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Vol. 62 No. 1

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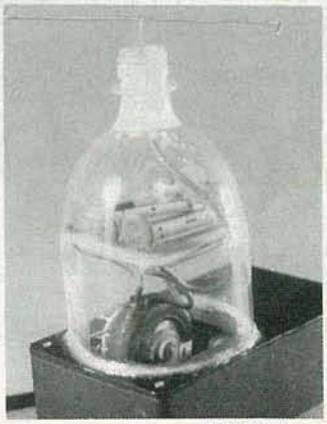

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TECHNOLOGY

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COMPUTERS

DEPARTMENTS

AND MORE

ON THE COVER

If you're looking for a computer that ranks high on customer loyalty, the Mac's the one. Satisfied Mac users are quick to defend their computers against the pro-IBM faction. Unfortunately, the high cost of owning a Macintosh has kept many potential users in the IBM ranks. If that describes you, check out our cover story to find out how you can invest about $400 and the cost of any 128K through SE-30 Mac logic board—and several hours work, of course—to build your own Macintosh computer. The finished product includes the case, power supply, 800K floppy-disk drive, a power/video board, and the video driver module. And with our version, it's easier to install or remove a board or a drive. Turn to page 31 for more details.

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WHAT'S NEWS

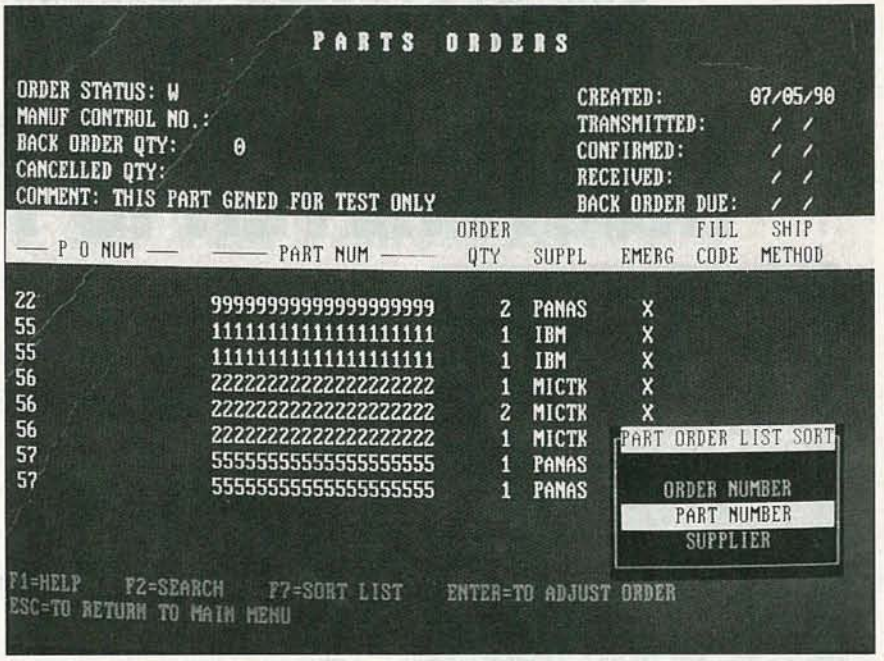
A review of the latest happenings in electronics.

Building robots with "survival instincts."

By studying the instincts and reflexes of living creatures, researchers at the Georgia Institute of Technology have demonstrated feasibility for a robot capable of making "instinctive" survival decisions such as seeking shade to cool down internal systems or changing travel plans to save fuel. A model of the hormonal systems that control "fight-or-flight" decisions in mammals could provide the blueprint for a generation of robots that could possibly navigate hazardous waste sites, coal mines, or even distant planets—without remote-control assistance.

The goal of Dr. Ronald Arkin is a robot that, when confronted by unmapped terrain, is capable of reacting instinctively, without the need for reprogramming or remote direction. By studying the endocrine system of mammals and other biological models, Dr. Arkin hopes to discover precisely what cognitive events or visual signals trigger and modulate particular movements in animals. Ultimately, he hopes to outfit Georgia Tech's mobile materials-handling robot, George, with sensors capable of transmitting information about a variety of internal scenarios or "schema," such as dwindling fuel reserves or dangerous temperature levels. Solution options could then be programmed into "receptor schema" that would be linked to a subsystem that makes routing decisions.

DR. RONALD ARKIN ADJUSTS the vision system that "George," Georgia Tech's specially modified materials-handling robot, uses to navigate to its objective.



A PARTS ORDERING SCREEN FROM IBM'S Electronic Service Management System/2, which provides independent service centers with direct, on-line communications with manufacturers.

How many transistors?

The 1968 Transistor Rule, deemed "obsolete but innocuous" by Commissioner Andrew J. Strenio Jr., has been repealed. The Federal Trade Commission ruling prohibited manufacturers from stating that a radio or walkie-talkie contained a specific number of transistors when some of those transistors did not actually detect, amplify, or receive radio signals. The "truth-in-advertising" rule was drafted to put an end to the deceptive promotional use of transistor count. So few transistors are used in modern radios and transceivers that the rule, in effect, already had been rendered meaningless. Strenio expressed hope that sometime in the future the FTC would have sufficient resources to undertake systematic "pruning projects" to remove other outdated and obsolete regulations under Federal law.

On-line service-center management.

Introduced at last summer's National Professional Electronics Convention in Las Vegas, NV, IBM's Electronic Service Management System/2 (ESMS/2) is a comprehensive, on-line solution that allows small- and medium-sized independent consumer-electronics servicers to electronically process warranty claims and order spare parts. With ESMS/2, service centers can communicate directly with the manufacturers for faster reimbursements on warranty claims and quicker turnarounds on parts orders. On-line pricing updates and service and technical bulletins from the manufacturers will also be available.

The software runs on the IBM PS/2 or IBM PC's, and a modem is required to access the IBM Information Network. ESMS/2 is available as software only, or in a package with a PS/2. Besides the communications capabilities, ESMS/2 provides other service-management functions, including work-order processing, parts inventory, and technician evaluations. It can also be used to generate receipts and invoices, custom and form letters, mailing lists, and reports. A LAN version is available for multiple users. **R-E**

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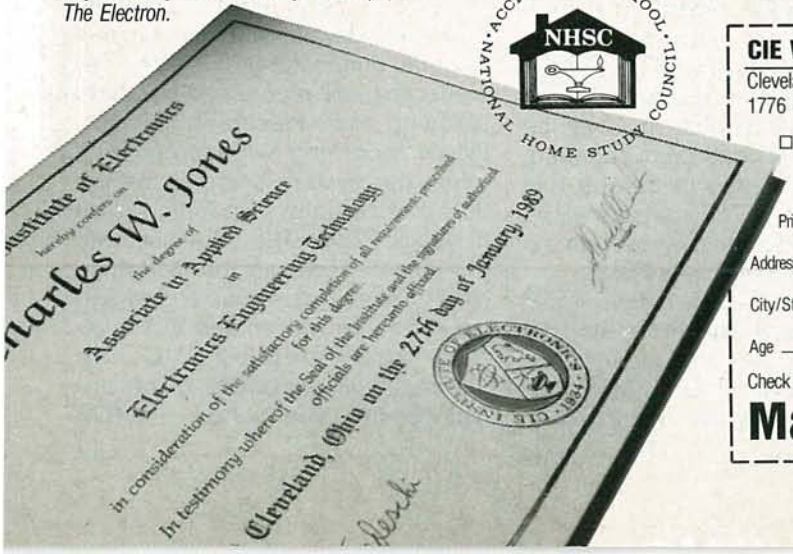

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VIDEO NEWS

What's new in the fast-changing video industry.

DAVID LACHENBRUCH

• **Photo CD.** An electronic photo album combining the best features of film and video photography has been developed by Eastman Kodak and Philips and is promised for worldwide introduction in mid-1992. Photo CD is a system for storing home still color snapshots digitally on a standard five-inch compact disc for playback on any television set or for printing with full-film definition at any time. Under Kodak's plan, amateur photographers will take their negatives to their neighborhood processor, who will transfer them to a disc. One disc will hold up to 100 exposures. A basic disc with 24 pictures will cost less than $20, according to Kodak, and that disc may be returned to add more pictures—up to 100. Storage of the pictures on the disc is basically a write-once CD-ROM process. Each disc will be packaged in a standard "jewelbox" container with an "index print" on the front cover—a page divided into 24 miniature color pictures showing the contents of the disc.

The player, which can also play audio CD's, is expected to sell for less than $500. Unlike videotapes and laser videodiscs, the Photo CD is standards independent. Because the signals on the disc are digital, it can be played on any TV anywhere in the world. The system is claimed to have four times the resolution of the best high-definition TV proposed to date, or about 16 times the detail of today's TV systems. Philips says it will produce several models of Photo CD players, and Kodak says it hopes to license other manufacturers.

• **Closed Captions for All.** A bill passed by both the House and the Senate and awaiting President Bush's signature at our press time will add a new feature to most television sets made or imported after July 1, 1993. Although decoders have been available for many years to display the closed captions available on an increasing number of programs, all future TV sets with screens 13 inches and larger will have them built in. The captions are on line 21 of the vertical blanking interval (VBI) between pictures, and are designed as an aid to the hearing impaired. They're also being hailed as a way to help foreign-speaking viewers learn English. The addition of the new feature is expected to add a few dollars to the cost of the set. The first manufacturer to introduce a wide range of closed-captioned sets is expected to be Zenith, which had planned to add the feature before the legislation was passed. Zenith, the only American manufacturer offering sets with built-in teletext, is expected to add the caption sets in 1991.

• **Program Chips.** Manufacturers of home video equipment must sit up many a night trying to figure out new products and features. The latest is a camcorder with ready-to-use programs. Canon's newest high-band 8mm (Hi8) camcorder is designed to accommodate both audio and video "program chips," which fit into slots on the side of the camcorder body. The graphic chips contain titles and simple automation—"Happy Birthday," "The End," and so forth. One chip, for example, includes an animated helicopter flying across the screen, pulling a banner on which the user may insert the title of his or her epic. The music chips contain electronically-generated ditties, which can be used as background accompaniment in three volume settings.

• **First HDTV Sets.** Thomson Consumer Electronics, the French firm that markets the RCA and GE brands in the United States, is scheduled to introduce what may well be the world's first mass-produced widescreen HDTV sets in Europe this month (January). The new sets will be ready for almost any TV system expected to be available in Europe.

The sets have a tube measuring 36 inches in overall diagonal in the 16:9 proportion, closer to Cinemascope dimensions than to the 4:3 of standard TV. They will be equipped to display standard European PAL and SECAM broadcast transmissions in two ways—either in the standard proportions taking up only part of the screen, or "blown up" to fill the full screen (but sacrificing part of the top and bottom of the picture). They are equipped with built-in satellite receivers and can also display both standard and enhanced-definition (MAC) pictures to be transmitted from some European satellites, as well as "Wide MAC," a widescreen version of the enhanced-definition pictures. And when the new HD-MAC widescreen transmissions with 1,250 scanning lines are available, they will display them in full definition.

The sets are equipped with two tuners, and have a "picture-outside-picture" (POP) feature that displays three smaller pictures vertically to the right of a standard 4:3 picture on the wide tube. Those pictures can be a quick table of contents of channels available, or a sequence of snapshots from any program. In addition, the set is designed to enhance any standard European transmission by doubling the number of lines to 1,250, resulting in an IDTV (improved-definition) picture. The price for all this? The equivalent of about $7,000 U.S., installed, including a 13-inch dish antenna for the upcoming high-powered European satellite transmissions.

• **Widescreen VCR.** A suitable companion to the Thomson widescreen TV set will be a widescreen VCR—and it's in sight. Standards have been developed for a compatible dual-dimension VHS video recorder that will record and play both standard and widescreen pictures. When recording widescreen pictures, the system compresses the data horizontally, expanding it on playback. Playback is automatic, with the recorder sensing the dimension of the picture on the tape and adjusting itself. The widescreen VCR system, developed by JVC and Thomson, is expected to be announced this year by JVC. **R-E**

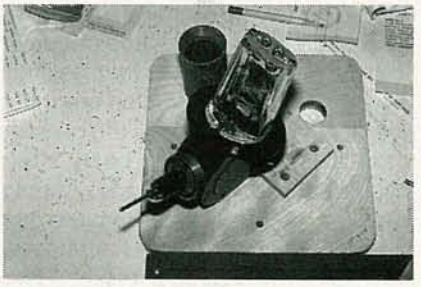
LETTERS

Write to Letters, Radio-Electronics, 500-B Bi-County Blvd., Farmingdale, NY 11735

MYSTERY MICROWAVE TUBE

I read with great interest about early attempts at microwave generation in Joseph Carr's article "Introduction to Microwave Electronics" (**Radio-Electronics**, June 1990). I acquired a strange tube, pictured here, that appears to be an old wartime military microwave tube. (Note the markings on the unit, and the fancy oak packing.) It doesn't seem to have enough external connections to be a klystron, and it has no magnets like a magnetron would. Is it from some early, secret radar unit, or from something much less glamorous, like a diathermy machine?

