing the Return key. Entering zeros will clear the memory location you are trying to load with a new value.

Now that the impedance of L1 is stored in D, and the combined impedance of R2 and C1 is stored in C, we can calculate their total impedance via the use of the "parallel" operator, which is signified by the # symbol.

Command: A = D # C

As indicated above, the result of this operation will be placed into memory location A, overwriting the previous

```
------------------------------------------------------------
              C O M P L E X   C A L C U L A T O R
                  (c) 1990 by James Tarchinski
------------------------------------------------------------

A: REL: 0          IMG: 0          OPERATIONS:(Format: E=A*B)
   MAG: 0          ANG: 0            +       Add
                                     -       Subtract
B: REL: 0          IMG: 0            *       Multiply
   MAG: 0          ANG: 0            /       Divide
                                     #       Calculate the equivalent
C: REL: 0          IMG: 0                    parallel impedance
   MAG: 0          ANG: 0

D: REL: 0          IMG: 0          COMMANDS:
   MAG: 0          ANG: 0            A     = enter value for A
                                     ZA    = zero value A
E: REL: 0          IMG: 0            ZERO  = set all values to zero
   MAG: 0          ANG: 0            QUIT  = exit program
------------------------------------------------------------
Command:
------------------------------------------------------------
```

Fig. 1. The friendly screen for the Complex Calculator program looks like this. The section on the right gives you help at a glance.

value held there, so the display for A changes to:

A: REL: 1.176477 IMG: 5.294118
MAG: 5.423261 ANG: 77.47118

Hence, the combined impedance of R2, C1, and L1 is found to be 1.176477 + 5.294118 ohms.

We now proceed by entering the impedance of R1:

Command: B
Enter the value of B.
Real part: 15
Imaginary part: 0

So the display of B becomes:

B: REL: 15 IMG: 0
MAG: 15 ANG: 0

Now we calculate the total impedance of the circuit:

Command: C = A + B

which yields:

C: REL: 16.17647 IMG: 5.294118
MAG: 17.02075 ANG: 18.12186

and then entering the total supply voltage of the circuit:

Command: D
Enter the value of D.
Real part:
Imaginary part:
Magnitude: 100
Angle: 20

changes the display of D to:

D: REL: 93.96927 IMG: 34.20202
MAG: 100 ANG: 20

To calculate the current I1, we divide the total circuit voltage (stored in memory location D) by the aggregate impedance (stored in memory location C):

Command: E = D/C

The result is placed in memory location E:

E: REL: 5.872027 IMG: .1925526
MAG: 5.875183 ANG: 1.878141

Finally, the voltage V2 is calculated by multiplying the current I1 (location E) by the combined impedance of R2, C1, and L1, which is still stored in memory location A.

Command: B = E*A

which returns the result:

B: REL: 5.888871 IMG: 31.31373
MAG: 31.86265 ANG: 79.34934

From this we can see that the voltage

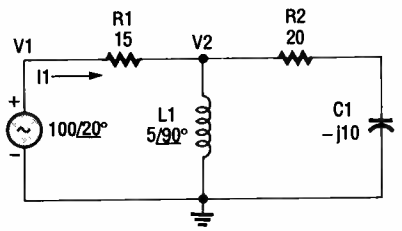


Fig. 2. This is an example circuit for testing your version of the Complex Calculator and for demonstrating how the program is used.

V2 is equal to 5.888871 + 31.31373 volts, or, in more explicit notation:

$V2 = 31.86265 \sin(\omega t + 79.34934°)$

Note that the value of V2 was calculated without the need to write down intermediate results and without having to manually transform complex numbers from one coordinate system to another.

Other Commands for CMPX-CAL. In the above example, the majority of the program's commands were described and demonstrated. Before we finish up, let's explore the few commands and operations not previously discussed.

First, let's look at the subtraction operation, which would look like:

E = C − B

As you would expect, with this operation the value of one memory location is subtracted from the value of another. The result is placed in the location specified before the equal sign.

The ZA command instructs the program to set memory location A to a value of zero. Any of the five locations can be cleared via a similar command (*i.e.*, ZB, ZC, ZD, ZE).

Similarly, the ZERO command clears all five memory locations at once. Finally, as you would expect, the QUIT command allows you to exit the program and return to your computer's operating system.

A couple of additional comments should be made about entering commands into the Complex Calculator. First, it is possible to list the same memory storage location twice on the right side of the equal sign. For example, the command:

B = A*A

will multiply the value in A by itself (*i.e.*, square it) and places the result in location B, overwriting any previous value in B. You can not, however, use the memory location that is specified on the left of the equal sign again on the right-hand side—if you attempt to do that, the program will generate an error beep.

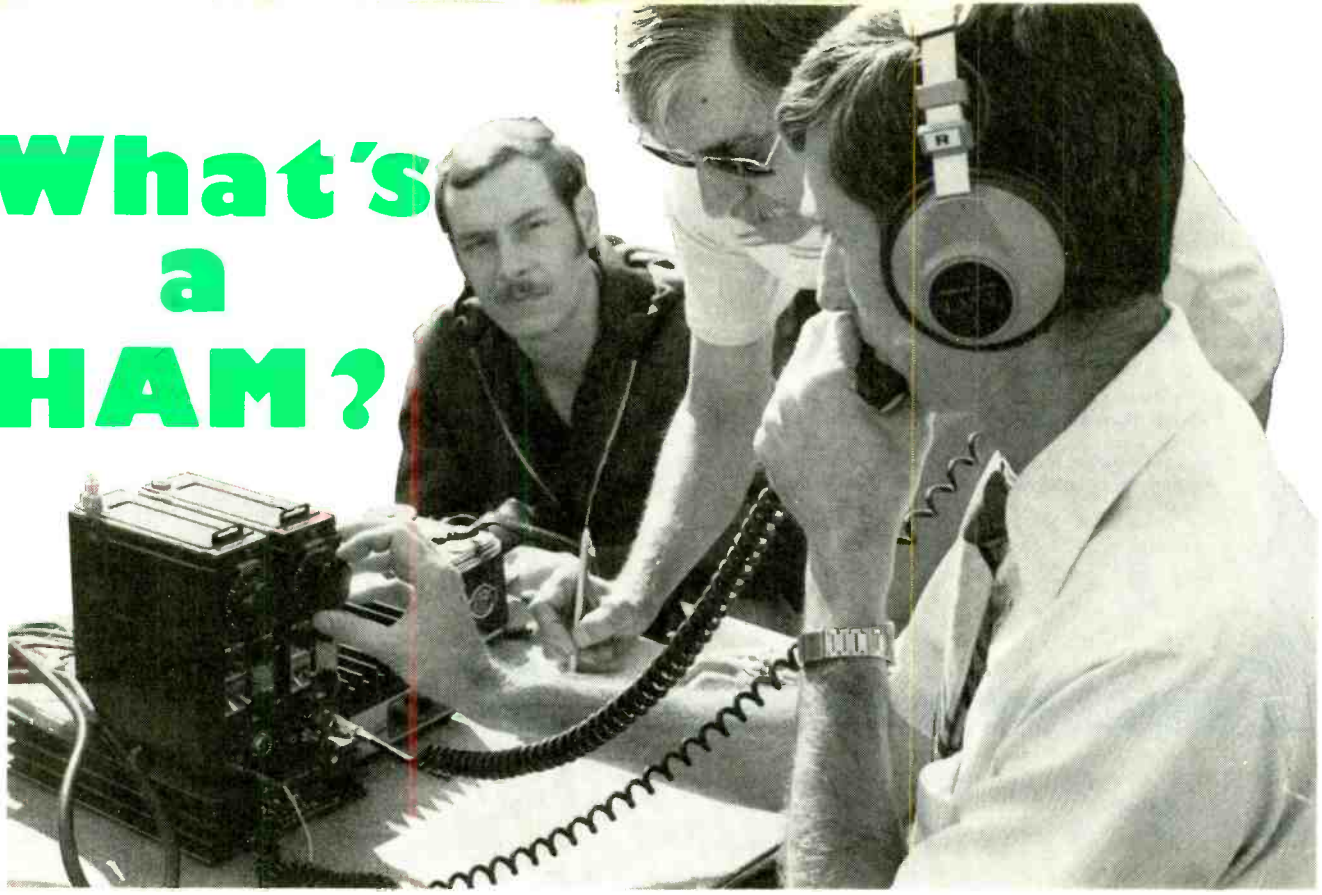
Also, if you want to copy a value from one memory location to another, you can do so with the command format:

A = B

That command will copy the contents of memory location B into location A, overwriting the previous value stored in location A.

That just about does it. The Complex Calculator program should help you turn mountains of calculatons into mole hills. I'm sure that with just a little practice you can easily use it to tackle even the toughest jobs. ■

What's a HAM?



We take an inquisitive look at the origins of the term "Ham" and other interesting facts about the king of hobbies.

BY KARL T. THURBER, JR., W8FX

Have you ever wondered why radio amateurs are known as "hams?" A few years ago, my wife ("XYL," or ex-Young Lady in ham-radio parlance) went shopping in downtown Atlanta while I attended the Atlanta HamFestival, a major annual amateur-radio convention. She happened to be wearing the HamFestival admission button, and several shoppers stopped her to inquire about the event. Many passersby thought that a hamfest meant that a pork connoisseur's taste-fest or a pig farmer's confab was in town!

Today, even with some 600,000 licensed amateurs in the United States (out of more than 2 million hams worldwide, including 1 million in Japan alone) relatively few really know what being a ham is about—even though many well-known personalities are radio hams. Check out this list of famous hams from the past and present:

- Senator Barry Goldwater, K7UGA
- King Hussein of Jordan, JY1
- Entertainer Ronnie Milsap, WB4KCG
- Astronaut Dick Rutan, KB6LQS
- Entertainer Donnie Osmond, ex-KA7EVD
- Guitarist Chet Atkins, WA4CZD
- Actor Marlon Brando, FO0GJ
- Entertainer Arthur Godfrey, K4LIB
- Astronaut Owen Garriott, W5LFL
- Broadcast Newsman Walter Cronkite, KB2GSD
- Entertainer Alvino Rey, W6UK
- Air Force General Curtis Le May, W6EZV
- Air Force General Francis "Butch" Griswold, K0DWC
- Broadcast Newsman Roy Neal, K6DUE
- Presidential offspring and former ARRL President Herbert Hoover, Jr., W6ZH

Even with such an impressive list of activists, few know what it means to be a ham. Fewer still know where the term "ham" comes from, are aware of the hobby's traditions and culture, understand its very distinctive lingo, or know how to become a ham. In this article, we'll try to rectify that lack of information.

A Little Background. Amateur radio deals with communicating; amateurs operate personal two-way radio equipment from their homes and cars to communicate. Hams—who participate in what is sometimes called the "king of hobbies"—are properly called radio amateurs.

As a service, the Federal Communications Commission (FCC) regulates amateur-communication practices, and a license from them is required to operate ham equipment in the United States. The service provides an opportunity for training, intercommunication, and technical investigation for qualified people interested in using radio for non-profit goals. Amateurs may design, build, modify, and repair their own equipment, but are responsible for the quality of their transmissions. The amateur rules are found in Part 97, Title 47, of the Code of Federal Regulations.

Internationally, 27 frequency bands are allocated to the amateur service; unlike broadcasting stations, no specific frequencies are assigned. That flexibility makes it possible for amateurs to communicate with all areas of the world, even through satellites orbiting the Earth. Amateurs worldwide can exchange messages by voice, telegraphy (Morse code), television,

The Royal Order of the Wouff Hong

To All Who Shall See These Presents:

Greeting!

The Royal Order of the Wouff Hong, in solemn conclave assembled, makes known by this Certificate that the esteemed Radio Amateur, KARL THURBER W8FX is a member of the Order in good standing, and is entitled to all the rights and privileges of membership, and the high regard of fellow amateurs.

Conferred at the Midnight Conclave of the Order, National Convention, American Radio Relay League, Held at Baton Rouge, La. July 27 19 79

The Old Man.

For The Brethren

Scribe

Amateurs paper the walls of their hamshacks with Wouff Hong certificates, along with their operating awards, other certificates, and rare confirmation (QSL) cards. Note the facsimile signature on the author's certificate: that of "The Old Man."

radioteletype (RTTY), radio facsimile (FAX), and sophisticated digital modes of operation such as packet-radio transmission.

It's A Matter of Terminology. It's intriguing that radio amateurs call themselves "hams," but rarely give any thought to the word's origin. Just where does it come from? Are hams virtuoso pork tasters, folks who live high off the hog, overacting actors and actresses, nonprofessional dabblers, or what? Unfortunately, history is sufficiently murky to prevent us from precisely tracing the word's origin, but we can at least give some clue as to its historical usage in amateur radio. Let's look at three possibilities.

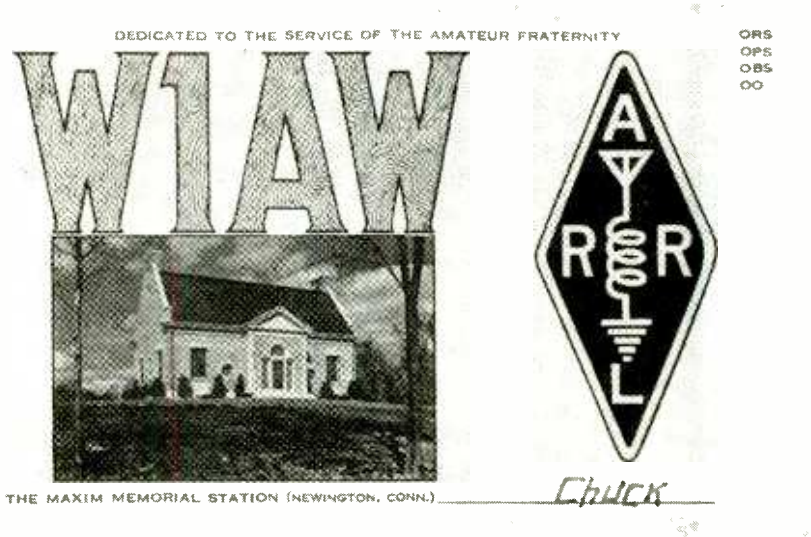
To start with, Bill Johnston, who operates amateur station WB5CBC, writing in November 1976 *QST* noted that in the 1800's, "ham" was slang used by railroad telegraphers to describe inexperienced telegraph operators. The word also has an equestrian meaning, and was used interchangeably with "plug," meaning green or second best, in referring to horses.

The definition of a ham as a poor operator probably first appeared in print in G. M. Dodge's classic book, *The Telegraph Instructor*, in 1898. The uncomplimentary term carried over to the early spark era when radio amateurs haphazardly competed with commercial stations for supremacy on a given wavelength. Amateurs were notorious for blotting out commercial signals and bringing on complaints such as "those blankety-blank hams are jamming you." That was especially true before Congress and the Department of Commerce, which regulated early radio law, relegated amateurs to operating below 200 meters (1500 kHz). Radio amateurs, who perhaps were unfamiliar with the true, uncomplimentary meaning of the term, picked it up and applied it to themselves anyway.

Dennis Burgoyne, KE8EY, in a letter to the editor of *CompuServe Magazine* in the December 1990 issue, suggested an acronym-based origin. It seems that a popular early-1900's magazine called *Home Amateur Mechanic* featured articles on do-it-yourself projects. In one issue, an article described the newfangled radio, a device that you could build at home that might enable you to converse with other owners. The home-built radio came to be referred to as the "Home Amateur Mechanic Radio," or HAM radio for short. People who built and used radios thus came to be known colloquially as HAM-radio operators. This explanation of the term's origin has the advantage of simplicity, and the acronym certainly makes sense.

As a third possibility, the word or acronym was used as the callsign of one of the first amateur wireless stations, operated in 1908 by the Harvard Radio Club. The members were Albert Hyman, Bob Almy, and Peggy Murray. At first, they called their station "Hyman-Almy-Murray." Tapping out the name in code was tedious, so they contracted it to Hy-Al-Mu, or HYALMU, using the first two letters of each name.

Things went well until 1909, when confusion resulted between their callsign and signals from the Mexican ship, Myalmo. So they decided to use only the first letter of each name,



After his death in 1936, the ARRL was able to persuade the FCC to award Maxim's callsign, W1AW, to its headquarters station, which previously was W1MK. Shown here is a W1AW QSL card confirming contact with the author in October, 1957.

Hamfests—amateur-radio oriented conventions—are immensely popular, especially during the spring and summer months. The core activity of most hamfests is the swap-meet area where amateurs buy, sell, and swap old and new equipment and parts.

identifying their station as HAM. That was fine, since in the unregulated, pioneering days of wireless, amateur-radio operators picked their own call letters and operating wavelengths.

There's more to this story, though, and supposedly it's all found in the Congressional Record. The resulting interference between amateur and commercial stations generated disputes similar to the range wars of the Wild West. The thorny interference situation came to the attention of Congress, which considered legislation to limit pesky radio-amateur activity. In 1911, Albert Hyman (of station HAM) chose the controversial Wireless Regulations Bill as a topic of a thesis at Harvard. An instructor insisted that he send a copy of the thesis to Senator David Walsh, a member of the committee hearing the bill. Walsh was impressed, and he sent for Hyman to appear before the committee.

Hyman described how the Harvard station, HAM, was built, and he decried the fact that if the bill were placed into law, the operators would have to close up the little station because they could not afford the license fees or meet other requirements contained in the bill. The debate began, and station HAM became a rallying symbol of the country's small amateur stations who hoped to be saved from the "menace" of the big commercial stations that didn't want meddlesome amateurs around to foul the valuable airwaves. When the bill reached the

Amateurs expend great quantities of time and money to propagate their signals louder, stronger, and farther. What would an amateur's mobile travel trailer be without one—or, better yet, several—large and ungainly (but efficient) antennas adorning it?

floor of Congress, each speaker talked about the "poor little amateur station, HAM." National publicity identified station HAM with radio amateurs.

I lean toward possibility number 3, but I'm not at all sure that we've solved this longtime mystery; undoubtedly, there are other hypotheses. But these three theories about the origin of the word surely are fascinating to recount, if nothing else.

Hams and Their Lingo. Just as interesting as the origin of the term "ham" is hams' own lingo. Just about every profession, and most hobbies, has its own distinctive and sometimes impenetrable jargon. Amateur radio is no exception: there is no end to the number of unique buzzwords and other terms used in "ham-speak." Let's unscramble some of this lingo.

The popular general call or attention signal made by amateurs, CQ, originated with the 19th century English telegraph system. Its classic meaning was "All stations" and it acted as a notification to all postal telegraph offices to receive a message. The term carried over into wireless and was used as a general call to all ships, being adopted by the London Convention of 1912 as the international general call or attention signal. Today, CQ means that I'm inviting anyone who hears me to reply. (CQ, by the way, also is the name of two amateur-radio magazines, one in Japan and one in the US).

As CQ begins a radio contact, the legendary 73 "ties the ribbons on" or ends it. Even if you're not an amateur, you've probably heard of the warm, fraternal term 73. It was, and still is, a popular, all-purpose amateur salutation. It's also the source of the CB (citizens band) "three's on you" idiomatic way of saying goodbye.

The term 73 is traceable to 19th-century railroad telegraphy usage, going as far back as 1857 when it was described in *The National Telegraph Review* as meaning "my love to you." It was one of the many "numerical wire signals" used in those days, and it eventually came to mean "best regards." Interestingly, there now is a popular ham magazine known as *73 Amateur Radio Today*. Also, a variation on 73 is the "88" signal, which harkens closely to the 1857 telegraph definition of 73. The term means "love and kisses."

Prosigns and Prowords. Prosigns are special telegraphic expression and procedure symbols, such as AA (separating parts of a message address), AR (over), AS (stand by), SK (end of transmission), and K (go ahead). They have been word-saving shortcuts since the earliest days of commercial wireless, and they may even have been used in railroad telegraphy as well.

VEC Groups

There are about 18 volunteer examiner coordinator groups authorized by the Federal Communications Commission, although some of these groups are small and offer only infrequent examination opportunities. The two main VEC groups operating nationally are the ARRL/VEC and the W5YI-VEC, both listed below. (Note: Some telephone numbers were not available at the time this article was prepared.)