TOM SHERWOOD
Xenia, OH



The device pictured is a Type-2J22 magnetron, and was used in pulsed oscillators for radar units operating in the 10-cm microwave band (3.267 to 3.333 GHz). It was discussed at length in Volume 6 of the M.I.T. Radiation Laboratory Series *on microwave and radar technology. Illustrations in the book depict the tube with the magnet and without it, as in your picture, and a schematic view. The 2J22 pictured here is complete except for the magnet, which indicates to me that it was a replacement part (the magnet remained with the equipment).—Joe Carr*

CAD-PROGRAM KUDOS

Several months ago, **Radio-Electronics** had a short review of a computer-aided drafting program for electronic schematics, called Autoskem, from BSOFT Software. After reading the article, I bought a copy of the program and was pleasantly surprised to find that my fifty dollars bought a full-featured CAD program fine-tuned for optimum use in making schematic designs. It comes with an extensive symbols library and allows you to edit symbols, create new ones, and create entire new symbol libraries. In addition, whole schematics or a section (text and all) can be saved as an object, to be called into other schematics as desired. The program is Microsoft-mouse compatible, and can save schematics to Hewlett-Packard Graphics Language (HPGL) format plotter files. It even includes a utility that allows you to print the HPGL files on a 24-pin dot-matrix printer. I highly recommend Autoskem to any IBM-PC-compatible user who needs an inexpensive, powerful schematics CAD program.

BRUCE O. YOUNG
Minot, ND

TESTING TAPE SPEED

I was very interested in Geoff Sale's letter concerning tape-deck speed calibration (*Letters*, **Radio-Electronics**, June 1990). My method is similar, and might interest other readers.

Not having a frequency meter, I built the frequency-to-voltage converter depicted in Fig. 1. Using a function generator set to about 1 kHz, I recorded a good-quality cassette on a very good cassette deck, monitoring the input frequency on the converter. At 1 kHz I got a reading of 6 volts. I then played the cassette back through the same machine, and got exactly 6 volts back. If it had not given the correct frequency I would have adjusted the motor speed accordingly—a high reading indicates too fast a tape speed, a low reading means too slow. The motor speed can be adjusted using either a built-in trimming potentiometer or an external one mounted on the PC board.

Record, play back, and adjust the motor speed until the playback voltage is exactly that of the function generator. Then record the whole tape; that will be your calibration tape.

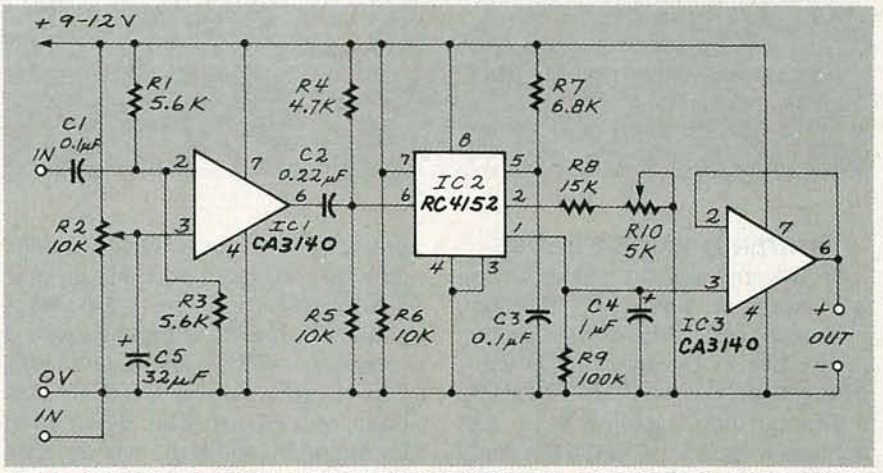


FIG. 1—CASSETTE MOTOR-SPEED CALIBRATOR. Set potentiometer R2 so that the potential at pin 2 of IC1 (the CA3140) is equal to that on pin 3. Careful adjustment will result in a sensitivity of 100 mV. Feed a frequency of ± 1000 Hz to the input ("IN") and use a DVM to measure the reading at the output ("OUT"). Set R10 to give a convenient reading.

The frequency-to-voltage converter can easily drive an analog instrument, which clearly indicates small variations in speed. The needle of the meter should be rock steady for a good drive mechanism.

I test a number of cassettes in the course of my work, and in the several years that I've used this frequency-to-voltage converter, I'd say that it is definitely better than a frequency counter.

By the way, I've been reading **Radio-Electronics** since the **Radio-Craft** days of the 1930's, and I think it's the best. Keep it up!

JOHNNY BRUYNS
Port Shepstone, South Africa

CLEANING VCR HEADS

After reading Larry Klein's response to Jo Anne Abbot's letter in the October 1990 issue of **Radio-Electronics**, I felt compelled to add to her statement whatever weight I could. As a Regional Support Representative for IBM for 30 years, I had *many* occasions to experience low-quality magnetic media (usually cheap diskettes). As advised by engineering and proved by countless field incidents, passing a *high-quality* media over the heads (i.e., formatting a couple of times, write/record for a few minutes) *will* clean them.

Ms. Abbot is correct in that high-quality tape or diskette manufacturers *do* put lubricant in the magnetic formulation that cheap media do not have. But it is the slightly abrasive quality of a *new* tape or diskette that cleans the head(s), and not the chemicals. After a few passes, the media surface will polish down and lose most of its cleaning ability. The lubricants in the formulation are there to reduce head wear, nothing else.

Cheap media will plug the head gap as a result of low-quality binder in the oxide mix. With a cheap binder, the oxide particles easily break away from the media surface and get down into the gap. Remember that, as small as the gap is, the particles are much smaller yet, and easily fill the gap and coat the head. While Larry Klein might not have heard of Ms. Abbot's cleaning method, I can assure him that it does work—with high-quality, *new* tape or diskette media—and eliminates the need for treacherous cleaner tapes or diskettes.

JAMES W. BIGGER
San Diego, CA

DESOLDERING IC's

Several letters relating to desoldering IC's have recently appeared here, and I'd like to present my technique. Use a "solder sucker" or desoldering braid. If the solder remaining has a frosty, lumpy appearance, put a little rosin flux on it and try again. After that, each contact will be over against one side of the circuit-board hole and bonded to the hole with a thin film of solder. Next, take a small screwdriver and push the stuck contact from one side of the hole to the other. The movement is small and hard to see, but you should feel and hear a slight "pop" when the film breaks. Do this to all contacts and pull the IC off; it works.

PAUL S. McKIBBEN
Lake Elizabeth, CA **R-E-**

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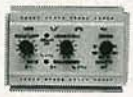

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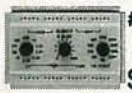

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EQUIPMENT REPORTS

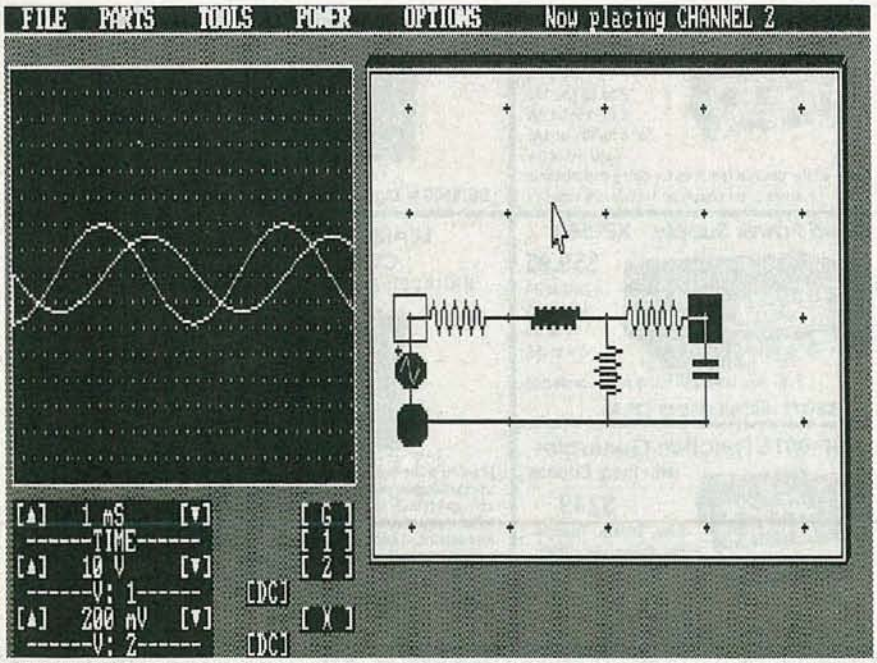
Global Specialties Protolab

Electronics can be a very rewarding career. Of course, it takes some work to get there—anything worthwhile does. But while we have nothing against the hard work and studying that is required to earn a degree, anything that makes the work more efficient is a godsend.

We recently found such a godsend: *Protolab* from Global Specialties (70 Fulton Terrace, New Haven, CT 06512). *Protolab* is an DC/AC Circuit Analysis Program that turns your PC into a computer-simulated electronics laboratory. With *Protolab*, you can build circuits and examine their behavior with test equipment. It gives you the advantage of having unlimited parts and all the test equipment you'll need—without the worry that you'll blow up your lab.

Protolab requires an IBM PC (or compatible computer) with at least 384K of RAM, a mouse, and a CGA display. (Unfortunately, the Hercules graphics adapter is not supported.) A separate version supports Macintosh computers.

Students who are studying circuit analysis should find the *Protolab* to be an ideal supplement to their classroom and laboratory instruction. (We'd also expect many schools to use the program as part of their course work, since it can eliminate the need for buying some test equipment.) Topics that are covered in the laboratory manual include DC series and parallel circuits, voltage dividers, temperature effects, superposition, polyphase systems, Delta-Wye conversion, phasor mathematics, resonance in tuned circuits, and other topics typically covered in the sophomore year of an electrical engineering or technology program.



THIS EXAMPLE SHOWS THE OSCILLOSCOPE making measurements of the RLC circuit on the right.

The *Protolab* screen is broken into two main sections: the circuit construction board and the test-equipment window. Most interaction with the program is done with the mouse, except for numerical component values which are entered by using the keyboard.

For example, to build a circuit, you would click the mouse on the mouse-command line over the word PARTS. A pull-down menu lets you select the part you want to place—resistors, capacitors, inductors, impedances, wires, and AC/DC voltage and current sources are available.

To place the component or source, you simply move to the appropriate place, and click the mouse. You're then asked for the part's parameters, for example, a coil's inductance and

continued on page 82

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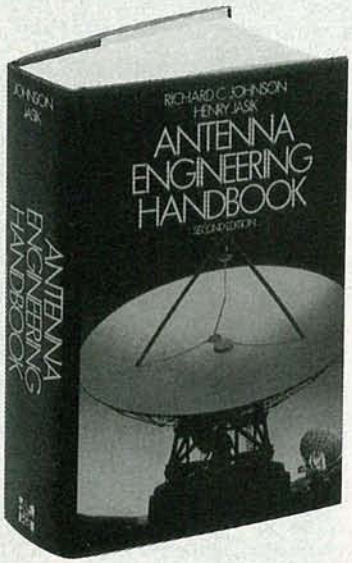

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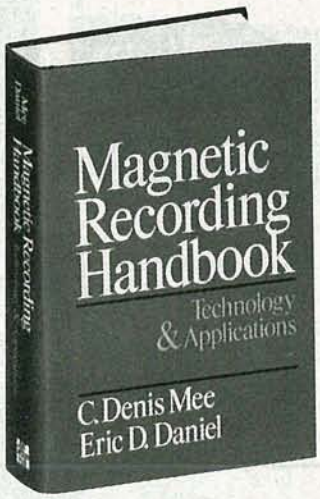

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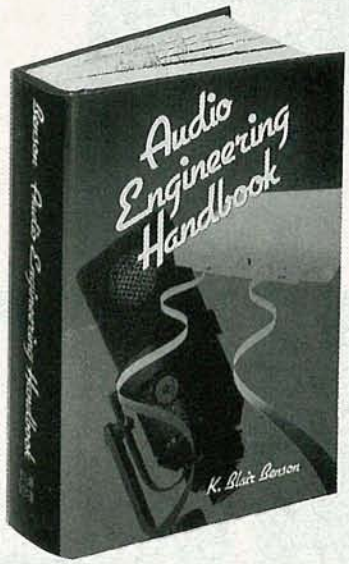

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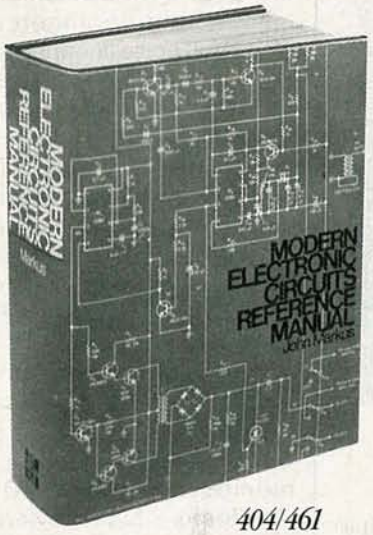

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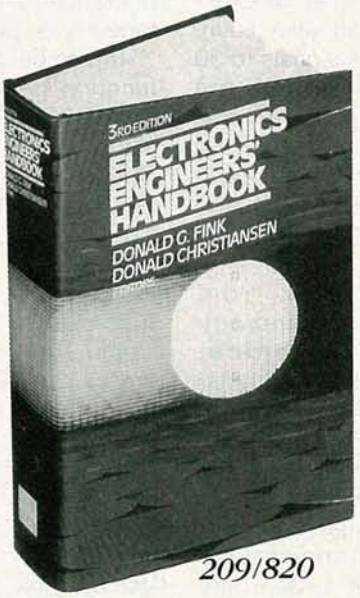

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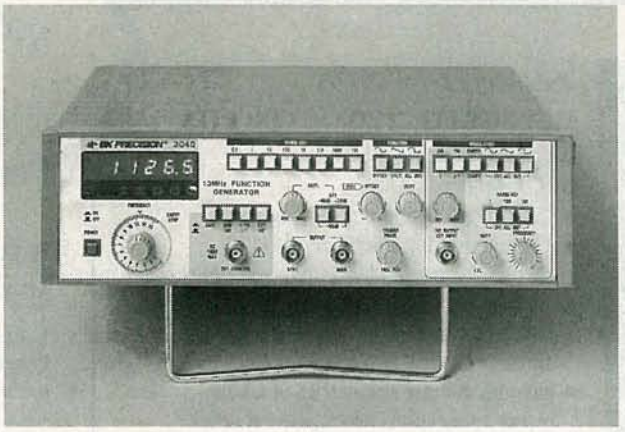

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The model *3040* 13-MHz function generator costs $1,195.00—**B&K-Precision**, 6470 West Cortland Street, Chicago, IL 60635; Tel: 312-889-1448.