Anchorage Amateur Radio Club
2628 Turnagain Parkway, Anchorage, AK 99517
Tel. 1-907-243-2221 or 1-907-344-5401

ARRL/VEC
225 Main St., Newington, CT 06111
Tel. 1-203-666-1541

Central Alabama VEC, Inc.
606 Tremont St., Selma, AL 36701
Tel. 1-205-874-1688 or 1-205-872-1166 (weekdays); 1-205-872-5450 (weekends)

Charlotte VEC
227 Bennett Lane, Charlotte, NC 28213
Tel. 1-704-596-2168

DeVry Amateur Radio Society
3300 North Campbell Ave., Chicago, IL 60618
Tel. 1-312-929-8500

Golden Empire Amateur Radio Society
P.O.Box 508, Chico CA 95927

Greater Los Angeles Amateur Radio Group
9737 Noble Ave., Sepulveda CA 91343
Tel. 1-818-892-2068 or 1-805-822-1473

Jefferson Amateur Radio Club
P.O.Box 73665, Metairie, LA 70033

Koolau Amateur Radio Club
45-529 Nakuluai St., Kaneohe, HI 96744
Tel. 1-808-235-4132

Laurel Amateur Radio Club., Inc.
P.O.Box 3039, Laurel, MD 20709-0039
Tel. 1-301-776-3046

The Milwaukee Radio Amateurs Club, Inc.
1737 N. 116th St., Wauwatosa, WI 53226
Tel. 1-414-774-6999

Mountain Amateur Radio Club
P.O.Box 234, Cumberland, MD 21502
Tel. 1-304-289-3576

PHD Amateur Radio Association, Inc.
P.O.Box 11, Liberty, MO 64068
Tel. 1-816-781-7313

Sandarc-VEC
P.O.Box 2446, La Mesa, CA 92044
Tel. 1-619-465-3926

Sunnyvale VEC Amateur Radio Club
P.O.Box 60142, Sunnyvale, CA 94088-0142
Tel. 1-408-255-9000

Triad Emergency Amateur Radio Club
3504 Stonehurst Place, High Point, NC 27260
Tel. 1-919-841-7576

Western Carolina Amateur Radio Society VEC, Inc.
5833 Clinton Hwy., Suite 203, Knoxville, TN 37912-2545
Tel. 1-615-688-7771

W5YI-VEC
P.O.Box 565101, Dallas, TX 75356-5101
Tel. 1-817-461-6443

The voice-equivalent or "prowords" such as clear, break, over, affirmative, negative, and roger are fairly self-explanatory. However, I should point out that, contrary to popular belief and war-movie usage, "roger" simply means "I have received your last transmission correctly," but doesn't mean "yes" or "affirmative."

A three-letter series of shortcut codes collectively called the "Q-Code" has been in use since 1912 when it was adopted by international agreement. The Q-code was designed to overcome language barriers faced by ship operators as they communicated among themselves and with shore stations around the world.

Most of the original 50-signal, universally understood codes are still in use today. Many more codes have been officially added and still more have been adopted informally by amateurs to handle situations that are not covered by the formal lists. Some of the more popular Q-code signals favored by amateurs include QTH (location), QRM (interference), QSL (acknowledgment of receipt), QSO (contact), and QST (calling all radio amateurs). Many of these codes have equivalents in the more recently developed police and CB-adapted "10-codes."

Three Amateur Radio Traditions. Amateur radio has many traditions and legends that reflect its long heritage. Three of these are quite intriguing.

The first tradition is that of "The Old Man," or "T.O.M." This is a reference to Hiram Percy Maxim (1869–1936), who, with Clarence D. Tuska, co-founded the American Radio Relay League (ARRL) in 1914. Maxim can't be credited with coining the term "ham," but some recognize him as the father of amateur radio: he served as the League's president for 22 years until his death in 1936. Maxim (whose call-sign, W1AW, was later awarded by the FCC to the ARRL for its headquarters station in his memory) was an imaginative engineer and inventor who pioneered in the development of the automobile and who also invented the Maxim silencer for firearms.

Maxim was a feisty, straight-arrow standards-setter who was highly revered in the amateur community. Many T.O.M. stories grew up around his accomplishments, principles, and philosophies, and some of the stories were authored by him under this *nom-de-plume*. Even today, some older amateurs judge controversial developments in the hobby by intuitively asking themselves, "What would The Old Man think about that?" The proword "old man," or "OM," by which radio amateurs routinely refer to each other over the air, is at least partly derived from this old-time ham tradition.

The tradition and symbology of the "Wouff Hong" is also a part of the fabric of amateur radio. Originally just a somewhat silly piece of spontaneous word invention, the Wouff Hong was a mythical creation of a then-anonymous writer using the name "The Old Man," found after his death to be Hiram Percy Maxim himself. The Wouff Hong was mentioned in a series of humorous stories in Maxim's "Rotten Radio" series in the ARRL's journal, QST. In the January 1917 issue, T.O.M. referred to the now-legendary Wouff Hong for the first time, discussing it in his article "Rotten QRM," referring to unnecessary interference by crummy operators (who amateurs of the present era likely would refer to as "lids").

The Wouff Hong was one of three mythical instruments of strangulation or torture designed by T.O.M. (along with his other nonsense-word creations, the Rettysnitch, and the Uggerumph) to attack poor operating practices and ensure good radio-operating techniques. The Wouff Hong actually appeared in physical form at the ARRL headquarters in time to be pictured in June 1919 QST, and it still is

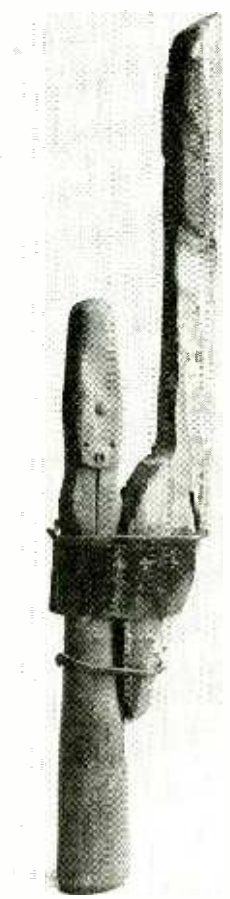
Here's the author's well-appointed amateur radio hamshack, as it existed in 1979. A host of digital-based technologies such as packet radio, satellite communications, computers, and the like have caused amateur radio hamshacks to change tremendously since then.

on display at ARRL headquarters today.

From this mythical, mystical symbol emerged the Royal Order of the Wouff Hong, a sort of radio-amateur secret society intended to symbolize an honorary inner circle of the League. Wouff Hong initiations are still conducted during large League conventions at the stroke of midnight.

The third colorful amateur tradition is that all amateurs, regardless of how elaborate their stations may be, are said to have their equipment located in their "hamshack." Early shipboard installations and shore stations tended to be located in their own isolated radio room or building, and for good reason. Why? In those pre-World War I days, the noisy spark transmitters produced an ear-shattering crash every time the key was depressed, thoroughly disturbing all within earshot.

If the early spark-rig amateur wasn't banished to a distant out-building, cabin, or detached structure far removed from family activity, he was at least relegated to space behind the basement furnace or in an attic crawl space where he wouldn't disturb the household. Nowadays, however, you'll find modern, silent amateur stations housed in almost every conceivable spot in the home. But, even if that spot is the most luxurious and comfortable part of the house, tradition demands that the spot still is always called the hamshack.



Originally spontaneous word invention by Hiram Percy Maxim, the Wouff Hong is one of three mythical instruments of torture that might be used to attack poor operating practices. It is still on display at the ARRL headquarters today.

Five Routes to a License. We've shown that there's a great deal of lore surrounding radio hams, and amateur radio definitely isn't a trifling hobby despite its obscure origins, its strange jargon, and its unusual traditions. It's one of the few hobbies in which you have to be licensed to participate, and most hams appreciate the hobby even more for its strict entry requirements. Maybe you'll give this fascinating and rewarding avocation a try, even if no one really knows for sure how the hobby was first named.

Hopefully this discussion of the term "ham" and the lingo surrounding amateur radio has whetted your appetite to learn more about the hobby. Since that might be the case, we'd be remiss if we didn't offer some suggestions as to what to do next to satisfy your curiosity and perhaps become a ham yourself. Getting an amateur-radio license is easier than you might think, especially since February 1991 as you no longer have to learn Morse code. Best of all, even beginner (Novice and Technician) licenses allow you to use voice and the latest digital and computer-based technologies on the air.

Just about anyone can become a radio amateur; there are no age limits. To obtain a license (a "ticket" in ham-speak), you must pass an exam. In 1985, the FCC undertook a program whereby licensed radio amateurs called Volunteer Examiners (or VE's)—amateurs in the community who volunteer their services as test-givers—were organized into testing teams by several authorized Volunteer Examiner Coordinator (or VEC) groups. There are about 18 VEC's, which are listed in the boxed copy entitled "VEC groups."

The VEC's are certified by the FCC to administer exams; questions are drawn from a regularly updated question pool developed by the FCC and the VEC's. The VEC's conduct exam sessions, often held at amateur hamfests. Although the FCC doesn't charge to issue or renew licenses, the VEC's may charge examinees nominal fees. But the good news is that you no longer have to travel to a distant FCC office to take amateur tests, which in many locations used to be given only a few times a year.

The VEC's administer the exams for the five classes of operator license:

Novice, Technician, General, Advanced, and Extra. Although you can initially qualify for any of the five operator classes, most people find the Novice and Technician licenses are the ideal entry points to the hobby.

The no-code Technician-Class exam, comprised of two written tests, has 55 questions and you don't need to know Morse code. Its prerogatives include all amateur privileges in the 6-meter (*i.e.*, 50-MHz) and higher bands. The Technician-Class operator who also has successfully completed the Morse-code requirement is known as a "Technician Plus" and is also allowed Novice-type operating privileges in the popular 10-, 15-, 40-, and 80-meter high-frequency bands.

The Novice Class is for beginners who don't have the technical knowledge to pass the Technician-level theory and regulations exam, but who can pass the less-demanding, 30-question Novice-level FCC theory/regulations exam and the 5-WPM Morse-code sending and receiving test. Privileges include radioteletype and voice operation in the 10-meter band and Morse in the 10-, 15-, 40-, and 80-meter bands, as well as some small VHF and UHF bands. (The Novice exams are the only amateur exams that can be given outside the VEC system. Any pair of General- or higher-class amateurs may administer these exams.)

The General-Class license is a middle-of-the-road amateur license. Its key features are a 13-WPM code requirement and privileges in at least a portion of every amateur band. It offers all amateur operating privileges except for the relatively few privileges that are reserved for the Advanced and Extra Classes.

A tougher theory examination characterizes the Advanced Class, which allows some additional frequency privileges in the HF bands. At the pinnacle is the Amateur Extra Class, with a still-stricter exam and a Morse code requirement of 20 WPM. The license authorizes full-privilege operation on all amateur bands. A little-known fact is that persons who can't pass a 13- or 20-WPM code exam because of a doctor-certified medical handicap can be excused from taking the code examinations.

For More Information. To get more details on getting started in amateur radio, contact your local amateur-radio club or one of the Volunteer Examiner Coordinator listed elsewhere in this article.

You also can obtain FCC Form 610 (Application for Amateur Radio Station and/or Operator License) from any of the FCC's 35 offices around the country. You can get the address of the FCC office nearest you, basic information on becoming a radio amateur, study publications, and/or the names of clubs and instructors in your area, from the American Radio Relay League (ARRL), (225 Main St., Newington, CT 06111; Tel. 1-203-666-1541).

Various amateur-license study packages, both books and software, are available from the National Amateur Radio Association (NARA) (P.O. Box 598, Redmond, WA 98073-0598; Tel. 1-800-GOT-2-HAM). Complete study programs are also available from The W5YI Group, P.O. Box 565101, Dallas, TX 75356; Tel. 1-800-669-W5YI.

Books and Study Aids. In preparing for the amateur exams, consider acquiring these three excellent books:

First there's *Now You're Talking! Discover the World of Ham Radio* This 320-page ARRL publication covers practically everything you need to know to earn a Technician- or Novice-class license. It's more than a study guide in that it also helps you select and set-up equipment for your first hamshack. It's $19 from the ARRL. The League also publishes the ARRL License Manual Series, one book for each license class (they are $6 each).

Second, check out *The ARRL Operating Manual, Fourth Edition*. It is an excellent primary reference covering the full gamut of on-the-air operating practices—a sort of one-stop operating encyclopedia. While not a license-exam study manual, the book makes an effort to be the entry vehicle for "no-code" Technicians. It's available from the League for $18.

And third we recommend *All About Ham Radio*. This is an introduction to amateur radio aimed at those without prior knowledge. In about 300 pages, Harry Helms, operator of amateur station AA6FW, uses humor and a friendly writing style to guide newcomers. The book isn't a complete license-exam study course, nor is it an A-to-Z operating reference. However, unlike many other beginner texts, this one devotes as much attention to what amateurs actually do and to amateur-radio culture as it does to formal operating topics, which are covered well in *The ARRL Operating Manual* anyway. The Helms book is $19.95 from HighText Publications, Inc. (125 North Acacia Ave., Suite 110, Solana Beach, CA 92075; Tel. 1-619-793-4141).

Besides these three books, there's also the complete Introduction to Amateur Radio teaching package, designed for youths. Carole Perry, WB2MGP, is a professional educator who has successfully introduced many youths to amateur radio. Now she offers her own training program for youngsters in grades 3 to 12. Her program is billed as a complete, ready-to-teach "plug-in" curriculum. It includes all necessary materials in-

(Continued on page 98)

Further Reading

Fifty Years of A.R.R.L., American Radio Relay League, Inc., (ARRL publication No. 0135) 1965.

Now You're Talking! Discover the World of Ham Radio, American Radio Relay League, Inc., (ARRL publication No. 3525) 1991.

The Radio Amateur's Operating Manual, American Radio Relay League, Inc., (ARRL publication No. 24, superseded by No. 1086) 1972.

Log Book Newsletter, Benicia Amateur Radio Club, June 1989.

Two Hundred Meters and Down, Clinton B. DeSoto, American Radio Relay League, Inc., 1936 (reprinted in 1981 as ARRL publication No. 0011, $8).

The ARRL Operating Manual, Steven Ford, WB8IMY, ed., American Radio Relay League, Inc., (ARRL publication No. 1086) 1991.

"Those Wild Hams of the 1920's," Charles C. Hay, W0LCE, *Popular Electronics*, October 1973.

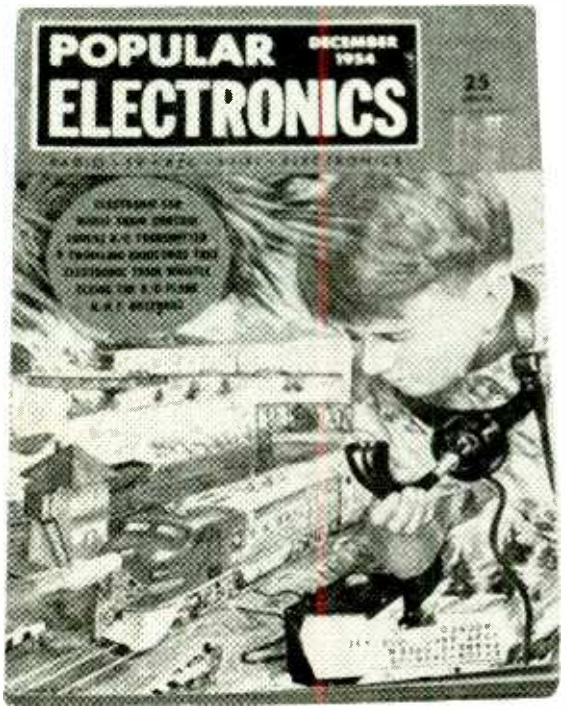
All About Ham Radio, Harry Helms, AA6FW, HighText Publications, Inc., San Diego, CA, 1992. ($19.95)

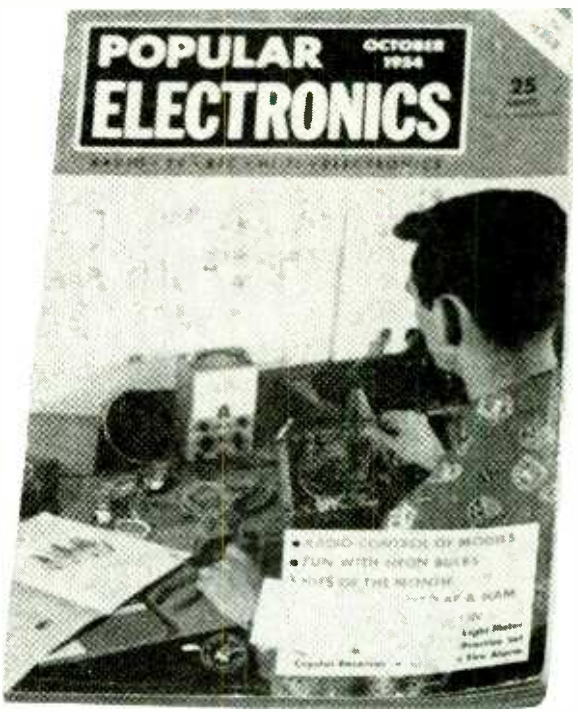
"It Seems to Us: The Wouff Hong," *QST* editorial, May 1953, June 1955, and February 1961.

"From Whence Came Ham," Bill Johnston, WB5CBC, *QST*, November 1976.

"Evolution of the Ham Shack," Howard S. Pyle, W7OE, *CQ*, August 1966.

Collecting Old Books and Magazines





Looking for a dose of radio nostalgia? How about an idea for an electronics project? You'll find both in old electronics books and magazines.

BY LARRY LISLE, K9KZT

Collecting old electronics books and magazines can be a lot of fun. Even if you have just a few you can see how this hobby of ours has grown and changed, from a little section on "Hertzian Waves" in the back of a text on natural philosophy to a giant industry. They also give lots of ideas for projects that you can build just as they were described, or that you can update with modern components and techniques.

You might even discover something new by looking at an old idea with fresh eyes. Do we really understand how a coherer works? Can super-regeneration, point-contact transistors, or tunnel diodes suggest solutions to current problems?

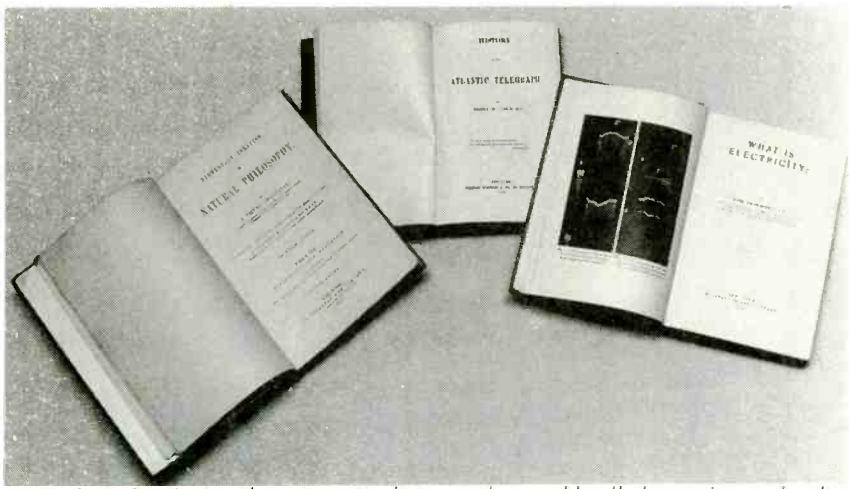
Finding Them. With very few exceptions, old electronics books and magazines are not expensive or hard to come by. The first step is to let people know you're interested. Put a notice in the local ham-club bulletin—even if you're not a member. Check out the area hamfests. Put an ad in the local newspaper. Sometimes very nice collections are simply thrown away!

Don't forget to check with your local library. Some libraries have a policy of disposing of electronic material after so many years because it's not current.

Finally, be sure to visit old book stores and antique shops in your area and tell the owners what you're after. Prices tend to be very low, except for very early magazines or collectibles such as past issues of *The A.R.R.L. Handbook*, and dealers might be reluctant to purchase collections they're offered unless they know someone's interested.

As you get into collecting you'll develop your own ideas on which direction to go, but here are a few thoughts on what to look for as you get started: First off, books from the 1800's are becoming hard to find, so grab anything you come across from that era. There was plenty written on electricity (motors, generators, and so on) and quite a bit on telegraphy, but precious little else.

The period from 1900–1920 was the era of wireless and "King Spark," with vacuum tubes becoming more common after about 1912. It's fun to read some of the textbooks of the period with the benefit of hindsight. The triode was dismissed by one from 1912 with, "This detector is said to be fairly sensitive, though of short life." This same text gave page after page to liquid barreters, and magnetic and thermo-electric detectors. It's also interesting to read various explanations



Books from the nineteenth century on what we today would call electronics are hard to come by. It brings home how young our hobby really is.

The growth of amateur radio has been documented from the beginning to the present in QST magazine. The very earliest issues are getting expensive, but those from the twenties onward sell for only a few dollars each. Sometimes they're even given away free to a good home.

of how crystal detectors worked—all of them wrong! It makes you wonder if we're overlooking something important today, or whether we think we know how a device works when we really don't. A standard reference of the era was *Principles of Radio Communication*, by Morecroft. It's often quoted in other books and is fairly easy to find today.

The twenties saw the start of broadcasting. Reading samples of the many books written at the time makes the thrill of hearing voices and music from afar new again. You'll probably want to include some of the "how-to" books of the period in your collection.

The twenties also saw the division of amateur radio from broadcast listening. A copy of *QST Magazine* from early in the decade and one from the later years will show the technical growth.

The thirties really bridged the gap between antique and modern radio. Broadcast sets at the beginning of the period still had the classic look of the twenties, while by the end of the decade, the all-American five-tube table radio was becoming more common. In amateur radio, the thirties started with self-controlled oscillators and regenerative receivers, and ended with stable transmitters

There have been several ham-radio handbooks. The most famous is published by the A.R.R.L.

and superheterodyne receivers. All of these changes were recorded in the electronic literature of the day and in magazines such as *Radio-Craft* and *QST*.

Books devoted to repairing radios became common in the thirties and if you're into antique-radio collecting you'll definitely be interested in acquiring some service manuals from the era. I'd especially recommend books on radio repair by Abraham Marcus and John T. Frye.

The forties began with the war years, and though plenty was happening in electronics, most of it wasn't made public until later. Since ham radio was officially off the air for the duration, amateur-radio magazines had a problem: What do you write about? For this reason, a copy or two of *QST* from the early forties should be in your collection. All magazines from the war years are scarce because of paper shortages and scrap drives.

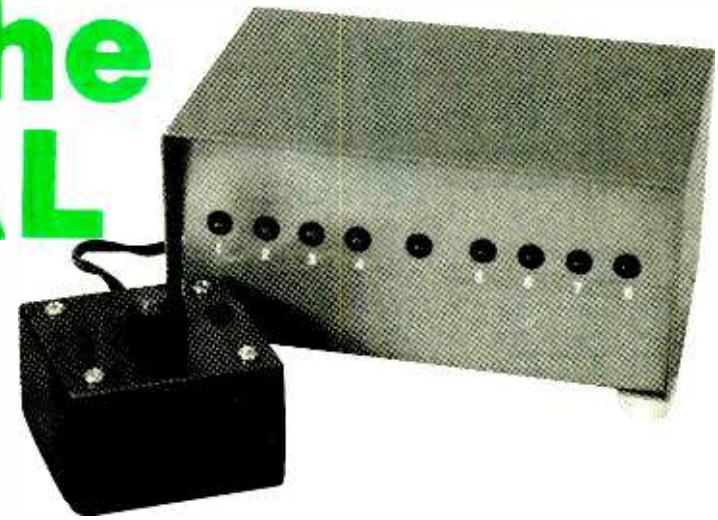
The late forties and fifties were a boom time for electronics. The wizardry of the war years was revealed and led to even more inventions. The general prosperity of the country also put electronics in more and more homes.

Many magazines were started or retitled to reflect the new age and every month consumers would read articles on FM radio, high-fidelity music systems, and television. All of these products needed servicing, so there was a heavy emphasis in many magazines on helping the "radio repairman" with a VOM and signal generator become an "electronics technician" with equipment that had only been in the laboratory just a few years before.

For hobbyists it was a great time.

(Continued on page 98)

Build the DIGITAL BOWL BOX



BY WILLIAM L. CALL

This circuit brings the old "College Bowl" concept of first-response answers to a moderator's questions into the '90's.

Many contests and game shows are based on the old "College Bowl" concept of first-response answers to a moderator's questions. Usually two teams are assembled, typically with four contestants each; a question is read, and the first person to respond gets the opportunity to answer the question. Middle and High Schools have gotten into the action with Math Bowls and Academic Bowls; even churches have gotten into the act with "Bible Bowls." In individual classrooms, many teachers have used the Contest Bowl idea to build excitement into classroom activities.

A key component of the Contest Bowl is an impartial judge to determine which participant responded first. Usually each contestant is given a pushbutton switch that is connected to an electronic device that determines which button was pushed first. Such a system can be quite elaborate (incorporating large and colorful displays, impressive sound effects, etc.) and complex. The system presented here, on the other hand, was designed to be compact and inexpensive. Since the heart of the electronic system is a digital IC often used in computer circuits, the unit has been dubbed the *Digital Bowl Box*.

Circuit Description. Figure 1 shows a schematic diagram of the Digital Bowl Box. At the heart of the circuit is a 74LS373 low-power Schottky octal (or eight-input) transparent latch, U1. At power up, U1's output-enable ($\overline{OE}$) terminal at pin 1 is held low via pull-down resistor R2 and the latch-enable (LE) terminal at pin 11 is high, via pull-up resistor R1-i (part of a 9-resistor network). That allows any signal presented to U1's data-input (D0–D7) terminals to be passed to its respective output. Since all of the data inputs of U1 are held high via pull-up resistors (R1-a–R1-h), each output of U1 is high. That reverse biases LED1–LED8 so all of them remain dark; only LED9 is illuminated.

Let's say that S1 is the first switch to close. That low pulls U1 pin 3 low, causing its corresponding output (pin 2) to go low. The low output on pin 2 forward biases LED1, causing it to light. At the same time, a voltage drop developed across R8 (as a result of current flow through LED1), turns Q1 on, which then causes Q2 and Q3 to turn on.

When transistor Q2 turns on, pin 11 (LE) of U1 is pulled low, latching U1 in its present state, keeping LED1 on, identifying the contestant who responded first, while locking out all subsequent respondent signals. With Q3 turned on BZ1 sounds. The 74LS373 and transistors have a response time of a few nanoseconds, making it highly unlikely (though not impossible) that a "tie" could occur.

After noting which contestant responded first, the moderator momentarily presses RESET (S9), which pulls pin 1 ($\overline{OE}$) high, clearing U1. That causes the highs presented to the data inputs of U1 (as a result of the pull-up resistors) to once again be passed to their corresponding outputs. As before, the LED's are now reverse biased, so no voltage drop develops across R8. That removes the bias from Q1, which causes Q2 and Q3 to turn off, turning off BZ1 and deactivating the latch.

Power for the circuit is provided by a traditional transformer, rectifier, and voltage-regulator system. As designed, the Digital Bowl Box supports up to eight contestants. An expansion jack (J3) is included in the circuit, allowing you to daisy-chain two Digital Bowl Boxes together for up to 16 contestants (eight for each team). The expansion jack parallels the LE control signals of the two Boxes. Only one LED will light, corresponding to the first switch depressed; full lockout of all other switches remains in affect. The expansion jack could be omitted if that option is not desired.

Construction. The majority of the Digital Bowl Box's circuitry was assembled on a printed-circuit board,

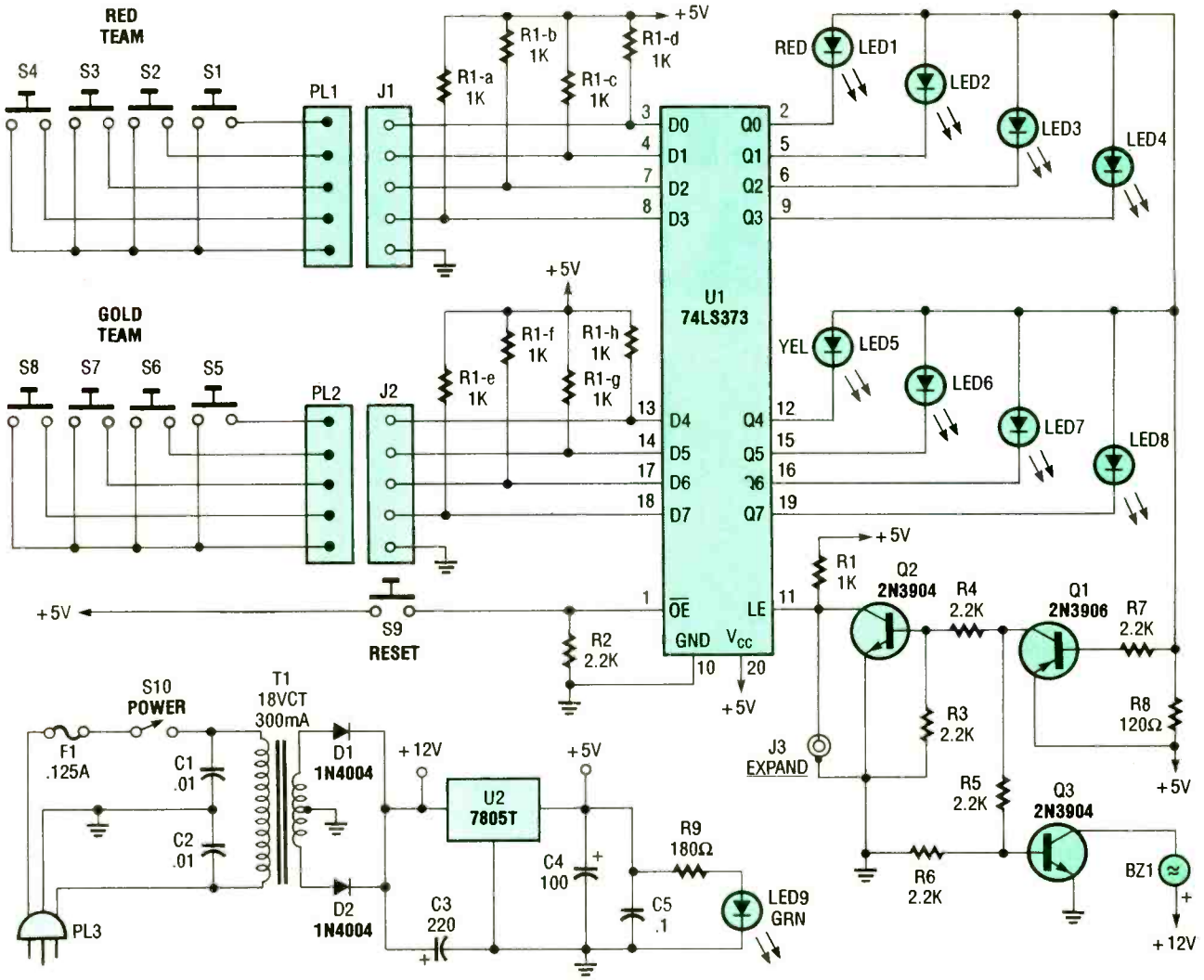


Fig. 1. At the heart of the Digital Bowl Box is a 74LS373 low-power Schottky octal (or eight-input) transparent latch, U1. Note that instead of 9-individual 1k resistors, the circuit uses a 10-pin 1k × 9 SIP bus-type resistor network.

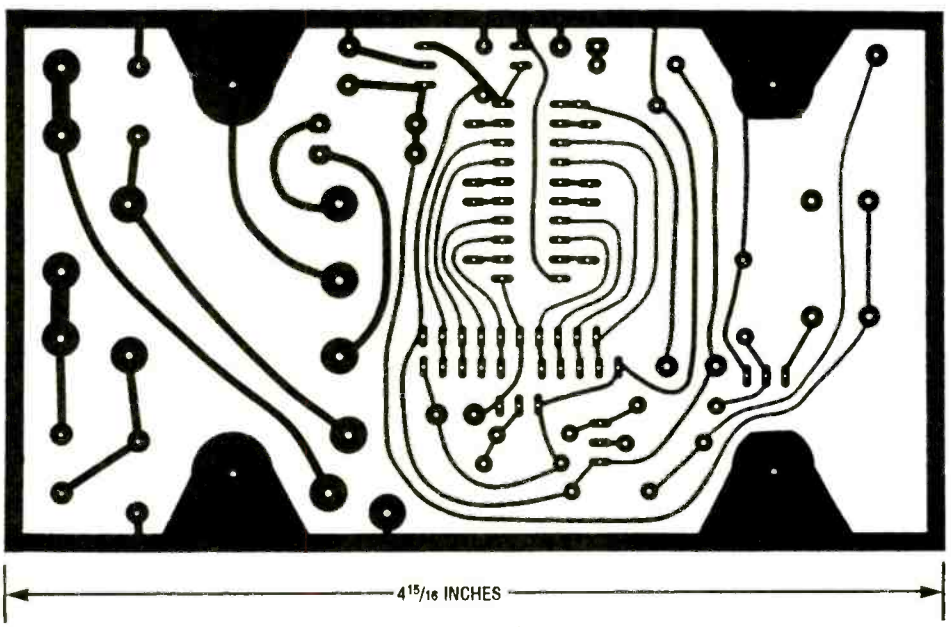


Fig. 2. Most of the Digital Bowl Box's circuitry was assembled on a printed-circuit board, measuring approximately 4 15/16 by 2 7/8 inches. A template for that printed-circuit layout is shown here full scale.

PARTS LIST FOR THE DIGITAL BOWL BOX

SEMICONDUCTORS

U1—74LS373 low-power Schottky, octal D-type latch, integrated circuit
U2—7805T 5-volt, 1-amp voltage regulator, integrated circuit
Q1—2N3906 general-purpose PNP silicon transistor
Q2, Q3—2N3904 general-purpose NPN silicon transistor
LED1–LED4—Red light-emitting diode
LED5–LED8—Yellow light-emitting diode
LED9—Green light-emitting diode
D1, D2—1N4004 1-amp, 400-PIV rectifier diode

RESISTORS

(All fixed resistors are ¼-watt, 5% units, unless otherwise noted.)
R1—1000-ohm × 9 SIP bus-type resistor network
R2–R7—2200-ohm
R8—120-ohm
R9—180-ohm

CAPACITORS

C1, C2—0.01-µF, 1000-WVDC, ceramic-disc
C3—220-µF, 25-WVDC, radial-lead electrolytic
C4—100-µF, 10-WVDC, radial-lead electrolytic
C5—0.1-µF, ceramic-disc

SWITCHES

S1–S9—SPST momentary-contact, pushbutton switches
S10—SPST toggle switch

ADDITIONAL PARTS AND MATERIALS

BZ1—12-volt buzzer (Mouser 251-0012)
F1—0.125-amp fuse
J1, J2—Panel-mount 5-conductor, DIN jack
J3—Panel mount, RCA phono jack
PL1, PL2—5-conductor DIN plug
PL3—3-conductor, molded AC power plug with line cord
T1—18-volt, center-tapped, 300-mA, transformer (Mouser 41WJ300)
Printed-circuit board materials, enclosure, strain reliefs, fuse holder, LED mounting clips, #6 × ½-inch sheet-metal screws, #6-32 × ¼-inch BH machine screws, 20-pin IC socket, 2 × 6-inch pine wood (see text), aluminum sheet metal, threaded aluminum #6-32 × ½-inch standoffs, #24 4-conductor shielded cable, wire, solder, hardware, etc.

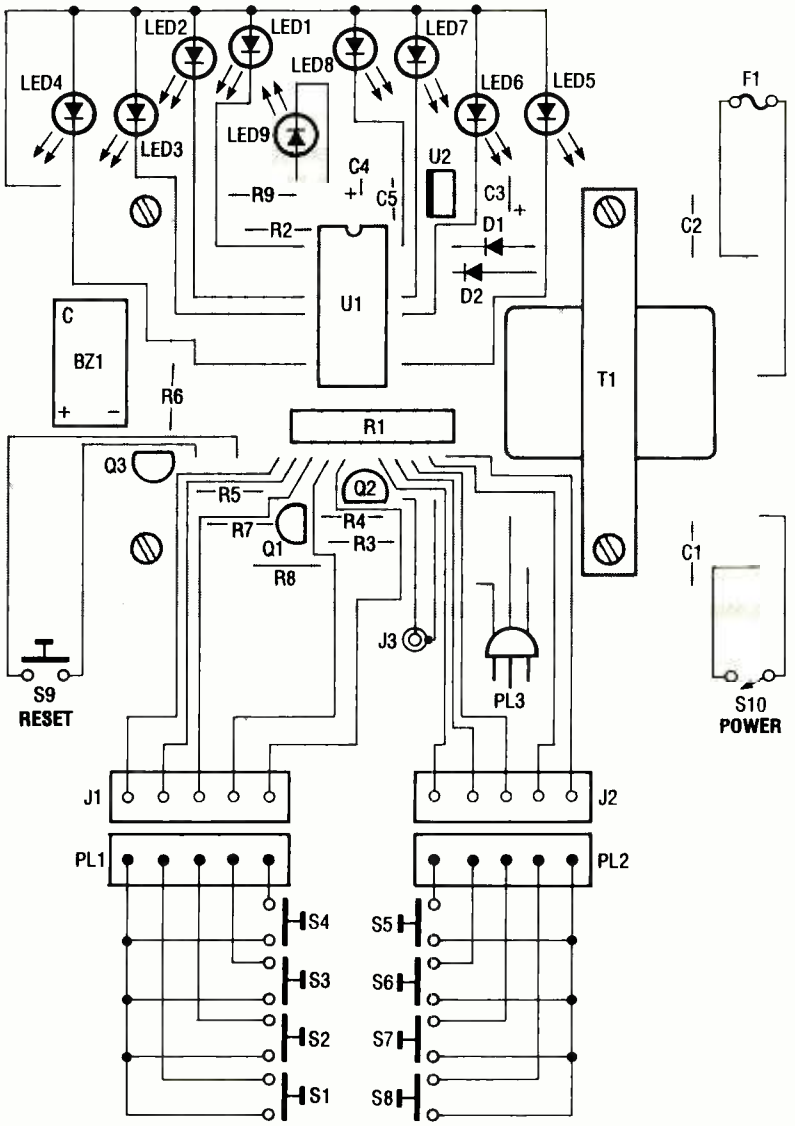


Fig. 3. In this parts-placement diagram for the printed-circuit board, note that the power transformer (T1) and the buzzer (BZ1) are mounted directly to the board. That means that due to physical space tolerances, the vendor-referenced components specified in the Parts List are required.

measuring approximately 4 15/16 by 2 7/8 inches. A template for that printed-circuit layout is shown in Fig. 2. A parts-placement diagram for the printed-circuit board is shown in Fig. 3.

Note that the power transformer (T1) and the buzzer (BZ1) are mounted directly to the board, eliminating interconnecting wires. Although that simplifies construction, it also requires (due to space tolerances) that the vendor-referenced components specified in the Parts List be used. Non-vendor-referenced parts are not critical. The switches, cabinet, switch wiring, and switch housings should be rugged enough to withstand the rigors of constant use.

Start by mounting a socket where U1 is indicated. Follow that by installing the passive components. Note that R1 is a 10-pin SIP bus-type resistor network, which is available from Digi-Key Electronics (701 Brooks Ave., PO Box 677, Thief River Falls, MN 56701-0677; Tel. 800-344-4539) as well as other sources.

After the passive components, mount and solder the active components to the board as indicated in Fig. 3. Once that's done, attach the transformer to the board with #6-32 × ¼-inch screws and ½-inch threaded metal standoffs; the transformer mounting holes double as the board-mounting holes. Install screws and standoffs at the other mounting holes. After first tightening the mounting

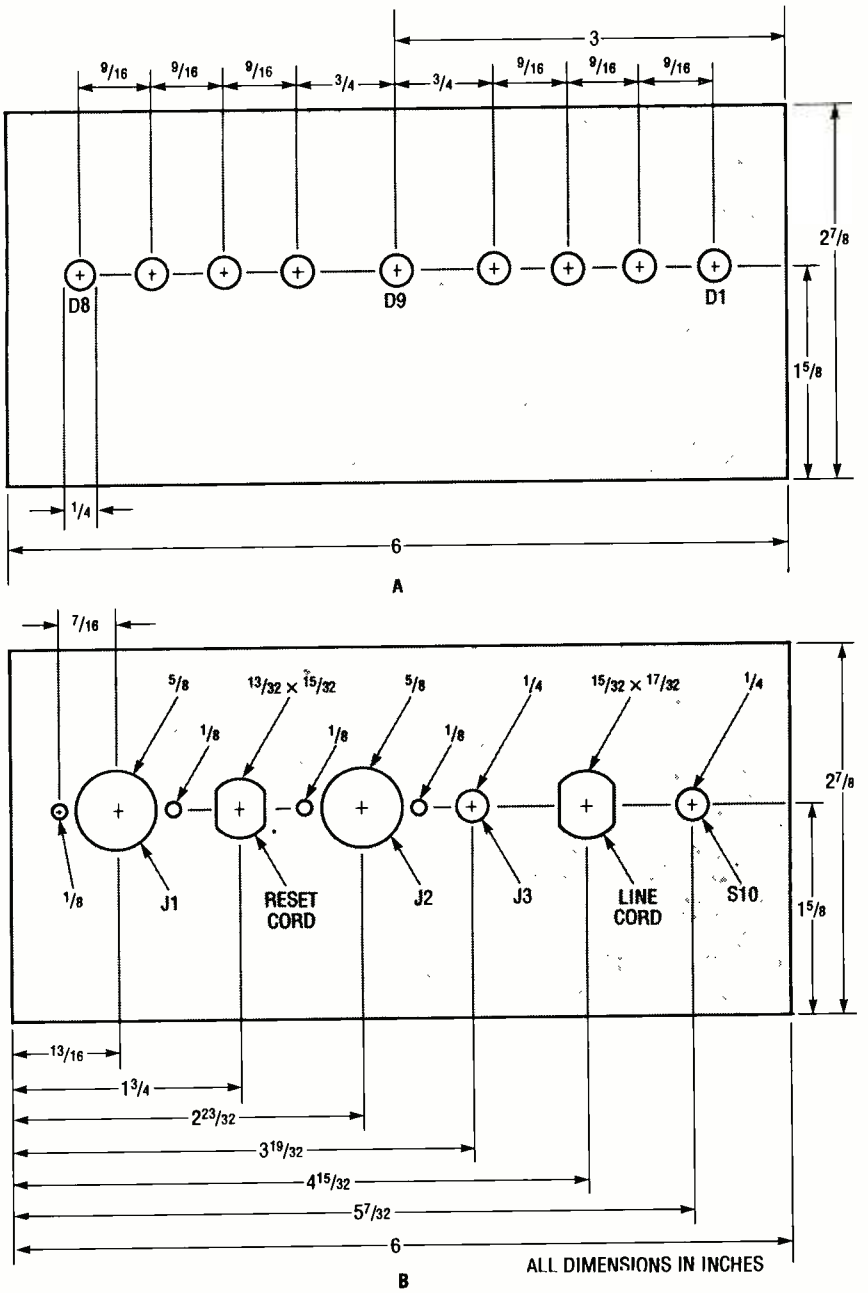


Fig. 4. Holes must be drilled in the front and rear panels of the enclosure to accommodate the off-board components; A shows the front panel layout while B shows the rear panel layout. You can layout your enclosure's front and rear panels in a similar manner, or follow any scheme that you choose.

screws to the stand-offs, solder the transformer terminals to the appropriate circuit-board pads. After that solder 4-inch lengths of pre-stripped hookup wire for the LED's, jacks, and power switch to the board.