POCKET INFO PAC. The battery-powered *Pocket Info Pac*, which measures 1¾ × 4 × 8⅜ inches and weighs just over one pound, lets users access images and scroll through electronic pages, much like reading a book, by simply pressing a series of three or four buttons on a touch pad, or through menu options. Using the innovative *Private Eye* ultra-miniature virtual display from *Reflection Technology* (**Radio-Electronics**, February, 1990) as its display, Colby Systems' *Pocket Info Pac* gives users instant access to any one of thousands of images. The high-capacity, handheld information-storage and -retrieval system lets users download, access, and control text and graphics using a built-in touch pad.

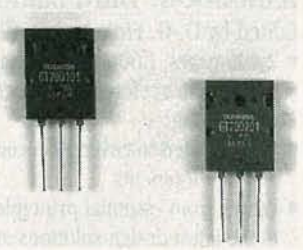
CIRCLE 11 ON FREE INFORMATION CARD

The Private Eye, although it weighs only 2.26 ounces and fits in the palm of a hand, allows users to view high-resolution images as a full 12-inch, 720 × 280-pixel image. The data is downloaded via a serial port from a Macintosh or MS-DOS-compatible computer and can be updated or changed according to the user's needs. The device can be configured with 1MB of standard memory or up to 16MB of optional memory, and is available with EPROM, STATIC RAM, or PSEUDO-STATIC RAM internal add-on memory. Also available are the plug-in Colby *Magic Memory Module* and *COLBYCARD* memory units.

The *Pocket Info Pac* costs between $899.00 and $2999.00, depending on the type of memory.—**Colby Systems Corporation**, 2991 Alexis Drive, Palo Alto, CA 94304; Tel: 415-941-9090.

AUDIO POWER TRANSISTORS. Three lines of audio power transistors from *Toshiba*, targeted at the U.S. power-amplifier market, are engineered with good noise linearity for low THD and low intermodulated distortion. Three audio product types—IGBT, MOSFET, and bipolar—are represented to provide performance and price options; all three meet class A and class AB power-amplifier standards.

The IGBT power transistors (pictured) include the 250-volt, 20-amp *GT20D101* and the complementary *GT20D201* that feature high forward transfer admittance, low saturation voltage, high input impedance, and an enhancement mode. The complementary P-channel/N-channel MOSFET pairs



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feature high forward transfer admittance, low ON impedance, and high-frequency operation. They provide optimal low switching distortion for the highest frequency response in high-end power amplifiers. The MOSFET pairs include the 18-volt, 10-amp *2SK1529* and *2SJ200*; the 200-volt, 12-amp *2SK1530* and *2SJ201*. The bipolar audio power transistors are high-voltage, high-current complementary NPN/PNP devices optimized for low-power dissipation and

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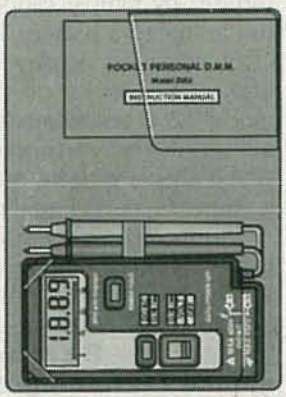
In quantities of 500, the IGBT power transistors range in price from $5.30 to $5.70 each, the MOSFET's range from $3.50 to $4.00 each, and the bipolar transistors from $1.70 to $2.10.—**Toshiba America Electronic Components Inc.**, 9775 Toledo Way, Irvine, CA 92718.

POCKET PERSONAL DMM. About the size of a slim pocket calculator (2×4×⅜ inches), *Techni-Tool's Personal DMM Meter (#393TE060)* offers easy one-hand operation. The compact unit features



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a high-speed auto-ranging and sample rate for bargraph display and an operating range from 0°C to 40°C, with maximum 80% RH. An automatic power-off function increases battery life to 250 hours. The DMM comes in a protective folding case, and weighs only 100 grams including the meter case and batteries.

The *Personal DMM Meter* has a suggested price of $49.95.—**Techni-Tool, Inc.**, 5 Apollo Road, P.O. Box 368, Plymouth Meeting, PA 92462; Tel: 215-825-4990; Fax: 215-828-5623.

BENCH/PORTABLE COUNTER/TIMER. For portable as well as bench-top use, *Optoelectronics'* model *UTC 8030* is both a full-featured, 3-GHz bench-top counter and a self-contained portable frequency finder that can be outfitted with its own batteries, antenna pack, and backlit readout for field work.

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As a counter-timer, the instrument makes direct and prescaled frequency, period, and time-interval measurements and calculates and displays frequency ratios. The *UTC 8030* provides 1-mV sensitivity, 1-PPM accuracy, 1-Hz resolution, and a 1-Hz to 3-GHz range. A display-hold feature makes it easy to record 10-place frequency readings. An external reference jack is provided for more accurate lab reference clocks. The unit offers signal-conditioning controls. A variable trigger control eliminates jitter and a 6-dB/octave low-pass filter and a switchable 20-dB attenuator allow the user to filter out noise.

As a portable frequency finder, the *UTC 8030* has a 10-Hz to 2400-MHz dynamic operating range, and 1-mV sensitivity up to 500-MHz. It features a 16-segment signal-strength bar

graph, augmented by an audio annunciator that beeps faster as signal strength increases.

The *UTC 8030* universal counter/timer costs $579.00. Options include a ±0.1 PPM time base ($125), a Ni-Cd battery pack ($75), and an LCD backlight ($40).—**Optoelectronics, Inc.**, 5821 NE 14th Avenue, Ft. Lauderdale, FL 33334; Tel: 800-327-5912 or 305-771-2050; Fax: 305-771-2025.

UPS-BATTERY TESTER. For testing lead-acid batteries—including the maintenance-free types such as sealed, recombination, and gel cells that are commonly used with standby, uninterruptable, and back-up power supplies—*Performance Technological Products* has introduced the model *1200* universal 12-volt battery tester. The batteries can be tested when series-connected with each other, and even while they are actively being charged. The device allows the user to log gradual changes in battery condition as they occur, providing a useful history for preventative maintenance. By subjecting the battery to an 80-amp electronic load for 10 seconds, the device can indicate whether the battery is "good," "weak," or "bad." Test results are easy to interpret; by simply clipping the tester to a battery, the LCD indicators display the status. Pin jacks on the model *1200* accommodate an auxiliary voltmeter, which allows precise measurements during testing.

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The model *1200* battery tester, with 12-inch leads and copper-plated, color-coded steel clips, costs $194.70.—**Performance Technological Products**, P.O. Box 947, Roswell, GA 30077.

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The *TPI 3000A* coaxial adapter/connector kit costs $150.00.—**Test Probes, Inc.**, 9178 Brown Deer Road, San Diego, CA 92121; Tel: 800-368-5719.

PORTABLE RESISTIVITY METER. For static control, *ACL's #475* meter is designed to provide fast, repeatable, comparative measurements of surface resistivity. The easy-to-use instrument has no cables or probes to adjust, and offers automatic ranging from 10^4 to 10^{14} ohms per square. Accurate to ±½ decade, the meter conveniently checks resistivity specifications for static-control products such as anti-static bags, static-dissipative mats, and conductive work surfaces. The rugged, portable meter comes with a leather carrying case and a rechargeable battery with a 115-VAC adapter/charger that provides 4–8 hours of steady operating time.

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The *#475* portable surface resistivity meter has a suggested price of $825.00.—**ACL Incorporated**, 1960 East Devon Avenue, Elk Grove Village, IL 60007; Tel: 708-981-9212.

FREQUENCY-LOGGING/-ANALYSIS SYSTEM. Designed for standalone, unattended frequency monitoring and logging in Wide FM, Narrow FM, AM, or single-sideband frequencies, a complete package from *ACE Communications* consists of a receiver that covers 100 kHz to 2036 MHz, plus control software and serial-interface hardware. The computer-driven system offers two basic types of analysis and logging functions. In one, a spectrum-analyzer-type display shows "spikes" of received frequencies vertically ranked by signal strength, with the horizontal axis representing the radio frequencies being received.

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The display can either be viewed on a screen or output to a dot-matrix or laser printer. The other, tabular, method lists active calls by frequency, signal strength, date, and time. It even keys the call to a tape recording of the audio portion of the radio transmission. Tabular data also can be printed or stored to disk. The RS232C serial interface allows remote operation and provides future expansion capabilities. A 4800-baud transfer rate is supported.

The frequency-logging and -analysis system has a suggested retail price of $1,290.00.—**Ace Communications**, Monitor Division, 10707 East 106th Street, Indianapolis, IN 46256; Tel: 800-445-7717; Fax: 800-448-1084.

PULSE GENERATORS. Built-in CRT displays enhance the flexibility and ease-of-use offered by *Tektronix's PG2010* family of pulse generators. The displays provide instant access to pulse-parameter information and show the timing relationships between the two channels and the pulse edges—without the user having to deal with an array of knobs and buttons. Each of the pulse generators provide menu-driven set up and built-in calibration, selectable from the Utility Menu, for enhanced accuracy. The 50-MHz pulse generators provide 250-ps transitions and programmability in portable packages that can be used with benchtop oscilloscopes or logic analyzers.

The instruments cover applications from general-purpose analog design through high-speed digital applications, and all pulse parameters can be controlled over wide ranges. Pulse period is adjustable from 20 ns to 10 seconds (±1% of setting ±1 ns) with 100-ps resolution. Delay and width are also adjustable with 100-ps resolution over ranges of 0.0 ns to 9.89990 seconds and 10 ns to 9.9 seconds, respectively. Each pulse generator also has a double-pulse mode and DC-50-MHz external trigger and gate input capabilities, as well as a counted-burst capability for 2–999,999 cycles per burst.

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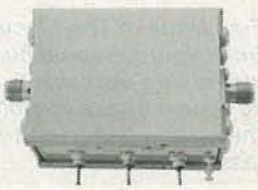
The *PG 2010* family provides a mix of available output levels and pulse-transition times. The *PG 2010* provides an adjustable output level to 2.5 volts p-p into 50 ohms within a ±2.5-volt window, and selectable transition times of 250 ps, 700 ps, and 1.8 ns. The *PG 2011* provides an adjustable output level to 10 volts p-p into 50 ohms within a ±10-volt window and transition times adjustable from 5.5 ns to 10 ms. The *PG 2011's* rise and fall transitions can be set together or independently. The *PG 2012* contains two pulse channels; one is equivalent to a *PG 2010* and the other is equivalent to a *PG 2011*.

Prices for the *PG 2010, PG 2011,* and *PG 2012* pulse generators range in price, depending on model and options ordered, from $6,950 to $12,900.—**Tektronix, Inc.**, P.O. Box 19638, Portland, OR 97219-0638, Attention: 65W; Tel: 800-426-2200.

PROGRAMMABLE ATTENUATOR. *Pasternack Enterprises'* model *PE7011-3A* is a 50-ohm programmable coaxial attenuator with an attenuation range of 0–60-dB steps, designed for DC to 1,000 MHz. The unit has a ½-watt average power handling capability, with 50 watts peak. Its switching time is 15 milliseconds, and its operating voltage is +12 VDC at 45 mA per step maximum. Connectors are SMA female.