The printed-circuit board assembly is now complete.

PCB Enclosure. Before the board can be mounted in its enclosure, it will be necessary to do a little preparatory work; e.g., holes must be drilled in the front- and rear-panels of the enclosure to accommodate the off-board components. Figure 4 shows the front and rear panel layouts for the author's unit. You can layout your enclosure's front and rear panels in a similar manner, or follow any scheme that you choose.

In any event, prepare the enclosure by punching or drilling nine ¼-inch holes in the front panel for the LED's. To promote the team concept, red LED's were used for one group of four outputs, and yellow for the other. (The corresponding switches, which we'll get to shortly, were mounted on plates that were painted red or yellow.) The LED's and switches can be labeled 1–8 or red 1 through red 4 and gold 1 through gold 4. If the application is for individual contestants rather than teams, like-colored LED's and plates might be preferable. The cabinet was labeled with embossed tape labels.

Mount the LED's into the front panel using plastic LED-mounting clips, and connect the anodes of all but LED9 (the power indicator) together with bare bus wire. Run the reset and power cords loosely through their cabinet holes and solder their ends to the board. Maneuver the board into position in the cabinet, and install the bottom mounting screws into the other end of the standoffs. Install clamp-in strain-relief bushings on the reset and power cords, and then install a pair of DIN jacks and the power switch.

Now the final soldering can be completed. The easiest way to solder to the LED's is to first melt some solder onto the end of the connecting wire and then separately to the LED lead. After that, reflow-solder them together. The switch jack terminals work well with this method too. Once the printed-circuit board has been mounted, and the connections between the circuit board and the off-board components have been completed, move on to the final phase of the project's construction.

Contestant Switches. Figure 5 shows one unit of the four-contestant switch arrangement used in the author's prototype. The contestant switches were housed in wood blocks (approximately 2½inches square) that were cut from 2- × 6-inch pine lumber using a table saw. However, if you happen to have some scrap 2-by-4 lying around, that can be used as well. The blocks were then drilled out using a drill press. A router with a 0.25-inch veining bit was used to cut a groove into the wood to hold the switch wiring snugly clamped under a metal, switch-mounting plate.

The switch-mounting plates were fabricated from 1/16-inch sheet aluminum, and cut just slightly smaller than the wood blocks. A hole was then punched in the center of each mounting plate for the switches, and smaller holes in each corner for the

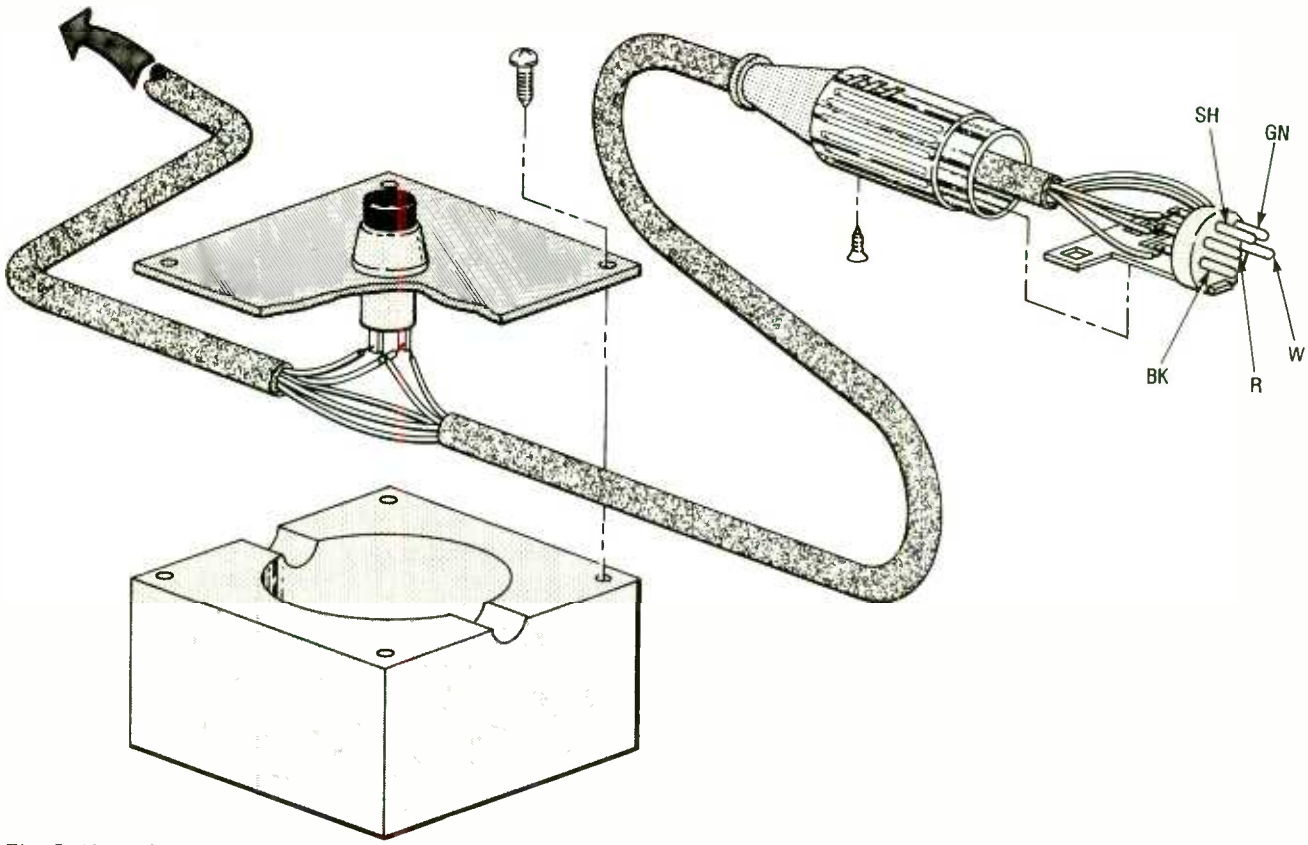
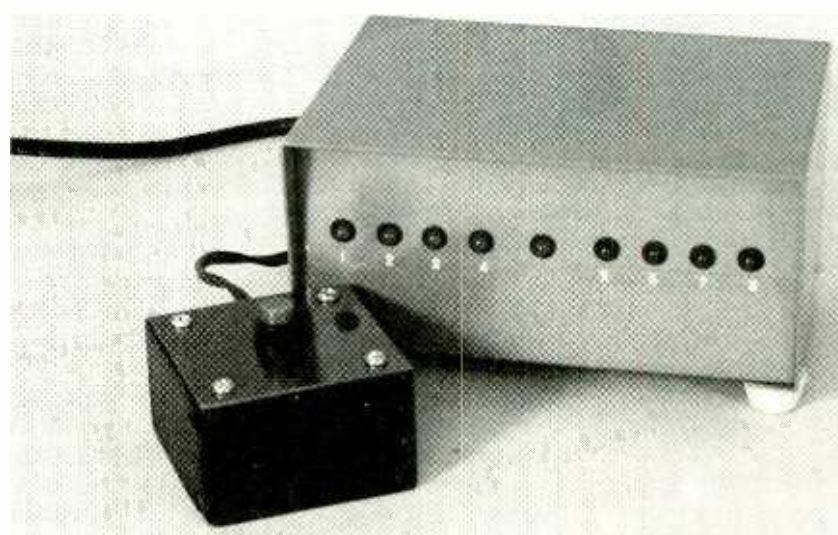


Fig. 5. Shown here is one unit of the four-contestant switch arrangement used in the author's prototype, which was wired together using an approximately 14-foot length of 4-conductor shielded cable for each team. Each switch within that arrangement has one terminal connected to one of the color-coded inner wires of the cable. The other switch terminal is connected to the cable shielding. After connecting the contestant switches to the cable, a heavy-duty DIN plug was connected to the free end of the cable.

plate's mounting hardware. Once the mounting plates are complete, mount the switches in position. Note that the recommended switches require a small notch in their mounting plate. If desired, small plastic enclosures could be substituted for the homemade switch boxes, using suitable strain reliefs on the wires.

The four-contestant switch arrangement (see Fig. 5) was wired together using an approximately 14-foot length of 4-conductor shielded cable for each team; that arrangement is less prone to tangling than individual switch cables. Shielded cable was used to lessen the chances of static discharges causing false triggering.

Prepare the cable by removing about 1.5-inch of insulation at three locations (each switch should be about 24 inches apart) along the multi-conductor cable. The fourth switch connects to the very end of the multi-conductor cable. Strip one color-coded inner wire for each switch. The color-coded wire is then soldered to one switch contact, and the bare shield wire is looped out and soldered to the other contact. A heavy-duty DIN plug was then connected to the other end of the cable.



Here's the author's completed prototype shown along with one unit of the four-contestant switch arrangement.

Conclusion. The design that has been described is the result of many successive improvements over the years. The Digital Bowl Box was developed in response to requests by local school systems for an affordable, compact, easy-to-use quiz-bowl apparatus, and nearly 100 similar systems are now in use in our area. Needing to build so many in a part-time operation, considerable attention was given to easy assembly methods. The unit reportedly has met its need well, and helps make contesting very exciting. ■

The Sky Buddy Gets an Alignment

By Marc Ellis

This month's column continues a project that has been occupying our attention for some time now: the restoration of a Hallicrafters Model S-19-R—better known as the Sky Buddy. That well-known, low-end shortwave receiver of the late 1930's was a favorite "starter set" for budding hams and shortwave listeners of the pre-World War II generation. See last month's column for a little more background on the set, plus a bibliography of the issues that have been devoted to the restoration so far.

Here's the LM21 at work providing alignment signals for the Sky Buddy repair project. The power supply is at left; the calibration book is partially under the headphones (which are used to zero-beat the frequency-meter output with the signal from the internal reference crystal).

By the beginning of last month's column, the receiver was in very nice physical shape, having been cleaned up to display-ready condition. However, there were still some electronic problems: audio gain was very low and, in addition, only a couple of strong local signals could be picked up on the broadcast band. Except for the weak audio, reception on the three shortwave bands seemed normal.

LAST MONTH'S PROGRESS

Through systematic troubleshooting, working backwards from the receiver's audio-output stage, the audio problem was traced to the coupling capacitor between the detector and first audio amplifier stages. Replacement of that leaky capacitor brought back the Sky Buddy's audio gain, but did nothing to clear up the broadcast-band reception problem.

What could cause this receiver to operate in a normal manner on its three shortwave bands (bands 2, 3, and 4), but not on the broadcast band (band 1)? The most obvious suspect was the primary of the broadcast-band antenna coil, which might well have been left connected to an outside antenna during a thunderstorm and damaged by a static charge from a nearby lightning strike.

That possibility, however, could almost be ruled out by a glance at the Sky Buddy's schematic. It turns out that the band 2 (1.7–5.6 MHz) and band 1 antenna coils share a primary winding. Since the set seemed to operate normally on band 2, the winding was probably okay.

Just to be on the safe side, I did check out the antenna-coil primaries during last month's troubleshooting session. That was accomplished by connecting a low-range ohmmeter across the set's "A1" and "A2" antenna terminals.

Those terminals connect to the primary of whichever antenna coil is selected by the Sky Buddy's bandswitch. So the three primaries could be checked for continuity simply by rotating the bandswitch through all positions. The ohmmeter did show continuity at each position, confirming my judgment that all antenna-coil primaries were good.

ALIGNMENT WITH THE LM21

With the antenna-coil primary given a clean bill of health, the next sensible move seemed to be to check the Sky Buddy's alignment. Such a move is always appropriate when servicing a receiver of this age since tube replacement over the years, deterioration of insulating and dielectric materials, and the absorption or loss of moisture content can all affect the resonant frequencies of the various tuned circuits.

In addition, the various screw-adjusted trimmer and padder capacitors used to tweak the tuned circuits are favorite targets for amateur "repair experts," whose uninformed twiddling can easily cause disastrous results.

My favorite signal source for the alignment of simple AM receivers is a World War II-vintage Navy surplus LM21 frequency meter. I have to admit that this an ungainly looking unit, lacking the trim packaging of the better-known Army Signal Corps

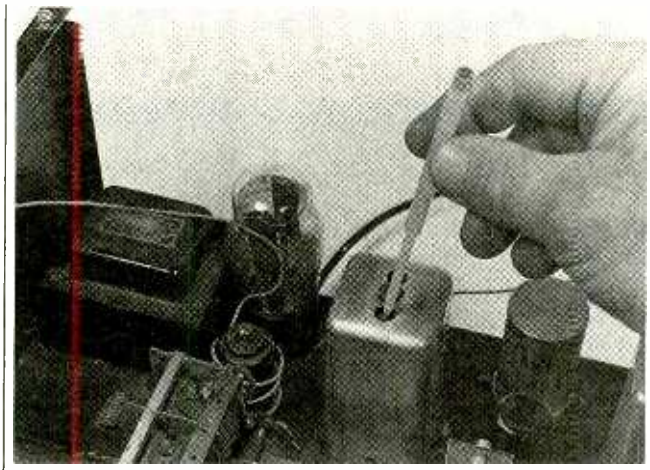
version, the BC221. The latter unit is housed in a trim wooden case, complete with a protected lectern-style housing for the unit's all-important calibration book and a handy compartment that can be used to hold an AC power supply.

However, LM21 units come with switch-selectable 400-Hz tone modulation. This is a feature that is quite important if one is to monitor the strength of the frequency meter's signal in the radio under repair by the usual method of connecting an AC voltmeter to the audio-output stage.

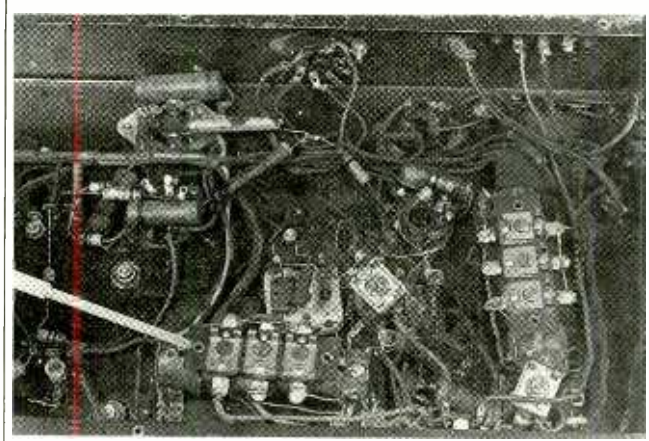
Few BC221's have either tone modulation or an AC power supply built to government standards. Apparently, in government service, that handy compartment was generally used for battery storage—AC power being a lot more common on shipboard than under army field-communications conditions.

Admittedly, the Navy power supply for the LM21 is a true boat anchor. It's housed in a case the same size as that of the LM21 itself, and is connected to the LM21 and the power line by a clumsy system of cables and plugs. Yet its battleship-like construction and custom-engineered design are comforting to have when operating an extremely sensitive and accurate instrument such as this frequency meter.

The LM21 (there are also earlier and similar models with lower "LM" numbers) and BC221 generate a signal whose frequency is within a percent or two of that indicated by the setting of the smooth-operating vernier dial. The official usable frequency range is 125--20,000 kHz, though higher frequencies can be attained through the use of harmonics. Accuracy is maintained through comparison with calibration signals generated by an internal 1000-Hz crystal.



Here's one of the IF transformers in the process of being tweaked for maximum gain. Note the wire signal-injection loop wrapped around the 6K8 oscillator tube (see text).



The light-colored alignment tool points to the horizontal row of oscillator trimmers for bands 1–3. The vertical row of RF trimmers for the same bands can be seen to the right of photo. The remaining, separately mounted, trimmers are oscillator and RF adjustments for band 4.

The frequency-meter signal can be picked up by a receiver under repair and used for testing and calibration. But the LM21 or BC221 can also be used in a manner somewhat similar to that of a modern frequency counter. A signal from a transmitter or oscillator under test can be received at the meter's antenna terminal and its frequency measured (by comparison with the meter's own signal).

I hadn't intended to digress so far on the subject of the LM21. But the fact is that the instrument is a very valuable tool for the antique-radio restorer.

These instruments still turn up in surplus catalogs, and are very commonly found at hamfests and other electronic flea markets. You'll usually find them at very reasonable prices because they are so under-appreciated and (I have to admit it) ugly. When considering the purchase of an "LM" frequency meter, check to see that the calibration book is present and that its serial number matches that on the frequency meter itself. The books are not interchangeable.

The government power supply, with the necessary interconnecting plugs and cables, should also be part of the deal. A manual would help, too. And after you get your meter home, take it apart and see if the reference crystal inside (this is a replaceable plug-in unit) is in a seamless, hermetically-sealed case.

The accuracy of non-hermetically-sealed units can't be trusted. If you're in doubt about yours, use it to set up your meter on one of the WWV frequencies or on the known frequency of a local radio station. Pick up the frequency meter signal on a receiver tuned to one of those stations and check for zero beat. If you hear any kind of a whistle, even a slow "growling" noise, your crystal may be off.

One good mail-order source to check for crystals, manuals, interconnecting plugs, and even the frequency meters and power-supplies themselves is Fair Radio Sales, 1016 E. Eureka St., Lima, Ohio 45802.

RESULTS OF THE ALIGNMENT

I started the alignment, as is standard procedure, with the IF channel. The LM21 was set to the manufacturer's specified IF frequency of 455 kHz, and its output coupled into the Sky Buddy by wrapping the wire from the meter's antenna terminal a couple of times around the body of the 6K8 oscillator-mixer tube (grid cap removed). I was readily able to hear the LM21's signal in the Sky Buddy's speaker and to observe a reading on the audio voltmeter I had connected across the speaker's voice-coil leads.

Using the "Increase Out-

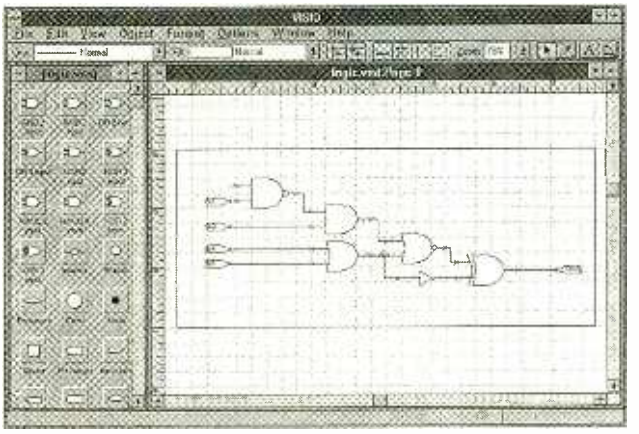
(Continued on page 94)

COMPUTER BITS

By Jeff Holtzman

One Cool Drawing Tool

Visio, a superb new drawing program, is my nomination for the best new Windows application of the year. Visio was developed by a company called Shapeware, which was started by several of the founders of Aldus Corp. (of PageMaker fame). What makes Visio so great is its user-centered focus. Visio uses direct representations of everyday objects to achieve simplicity of use, but has an object-oriented underpinning that allows advanced users and corporate managers to customize its behavior extensively. I predict a huge success for this program, as well as a rash of imitators that are certain to follow.



Visio is a drag-and-drop drawing program that lets you quickly and efficiently assemble network diagrams, office layouts, electronics schematics, and the like from standard components.

Traditional CAD, presentation, and drawing packages (e.g., AutoCAD, Freelance, and Designer, respectively) typically provide tools for creating primitive geometric shapes (lines and arcs, rectangles and ellipses, and so on), and manipulating them. That's great for mechanical engineers, draftpersons, and professional illustrators. But those of us who lack the time, talent, or inclination have long needed a higher-level approach. Visio provides that approach—brilliantly, yet simply.

The program lets you add shapes of arbitrary complexity to your drawings simply by dragging them from a stencil and dropping them where desired in your drawing. Visio comes with more than a dozen stencils with useful shapes for creating flow charts, network diagrams, block diagrams, office layouts, and more. You can customize the built-in stencils, purchase additional ones, and/or create your own.

By way of analogy, consider house building. The traditional approach gives you raw materials: wood, concrete, and the like, and wishes you good luck. Visio, on the other hand, gives you high-quality prebuilt doors, windows, and fixtures. You can build a house either way, of course, but the Visio approach takes you farther faster.

INSIDE VISIO

A Visio drawing consists of a foreground page and zero or more background pages. The background pages can be shared among several foreground pages; a Visio drawing file can contain multiple foreground and background pages. You can associate a template with a drawing. A template contains page setup information: text, line, and fill styles; a link to a stencil file; a color palette; and more. You can convert among drawings, templates, and stencils quite easily, which simplifies the process of creating your own templates and stencils.

A Visio drawing contains one or more objects (line, rectangle, arc, ellipse, or complex shape). You can create objects from scratch (the wood and cement approach), or drag and drop them from a stencil; you can also have several stencils open at once. Visio objects are intelligent. Each object has an associated ShapeSheet—*i.e.*, a spreadsheet that specifies various aspects of that object's behavior.

Some behavioral characteristics are simple; others are complex and based on attributes of the object itself, other objects in the drawing, and mathematical formulae. For example, you can specify line width, text font, and ability to be resized. One sample object is a grid that does not change relative row heights and column widths, but actually adds rows and columns as you resize it. Other shapes grow and shrink as you add text to them.

In addition, Visio objects have connecting points to which you can glue other objects. For example, you could create a network diagram by dropping several computers, servers, hubs, and printers into a drawing and connecting them by drawing lines or using the auto-connect feature. You could subsequently move the symbols around, and the connecting lines would resize and move to maintain the connections. How many times have you re-

drawn connecting lines when the computer could have done it for you? What a great feature!

Another extremely useful feature of Visio is the master shape. After you drop a shape from a stencil onto a drawing, the connection between the two is lost. However, each drawing maintains its own local stencil that contains one copy of every object in the drawing. By changing the master shape, you change every copy in the drawing. You can change line width, text font, color scheme, and any other attribute in that way.

OTHER FEATURES

Like traditional drawing programs, Visio includes tools for grouping, ungrouping, aligning, and rotating objects to any arbitrary angle. You can also include bitmaps in a Visio drawing; and you can use DDE and OLE to link Visio drawings to documents in other applications, as well as objects from other applications to Visio. You can also import and export files in several common formats (CGM, DXF, PCX, TIF, and Macintosh PICT).

Visio borrows several ideas from Microsoft's Word for Windows, including the template concept, retention of descriptive information about a drawing (title, subject, creator, keywords, and description) and fields. A field is a textual place holder for some value that gets updated dynamically. For example, print date and time, object name and ID, and line length. The latter gives you the ability to create mechanical drawings with automatic dimension lines. And the program supports scaling and automatic dimensioning in common units (*e.g.*, 1 inch = 1 foot).

Visio also includes several traditional tools for creating and manipulating geometric primitives. One cool tool is the pencil, which uses Shapeware's gesture-recognition technology to decide whether you're drawing a straight or curved line. Another is the rubber stamp, which allows you to drop instances of an object as fast as you can drag and click. Features like that make using this program a joy.

USER INTERFACE

I've always admired PageMaker's user interface, and Visio continues the tradition—although I do miss the floating tool palette. In addition, some of the keyboard shortcuts are random. On the other hand, multi-level undo and redo are very useful. My biggest complaint with the software is the limited number and method of specifying line widths (except in a ShapeSheet). You may specify line widths only in units of 1, 3, 5, 9, 13, or 17 pixels. Unfortunately, the relationship between "pixels" and common real-world units (*e.g.*, points) is unspecified. However, given Visio's overall strength, I can easily live with that limitation.

So who is a good candidate to use Visio? Anyone who needs to create drawings out of standard components. Visio can't do what CorelDraw or Adobe Illustrator can do for highly stylized, one-of-a-kind drawings. But for anyone in a technical discipline, this is a must-have program. ■

VENDOR INFORMATION

Visio ($249)
Shapeware Corporation
1601 Fifth Avenue, Suite 900
Seattle, WA 98101-1625
Tel. 206-467-6723.

CIRCUIT CIRCUS

By Charles D. Rakes

LM3909 Applications

This time around, I'd like to share with you a number of circuits based on the LM3909 oscillator/flasher, an 8-pin IC that was originally designed to flash LED's from a low-voltage source while using very little energy. The LM3909, an efficient low-voltage oscillator, requires only a single external timing capacitor to get it oscillating, and can be operated from any DC power source that falls in the range of 1.5 and 6 volts. Once activated, the IC will continue to operate until the supply voltage drops to about 1 volt. Its power requirement is so low that a single C-cell battery will flash an LED for over a year.

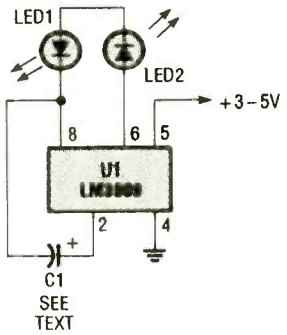


Fig. 1. In this circuit, the LM3909 is used to drive a pair of series-connected LED's.

DUAL LED DRIVER

Figure 1 shows a circuit in which the LM3909 is used to drive a pair of series-connected LED's. In that circuit, C1 (a 470-μF capacitor) sets the operating frequency of U1's internal oscillator to about 1 Hz; a 100-μF unit would increase the frequency to about 14 Hz, and a 47-μF unit would push the operating frequency to about 20 Hz. Larger capacitor values can be used to lower the circuit's oscillating frequency.

The circuit's power source can be 3 to 5 volts with two LED's, and as low as 1.5 volts with only one. The average operating current for the circuit is less than 1 mA.

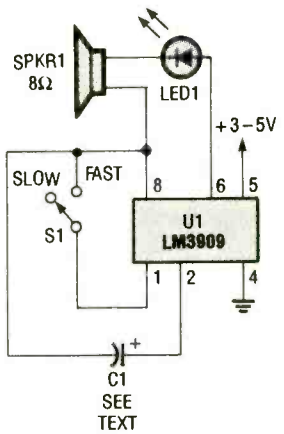


Fig. 2. The LM3909 can also be used to drive both an LED and a speaker. In this circuit, each time that LED1 blinks, SPKR1 (an 8-ohm speaker) gives out a sharp tick.

LIGHT/SOUND CIRCUIT

Figure 2 show another application of the LM3909, wherein it is used to drive both an LED and a speaker. In that circuit, each time that LED1 blinks, SPKR1 (an 8-ohm speaker) gives out a sharp tick. When S1 is placed in the fast position, the LM3909's internal timing resistor is shorted out, causing the oscillator's frequency to increase by more than two to one. You can experiment with different values of electrolytic capacitors to obtain a desired frequency.

VARIABLE AUDIO-FREQUENCY OSCILLATOR

Our next circuit, see Fig. 3, shows a variable audio-fre-

PARTS LIST FOR THE DUAL LED DRIVER

U1—LM3909 LED flasher/oscillator, integrated circuit
LED1, LED2—Light-emitting diode
C1—See text

ADDITIONAL PARTS AND MATERIALS

Perfboard materials, enclosure, 3–5-volt power source, wire, solder, hardware, etc.

PARTS LIST FOR THE LIGHT/SOUND CIRCUIT

U1—LM3909 LED flasher/oscillator, integrated circuit
LED1—Light-emitting diode
C1—See text
S1—SPST toggle switch
SPKR1—8-ohm, 4-inch speaker

ADDITIONAL PARTS AND MATERIALS

Perfboard materials, 3–5-volt power source, wire, solder, hardware, etc.

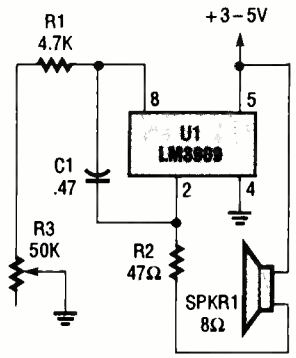


Fig. 3. In this variable audio-frequency oscillator, the output of U1 at pin 2 is used to drive an 8-ohm speaker through R2 (which functions as a current-limiter).

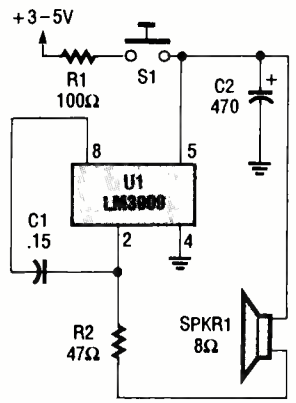


Fig. 4. The LM3909 can also be used as the basis of a simple electronic siren.

quency oscillator built around the LM3909. In that circuit, the output of U1 at pin 2 is used to drive an 8-ohm speaker through R2 (which functions as a current-limiter). The oscillator's lower frequency is set by the value of C1, while its upper-frequency limit is set by the external resistance (actually two resistors, R1 and R3) which are situated between pin 8 and ground (pin 4).

A pair of internal timing resistors set the oscillator's lowest attainable frequency with a given timing capacitor. Therefore, the oscillator's frequency can only be lowered by increasing the timing capacitor's value. However, the frequency can be increased by externally lowering the overall value of the two internal timing resistors. That's done by connecting a resistor between pins 8 and 4 (ground) of U1. By paralleling a resistor between pins 8 and ground, the value of the device's internal timing resistors is effectively reduced, thereby increasing the oscillator's operating frequency (assuming that C1 remains constant).

A SPST switch may be placed between pins 1 and 8 and used as a frequency-range switch. If additional ranges are desired, you can add a multi-position switch (such as a 5–10 position rotary type) to select different values for C1.

PARTS LIST FOR THE VARIABLE AUDIO-FREQUENCY OSCILLATOR

U1—LM3909 LED flasher/oscillator, integrated circuit
C1—0.47-μF, ceramic-disc capacitor
R1—4700-ohm, ¼-watt, 5% resistor
R2—47-ohm, ½-watt, 5% resistor
R3—50,000-ohm potentiometer
SPKR1—8-ohm, 4-inch speaker

ADDITIONAL PARTS AND MATERIALS
Perfboard materials, enclosure, 3–5-volt power source, wire, solder, hardware, etc.

PARTS LIST FOR THE ELECTRONIC SIREN

U1—LM3909 LED flasher/oscillator, integrated circuit
R1—100-ohm, ½-watt, 5% resistor
R2—47-ohm, ½-watt, 5% resistor
C1—0.15-μF, ceramic-disc capacitor
C2—470-μF, 16-WVDC, electrolytic capacitor
S1—Normally open pushbutton switch
SPKR1—8-ohm speaker

ADDITIONAL PARTS AND MATERIALS
Perfboard materials, enclosure, 3–5-volt power source, wire, solder, hardware, etc.

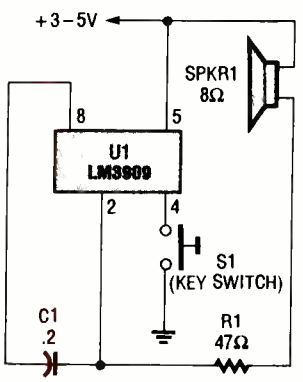


Fig. 5. With only a minor circuit change, the basic LM3909 oscillator configuration can be turned into an code-practice oscillator.

PARTS LIST FOR THE CODE-PRACTICE OSCILLATOR

U1—LM3909 LED flasher/oscillator, integrated circuit
C1—0.2-μF, ceramic-disc capacitor
R1—47-ohm, ½-watt, 5% resistor
S1—Morse-code key
SPKR1—8-ohm speaker

ADDITIONAL PARTS AND MATERIALS
Perfboard materials, enclosure, 3–5-volt power source, wire, solder, hardware, etc.

ELECTRONIC SIREN

In our next circuit, see Fig. 4, the LM3909 is used in a simple electronic siren. A large storage capacitor (C2), a resistor (R2), and a pushbutton switch converts the standard oscillator configuration (see Fig. 1) into a fun noise maker that can keep the kids busy for hours on end.

When S1 is closed, C2 begins to charge rapidly through R1. When the charge on C2 reaches about 1 volt, the oscillator starts. As the voltage across C1 increases toward +V, the oscillator's output frequency also increases. Releasing (opening) S1 removes power from the circuit. The oscillator continues to operate, with a decline in output volume and frequency until C1 discharges to about the 1-volt level.

Experiment with the siren circuit by selecting different R1/C2 combinations to obtain a desired rise and fall output. Change the value of C1 to vary the oscillator's frequency. Keep the value of R2 at or above 47 ohms to protect the IC from drawing too much current.

CODE-PRACTICE OSCILLATOR

With only a minor circuit change, the basic LM3909 oscillator configuration can be turned into an code-practice oscillator. Refer to Fig. 5. With a key switch (S1) added to the basic circuit and the right timing capacitor, the circuit can be made to produce the desired tone. The circuit can be powered from a pair of AA

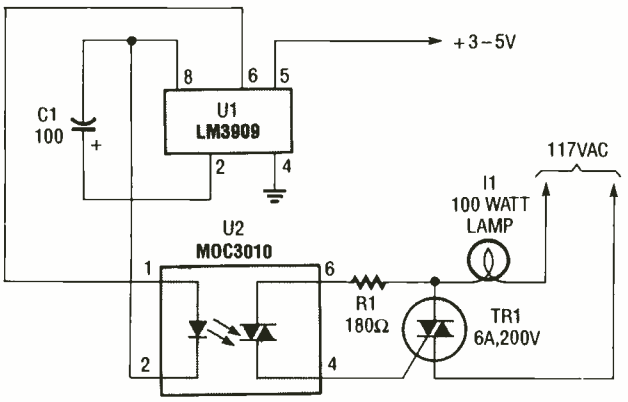


Fig. 6. Here the LM3909 (configured as a timing oscillator) is used to control a 117-volt AC lamp through an MOC3010 optoisolator/coupler.

PARTS LIST FOR THE LAMP PULSER

U1—LM3909 LED flasher/oscillator, integrated circuit
U2—MOC3010 optoisolator/coupler with Triac driver output, integrated circuit
TR1—6-amp, 200-PIV Triac
R1—180-ohm ¼-watt, 5% resistor
C1—100-μF, 16-WVDC, electrolytic capacitor
I1—100-watt AC lamp (see text)

ADDITIONAL PARTS AND MATERIALS

Perfboard materials, enclosure, IC sockets, 3–5-volt DC power source, AC molded power plug with line cord, wire, solder, hardware, etc.

batteries (which will run the circuit for a good while) connected in series. And since there's no battery drain when its not in use, an on/off switch isn't required for this circuit.

LAMP PULSER

In Fig. 6, the LM3909 is configured as a timing oscillator, whose output is used to pulse a 117-volt AC lamp on and off. The pulsed output of U1 is fed to the input of U2 (an MOC3010 optoisolator/coupler), causing its internal LED to turn on in time with the signal's positive alteration. Light from the internal LED striking the output device (in this case, a Triac driver) causes it to be turned on and off in time with the oscillations of U1. That, in turn, feeds a pulsed signal to the gate of TR1 (a 6-amp, 200-PIV Triac), causing that Triac and I1 (a 100-watt lamp) to turn on with each positive-going transition of the oscillator signal.

The circuit can easily handle three 100-watt lamps; by heat sinking the Triac, loads of up to 6 amps may be controlled. As before, the oscillator's output frequency can be changed by varying the value of capacitor C1.

Take a close look at the LM3909 circuits and see if you can incorporate one into a future project or you might consider spending an hour or two trying out one or more of the circuits just for fun. In any case, I believe that you'll find the LM3909 a very versatile and useful device.

Well, that's about all the space allotted to us for this month, but be sure to join us again . . . "same time, same station." ■

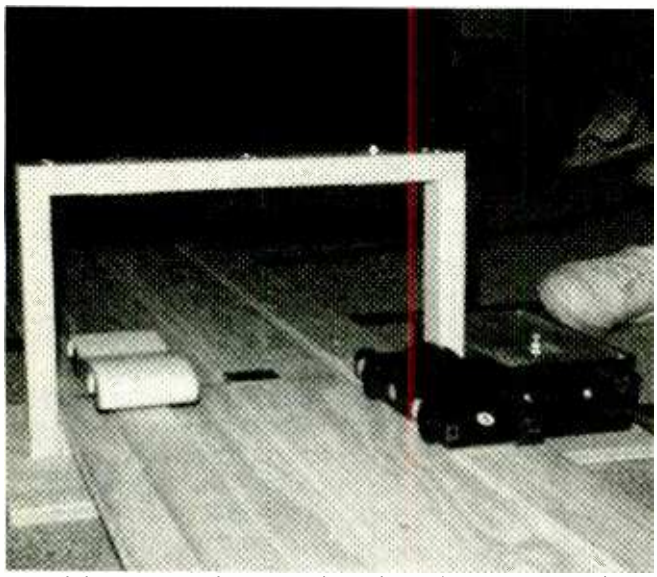
THINK TANK

By John J. Yacono

Logic Gates and Derbys

As I promised last time, I'll continue to describe the key differences between the bipolar-logic and CMOS-logic families. This month, I'll also present some pinewood-derby circuits submitted by participating readers.

To quickly review, I've already pointed out that bipolar devices are driven by current, while CMOS devices respond to voltages. That allows CMOS devices to operate over a range of power-supply voltages, while bipolar circuits can only be designed to operate at a specific supply voltage (5 volts is the established standard).



"And the winner is the car on the right, as it zooms across the finish line!" Thanks to the handy circuit installed in the track, we know that for sure.

That fact also forces the voltage ranges used to represent bipolar highs and lows to be rigidly defined, while CMOS highs and lows are defined as percentages of the supply voltage. As you'll see, the difference in power-supply requirements is directly or indirectly responsible for almost all the other differences between the two families as well.

For example, since a bipolar device depends on significant current to operate, by Joule's Law, a bipolar IC will generate more heat than a similar CMOS circuit operating at the same speed with the same supply voltage. That also means the transistors in bipolar-logic circuits must be spaced far enough apart to keep them from affecting one another or even causing a catastrophic break down. That, in turn, limits the amount of bipolar circuitry that can be crammed into an IC package.

While there are similar limits for CMOS circuits, those limits are much broader, so much more CMOS circuitry can be crammed into the same IC package. Furthermore, the FET's in CMOS chips are physically simpler and thus smaller than bipolar transistors. As a result, CMOS circuits can be designed smaller still.

Since bipolar IC's consume more current and generate more heat than CMOS units, they also require more power. On the plus side, though, that also means that bipolar-logic circuits are capable of handling significant current. Therefore, depending on their architecture (which we won't discuss now), bipolar circuits can generally provide more output current than CMOS circuits.

There are two other key drawbacks to CMOS circuits: speed and sensitivity to electrostatic discharges (ESD) or electric shocks. While ESD damage can be prevented by observing good handling procedures (such as grounding all nearby objects and people in a workshop to create a "static-free environment"), little can be done to overcome the speed limitations of a true CMOS circuit. When you consider all the great advantages of CMOS circuits, it seems a shame that one of their shortcomings is so significant (think about it—operational speed is the one thing we demand from a logic circuit).

Fortunately, IC designers have struck a compromise between bipolar and CMOS logic, resulting in hybrid IC's—circuits that are a combination of bipolar and CMOS components. Such designs seek to minimize the disadvantages of both families by combining their strengths. A rather elegant compromise that we'll explore in more depth in a later issue.

DESIGNATIONS

The only difference between the two families that is *not* based on their power-supply requirements is how they are designated; the designation for TTL chips have the prefix "74," while CMOS chips have the prefix "4." Often there is a letter or two before a prefix that represents the manufacturer. For 74-series chips, there might also be a couple of letters immediately following the 74 that tells you the chip's architecture. The numbers that follow all that tell you the

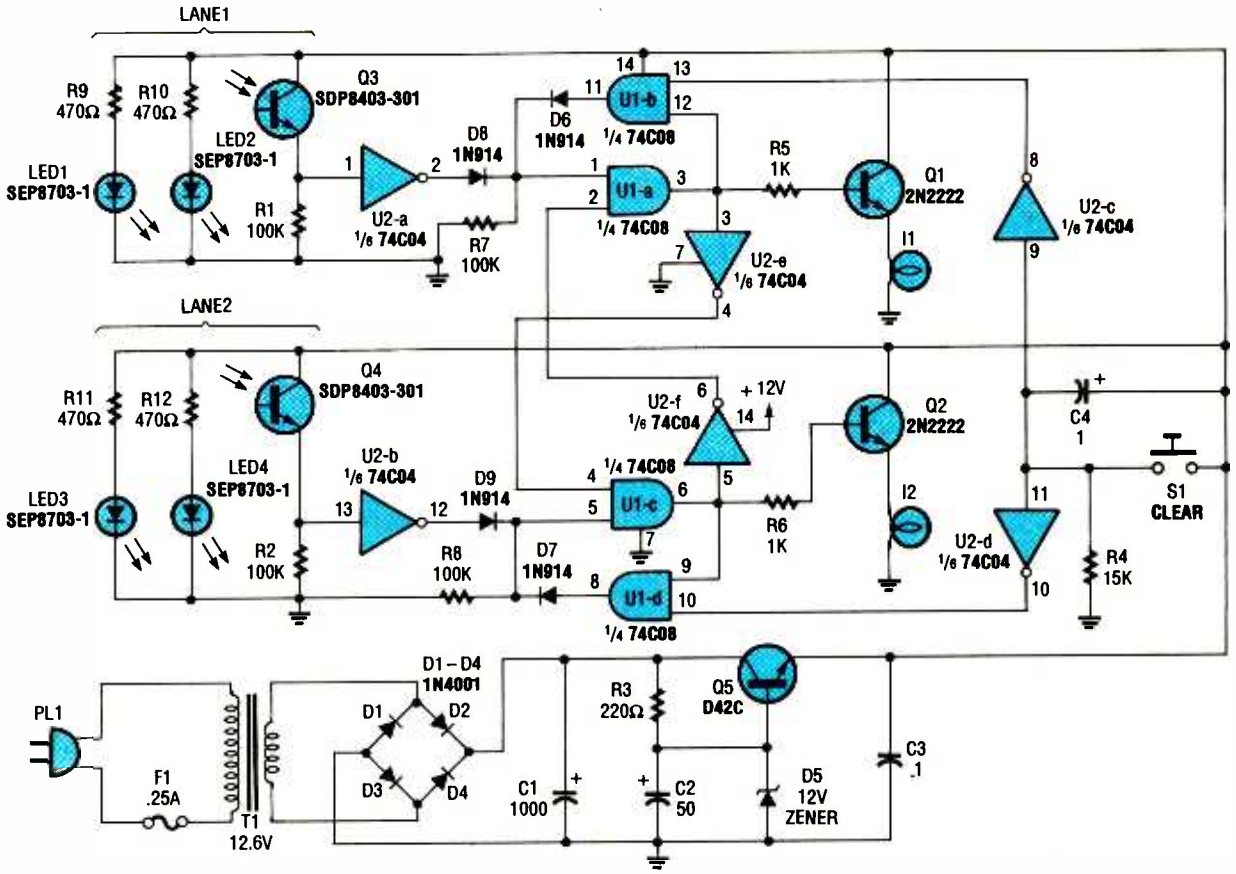


Fig. 1. This derby-winner indicator uses infrared emitters and sensors to detect a car crossing the finish line. The first car to finish locks out the data from the second car, and the system can be reset by depressing S1.