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In 100-piece quantities, the *PE7011-3A* programmable attenuator costs $168.00 each.—**Pasternack Enterprises**, P.O. Box 16759, Irvine, CA 92713-6759; Tel: 714-261-1920. **R-E**

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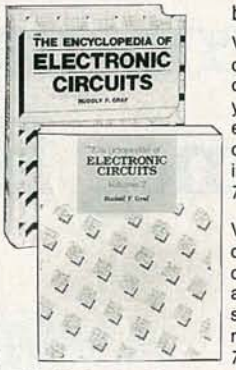

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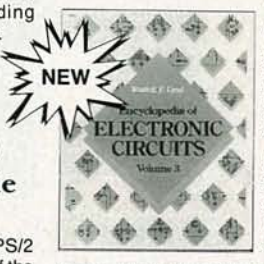

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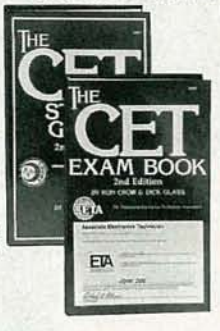

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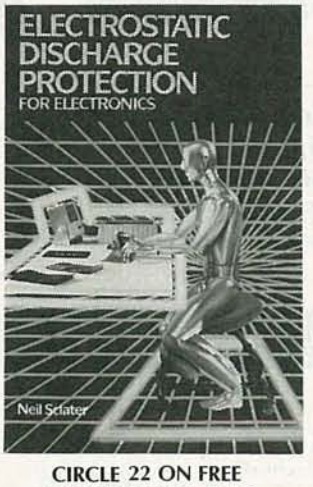

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workplace. It explains how to design ESD-protective packages, materials, and containers; handle and store electronic components; simulate electrostatic discharges; and train employees in static-control techniques, including the use of protecting ground straps and clothing. The book also provides a glossary of ESD-related terms and phrases and a listing of static-control product vendors.

ELECTRONIC INTERCONNECTION SYSTEMS: PRODUCT ORDERING GUIDE; from 3M Electronic Products Division Catalog, P.O. Box 3064, Cedar Rapids, IA, 42406-3064; free.

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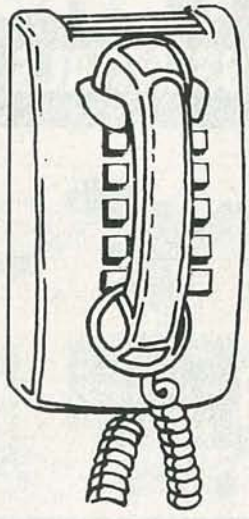

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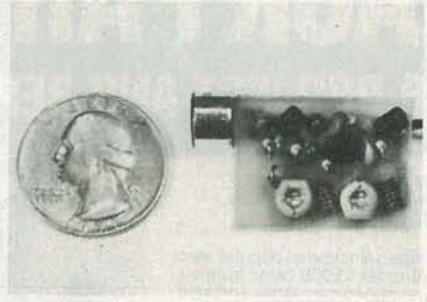

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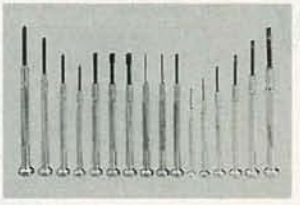

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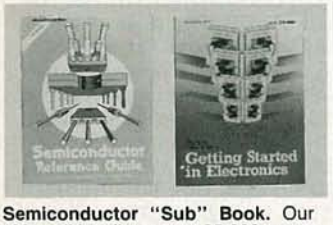

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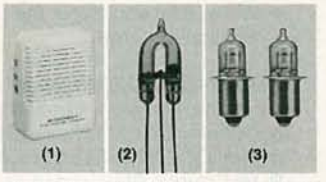

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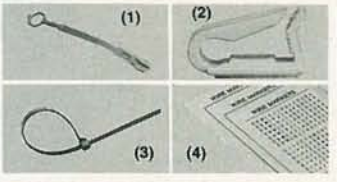

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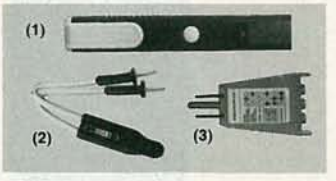

(1) AC Sensor. Indicates the presence of 70 to 440VAC without direct electrical connection. Safety first! #22-103 ..... **9.95**

(2) Neon Circuit Tester. 90-300V AC/DC. #22-102 ..... **1.99**

(3) AC Outlet Fault-Finder. 3-prong for grounded outlets. #22-101 .. **5.95**

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BUILD A MACINTOSH-COMPATIBLE COMPUTER

CHARLES COLBY*

At last, a Mac-compatible computer for people on a budget—and it can be cheaper and more powerful than the new Classic Mac from Apple!

HAS THE HIGH COST OF OFF-THE-SHELF MACS kept you restricted to the confined world of MS-DOS computers? Well, you can stop feeling confined because, for about $400.00 and a few hours work, plus the cost of any 128K through SE-30 Mac logic board, you can build your own Mac! And that price includes the case, power supply, 800K floppy drive, special power/video board, video driver module, and a 14-inch Mac-compatible monitor.

The unit is 100% compatible with all Mac software, since it uses the real Apple Macintosh main logic board or motherboard. Even the earliest motherboards can be the start of a powerful machine. For example, with third party add-ons, you can increase the RAM of a Mac 128K through Mac SE to 1, 2.5, or 4 megabytes; you can increase the RAM on an SE-30 to 4, 8, 16, or 32 megabytes! There are accelerators available to let the unit run with a clock speed as high as 50 MHz even with a Mac 128K. With add-on boards, you can use a 19- or 21-inch 1024 × 768 pixel high-resolution monitor.

If you don't already have a Mac, any version of our Macintosh "clone" is a good starter machine. If you already have a Mac, you can put together a good second or third machine. If you are in any Mac-related service business, you'll especially appreciate how much easier it is to install or swap an internal component. That's because the case we use makes it easier to install or remove a board or drive as compared to a standard Mac case.

*Charles Colby is the president of Colby Systems Corporation, a company specializing in portable computers, terminals, Macintosh-compatible computers, and accessories.

Technical description

As shown in the block diagram of Fig. 1, the desktop Mac contains a real Apple Macintosh motherboard. The Mac motherboard is a very cleverly designed self-contained computer—it contains all of the essential components. The CPU in the Mac 128K, 512K, 512KE, Mac Plus, and Mac SE is a Motorola 68000 16-bit processor running at 8 MHz; a 16-MHz Motorola 68030 32-bit processor is found in the Mac SE-30. The motherboard also contains bios ROM's, RAM, various glue-logic chips, a keyboard- and mouse-input processing IC, and a custom Sony sound processor. There are two serial output ports: one for a modem and one for a printer—there are no parallel printer output ports. A small computer system interface (SCSI) port is found on a Mac Plus, SE, and SE-30, although SCSI adapters are available for other versions.

Also on the motherboard are the video chips that generate the Mac's 512 × 342 pixel, 22.5-kHz horizontal rate video. There are many third-party accelerators and big-screen video boards available for Macs; the Mac SE and SE-30 have expansion ports on the motherboard to accommodate them, and there are special expansion devices available that clip over the 68000 chip in the 128K, 512K, 512KE and Mac Plus boards eliminating the need for the expansion ports.

The motherboard is the most important part of this or any other Mac-compatible project. They can cost anywhere from 50 to 1500 dollars, depending on which model you want.

All that is needed to make the motherboard operate is a power supply, a video/sync adapter to drive an external monitor, a Mac-compatible floppy drive, an SCSI hard drive (optional), and a case in which to put them. The power supply is an IBM-PC clone type, so it is low in cost.

We'll show you where to get everything you need, and how to put it all together. We'll even show you how to build the interface that makes this project possible.

There are some external accessories required to make a complete operating computer, and one of them is a mouse or trackball. There are two basic types of Mac mice and trackballs. The original type is for the Mac 128K, 512K, 512KE, and the Mac Plus. Those all have a male 9-pin "D" connector. The newer type used with the SE and the SE-30 has a 4-pin male mini-DIN connector. They are known as ADB-type, which stands for Apple Desktop Bus which uses a proprietary Apple serial protocol. An IBM-PC type mouse or trackball will not work on a Mac.

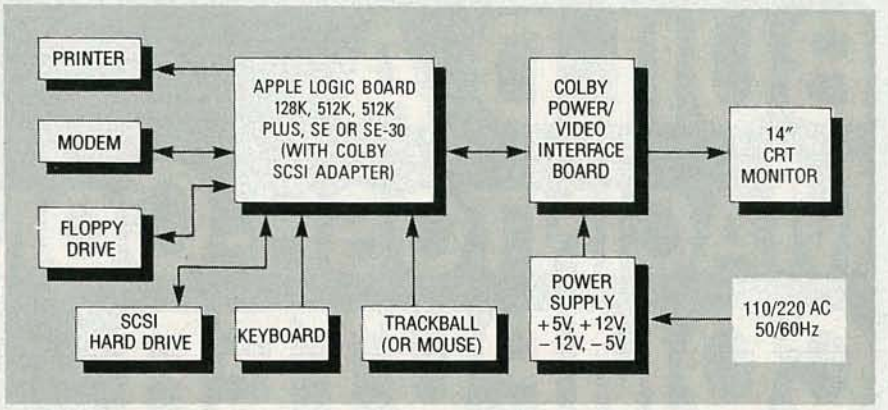


FIG. 1—YOU CAN SEE FROM THE BLOCK DIAGRAM, that the Colby Mac contains a real Apple motherboard.

A keyboard is also required. The original keyboard for the Mac 128K, 512K, and Mac Plus uses a 4-pin modular jack like the one on the handset of a telephone. However, the wiring in a telephone cable is different than a Mac keyboard cable.

Our desktop Mac uses a special 14-inch monitor. With a horizontal frequency of 22.5 kHz, it will not work with an IBM-PC or clone. It is available in either amber or paper-white phosphor versions. The monitor will work with all Macintosh computers with a proper Colby interface.

The one thing that sets our Mac apart from true Apple Macs is the power/video interface board that allows an IBM-PC style power supply, the monitor, and an Apple motherboard (logic board) to be connected together in one system. The interface board can either be built or purchased fully assembled. If you wish to build the board, PC foil patterns are provided, or you can buy a ready-made bare board.

Where to buy parts

Before building the interface board, let's discuss all of the other necessary components, where you can get them, and how much they cost. As mentioned earlier, you need an Apple 128K, 512K, 512KE, Plus, SE or SE/30 motherboard ($50.00 to $1400.00), a modified IBM-PC clone case ($89.00), a power supply ($69.00), a keyboard ($89.00–$129.00), a mouse or trackball ($49.00–$79.00), a monitor ($189.00), a floppy drive ($189.00), and perhaps an optional 40-MB hard drive ($299.00–$399.00). You'll also need the interface adapter board described in this article; it'll run you $59.00 in the assembled form (not including a $30 video/sync processor module), or you can build it yourself.

The most difficult part to find is the Apple motherboard. The

PARTS LIST—128K THROUGH MAC PLUS

1. Any Apple motherboard, 128K, 512K, 512KE or Mac Plus
2. PC case (Gettys Electronics)
3. 200-watt power supply (must fit in Gettys case)
4. 800K Mac-compatible internal floppy drive (must fit in Gettys case)
5. Modular-plug type Mac keyboard
6. 9-pin D-type trackball or
7. 9-pin D-type mouse
8. 14-inch Mac-compatible monitor (optional adapter for regular Mac)
9. Power/video adapter board
10. 20-pin floppy cable
11. 10-conductor power cable
12. 9-conductor video output cable
13. Internal modular keyboard cable w/bracket
13. Cermagraph 74OS video/sync processing module
14. 3.6V lithium battery for CPU real-time clock