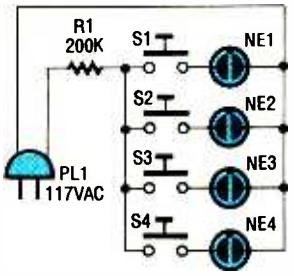


Fig. 2. Truly a straightforward design, this winner indicator could hardly be made simpler. When one of the neon lamps ignites, it deprives the others of sufficient voltage to ignite.

function of the chip. There may be up to three additional letters or a letter and a number following the designation that tell you more detail about the chips inputs, outputs, and/or package style.

For example, consider the designation AM74S182-S3. The letters "AM" indicate the chip was made by Advanced Micro Devices, the "74" tells you the device is based on bipolar transistors (as opposed to FET's), the "S" stands for "Schottky" architecture (which we won't get into yet), the number 182 indicates the chip is a look-ahead carry generator, and the "S3" indicates that the chip has low-leakage outputs (which we'll also discuss at some other time).

Now let's turn our attention to the reader mail. As mentioned, the letters all deal with pinewood-derby circuits.

THE WINNER IS . . .

The enclosed circuit (see Fig. 1) was developed on request to determine the winner in close races of a pinewood derby. A bridge over the track (see photo)

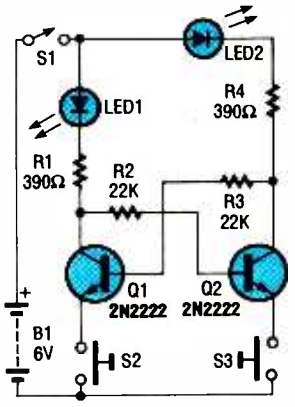


Fig. 3. Note how depressing a switch (grounding the emitter of a transistor) not only lights an LED, but deprives one of the transistors of base current, too.

was constructed to support the infrared LED's (LED1–LED4) and the winning-car lights (I1 and I2). The two pairs of LED's are aimed down at two IR phototransistors (Q3 and Q4), each of which is embedded in a lane of the derby. When a car moves down a lane and passes under the bridge, it momentarily prevents the IR from reaching its corresponding phototransistor.

Pins 1 and 13 of U2 are held at a logic 1 whenever the IR detectors are illuminated by the IR LED's. The 1's are inverted by U2-a and U2-b and the resulting logic 0's are applied to pins 1 and 5 of U1. Since those pins are low, the outputs of those gates (pins 3 and 6) will be at logic 0 regardless of the logic of pins 2 and 4. Those outputs (pins 3 and 6), thus keep transistors Q1 and Q2 off, so the indicator lights remain off.

If a car interrupts the IR beam of lane 1, pin 1 of U2-a is pulled to a logic 0 by

R1, and pin 2 produces a logic 1 that is passed to pin 1 of U1-a. Since there was already a logic 1 on pin 2 of U1-a (provided by U1-f, which inverts the output of U1-c), U1-a's output goes high. That turns on Q1, allowing the indicator lamp for lane 1 to light, declaring the winner.

The output of U1-a is inverted by U2-e and the logic 0 produced is applied to pin 4 of U1-c. The car coming in second on lane 2, results in a 1 being applied to pin 5 of U1-c. However, since pin 4 is at a logic-0 level and pin 5 is at a logic-1 level, pin 6 of U1 will also be at a logic-0 level. So the signal at pin 4 has locked out the signal from to the second car (lane), preventing its light from coming on.

The cross coupling between the indicator circuits allows the circuit for the winner's lane to lock-out the data from the losing lane when the winning car is in lane 2 also. So there can only be one indicator light on at a time.

Capacitor C4 provides a pulse on power-up to ensure that when the unit is turned on neither light comes on. The switch (S1) marked "clear" is a momentary pushbutton that is used at the end of each race to extinguish whichever light is on and prepare the circuit to judge the next race.

—Roy R. Worrall, Ocala, FL

Definitely a very stable design. I like the use of the diode pairs (like D6/D8) that act like OR gates to reduce the number of chips used. The circuit can be simplified further if U2 is dispensed with. To accomplish that, the phototransistors should be swapped with their current-limiting resistors, C4 and S1 should be swapped with R4, and U2-e and U2-f should be replaced with inverting transistor circuits.

PUSHY SOLUTION

Although it is unfair to the other writers of this great magazine, the first sections I look at when **Popular Electronics** arrives are "Think Tank" and "Circuit Circus." I've been an on and off subscriber to the magazine since the 1950's.

I designed one of the simplest circuits to determine which of a group of pushbuttons was pressed first (see Fig. 2). Using one resistor and one neon lamp per player (or whatever will activate the switches), only the first switch closed will light its lamp. The characteristics of the neon lamp, requiring 60 to 100 volts to ignite and very little current, make this simple circuit work. (If a low-voltage neon lamp is used, put two lamps in series. Otherwise use a larger value resistor). The first switch closure ignites the appropriate lamp, and after that happens there is insufficient voltage to fire any of the others. Have fun with this one!

—Tom Karg, Oil City, PA

Thank you for being such a fan of the column. As you surely know, your circuit can be readily adapted for pinewood derby use. One simple method for doing so would be to mount a small magnet on the underside of each car and replace the pushbutton switches with reed switches embedded in a car lane. With that done, when a car passes over a reed switch, its magnet will activate the reed switch, lighting the appropriate lamp.

QUICK-DRAW MCGRAW

Quick Draw McGraw is a game of agility. The object of the game is to prevent your opponent from lighting the LED on your side of the circuit before you light his (see Fig.3). When you yell "draw," the first one to press his or her switch (S2 or S3) wins the contest. The results are registered by LED1 or LED2.

To make the game even more exciting, you can try replacing S1 with a pair of contacts located on the surface of a channel wide enough to accommodate a ball bearing. When a ball bearing rolls down the channel and completes the circuit, you go for your trigger switch. Or you can leave S1 closed and hold both S2 and S3 closed. The first one to release his switch wins the game.

—Nolan Friedland, Cambridge, MN

Note the cross coupling between the circuitry for each player. That duplicates the cross coupling in the circuit of Fig. 1; albeit, this circuit is much simpler in execution.

Now let's change pace just for a moment to address a request from a reader.

A NEED

Every year my community has a pinewood derby for the kids. The children are given a standard block of wood, from which they carve a car of their own design. Unfortunately, as each "heat" proceeds, it becomes increasingly difficult to judge which car is the winner.

We have six cars racing at a time. What I need to find is a way to electronically judge and display first through sixth place. It doesn't need to be anything fancy, a simple light on each lane would suffice. Do you have any schematic diagram of a circuit that might do the job or have any suggestions?

Any help that you or your readers can provide would be greatly appreciated.

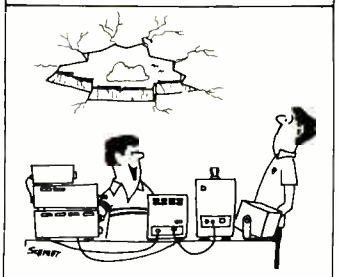
—Stephen Guye, Galt, CA

It's really nice that you take such a vested interest in your community and its youth. It's paradoxical to note that electronic technology, which has made the world a smaller place (with FAX's, satellites, TV, etc.), has taken a little of the friendliness out of most communities (folks are too "busy" thanks to TV, VCR's, video games, at-home shopping, etc.). I suppose, it only makes sense to use electronics to set things straight by bringing people together again.

I'm sure Stephen is not alone in his quest, so if anyone out there can help him, please send your comments or plans to this column. I'll try to group the responses together and dedicate a column or two to the circuits.

All of the contributions that fit Stephen's criteria and appear in these pages will be rewarded with a special MCL1010 chip, mentioned back in my first column (April 1991). Of course, you will also receive the usual book.

That's all until we get together next time. In the meantime, if you have other circuits, comments, or questions please address them to: *Think Tank*, **Popular Electronics**, 500-B Bi-County Blvd., Farmingdale, NY 11735. If your letter appears in *Think Tank*, you'll receive a book from our big pile. ■



"I solved the overheating problem."

DX LISTENING

By Don Jensen

What's In the Future For Shortwave Broadcasters

Where do the big boys go? What do they do now? That's a question that many of the world's major shortwave broadcasters are asking themselves these days. For decades, many of the large international shortwave defined themselves—and when it came to funding, justified their existence—in Cold War terms.

This sketch of a small boy in traditional Bolivian garb is from an information leaflet sent to listeners by Radio San Gabriel, a shortwave outlet occasionally heard in Spanish on 6,084 kHz at around 1100 UTC.

The death of international Communism, the break-up of the Soviet Union, and the democratization of Eastern Europe changed all of that. In years gone by, broadcasters like the *Voice of America*, the *BBC*, and *Radio Free Europe* battled the Iron Curtain's jamming of their signals. Ironically, not long ago Bulgaria, once one of the most vehement of radio's "cold warriors," announced that it hopes to lease air time to western commercial broadcasters on two surplus shortwave transmitters, which once were used only for jamming.

To address these concerns, a few months ago the Voice of America convened a gathering of some 100 international broadcasters in Washington D.C. The New York Times reported that Robert Coonrod, deputy director of the VOA, summarized the conference by saying it "helped us to think through how to present ourselves to our own societies, and explain why what we do is important."

Explaining themselves, and their importance, to homefolks has become a necessity for shortwave broadcasters in the post-Cold War era. In the "good old, bad old" days, most western governments were more than willing to fund expensive international SW services to counterbalance extensive and powerful propaganda broadcasts from behind the Iron Curtain.

Today, though, that battle of the airwaves has been won. In some ways, western shortwave operations are victims of their own successes. Taxpayers in many countries are now asking why they should continue to finance their foreign SW services.

The broadcasters' conference in Washington responded, calling attention to the need to continue broadcasting to areas of ethnic conflict and political turmoil, the New York Times article recounted. Longtime and well-known shortwave-broadcasting consultant George Jacobs told the gathered station representatives that their programming during the past decades had been vital. Western broadcasters, he said, had taught people in the former Communist nations how to take apart the old economic system. "Now they'd like to hear how to put it together," Jacobs said.

Another reason for continuing international broadcasting, said Susan Roehm of Radio Free Europe/Radio Liberty, is that SW radio from the West often still acts as "a stabilizing element in the lives" of listeners in areas of unrest, such as Uzbekistan and Tajikistan, which was set adrift with the fall of the USSR.

But the big international stations are looking at different ways to get their programming to audiences in developing nations such as those, and, in general, to listeners around the world. Not far in the future, many observers believe that direct satellite-transmission systems will deliver these programs to foreign listeners. At the moment, more and more of the major international stations are leasing time on ex-Soviet and Eastern European shortwave transmitters to get better audience penetration in these areas. But the Times also reports that international broadcasters, large and small, are faced with competition from

fledgling local AM and FM stations that are springing up throughout the former Communist bloc.

In response, some, like *Radio Nederland* and *Radio Austria International*, have joined the competition, rather than fight. They are selling program packages to those local AM/FM stations. So do those alternatives mean that shortwave's day is over? Should SWL's be concerned that, after nearly 70 years, there soon will be nothing left to tune in? The visiting broadcasters at the VOA's conference think not.

The regular annual airmail rate for the monthly magazine is $40 for U.S. subscribers. The address is BBC Worldwide, c/o BBC World Service, P.O. Box 76, Bush House, Strand, London, WC2B 3PH, England.

IT'S NOT WHAT YOU SAY

Speaking of the venerable BBC, its reputation for doing things right was built with much effort over many long years. There's an old story that, in the beginning, BBC announcers were required to wear formal attire even though listeners could not see them while they were on the air. The idea, supposedly, was that clothes made the man, lent a serious tone, a sense of authenticity and authority to the news the speaker was reading.

Not only was what the announcer said important, but how he said it. Because of that, the BBC, as early as 1924, established a Pronunciation Research Unit. Dan Shelby, Frederick, MD, reports in the "WDXC Contact" that phoneticist Arthur Lloyd James lectured BBC announcers on the subject, leading to a request for a full-time pronunciations adviser. A committee on spoken English was established, which, over the years, included the likes of dramatist George Bernard Shaw, poet Robert Bridges, and other world-class writers.

The group also had language scholars, phonics professors, Shakespearian actors, and other notable experts. Eventually the committee grew to more than 30, an unmanageable number. Today, the Pronunciation Research Unit has a staff of three linguists and a clerk, led by Graham Pointon, who used to lecture on English phonics at a Norwegian university, Shelby says.

The office deals mostly with the pronunciations of foreign names that pop up in BBC newscasts. It keeps an index of a quarter million entries (phonetically sounding out the names), with additional cards added each week as new places and personalities crop up in the news. The rule of thumb on pronouncing names, Shelby says, is to ask the owner whenever possible, even when, as it happened, a person is a convicted criminal.

Traditional world-band radio will not be phased out, said the VOA's Myrna Whitworth. In the event of political upheavals anywhere in the world, local AM/FM stations can be forcibly shut down. Experienced listeners know that those stations usually are the first targets of both revolutionary hotheads and reactionary dictators. Shortwave, Witworth said, remains a reliable broadcasting tool since news and information programming that originates from outside the affected area can still get through. The coming century will bring real challenges to broadcasters, but shortwave radio, doubtless, will continue to have a major role.

What do you think world-band broadcasters should do in the years ahead? Should they emphasize news to a greater extent? Has shortwave a greater role to play in education, world culture, or tourism? Specifically, what types of programs—or program formats—would you prefer to see developed or expanded. Drop me a note with your thoughts on shortwave's future. I'll include the best ideas in a forthcoming column. The address, as always, is Don Jensen, *DX Listening*, **Popular Electronics,** 500-B Bi-County Blvd., Farmingdale, NY 11735.

THE BBC'S NEW MAG

For many years, SWL's who are special fans of the incomparable British Broadcasting Corporation programs have subscribed to its program guide known as "London Calling." It was, frankly, the best way to insure that you didn't miss any of the fascinating informational, entertaining, dramatic, or musical programs aired on BBC's all-English-language World Service on shortwave.

The 28-page monthly disappeared last fall: However, it is not dead. The familiar London Calling was simply folded into a new 100-page magazine called "BBC Worldwide." A preview by Dan Smith, writing in the "World DX Club bulletin," says the new BBC's magazine is not only larger, but "much brighter and nicer to read."

As usual, readers will find listings of specific BBC programs scheduled for the month ahead, program highlights, five pages of frequency charts telling listeners where to tune, plus summary details of other language services. There are also numerous articles related to BBC programming. An early issue included features on Cuba, composers Gershwin and Kern, collecting news items on audio tape, sports events, a semi-technical article on sunspots, science and popular culture stories, plus book reviews, a crossword puzzle, and letters from readers.

DOWN THE DIAL

Looking for some interesting listening on shortwave? Try these.

BHUTAN—5,025 kHz. *Bhutan Broadcasting Service* is a very difficult catch in much of North America, but it has been heard in California from 1410 until its 1450 UTC sign off, with popular music and English news.

GUATEMALA—3,380 kHz. *Radio Chortis* broadcasts all in Spanish, but if you enjoy lots of the lilting marimba music so typical of Central American, try this station from around 0230 to its 0300 UTC sign off.

LEBANON—6,543 kHz. *Voice of Lebanon* broadcasts in both Arabic and French. It has been reported here with Arabic music, advertisements, and identifications from about 0335 UTC.

UNITED ARAB EMIRATES—11,945 kHz. *Radio Dubai* can be heard with its English program from 0328 until 0355 UTC. If that frequency doesn't work for you, try one of these alternates—13,675, 15,400 or 15,435 kHz—airing at the same time. ■

*Credits: E. Newbury, NE; Mike Westdal, CA; Hans Johnson, MD; Scott Newman, NY; North American SW Association, 45 Wildflower Road, Levittown, PA 19057; World DX Club, c/o Richard D'Angelo, 2216 Burkey Drive, Wyomissing, PA 19610.

By Joseph J. Carr, K4IPV

"Loading Up" A Tower?

For a long time, ham operators have delighted in "loading up" nearly anything they think might radiate a signal. Loading up basically means that some method is found whereby the impedance of some strange object can be matched to the output of the transmitter. In the vacuum-tube days, pi-network output circuits made it easy. Even today (when a rig's outputs are untuned), an antenna-tuning unit (ATU) can be used to match very odd impedances. And what kind of strange "antennas" have been loaded up? Loaded bedsprings were popular in the 1930's.

In about 1963, I participated in a hidden transmitter hunt in Norfolk, VA where the "fox" (hidden mobile unit) loaded up a long chain-link fence around a factory lot. And the year before, I was told that the same character had loaded up the railroad tracks on 75-meters!

Many amateur radio and other stations use rotatable beam antennas mounted on three-sided towers, which typically range in height from 30 to 120 feet. In my locale, towers of 30 feet, or less than three feet above the roof line (whichever is taller) can be erected without a permit, as long as they are attached to the house and are located so that they will not fall onto power lines or across the property line in a catastrophic failure. Higher towers must be erected under permit and properly inspected by the county.

The towers typically support a two or more element (three is popular) Yagi/Uda beam antenna, quad, or some other highly directional antenna. But the tower itself can also be treated as a vertical antenna under the right circumstances.

If the tower is close to 66-feet high (which is a popular height for amateur-radio towers), then the tower is already λ/4, at 75/80 meters, so it can be used as a resonant vertical on that band. The same tower can also be used on lower frequencies if the proper antenna-tuning unit (ATU) is provided.

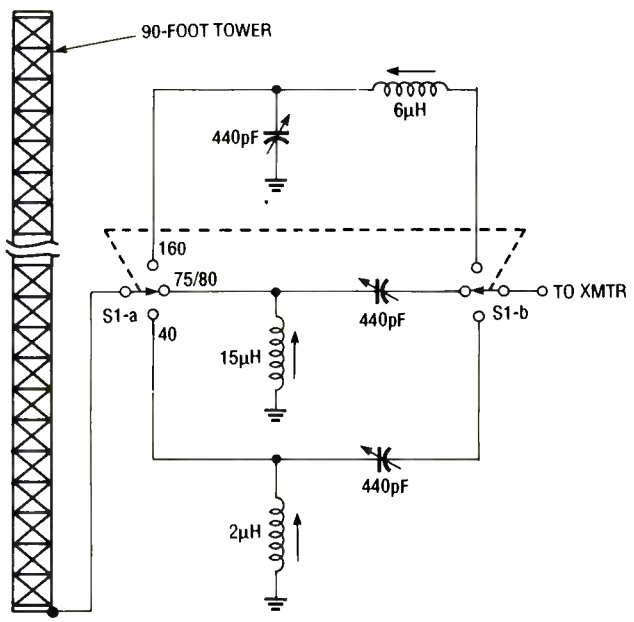


Fig. 1. This 80- to 110-foot tower (considered a random length, vertically polarized, Marconi antenna) is insulated from ground, and is fed using a simple L-section or reverse L-section ATU.

RADIO TOWERS

Figure 1 shows a situation in which an 80- to 110-foot tower—which is considered a random length, vertically polarized, Marconi antenna—is insulated from ground. Like other such antennas, it is fed using a simple L-section or reverse L-section ATU. Note the configuration of the circuit and approximate values of the inductor and capacitor used in each configuration.

On the 40- and 75/80-meter versions, the tower is too long, so a series capacitance and shunt inductance are used for the ATU (*i.e.*, reverse L-section coupler). But, for 160-meters, the tower is too short, so the inductor and capacitor are reversed. There is only one small problem with the design illustrated in Fig. 1: insulated towers are expensive to buy and install compared to grounded towers. In addition, lightning protection is probably better in the grounded tower.

So how do we load up a grounded tower? See Fig. 2. Note that in that illustration, the tower is grounded at its base. If the tower is mounted to a concrete pedestal (the usual arrangement), then a separate ground rod and ground wire adjacent to the pedestal must be provided. (Concrete is not a good insulator, but it is not a good conductor either.) A delta-feed system (a single wire from the ATU connected to a point on the antenna where an impedance match can be achieved) is normally used with such an antenna.

It is important that the ATU be placed away from the tower base (as shown) and that a wire be run straight to the antenna feedpoint. That system is an example of several possible shunt-feeding systems.

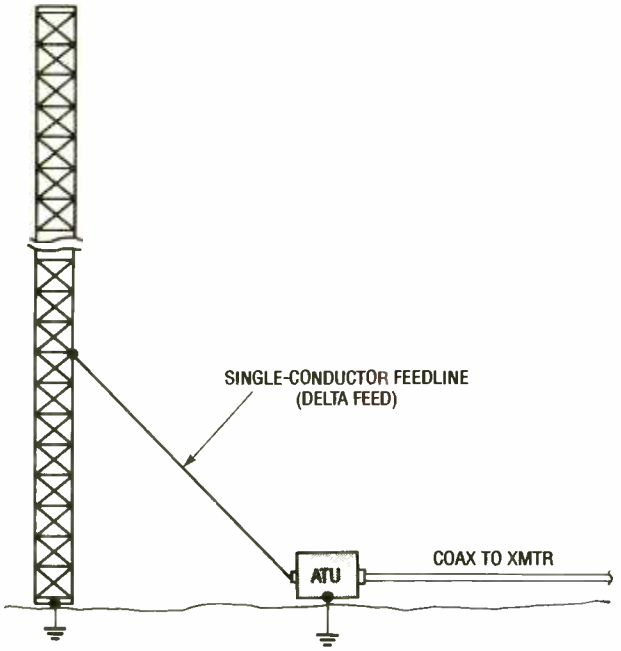


Fig. 2. Here the antenna tower (mounted to a concrete pedestal) is grounded at its base.