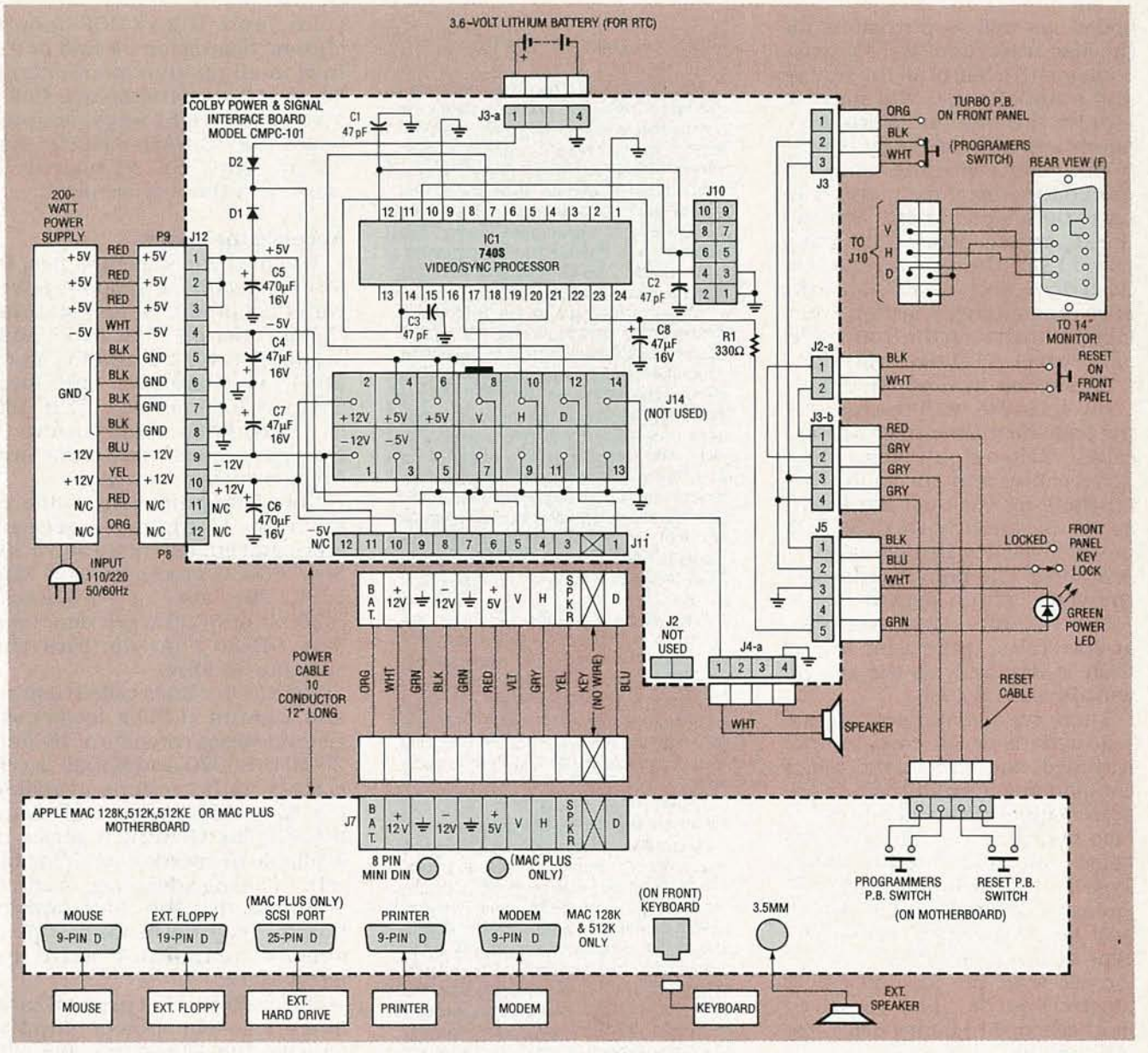


FIG. 2—SCHEMATIC FOR THE 128K, 512K, 512KE, and Mac Plus versions.

first Mac board, the 128K, sells for $50–$100, but the 128K RAM & old ROM's limit the software that you can use. Although the 512K version ($199–$299) has more capacity, it, too, is limited to older versions of software. However, there are RAM-upgrade kits available for both models. The 512KE version ($299–$399) has enhanced ROM's. It works with later software and the RAM can be expanded.

The Mac PLUS, $399–$499, is the workhorse of the Mac line—more of them are in use than any other type. It has later ROM's, and can hold 4 MB of RAM. It runs most current Mac software and, although it has no expansion slot, its speed can be increased with an add-on accelerator board. The Mac SE, $499–$599, has an expansion slot, a 68000 16-bit processor running at 8 MHz, and 4 MB of RAM. It runs all current Mac software and can be accelerated to 50-MHz operation. The SE/30 model, $1200–$1500, is very fast at 16 MHz, and has a 68030 32-bit processor with a math co-processor and an expansion slot. It runs all current Mac software and can also be accelerated to 50-MHz operation.

There are many Apple dealers who sell parts and motherboards, other than those mentioned in our sidebar; check your local phone book. There are also hundreds of local computer dealers (not just specifically Apple) who stock Apple parts and various motherboards.

While there must be over one hundred IBM-PC clone cases available, there is only one model we have found to be suitable for use with a Mac motherboard. The unit has been modified by a company called Gettys Electronics. They put a long horizontal slot at the back along the bottom of the rear panel, which allows the connectors on a Mac motherboard to protrude through the opening and eliminates the need to cut and file heavy sheet steel. The case will work with any of the Mac motherboards. All of the necessary mounting holes have also been

added, as well as provisions for the Mac reset function. The case comes with a bag of all the screws and standoffs you will need to mount the Mac motherboard, power supply, and floppy drives. It also comes with the cables required to connect the power supply to the adapter board, hook up the key switch, connect the green power LED, the reset button, the hard-drive access LED, and the Mac programmer's switch (mislabeled "turbo" on the front panel of the case). All of that adds up to a big savings in assembly time.

Not included with the case are the logic-board-to-power-adapter cable, video-output cable, hard-drive cable, and the mounting brackets for 3½-inch hard drives. (A 5¼-inch hard drive will mount easily without adapter brackets.) The power supply for the case, which provides +5, −5, +12, and −12 volts is rated at 200 watts; quite a bit higher than is required, so the system will always run cool.

There are some cables that are required inside the case, but not included, to connect the major components. One of them is the power signal cable from the interface board to the Mac motherboard, and there are two types. Type 1, a 10-conductor cable, is for use with 128K, 512K, 512KE and Mac Plus motherboards. Type 2, a 12-conductor cable, is for use with the SE and SE-30 motherboards. The required motherboard-to-floppy-drive cable provides both power and signals in one 20-pin flat cable. The video/sync output cable goes from the power/video interface board to the rear panel of the unit. It is a 10-pin-to-9-pin cable. The optional 50-to-50 pin SCSI hard-drive signal cable goes from the Mac motherboard to the hard drive. All cables must be built or purchased from one of the sources mentioned.

Add-on video boards

Most add-on boards for the Mac 128K through Mac SE will work in the Colby Desktop Mac. Although Apple has never manufactured big-screen boards for the early Macs, many aftermarket companies do. One problem with some add-on video boards is that they are designed to plug into Apple SE-30 motherboards at a right angle. These boards will not work with the case we described because they are too high. We do know that boards from E-Machines, Inc., Lapis Technology, Sigma Designs, Nutmeg, Moniterm, and Colby Systems will work in the Colby Mac. Of course, if you use a bigger case, you can use whatever size boards you like.

Colby Systems Corporation manufactures 640 × 480 monochrome, gray scale, 8- or 24-bit color, and 1024 × 768 monochrome boards for 19- and or 21-inch monitors that mount parallel with the motherboard. Colby also makes right-angle adapter board (SE-30 RAB, $49.99) that adapts most SE-30 boards to work with the case we used.

Accelerator boards

Two of the best companies, in terms of technical support, price, variety of products, and state-of-the-art offering, that make add-on accelerator boards for Macs are Dove Computer and Total Systems Incorporated (TSI). You can purchase their products through dealers, mail-order, and Colby Systems, as well.

Dove Computer has a line of medium- to high-end accelerators that enable you to add a 33-MHz 68030 processor to a Mac 128K! They also have a low-cost ($500.00) 68030 accelerator for a Mac SE-30 that doubles the speed to 33 MHz.

TSI has two lines called Gemini and Gemini II. The lower-cost Gemini series consists of 16- and 20-MHz 68020 and 68030 accelerators with versions available for Mac 128K through Mac SE-30. The Gemini II series is available in speeds from 33 to 50 MHz. The big advantage of accelerators is that the older motherboards may be brought up to speeds comparable with the latest Macs.

One problem that plagued early Macs was the power supply, which could deliver only about 35 watts—barely enough to run the standard motherboard, a 9-inch CRT, a floppy drive, and a keyboard. Once you started adding accelerators and hard drives, many power supplies went up in smoke. Apple has since redesigned the power supply in the Mac SE and SE-30 to output 60 watts. But because of the early problems, most reputable accelerator manufacturers have a separate 110 VAC-to-5 VDC power supply available to run the accelerator to prevent overloading the Mac's power supply. If you use a hefty enough power supply, you can save some money when you buy an accelerator. For example, all Dove and TSI accelerators are available without the additional power supply at a correspondingly lower price.

MAC VS IBM-PC

The Apple Macintosh was introduced January 1, 1984 with the now-famous TV commercial shown during the Superbowl football game where the girl in jogging shorts throws a sledgehammer into a movie screen amid an audience of "followers" with shaved heads, all dressed alike, bowing to a uniformed "leader." The "leader" was intended to be representative of IBM. Apple's message was 1984 won't be like 1984. Did it work?

Apple's challenge to the IBM dominance of the personal-computer market has produced sales of five or six million computers, vs IBM and clones of 40 to 50 million units. Who won? Both did, and are continuing to win, as the need for small computer systems accelerates worldwide. The clear advantage of the Mac's easy-to-learn, easy-to-use graphical interface and operating system makes it possible to do productive work on a Mac in one tenth to one fiftieth of the time required to become proficient at some MS-DOS based programs on an IBM-PC or clone.

Time will tell what effect Windows™ 3.0 will have in the race between the IBM world and the Mac world. Many people think the Mac will triumph. Yet the absence of true Mac clones (Apple will not let it happen) has kept the cost of the Macs very high in relationship to the relatively low prices found in the IBM-PC and clone arena.

The Mac 128K was a true major innovation in it's day, and innovations continue. For example, system 7.0, due out anytime now, promises to add many new features.

The Mac paved the way to desktop publishing by providing the first small computer with bit-mapped graphics, WYSIWYG text, and an innovative easy-to-use operating system that changed the face of personal computing. Even six years later, the 128K Mac is still a useful machine and can do simple word processing and drawing functions almost as well as the latest $11,000.00 Mac FX.

Apple isn't known for low prices, but it is one of the few companies ever to go from two guys building computers in a garage to a multi-billion dollar yearly sales organization with six or seven thousand employees and a billion dollars in the bank...all in a span of 12 years. **R-E**

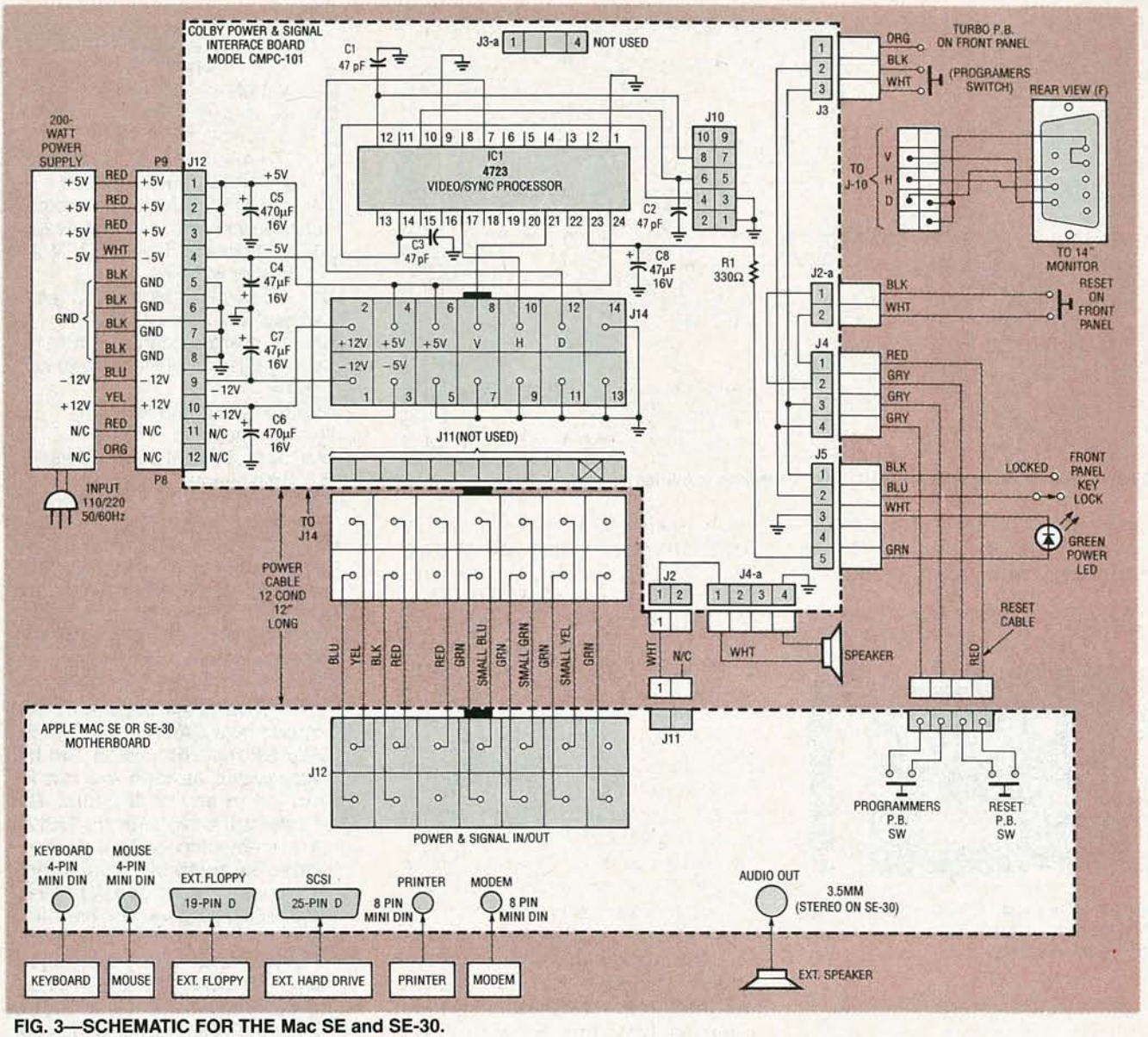


FIG. 3—SCHEMATIC FOR THE Mac SE and SE-30.

Building the Mac

Let's go over, step-by-step, the procedures necessary to get your Macintosh-compatible computer up and running. A wiring schematic for the 128K, 512K, 512KE, and Mac Plus versions is shown in Fig. 2, and one for the Mac SE and SE-30 is shown in Fig. 3. Regardless of which version you're going to build, you will need the power/video interface board. Should you decide to build the board yourself, a parts-placement diagram is shown in Fig. 4. A photograph of the completed board is shown in Fig. 5.

The first step is to make sure that the motherboard will fit in your case. There is a vertical metal tab, 2-inches high by 1-inch wide, near the two PC-mounted pushbuttons at the rear of all Mac motherboards. You will probably have to bend the metal tab parallel with the motherboard to clear the new case. The tab on the opposite side of the board must also be bent down, but not as low as the other tab.

PARTS LIST FOR MAC SE & SE-30

1. Apple SE or SE-30 motherboard
2. PC case (Gettys Electronics)
3. 200-watt power supply (must fit in Gettys case)
4. 800K Mac-compatible internal floppy drive (must fit in Gettys case) Colby FDD-800K
5. ADB-type Mac keyboard
6. ADB-type trackball or mouse
7. 14-inch Mac-compatible monitor
8. Power/video adapter
9. 20-pin floppy cable
10. 14-conductor power cable
11. 9-conductor video output cable
12. Cermagraph 4723N video/sync processing module

The only difference between a Mac 512K and a 512KE motherboard is that the 512KE has enhanced 128K ROM's (versus the older 64K ROM's). The later ROM's are available as upgrades. Do not attempt to copy Apple ROM's, as doing so would be a copyright infringement, and Apple has prosecuted many people who have copied their ROM's. If you obtain a motherboard without ROM's, they are installed in two 28-pin sockets on the motherboard, one marked ROM LO and one marked ROM HI.

The Apple ROM marked 342-0342-A, B, or C goes in the ROM LO socket and the ROM

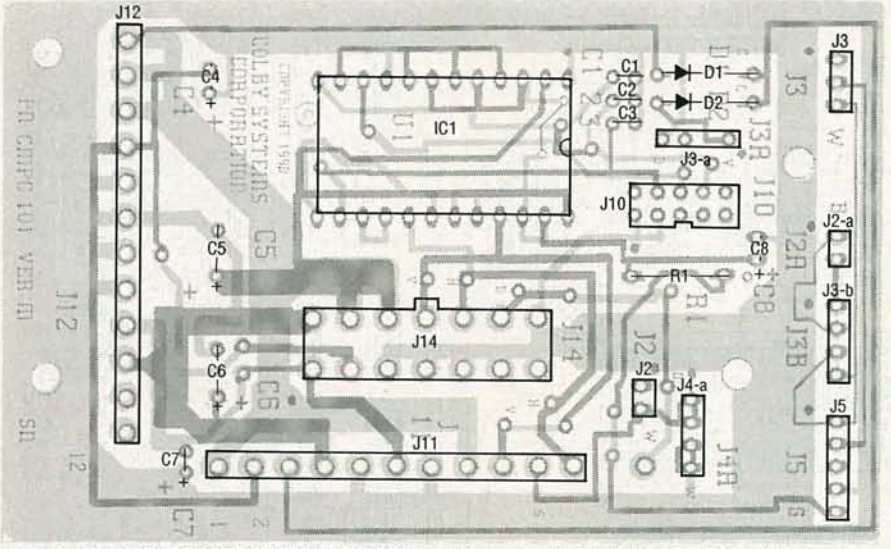


FIG. 4—PARTS-PLACEMENT DIAGRAM for the power/video interface board.

marked 342-0341-A, B, or C goes in the ROM HI socket. Those numbers are for 128K ROM's. The early 64K ROM's for pre-Mac 512KE motherboards are marked 342-022-A for ROM LO and 342-0220-A for ROM HI; they should be used only with 128K and 512K motherboards running very early Mac software, 400K single-sided floppies, and no hard drive. Mac SE ROM's are marked 342-0353A for ROM LO and 342-0352A for ROM HI. Mac SE-30 ROM's are on a single SIMM-type (single inline memory module) PC board, and not in 28-pin sockets. The latest ROM for an SE-30 is marked 638-4339.

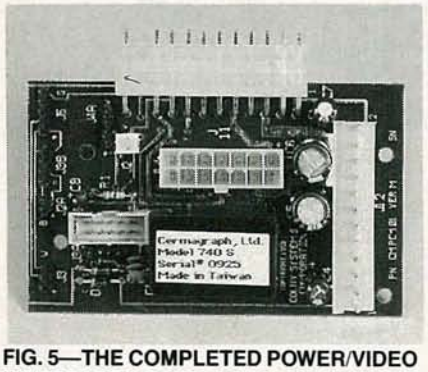


FIG. 5—THE COMPLETED POWER/VIDEO INTERFACE BOARD. It is the key to building your own Mac.

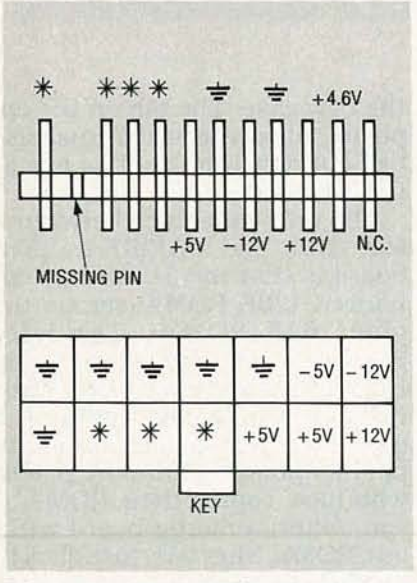


FIG. 6—MEASURE THESE VOLTAGES on the two connectors on the power/video interface board. The pins that are marked with an asterisk should have no more than 2 volts on them when not connected to the motherboard.

Plug in the two cables from the power supply, P8 and P9, into J12 on the power/video interface board. Measure the voltages on J11 and J14, on the power/video interface board as shown in Fig. 6. An 8-ohm, 20-watt resistor must be used as a dummy load on the +5-volt line to obtain proper readings. In a Mac 128K through Mac Plus, plug in the 10-conductor cable from J11 on the power/video interface board to J7 on the Apple motherboard. Plug in the 1-conductor cable from J11 on the Apple motherboard to J2 on the power/video interface board. Plug in the 2-conductor cable from the speaker to J4-a on the power/video interface board.

In a Mac SE or SE-30, plug in the 14-conductor cable from J14 on the power/video adapter board to J12 on the Apple motherboard. Plug in the 1-conductor cable from J11 on the Apple motherboard to J2 on the power/video interface board. Plug in the 2-conductor cable from the speaker to J4-a on the power/video interface board. The inside of a medium-cost SE version is shown in Fig. 7 and the inside of an SE-30 is shown in Fig. 8. The extra boards you see inside the SE-30 are for the Colby voice navigator ($499), which allows you to perform certain tasks using voice commands rather than a mouse or trackball. The voice navigator is shown in Fig. 9.

Turn on the power and, within 2 seconds, you should hear the familiar Mac "boing" sound on Macs 128K through SE and the multi-note 0.5-second chime on the SE-30. Those sounds indicate that the Mac motherboard has run through and successfully completed its on-board self-diagnosis routines. If you do

PARTS LIST—POWER/VIDEO ADAPTER

R1—330 ohms, ¼-watt
C5, C6—470 µF, 16 volts, electrolytic
C1–C3—47 pF, ceramic disc
C4, C7—47 µF, 16 volts, electrolytic
D1, D2—1N4001 rectifier diode
IC1—Cermagraph video/sync processing module (740S or 4723N)
J11—12-position right-angle Molex connector with key
J12—12-position Molex connector without key
J14—14-position connector with key
J10—10-position video & sync connector
J2, J2-a—2-pin header
J3—3-pin header
J3-a, J3-b, J4-a—4-pin headers
J5—5-pin header
Miscellaneous: PC board, 24-pin IC socket, solder, etc..

Note: The following items for the power/video interface are available from Maus Electronics: A bare PC board (#CMP-101), $19.99; a PC board and all parts except the video/sync module (#CKP-128), $36.99; an assembled and tested power/video interface (#CAT-128), $59.99. BE AWARE that the cables and the video/sync module are not included in any of the kits. The modules are available for $29.99. A step-by-step build-it-yourself video is available from Colby Systems Corporation for $19.99 plus $3.99 postage and handling (#PS-800K). A new book, "Building your own Colby Mac Desktop and Colby Mac Portable," will also be available from Colby Systems. Call, write, or fax for more information.

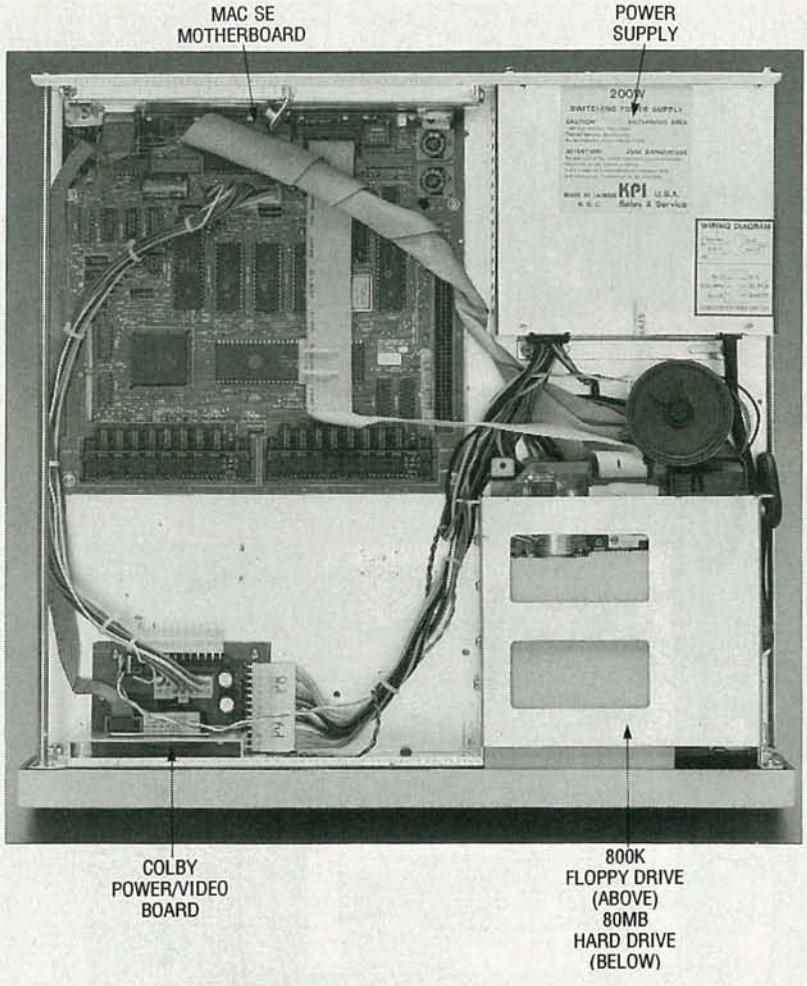
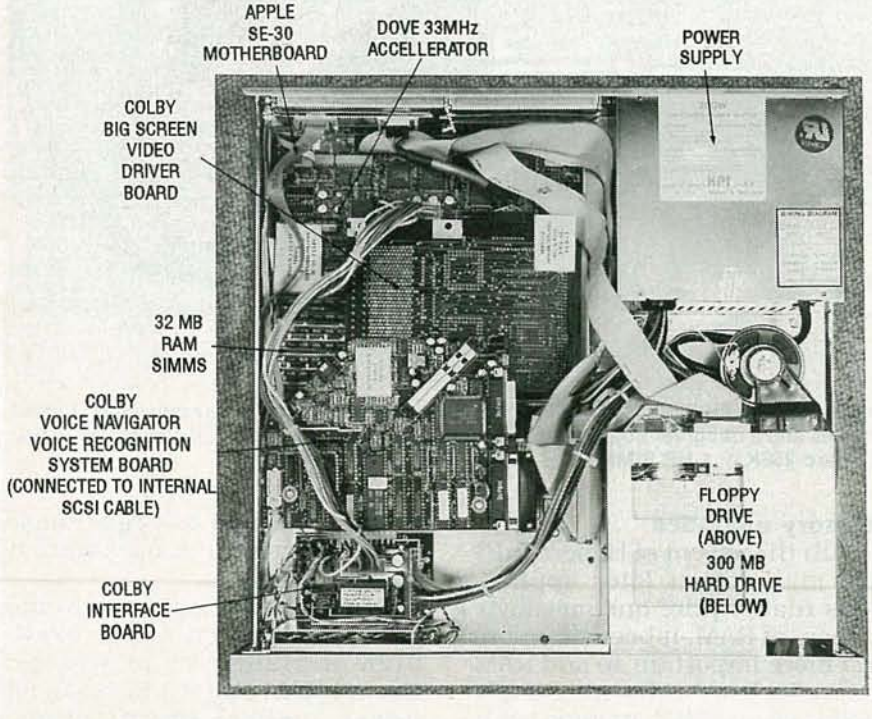


FIG. 7—THE INSIDE OF THE MEDIUM-COST SE VERSION.