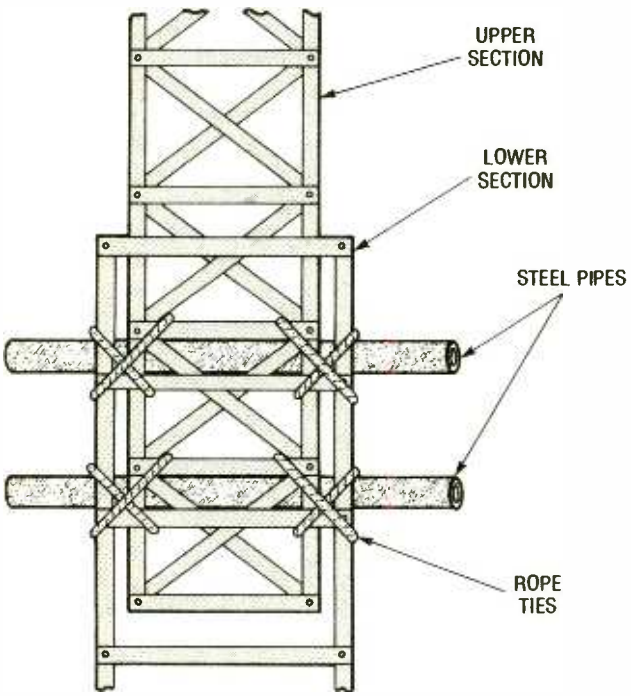


Fig. 3. If you have a slip-up tower, and intend to climb it (whether in retracted or extended positions), place a safety bar in it (as shown here) to prevent it from slipping, even if the tower has locking features.

If the tower is a tilt-over or slip-up type, then it might be a little difficult to excite it with RF power because the mechanism that makes it tilt or slip is discontinuous electrically. Those towers are quite popular, even though costly, because they allow the antenna to be worked on at or near ground level, rather than up in the air. They allow you to run a wire across the junction or up the entire length of the tower. You simply have to make sure that the wire clears and does not interfere with the tower-lowering mechanism.

SAFELY ERECTING A TOWER

Radio towers are dangerous devices, and care should be used when working on them. Always use the "buddy system" and work with one or more friends.

Always use a safety belt when on the tower. And always make sure that the tower will not fall over power lines, structures, or your property line if it gets away from you. Follow all of the manufacturer's recommendations; they are good sources of advice about their products. And be sure to obey all local codes, rules, regulations, and laws.

If you have a slip up tower, and intend to climb it (whether in retracted or extended positions), place a safety bar in it (as shown in Fig. 3) to prevent it from slipping (and possibly cutting off your arms and/or legs), even if the tower has locking features. Locking features can fail. The safety bar used in Fig. 3 is a 1- to 3-inch hard steel, thick-wall section of pipe placed so as to prevent the tower sections from slipping (collapsing).

That's all for now; see you next month. In the meantime, if you want to know more about towers and antenna-tuning units, you might want to obtain my books "Receiving Antenna Handbook" (HighText Publications, 7128 Miramar Road, #15, San Diego, CA, 92121; Tel. 619-693-5900) and "Practical Antenna Handbook" (TAB/Mc-Graw Hill, Blue Ridge Summit, PA 17294; Tel. 800-233-1128). ■

SCANNER SCENE

By Marc Saxon

Tuning in TV, and more!

When the Realistic PRO-43 handheld scanner came out, it was hailed by many aficionados as the most wonderful thing since the discovery of the Doublestuf Oreo. The 200-channel deluxe handheld covers virtually all bands, including the 225–400-MHz UHF aeronautics band (used by the military). While all of that is great, not every scanner owner is interested in the UHF aeronautics band.

The Realistic PRO-39 offers all the features of the PRO-43—minus the aeronautics band and about $50 from the price tag!

Radio Shack's answer is the *Realistic PRO-39* handheld scanner. It is a deluxe scanner with features very similar to the PRO-43, but there are two major differences. First, the PRO-39 doesn't include 225–379.995 MHz in its coverage. Second, at $299.95, it sells for $50 less than the PRO-43. Otherwise, the two units have a lot in common.

The PRO-39 covers 30–54, 108–174, 380–512, and 806–960 MHz (minus the cellular bands). The 200-channel (10 banks of 20 channels) scanner features HyperScan (25 channels-per-second scan/50-cps search), two-second scan delay, priority channel, a backlit LCD readout, a flexible antenna with BNC connector, and a belt clip. The PRO-39 will retain its memories for an hour after the batteries are removed. It uses six "AA" batteries, or it can take rechargeable types.

The Realistic PRO-39 is a fine scanner. For those who like the PRO-43, but don't figure to get any use out of the UHF aeronautics band, the PRO-39 is definitely the scanner to investigate as a very suitable replacement. It performs just as nicely as the PRO-43 on the bands that they have in common.

Your nearest Radio Shack has the PRO-39 right on the counter.

WON'T ACCEPT PROGRAMMING

Readers regularly write to report being baffled by the fact that some scanners refuse to accept the frequencies that they try to program in. That happens most often when a frequency with four digits after the decimal (such as NASA's 173.6875 MHz) is attempted. The scanner might take the frequency, but it shows up on the display as 173.685 MHz.

At that point, they become frustrated and think that they did something wrong, only to realize that any similar frequency they attempt to program in won't be accepted that way. Some scanners, especially handhelds, "round off" all entered frequencies to the nearest 5-kHz point. If the frequency is something like 155.88 or 154.325, it will be accepted "as is." It is only when stations operate on frequencies between the 5-kHz points that some scanners balk at the programming.

Scanner owners then fear that they won't pick up the communications on those frequencies because of their rebellious radios. That is not a real problem, however. The frequency that the scanner is displaying can't be more than 2.5 kHz from the frequency that it had refused to accept as programmed. FM signals are 16-kHz wide, which means that they extend at least 7-kHz above and below their center assigned frequency. With the scanner tuned a mere 2.5 kHz away from the center frequency, any sig-

nals that occur there still will be heard normally, without suffering from the very slight detuning.

FEDERAL FREQUENCY DIRECTORY

The new, eighth edition of the *Top Secret Registry of U.S. Government Radio Frequencies* is out. This is *the* book, the standard reference to federal agencies such as the FBI, DEA, Customs, Secret Service, BATF, FCC, FAA, Immigration, Treasury, Border Patrol, Marshals, EPA, NRC, USPS, GSA, CIA, State Department, national parks, and other agencies. It also has Canadian federal listings. It has complete UHF aeronautic (225–400-MHz) band listings, and U.S. military listings, now *worldwide*. It has CTCSS tones, paging, bug, and vehicle-tracking frequencies, plus a lot more! This huge, 268-page, professional-grade monitoring directory is relied upon by law-enforcement agencies, private-security personnel, the news media, the communications industry, and the leading scanner monitors.

If your local communications dealer doesn't carry the book, order it from CRB Research Books, P.O. Box 56, Commack, NY 1172. It costs $21.95 plus $3.50 shipping ($4.50 Canadian). Residents of NY state must add $2.15 sales tax. Phone orders are accepted weekdays (except Wednesday) from 10:00 AM to 2:00 PM EST at 516-543-9169; 24-hour fax: 516-543-7486.

TV TIP

Mike Giamportone, of Marysville, MI, reminds readers that if they place their scanners into WFM mode, they can pick up the audio of TV channels. TV Channel 2 comes in on 59.75 MHz, Channel 3 on 65.75 MHz, Channel 4 on 71.75 MHz, Channel 5 on 81.75 MHz, Channel 6 on 87.75 MHz, Channel 7 on 179.75 MHz, Channel 8 on 185.75 MHz, and Channel 9 on 191.75 MHz were the examples he passed along.

While Mike's idea might sound a bit odd, last week I had to drive somewhere at night and missed an important program that I wanted to catch. I took Mike up on his concept and programmed the TV station's audio channel into my mobile rig. I had no video, but all I missed was seeing Marge's blue hair and Bart's crew cut!

MORE MAIL

From M.J.C., Registered Monitor KCA6BDH, of Glendora, CA, sent along some frequencies of interest. Glendora Police are on 154.845, local government on 153.86, and Fire Dispatch on 470.5375. He also has the Pasadena Police on 482.3375, with the Fire Department on 153.89. West Covina Police are on 506.3375 MHz and Fire Department on 156.165 MHz. Montebello Police use 482.2125 MHz.

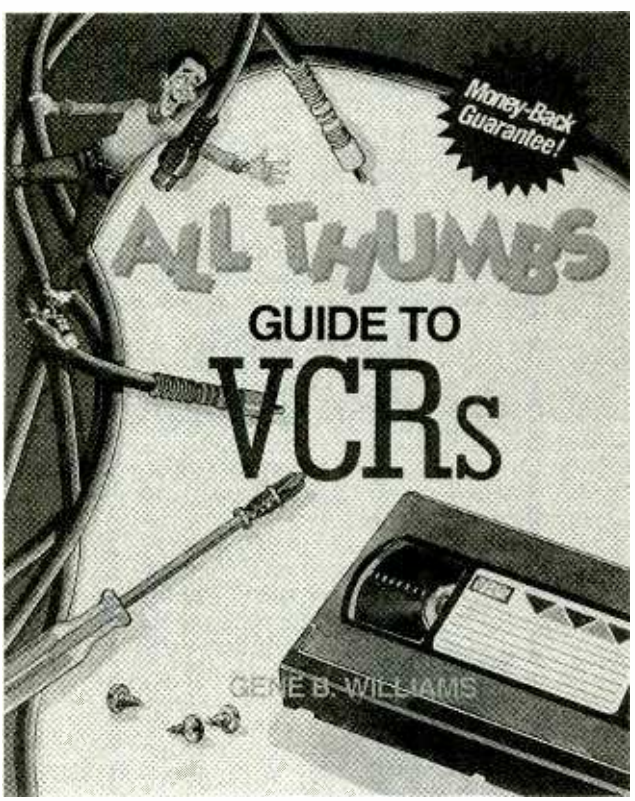
Zeb Morris, of Marion County, AL, advises that the Haleyville Police are now on 154.74, 155.64, and 460.025 MHz, with the Fire Department using 154.13 MHz. The Sheriff uses 155.625 and 158.955 MHz. Ambulances are on 155.16 MHz in the area, with hospitals using 155.34 and 158.895 MHz. The Bear Creek Police use 155.01, 155.055, and 155.64 MHz, with the Fire Department on 154.13 MHz.

Be with us next month. Send in your frequencies, questions, ideas, and scanner-related material to *Scanner Scene*, **Popular Electronics**, 500-B Bi-County Blvd., Farmingdale, NY 11735. ■

ELECTRONICS LIBRARY

All Thumbs Guide to VCRs

by Gene B. Williams



Written for the average homeowner whose budget doesn't allow for costly appliance repairs, this book explains basic maintenance procedures intended to reduce the number of malfunctions and prolong the life of your VCR. In addition, the book explains how to perform basic repairs. The heavily illustrated guide takes readers step-by-step through all the necessary maintenance tasks and those repairs that can be tackled by novices. Beginning with a chapter on safety precautions, the book describes standard VCR features and explains how a VCR works, before getting into maintenance and repair instructions. The book explains how to clean and lubricate VCR components, repair worn idlers and belts, replace blown fuses, salvage damaged videocassettes, eliminate snowy or distorted pictures, fix faulty buttons, and adjust takeup reels. It also includes quick and easy VCR programming tips.

All Thumbs Guide to VCRs costs $9.95 and is published by TAB Books, Division of McGraw-Hill Inc., Blue Ridge Summit, PA 17294-0850; Phone: 1-800-822-8138.

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1993 COAXIAL PRODUCTS CATALOG

from Pasternack Enterprises

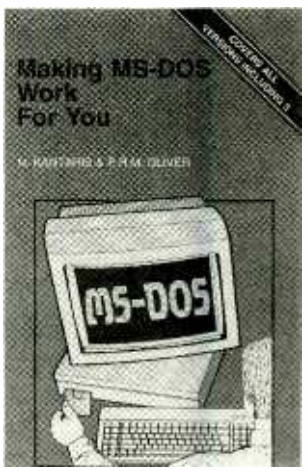
This 62-page catalog features a line of coaxial cable, switches, adapters, detectors, connectors, attenuators, terminations, and cable assemblies; amplifiers; breakouts; cutting tools; patch cords; programmable attenuators; push-button attenuators; waveguide adapters; and twinaxial adapters and connectors. Pricing on more than 3000 standard catalog items is supplied. New products include a wide variety of adapters and connectors. The catalog also contains information on more than 500 new types of cable assemblies.

The 1993 Coaxial Products Catalog is free upon request from Pasternack Enterprises, P.O. Box 16759, Irvine, CA 92713-6759; Tel: 714-261-1920; Fax: 714-261-7451.

CIRCLE 91 ON FREE INFORMATION CARD

MAKING MS-DOS WORK FOR YOU

by N. Kantaris & P.R.M. Oliver



Aimed at those who are already comfortably using the MS-DOS operating system, this book focuses not on the basics but on customizing the DOS to get the most efficiency, productivity, and enjoyment out of computing. The book presents the information that busy readers are most likely to need first, although it isn't necessary to read the book from front to back. It explains how to write customized batch files that allow you to display what you want on your screen, in the form and order that you want it; how to design and set up a fast, interactive, professional-looking menu system so that you or anyone else can easily run utility applications or commercial software packages; how the ANSI display and keyboard commands can be used to position the cursor on any part of the screen, change the intensity of the displayed characters, or change their color; how the Edit screen editor or Edlin line editor can be used to enter escape commands into simple ASCII files to allow control of both your screen display and your printer; and how to control the operation of dot-matrix and HP-compatible laser printers. In addition, the book explains how to use several practical routines, such as moving and finding files, protecting files from accidental erasure, a screen saver, and a disk-cataloging system. Detailed coverage of the Debug

program explains how it can be used to create, see, and change the contents of any program, and includes information on how to find your way around the names and tasks of the CPU registers and the meaning of some simple assembler mnemonics.

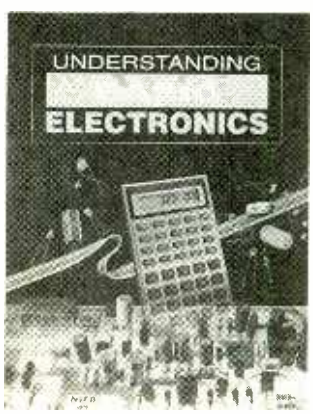
Making MS-DOS Work For You (order no. BP319) is available for $6.50 plus $2.50 shipping and handling from Electronics Technology Today Inc., P.O. Box 240, Massapequa Park. NY 11762-0240.

CIRCLE 97 ON FREE INFORMATION CARD

UNDERSTANDING BASIC ELECTRONICS

by Larry D. Wolfgang, WR1B

We live our lives surrounded by electronics, yet most people don't understand even the most basic concepts of the field. For those who are interested in learning about electronics, but have been put off by the engineering jargon and advanced mathematics, this book provides an easy, reader-friendly stepping stone to learning electronics. The text offers clear, concise explanations of electronics concepts, with new terms explained as they are introduced. Mathematics isn't ignored; in fact, the book's first section is devoted solely to developing the necessary math skills, from choosing the correct calculator to mastering trig functions and understanding logarithms. Two subsequent sections are devoted to elementary DC and AC electronics. The book's final section introduces more electronic building blocks, covering semiconductor materials, diodes, bipolar transistors, field-effect transistors, integrated circuits, and vacuum tubes. The four main sections are divided into chapters, and those chapters are further divided into stand-alone lesson modules, generally two pages in length. Throughout the book, the text is accompanied by drawings, cartoons, and other illustrations to demonstrate the concepts being taught. Readers are encouraged to learn without pain and, perhaps, to consider electronics as a hobby or even a career.



Understanding Basic Electronics costs $17.00 and is published by the American Radio Relay League, 225 Main Street, Newington, CT 06111.

CIRCLE 92 ON FREE INFORMATION CARD

THE "TOP SECRET" REGISTRY OF U.S. GOVERNMENT RADIO FREQUENCIES: 8th Edition

by Tom Kneitel, K2AES

Providing the largest amount of federal frequency information assembled in a single volume, this book has become the standard reference guide used by law-enforcement agencies, private security personnel, the news media, the communications industry, and scanner hobbyists. It includes frequency listings for the FBI, DEA, Customs, Secret Service, FCC, IRS, CIA, Immigration, Coast Guard, U.S. Marshal, Treasury Department, federal prisons, national parks, the Postal Service, NOAA, the Border Patrol, FEMA, the Armed Forces, the Department of Energy, the U.S. Mint, the Bureau of Indian Affairs, the White House, the Federal Reserve, the U.S. Attorney General, the State Department, the EPA, and more. In addition, the book provides foreign-government military listings for hot spots in the Caribbean, Latin America, and the Middle East; agent's codes and lingo; military buzzwords; Canadian listings; military frequencies at civilian airports; and a listing for the secret USAF facility named on national TV as the site where UFO's are being studied and tested. The book also includes maps, monitoring tips, and by-frequency listings of key VHF/UHF channels. The 8th edition contains updated and new listings.

The "Top Secret" Registry of U.S. Government Frequencies, 8th Edition is available for $21.95 plus $3.50 shipping and handling ($4.50 to Canada) from CRB Research Books, P.O. Box 56, Commack, NY 11725; Tel: 516-543-9169, (Monday, Tuesday, Thursday, Friday: 10 AM to 2 PM); 24-hour fax: 516-543-7468. NY residents please add $2.16 sales tax.

CIRCLE 90 ON FREE INFORMATION CARD

TEST INSTRUMENT CATALOG

from HC Protek, Inc.

A series of four compact DC power sources as well as a new 3¾-digit, true-RMS, 4000-count DMM with bar-graph display are among the more than 50 test instruments featured in this 40-page catalog. It includes specifications and features, clearly defined for all product categories, and spells out vital information for oscilloscopes, spectrum analyzers, digital and analog multimeters, frequency counters, pulse and audio generators, temperature and digital panel meters, insulation breakdown testers, clamp-on current meters, and power supplies.

The Test Instrument Catalog is free upon request from HC Protek, Inc., P.O. Box 59, Norwood, NJ 07648; Tel: 201-767-7242; Fax: 201-767-7343. ■

CIRCLE 93 ON FREE INFORMATION CARD

NEW PRODUCTS

Computer-Enhanced Telephone

Combining telecommunications, consumer electronics, and computer technology, *Philips' Enhanced Telephone (ET)* represents the next generation of telephones. The screen-enhanced phone offers visual telephony features and text telephone capabilities that comply with the Americans with Disabilities Act. It also will enable the eventual delivery to homes and businesses of a new range of consumer and business services such as home banking and making airline reservations. The phone is compatible with the Analog Display Services Interface (ADSI), currently under development by Bellcore, which will permit automatic switching between voice and data for seamless interaction between users and network services.

About the size of a standard full-feature desk phone, the Philips ET incorporates a five-inch, tilt-up LCD screen, a slide-out QWERTY-style keyboard for entering messages, an auto-answer modem, and an auxiliary port for connecting printers or other peripheral devices. The telephone also comes with a built-in, industry-standard memory-card reader, so that new software applications can be added as they become available. That feature will allow the phone to meet changing consumer and business needs.

Using Smart Card technology, powerful local processing, and message-based communications, the Philips ET makes it easy for users to access new transaction-based services including information services, banking, shopping, bill paying, and travel reservations—for the cost of a local call. Smart Cards, which have password protection and a coded security system, offer coded security and privacy. With up to 3K of user memory, Smart Cards can store information ranging from telephone and account numbers to ticketing and transaction data. Philips envisions such future applications as booking and confirming a flight from your home, then bringing your Smart Card to the airport where it can be inserted in a reader/printer that will print out a boarding pass.

The text telephone capabilities allow businesses to comply with the Americans with Disabilities Act without having to buy dedicated devices. The Philips ET provides one-key switching between voice and text communications to allow the use of the voice-carryover capability offered by network carriers' Telecommunications Relay Services. It supports off-line text preparation, so users can type ahead of incoming text messages and can send stored messages.

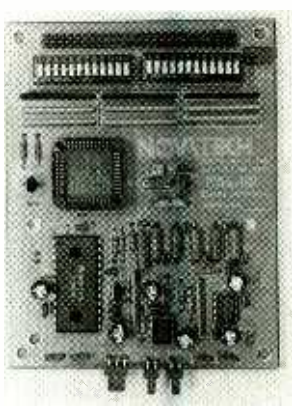
Call management services such as call forwarding, three-way calling, caller ID, automatic busy recall, automatic call return, selective call waiting, do not disturb, and calling-number delivery blocking are supported and enhanced by the phones display screen. The Philips ET also provides a clear visual call-waiting indication and supports distinctive ringing for such services as TeenLine and protected number service.