8—THE INSIDE OF THE SE-30 VERSION. The extra boards you see are for the Colby voice navigator and big-screen driver board.

not get either of those sounds, or you get a brash sound or none at all on a Mac 128K through Mac Plus, or a multi-note chime that lasts for about 1½ seconds, then there is a problem on the motherboard. If that's the case, recheck the voltages at J7 or J12 on the motherboard. Recheck the ROM's to be sure they are in the correct sockets, that they are seated correctly, and that there are no pins folded under. Recheck the RAM; be sure it is seated correctly and that R8 and the jumpers are set correctly. If you have access to a Mac that you know is working properly, you can test the RAM SIMM's in that unit to verify that they are good.

Plug in the following cables one by one, and turn on the power after plugging each cable in to verify that you hear the correct boing or chime each time. By doing so, if there is a shorted or misplaced cable, you will know which cable is the suspect as you plug it in. All J numbers referred to are on the power/video interface board. Plug the 10-position video-output cable into J10. Plug the 9-pin "D" cable and verify that you have a raster on the CRT. There should be about a 1-inch black area between the edge of all sides of the raster and the plastic case bezel.

Plug one end of the 4-conductor reset cable into J4; the other end with the 1 × ½-inch PC board adapter plugs onto the 4 contacts on the top of the two black plastic pushbutton switches on the left rear of the Apple motherboard. Bend the pushbutton contacts so they are vertical and plug the adapter PCB on so the 4-conductor wire comes off toward the center of the motherboard.

Plug the 5-connector cable from the power-on LED and keylock switch into J5. With the keylock switch in the "on" (unlocked) position, verify the boot boing or chime. Then turn the key lock switch to the locked position and make sure you don't get the boing or chime. That essentially shorts the contacts on the programmer's switch and keeps the motherboard from booting.

Plug the connector with the orange, black, and white wires from the "turbo" pushbutton onto J3. Test the switch by turn-

ing on the power, waiting for the Mac raster to appear; then press the switch and a dialogue box should appear in the center of the screen. Note that it is not actually a turbo switch; it is used for activating the Mac function known as "programmer's switch" (see an Apple manual for a complete explanation). Also, the pushbutton switch is not exactly the right type for a programmer's switch; it is a push-push alternate action type where it actually should be a momentary pushbutton.

If you like, you can unsolder the switch from the PCB next to the key lock and replace it with the correct type of switch, or just remember to push it twice if you use it. Unless you plan to do any programming, you will not need to use it. The switch can also function as a simple "lock" for your computer. If you press it once and lock the button in, the computer will not boot.

Now plug in the 2-conductor black and white cable that goes to the front panel "reset" pushbutton. Test it by turning on the power and waiting for the boing or chime. When you press the button, the computer should reset; that is, it should boing or chime after each press.

Plug in the 20-conductor ribbon cable from J6 on 128K through Mac Plus boards or J8 on SE or SE-30 boards to the floppy drive. The cable is keyed so it cannot be inserted incorrectly. It also has several internally cut wires to make it work correctly with the Mac motherboards.

Plug in a mouse (or trackball) and a keyboard at the rear of the motherboard. Add an internal or external hard drive as desired. Insert an Apple system disk in the floppy and boot the computer so you get the Mac desktop. Table 1 shows the various combinations of system versions that work with different Mac motherboards. Note that motherboards with 64K ROM's use System 4.1, up to 6.0. Mac Plus motherboards (128K ROM's) use System 6.1 to 6.04. System 6.04 is the most bug-free, but is too large for use without a hard drive. If there is no hard drive, system 6.03 is recommended. System 6.05 is not recommended for the Plus or SE series; use it on the Mac FX IIci, etc..

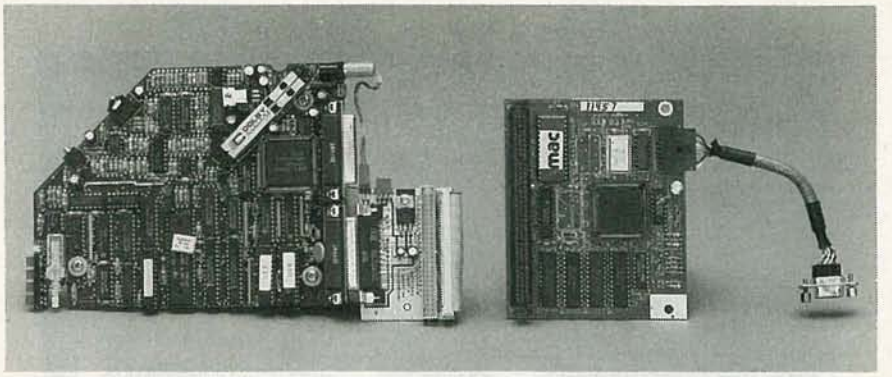


FIG. 9—THE VOICE NAVIGATOR allows you to perform certain tasks using voice commands rather than using a mouse or trackball.

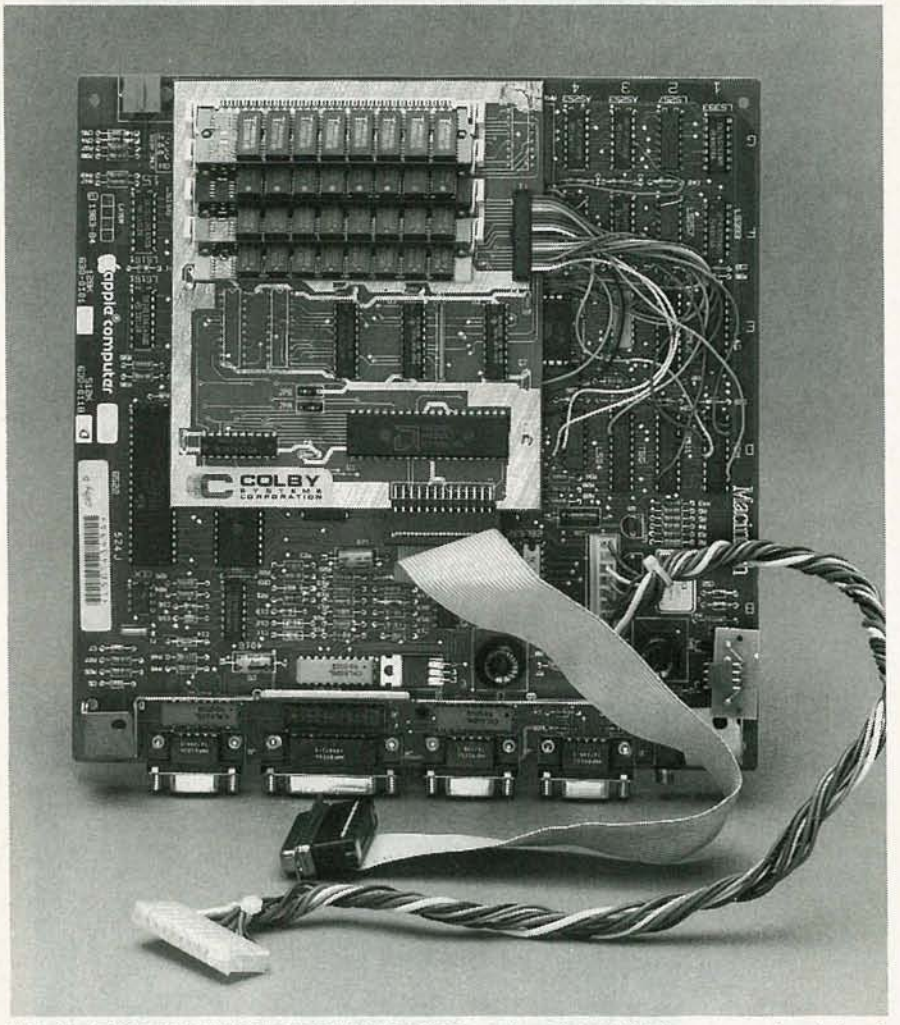


FIG. 10—THE COLBY SIMM ADAPTER BOARD requires that 2 DIP's be removed and about 22 wires and a daughter board to be soldered onto the motherboard. It allows you to use standard 256K or 1-MB SIMM's.

Memory upgrades

With the advent of Hypercard™ and many other later applications that require one megabyte or more of RAM, it becomes more and more important to add RAM to run the latest software. Simply install each SIMM module with chips to the right of the SIMM by pressing the SIMM module firmly in the socket at a 45-degree angle and gently rolling it back until it snaps into place.

Originally, the only way to upgrade memory on a Mac 128K, 512K or 512KE was to unsolder the old RAM chips and solder in newer, higher-capacity chips. More often than not, that resulted in damaging the fine

SOURCES OF MAC PARTS

MEMORY AND ROM UPGRADES
- Colby Systems Corp.
- Dove Computer
- Total Systems Inc.

MAC MOTHERBOARDS
- Your local computer or Apple dealer
- Mac Heaven
- Pre-Owned Electronics, Inc.
- Shreve Systems

MAC-COMPATIBLE KEYBOARDS AND MOUSE OR TRACKBALL
- Abaton Technology
- Any Apple dealer
- DataDesk Int'l.
- Colby Systems Corp.

SPECIAL CASE AND POWER SUPPLY
- Gettys Electronics

HARD DRIVES (20 to 300 MB)
- Any Apple dealer
- Colby Systems Corp.
- SuperMac Technology

HARD DRIVE BRACKETS, CABLES, AND FORMATTING SOFTWARE
- Maus Electronics
- Colby Systems Corp

MACK-COMPATIBLE INTERNAL FLOPPY DRIVES
(you must use the Colby FDD-800K in the case we used)
- Colby Systems Corp.

MAC-COMPATIBLE EXTERNAL FLOPPY DRIVES
- Any Apple dealer
- Colby Systems Corp.
- Appied Engineering

POWER & VIDEO CABLES AND VIDEO PROCESSOR MODULE
- Maus Electronics

MAC II COMPATIBLE 14" MONITOR
- Colby Systems Corp.
- Nuvotech

APPLE MACINTOSH OPERATING SYSTEM SOFTWARE
- Any Apple dealer

ADDRESSES

- Abaton Technology
48431 Milmont Dr.
Fremont, CA 94538
Phone: 415-683-2226
- Applied Engineering
PO Box 5100
Carrollton, TX 75011
Phone: 214-241-6060
- Colby Systems Corp.
2991 Alexis Drive
Palo Alto, CA 94304
Phone: 415-941-9090
Fax: 415-949-1019
- DataDesk Int'l.
7651 Haskell Ave.
Van Nuys, CA 91406
Phone: 800-826-5398
(in CA: 800-592-9602)
- Dove Computer
Phone: 919-763-7918
- Gettys Electronics
22018 Frontier Rd.
Clovis, CA 93618
Phone: 209-299-7828
- Mac Heaven
14101 Park Long Court
Chantilly, VA 22021
Phone: 703-263-2567
- Maus Innovations
121 S. Corona
Denver, Co 80209
Phone: 303-744-9512
- Nuvotech
2015 Bridgeway Ste 204
Sausalito, CA 94965
Phone 415-331-7815
- Pre-Owned Electronics, Inc.
30 Clematis Ave
Waltham, MA 02154
Phone: 617-891-6851
Fax: 617-891-3556
- Shreve Systems
2421 Malcom St.
Shreveport, LA 71108
Phone: 318-635-1121
Fax: 318-865-2006
- SuperMac Technology
485 Potrero Ave.
Sunnyvale, CA 94086
Phone: 408-245-2202
- Total Systems Inc.
Phone: 503-345-7395

traces of the motherboard. Also, the fact that the board is a four- or six-layer board makes desoldering very difficult. There is now an easier way to upgrade 128K and 512K motherboards without desoldering all the old RAM chips one-by-one.

TABLE 1

Version	System	Finder
Mac 128K	4.1	5.5
Mac 512K	4.1	5.5
Mac 512KE	6.0 to 6.04	6.1–6.1.4
Mac Plus	6.0 to 6.04	6.1–6.1.4
Mac SE	6.0 to 6.04	6.1–6.1.4
Mac SE-30	6.0 to 6.04	6.1–6.1.4

The Colby SIMM adapter board requires only 2 DIP's to be removed and about 22 wires and a daughter board to be soldered onto the motherboard, as shown in Fig. 10. That will save you about 3–4 hours of work, is much less likely to damage your motherboard, and allows you to use standard 256K or 1-MB SIMM's instead of discrete RAM chips. It also has a built-in SCSI port to enable you to operate a hard drive on a Mac 128K or 512K (128K ROM's are required).

The Mac Plus motherboard was the first Mac to use SIMM RAM. Unlike IBM-PC clones, the Mac uses only eight chips per SIMM instead of nine, because there is no provision for parity checking. There are two types of SIMM's that will work on this unit; 256K and 1-MB types. In general, they can be identified by inspecting the individual RAM IC's. The 256K chips have leads on all four sides, whereas the 1-MB chips have leads on only two sides.

The Mac Plus can be configured with 1 MB consisting of four 256K SIMM's, 2 MB consisting of two 1-MB SIMM's, 2.5 MB consisting of two 256K SIMM's and two 1-MB SIMM's, or 4 MB consisting of four 1-MB SIMM's.