The Philips Enhanced Telephone costs $639 and is being distributed by Information Access Systems of Atlanta, GA. For more information, call 404-962-3517.

CIRCLE 100 ON FREE INFORMATION CARD

DIGITAL-SYNTHESIZER KIT

Aimed at electronic designers and hobbyists, *Novatech Instruments' Model DDS-3 Direct Digital Synthesizer Kit* provides a precision 12-MHz signal source at a reasonable, do-it-yourself price. It can be programmed to output sine and TTL/CMOS signals from 2 Hz to 12 MHz in 2-Hz steps. The output frequency is determined by setting a 23-bit binary word using either a DIP switch or a parallel ribbon cable input. The output amplitude is 1.4 volts peak-to-peak into an open circuit. The user can obtain fast switching of the output frequencies because the transition time for changing frequencies is less than 250 ns. Spectral purity is better than −90 dBc phase noise at 1-kHz offset, −45 dBc spurious and −40 dBc harmonic. Stability is better than 10 ppm.



The kit includes a 3.5 × 4.5-inch printed-circuit board and all parts needed for assembly. It requires +5 volts DC and −5-volts DC.

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Address _____

City _____ State _____ Zip _____

All orders payable in U.S.A. funds only. Allow 6-8 weeks for delivery.

The Model DDS-3 Direct Digital Synthesizer Kit costs $119.95 plus $5 shipping and handling. (Washington State residents must add 8.2% sales tax.) For more information, contact Novatech Instruments, Inc., 1530 Eastlake Ave. E., Suite 303, Seattle, WA 98102; Tel: 206-328-6902.

CIRCLE 102 ON FREE INFORMATION CARD

HAMLINK TELEPHONE INTERFACE

With the *HamLink* telephone interface from *A.R.E.*, you can control your transceiver or receiver from any TouchTone phone in the world. The device goes between the telephone line and the computer port of your radio. HamLink can share a telephone line with an answering machine without a problem. Once in place, it can control the radio's frequency, mode, band, and scan memories, and can operate in split-mode. A secret access code prevents unauthorized use of your

equipment; if you like, you can share that code with friends to let them use your gear remotely. HamLink allows you to monitor the DX frequencies and work all of the rare ones from your office. If you live in an apartment or condo where you can't have an HF station, you can put the HamLink at a friend's home or at a club station and use it by telephone. The device even has a synthesized voice that announces frequency and mode, so you always know where you are operating. You can command your radio to go to a specific frequency, or you can tune your radio in 10-Hz, 100-Hz, 1-kHz, or 5-kHz steps.

The HamLink telephone interface costs $2669. For additional information, contact Amateur Radio Engineering, Inc., P.O. Box 169, Redmond, WA 98073; Tel: 206-882-2837.

CIRCLE 103 ON FREE INFORMATION CARD

TRUE-RMS DMM WITH FREQUENCY COUNTER

A 4½-digit, true-rms digital multimeter from *American Reliance*, the *Model 700T* features a built-in frequency counter. The sophisticated DMM provides high measuring accuracy (0.5% basic accuracy). Functions include DC and AC voltage measurement, direct and alternating current measurement up to 20 amps, diode check, audible continuity check, and data hold. The DC voltage ranges are 200 mV, 2 volts, 20 volts, 200 volts, and 1000 volts, with resolutions of 10 μV, 100 μV, 1 mV, 10 mV, and 100 mV, respectively. The AC voltage ranges are 200 mV, 2 volts, 20 volts, 200 volts, and 750 volts with resolutions of 10 μV, 100 μV, 1 mV, 10 mV, and 100 mV, respec-

tively. The DC and AC current ranges are 200 μA, 2 mA, 20 mA, 200 mA, 2 amps, and 20 amps with resolutions of 10 nA, 100 nA, 1 μA 10 μA, 100 μA, and 1 mA, respectively. The frequency counter measures frequencies up to 200 kHz. Its ranges are 20 and 200 kHz with attenuation of −20dB available in each range. The Model 700T has a 0.43-inch high display with low-battery and decimal annunciators. The instrument is drop-proof to four feet.

The Model 700T digital multimeter costs $199.95. For further information, contact American Reliance Inc., 9952 East Baldwin Place, El Monte, CA 91731; Tel: 800-654-9838 or 818-575-5110; Fax; 818-575-0801.

CIRCLE 104 ON FREE INFORMATION CARD

COLOR LAPTOP

The first color laptop to be offered by *Radio Shack* is the *Tandy 3830 LS/C*. The active-matrix color laptop features the 25-MHz Intel 80386SL microprocessor as well as an optional 80387 SX-25 coprocessor slot; four megabytes of standard memory expandable to 8MB; 16K of cache memory; an 84-key keyboard; an integrated mini track ball; a 3.5-inch 1.44MB floppy-disk drive; and an internal 19-ms, 80MB hard

drive. For vivid color in all lighting conditions, the 3830 SL/C has an active-matrix TFT LCD with fluorescent backlighting, built-in VGA graphics from 640 × 480 resolution in 256 colors, and an 8.4-inch diagonal screen. The laptop weighs 6.9 pounds with its rechargeable battery. That battery provides up to two hours of continuous use and can be recharged in just two hours, or six hours while in operation. A universal, worldwide 110/220-volt AC adapter is included. Other standard features include an external mouse port; an external, 101-key keyboard port; an internal modem slot; one serial port; and one parallel port that supports either a printer or an external 5.25-inch floppy-disk drive. Bundled software pre-installed on the hard drive includes MS-DOS 5.0, Microsoft Windows 3.1, America Online, and utility programs. An expansion bus connector attaches to the optional Tandy Docking Station, which provides two 16-bit expansion slots for Super-VGA graphics cards, external CD-ROM drive interface cards, network, and other AT-style cards.

The 3830 SL/C costs $3299 and can be ordered for second-day deliver at nearly 7000 Radio Shack stores nationwide. For more information, contact Radio Shack, 700 One Tandy Center, Fort Worth, TX 76102.

CIRCLE 105 ON FREE INFORMATION CARD

THX-CERTIFIED POWER AMPLIFIER

Approved by LucasArts Entertainment Co. for use in Home-THX audio systems, *NAD's 2700THX* is a 150-watts per-channel stereo power amplifier with impressive dynamic power, excellent current-producing capability, and high reliability. The Home-THX concept brings to home theater performance equivalent to that heard in LucasArts-licensed commercial THX theaters. The program establishes strict specifications that must be met by audio-for-video components. The existing 2700A design required only minor changes to meet the rigorous Home-THX standards. Those refinements primarily effect sensitivity and gain structures, and additional improvements were made in

terms of high-frequency clarity, low-bass definition, and rejection of RF interference with unusual cable or speaker loads.

The 2700THX is based on the NAD Power Envelope design, which delivers enormous dynamic headroom with real-world musical transients. The 2700THX can deliver as much as 600 watts per channel (at 4 ohms) IHF dynamic power. The design works particularly well in home-theater applications, where film special effects can exceed the dynamic range of music and overtax the capabilities of standard power amplifiers. Both normal and THX inputs are supplied.

The Model 2700THX has a suggested retail price of $829. For additional information, contact NAD, 633 Granite Court, Pickering, Ontario, Canada L1W 3K1; Tel: 416-831-6936; Fax: 416-831-6936.

CIRCLE 106 ON FREE INFORMATION CARD

HIGH-CURRENT DC POWER SUPPLY

For powering high-current demand products such as autosound units, two-way radios, cellular phones, and 12-volt DC appliances, the *Model 1686* 3–14-volt, high-current DC bench power supply from *B + K Precision* offers good regulation and low ripple. The device eliminates the need to have a car battery or unregulated supply at your bench when servicing a device or just powering it from AC mains. For versatility, the plus and minus outputs are fully isolated, so either polarity can be floated or grounded. Two Model 1686 power supplies can be connected in parallel to double the current output, or in series to double the voltage output. The device has reverse-polarity protection from an external DC source, overload protection, short-circuit protection, and current limiting.

The Model 1686 is conservatively rated for continuous

operation at maximum power output without overheating. It is designed to output 12-amps maximum at 13.8 volts DC (the maximum current is lower at lower voltages). With two analog meters, the Model 1686 provides simultaneous monitoring of voltage and current output. Voltage is continuously adjustable over the output range.

The Model 1686 DC power supply has a suggested price of $199. For further information, contact B + K Precision, 6470 Cortland Street, Chicago, IL 60635; Tel: 312-889-1448; Fax: 312-794-9740. ■

CIRCLE 107 ON FREE INFORMATION CARD

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INSTRUCTION FOR PLACING YOUR AD!

HOW TO WRITE YOUR AD

TYPE or PRINT your classified ad copy CLEARLY (not in all capitals) using the form below. If you wish to place more than one ad, use a separate sheet for the additional ads (a photocopy of this form works well). Choose a category from the list below and write that category number into the space at the top of the order form. If you do not specify a category, we will place your ad under Miscellaneous or whatever section we deem most appropriate.

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Our classified ad rate is $1.00per word. Minimum charge is $15.00 per ad per insertion (15 words). Any words that you want set in bold or caps are 20¢ each extra. Bold caps are 40¢ each extra. Indicate bold words by underlining. Words normally written in all caps and accepted abbreviations are not charged as all-caps words. State abbreviations must be Post Office 2-letter abbreviations. A phone number is one word.

CONTENT

All classified advertising in the **PE Market Center** is limited to electronics items only. All ads are subject to the publisher's approval. We reserve the right to reject or edit all ads.

DEADLINES

Ads received by our closing date will run in the next issue. For example, ads received by April 14 will appear in the August, 1991 issue that is on sale June 18. The PE Market Center is published monthly. No cancellations permitted after the closing date. No copy changes can be made after we have typeset your ad. NO REFUNDS, advertising credit only. No phone orders.

AD RATES: $1.00 per word, Minimum $15.00.

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160 — Business Opportunities
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330 — Computer Software
360 — Education
390 — FAX
420 — Ham Gear For Sale
450 — Ham Gear Wanted
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33 - $33.00	**34** - $34.00	**35** - $35.00	**36** - $36.00
37 - $37.00	**38** - $38.00	**39** - $39.00	**40** - $40.00

Ad No 1—Total words _____ × $1.00 per word = $ _____

All Caps words _____ × .20 per word = $ _____

Bold words _____ × .20 per word = $ _____

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TOTAL COST OF AD No. 1 $ _____

Total classified ad Payment $ _____ enclosed.

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7PE37

THE BATTERY BUTLER

(Continued from page 36)

pin 5 of U5, the circuit will never return the ready state and the battery will be overcharged. The total amount of charge that the Ni-Cd battery receives can be adjusted by R25. The maximum charge level can be determined by starting with the voltage at pin 9 of U5 near the level of voltage at pin 5 of U5 and adjusting R25 to obtain a greater voltage difference each time the battery is cycled, but still allowing the circuit to come to the ready state. Note that as a Ni-Cd battery ages, its ability to hold a complete charge will decrease and R25 may have to be reset to compensate for the aging battery.

Set S1 to the SLOW position. LED1 should begin flashing red, indicating that the battery is being discharged via R39. In a few minutes, transistor Q4 and resistor R39 should be warm to the touch; that's normal. Connect the DVM across the battery terminals, and note that the voltage should begin decreasing towards the present discharge limit. Once the voltage across the battery is at the discharge level, LED1 should begin flashing green and the voltage across the battery should rapidly start moving up.

Depending on the type of battery, the circuit will reach the ready state, which is indicated by LED1 being in a steady green state, in 4 to 5 hours. If it does not, adjust R25 to bring the voltage at pin 9 of U5 closer to the voltage at pin 5 of U5.

The battery can remain connected to the Battery-Butler for prolonged periods without damage to the battery. A 20-mA trickle charge is maintained across the battery after the unit returns to the ready state. However, it is recommended that the battery, once charged, be removed from the circuit if the charger is to be turned off. The input circuit load will drain a small amount of current from the battery over extended periods.

The Battery-Butler can hold a battery on a trickle charge to offset the internal losses of Ni-Cd batteries incurred during storage. To use that feature, apply power to the circuit without a battery connected. Place S1 in the SLOW position. LED1 should immediately go to a steady green state. The Ni-Cd battery may now be connected. A 20-mA trickle charge will be maintained across the battery until the circuit is reset.

Operating Tips. Avoid making or disconnecting DVM connections to the circuit or the battery once a charge/discharge cycle has started. The circuit detects very small changes in voltage in the comparator section, and DVM connections and other external noise sources can cause erratic circuit operation. Operate and charge your Ni-Cd batteries at normal room temperatures. Avoid extreme heat and cold. Ni-Cd batteries will recover from occasional dips to near-freezing temperatures. However, extreme heat (above 40°C) will dry out the seals of most Ni-Cd batteries, resulting in electrolyte loss. ■

MITSUBISHI TV

(Continued from page 29)

flip-open panels or doors. The on-screen menu displays are almost self explanatory, but if you do need help, the 98-page owner's manual is well organized and offers plenty of illustrations. There are 20 pages of hook-up instructions and diagrams alone. Some of the text is not quite idiomatic English, but it is all quite understandable.

While there are many projection TV sets that deliver bigger pictures, in most home environments, 45-inches is adequate for full enjoyment of the "home-theater" experience. This Mitsubishi set is not inexpensive, but its performance rivals that of sets costing even more. For more information on the Mitsubishi VS4517S contact the manufacturer directly, or circle No. 120 on the Free Information Card. ■

ANTIQUE RADIO

(Continued from page 67)

put" control on the LM21, I kept the signal stength low enough to just barely attain a usable reading with the receiver's volume control advanced about one-third. Although the Hallicrafter's service notes advised leaving the Automatic Volume Control on, I felt more comfortable with it off. That way, I could be sure that any observed changes in receiver output would be caused by my adjustments, and not the action of the AVC.

As I adjusted each of the four IF trimmer screws, the output began to increase considerably, and as it did, I kept reducing the output of the signal generator to a minimal amount in order to reduce the possibility of false readings due to overloading. And I adjusted all the IF trimmers several times, as is standard practice, because the adjustments are interdependent.

When I had finished, I was satisfied that I had squeezed a lot more gain out of the IF channel. And I felt that its somewhat misadjusted condition had probably been caused solely by aging effects and not tampering.

After completing the IF alignment, I went on to work on the receiver's RF adjustments. That involved setting the LM21 to a manufacturer-specified frequency at the high end of each band, picking up the signal on the receiver by coupling it to the antenna terminal (via a 400-ohm resistor as suggested by the Hallicrafters service notes), and setting a specific oscillator trimmer to make the receiver's dial setting correspond to the test frequency. After each oscillator adjustment, the matching mixer trimmer is adjusted for maximum indication on the audio-output meter (as before, the signal is kept as weak as possible during this process to avoid overloading).

After setting the high end of each band, the LM21 is set to a frequency (specified by the manufacturer) much lower in the band, and the dial setting checked. On bands 1 and 2, a screw-adjusted padder capacitor is provided to adjust the dial setting to conform to this lower frequency, if necessary (after which, the oscillator and mixer trimmers may need readjusting because of interlocking effects). On the higher bands (3 and 4), no padders are provided, but these are supposed to be unnecessary.

The RF alignment of this receiver was an extremely frustrating experience. Once again, I saw no sign of misadjustment due to tampering, but I found it impossible to arrive at a perfect setting for each band within the adjustment range of the trimmers and padders provided. I found myself screwing some of the capacitors all the way closed and opening others to the maximum to get settings that—while close to acceptable—are definitely a compromise.

To top it off, no amount of tweaking helped the broadcast-band problem. The LM21 signal simply came in over a broad area of the dial, and was not tunable by the trimmers or padder. We'll look into the matter further next month!

Until then, I'll look forward to receiving your letters. Write me c/o *Antique Radio*, **Popular Electronics**, 500-B B-County Blvd., Farmingdale, NY 11735. ■

ELECTRONICS MARKET PLACE

FOR SALE

LASER & special effects products. Lasers from $9.95. We specialize in laser and solar energy products for commercial, and hobbyists applications. Free catalog: **DESIGN IMAGES,** DeptP7, Box 292125, Lewisville, TX 75029. (214) 221-9711.

VOICE Changer, change your voice from man to woman, or child to adult and visa-versa. 16 stages of change with 8 being normal. Operates on 9 volts. $55.95 assembled and tested, plus $3.50 S/H. Send payment to **JM ELECTRONICS,** Dept. P, Box 150454, Altamonte Springs, FL 32715-0454.

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EARN UNLIMITED: Earn Six Figure Income As A Mortgage Regional Manager. 1-800-365-7550 Ext. 3464.

LUCRATIVE OPPORTUNITIES: NO Selling! NO Advertising! $2.00/SASE: RJT, Box 10362-(PE), Pittsburgh, PA 15234.

COMPUTER PROFITS! METHODS Make Money Using PC From Home! Write: CREATIVE, 153 Princeton, Dover, NJ 07801.

FOR SALE OR TRADE

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ADVERTISING INDEX

POPULAR ELECTRONICS magazine does not assume any responsibility for errors that may appear in the index below.

WHAT'S A HAM?

(Continued from page 58)

cluding a teacher's manual, code-practice oscillator, code-practice audiocassette, and a videotape showing classroom use. The package is priced at $99.95. Also available are Novice- and no-code Technician-license courses for the IBM PC; those are $49.95. Contact Media Mentors, Inc., (P.O. Box 131646, Staten Island, NY 10313-0006; Tel. 1-718-983-1416) for further information.

Other examination study books and aids are published by Ameco Publishing Company (P.O. Box 350, Mineola, NY 11050-0350; Tel. 1-516-741 5030), Gordon West Radio School/Radio Amateur Callbook (P.O. Box 2013, Lakewood, NJ 08701; Tel. 1-908-905-2961), and VIS Study Guides (119 Comanche Drive, P.O.Box 16646, Hattiesburg, MS 39404; Tel. 1-601-261-2601).

There are other useful publications, too numerous to discuss individually, so we've listed them in the boxed text entitled "Further Reading." So if your interest has been piqued by this article, you have plenty of resources to help you follow through. ■

COLLECTING OLD BOOKS & MAGS

(Continued from page 60)

There was plenty of war-surplus electronic equipment at incredibly cheap prices, radio-controled models were finally practical due to miniaturization, and the availability of low-cost transistors began a new era in building simple projects.

All of these changes were documented and presented in a then-new magazine: *Popular Electronics*. Copies of that magazine belong in everyone's collection.

There were many other electronics magazines and books published during the fifties. Unfortunately many are being lost because they aren't old enough to be antiques, but aren't current. They're well worth saving though, if only for the thousands of projects they contain. The transistors often recommended, the CK722, 2N35, and 2N107 or 2N170 are long gone, but they can be replaced by modern small-signal types without other changes in the circuit. ■

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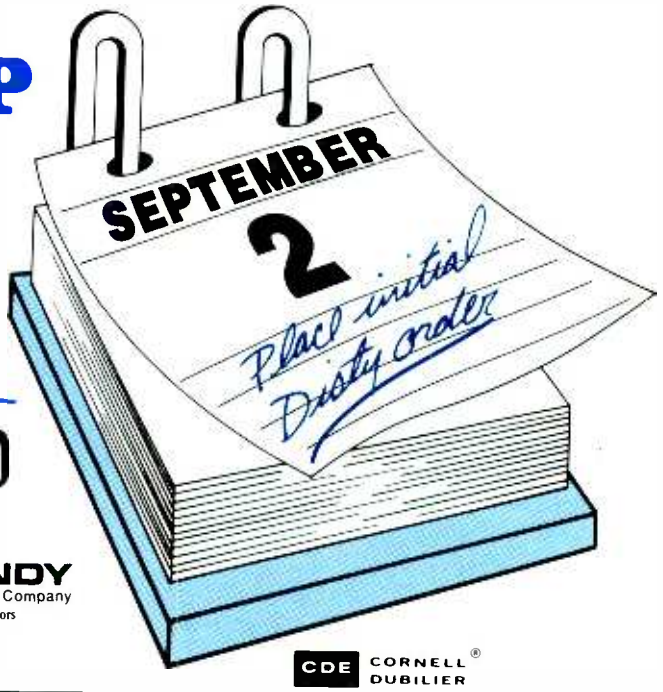

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The professional discussions seen on the TV screen in your home reveals how to detect and disable wiretaps, midget radio-frequency transmitters, and other bugs, plus when to use disinformation to confuse the unwanted listener, and the technique of voice scrambling telephone communications. In fact, do you know how to look for a bug, where to look for a bug, and what to do when you find it?

Bugs of a very small size are easy to build and they can be placed quickly in a matter of seconds, in any object or room. Today you may have used a telephone handset that was bugged. It probably contained three bugs. One was a phony bug to fool you into believing you found a bug and secured the telephone. The second bug placates the investigator when he finds the real thing! And the third bug is found only by the professional, who continued to search just in case there were more bugs.

The professional is not without his tools. Special equipment has been designed so that the professional can sweep a room so that he can detect voice-activated (VOX) and remote-activated bugs. Some of this equipment can be operated by novices, others require a trained countersurveillance professional.

The professionals viewed on your television screen reveal information on the latest technological advances like laser-beam snoopers that are installed hundreds of feet away from the room they snoop on. The professionals disclose that computers yield information too easily.

This advertisement was not written by a countersurveillance professional, but by a beginner whose only experience came from viewing the video tape in the privacy of his home. After you review the video carefully and understand its contents, you have taken the first important step in either acquiring professional help with your surveillance problems, or you may very well consider a career as a countersurveillance professional.

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