One megabyte of memory (four 256K SIMM's) is normally present in the Mac Plus. It is located on four SIMM's at an angle of about 45 degrees to the main board in front of the 68000 processor. Remove all four of the SIMM's currently installed in your Mac Plus. Use your fingernail or small screwdriver to gently bend the plastic locking tabs out to the left and right to release the SIMM. CAUTION: The plastic retaining tabs will break very easily if you are not careful. Push them only enough so they clear the edge of the SIMM.

Locate resistor R8 in the corner of the motherboard nearest the printer port; clip it on one end and bend it aside to prevent contact. Do not remove it, so that if you want to reconfigure your Mac Plus back to one megabyte, you can do so easily.

Starting with the SIMM slot in the rear nearest the 68000 processor (row 1), install a 1-MB SIMM module in the rear socket on the Mac Plus motherboard by pressing it firmly into the socket at a 45-degree angle and gently rolling it back until the locking tabs snap into place. For 2.5 MB, two of the original Mac Plus 256K SIMM's go in the third and fourth sockets and two 1-MB SIMM's go in the first and second. For 4 MB, all four sockets must be filled with 1-MB SIMM's.

Replace the keyboard, mouse, and other attachments and power-up your Mac Plus. To test the memory installation, pull down "About the Finder" under the Apple DA menu for the registered amount of RAM. Note that with memory configurations

larger than 1 MB, the Macintosh will take an extra 15–30 seconds to boot up.

Like the Mac Plus, the Mac SE motherboard has 4 SIMM sockets and can be configured with 1 MB, 2 MB, 2.5 MB, or 4 MB of RAM. There are two versions of the SE motherboard and the placement of the SIMM's and jumper differs, so you must determine your logic board type. Type 1 has resistors and no jumper, and type 2 has a jumper on the header. Adhere to the instructions pertaining to your particular motherboard.

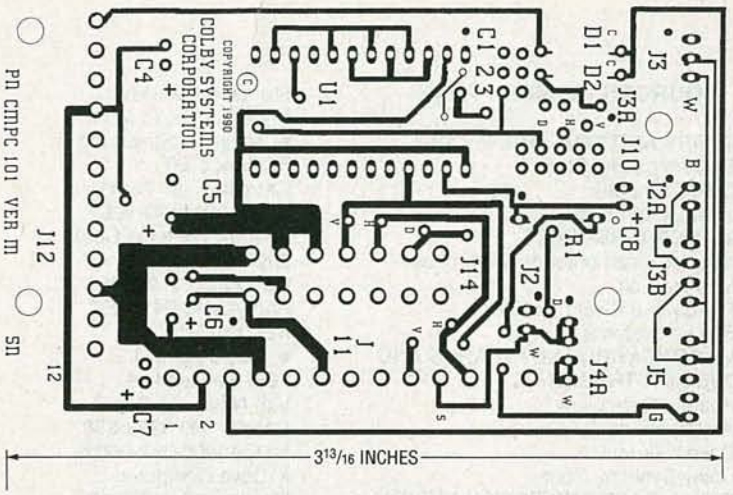
One megabyte of memory is typically installed in most SE motherboards with four 256K SIMM's filling the four memory SIMM slots. Remove all four original SIMM's, working from the front to the rear on both sides. If your SE has a resistor, clip the R35 resistor on one end and bend it aside to prevent contact. Do not remove it, as you may want to reconfigure to 1 MB later on.

The SE memory requirements with resistor R35 are as follows: For 2 MB, install two 1-MB SIMM's in SIMM sockets 1 and 2 (second row). For 2.5 MB, install two 1-MB SIMM's in position 1 and 2 (first row). Place two of the Apple 256K SIMM modules in positions 3 & 4 (second row), and completely remove the jumper. For 4 MB, install four 1-MB SIMM's in all four positions and completely remove the jumper

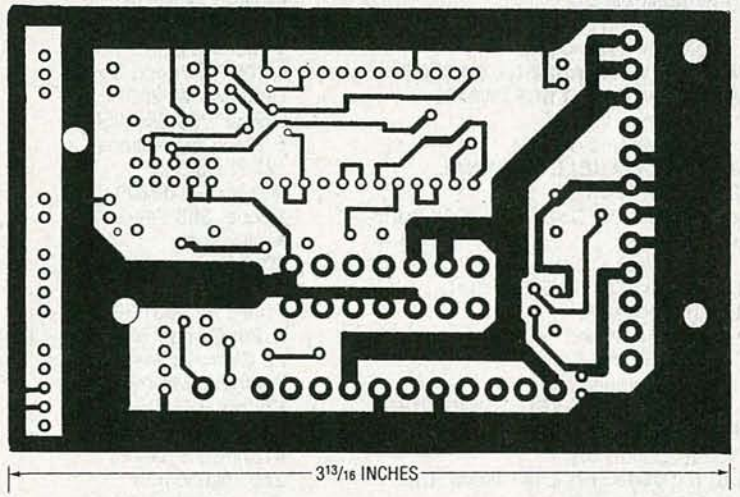
The three-pin jumper tells the SE what type of SIMM's are in use. The standard configuration is 1 MB of memory consisting of four 256K SIMM's installed in both rows. The jumper will be installed on the jumper block terminals labeled "1M."

The memory requirements for the SE version with a jumper are as follows: For 2 MB, install two 1-MB SIMM's in sockets 3 and 4 (second row). Move the jumper to the jumper block terminals labeled "2/4 MB." For 2.5 MB, put two of the Apple 256K SIMM modules in positions 1 and 2 (first row). Install two 1-MB SIMM's in positions 3 and 4 (second row), and completely remove the jumper. For 4 MB, install four 1-MB SIMM's in all four positions and completely remove the jumper.

Replace the keyboard, mouse, and other attachments and power-up your Mac Plus. To test your memory installation, pull down "About the Finder" under the Apple DA menu for the registered amount of RAM. The Mac SE-30 can be configured as follows: 1 MB with four 256K SIMM's in bank A, 2 MB with four 256K SIMM's in bank A and four 256K SIMM's in bank B, 4 MB with four 1-MB SIMM's in bank A, 5 MB with four 1-MB SIMM's in bank A and four 256K SIMM's in bank B, 8 MB with four 1-MB SIMM's in bank A and four 1 MB SIMM's in bank B, 16 MB with four 4-MB SIMM's in bank A, and 32 MB with four 4-MB SIMM's in bank A and four 4-MB SIMM's in bank B. Note: Since the Mac SE-30 runs at 16 MHz, it is recommended that 80 ns RAM be used (denoted by a -8 or -80 suffix on the part number on the individual chips on the SIMM).



THE COMPONENT SIDE of the power/video interface board.



THE SOLDER SIDE of the power/video interface board.

You must remove the original SIMM's found on your SE-30 motherboard if you are installing 1-MB SIMM modules. Note: This step is not necessary if you are installing 2 MB. Gently bend the plastic locking tabs out to the right and left to release the SIMM module. Rotate the SIMM forward to clear the locking tabs and remove all four SIMM's. Place the SIMM's on a non-static surface, such as the anti-static bags and pink foam supplied with your new SIMM's. Repeat this same procedure until all of the original SIMM's are removed.

Install each SIMM module with chips to the right of the SIMM by pressing the module firmly in the socket at a 45-degree angle and gently rolling it back until it snaps into place. 256K SIMM's are about $24.99, 1-MB SIMM's are about $49.99, and 4-MB SIMM's are about $299.99. **R-E**

BUILD A NEGATIVE ION GENERATOR

Build this negative ion generator and put some charge in your life.

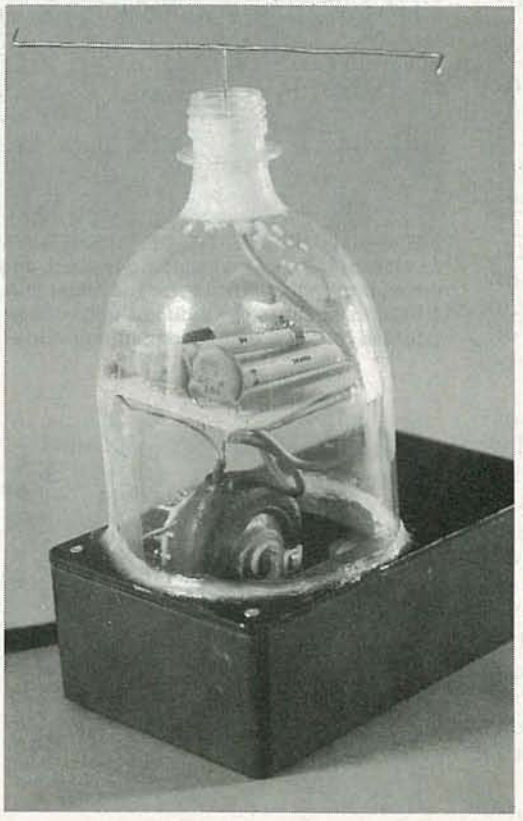
ANTHONY J. CARISTI

IF YOU'VE SEEN ADVERTISEments for negative ion generators in mail- order catalogs and wondered how they work, this project is for you. The simple version described here provides insight into their theory and applications, and is both informative and entertaining. Some of the demonstrations you can do with it will amaze you and your friends.

Many claims have been made for the beneficial attributes of negative atmospheric ions on human and plant life, especially by a Dr. Albert Krueger of the University of California. Studies have shown that negative ions promote physical and mental alertness and well-being, while positive atmospheric ions (such as in polluted air) cause discomfort and lassitude.

Certain negative ion properties can be demonstrated. For example, the surrounding air after a thunderstorm smells clean and fresh, due to generation of negative ions from lightning. The negative ions attach to smoke, dust, and pollen particles, bringing them to the ground to discharge, leaving fresh, clean air. That's why a cool room with a breeze is invigorating, compared with one that's stiflingly heated. Cool air is generally negatively ionized, whereas heated air is generally positively ionized.

Negative ions are air molecules with one or more excess electrons, produced in this case by a low-power, 9 to 14-kilovolt DC supply. The positive terminal is grounded, and the other (the emitter) is a needle exposed to air. (To generate positive ions, the polarities would be reversed.) Extra electrons on the emitter's surface produce a high local electric field owing to its pointed shape. The electrons exit the emitter needle's surface due to the polarization of surrounding air molecules between the emitter needle and ground. The electrons collide with the air molecules and produce negative ions.



A common misconception regarding high-voltage corona or arcing is that electrons are "overcrowded" on the tip, and forced off by mutual repulsion. What actually causes corona is the high electric field at the tip, which is directly proportional to the voltage, and is enhanced by sharpening an electrode tip to a fine point.

The high electric field strains the air molecules, polarizing them by a phenomenon called dipole polarization. If the electrode is positive, electrons are literally ripped off, creating positive ions, or if the electrode is negative, they're forced to accept electrons, creating negative ions.

High-voltage supplies like those in TV's need careful design, so no undesired discontinuities like sharp points or edges cause arcing. However, for the negative ion generator discussed here, the goal is to generate corona, not to avoid it, and the high electric field in the vicinity of a discontinuity more readily polarizes and ionizes air molecules.

The reason for the high electric field at the tip of a needle is due to its small localized radius of curvature. A sphere has a much more uniform electric field at its surface, due to its constant and much larger radius. The audible hiss caused by a high-voltage discharge is called "corona wind," and is often heard in older large-screen color TV's, especially on humid days, when the breakdown potential of the surrounding air is reduced, making the flyback transformer arc. You can often also feel it, if the corona is strong enough.

The negative ion generator de-

scribed here is low-cost, easy to build, and uses a high-voltage flyback transformer from an old black-and-white TV. It generates high voltage, but at very low current. However, the safety precautions taken for any high-voltage device should be observed here.

The circuit

The schematic of the negative ion generator appears in Fig. 1; T2 is a TV flyback transformer with an open ferrite core partially enclosed in an aluminum bracket. The only original connections used are one low-voltage tap as ground, and the lead connecting to the flyback transformer output winding (at right).

The other low-voltage taps aren't used, and the new feedback and bifilar primary windings are wound on the ferrite core. The bifilar primary winding goes to the collectors of an astable multivibrator made up of Q1 and Q2, with the center tap driven by the +3–5 volts DC from IC1. The astable energy-storage elements are the inductances of the new feedback and bifilar primary windings.

The term bifilar means a pair of transformer windings optimally coupled by having been wound in the same direction, either adjacent to or, preferably, superposed on top of one another. The feedback winding goes to the bases of Q1 and Q2 for positive feedback, with the center tap driven by the +3–5 volts DC from IC1 through R3. The transistors are then forward-biased by the opposite ends of each half of the feedback winding.

When power is applied, the current through Q1 and Q2 is unequal, due to differences in doping, layer thickness, and base-emitter (B-E) turn-on voltage. That's what causes oscillation; if all the astable parts were perfectly balanced (nearly impossible), it might not oscillate at all. Whichever transistor carries higher current saturates due to positive base feedback, and the other cuts off.

When the sharp increase in transistor current in half the bifilar primary winding is maximized, the induced voltage reverses, so the second transistor conducts and the first one cuts off. The collector waveform

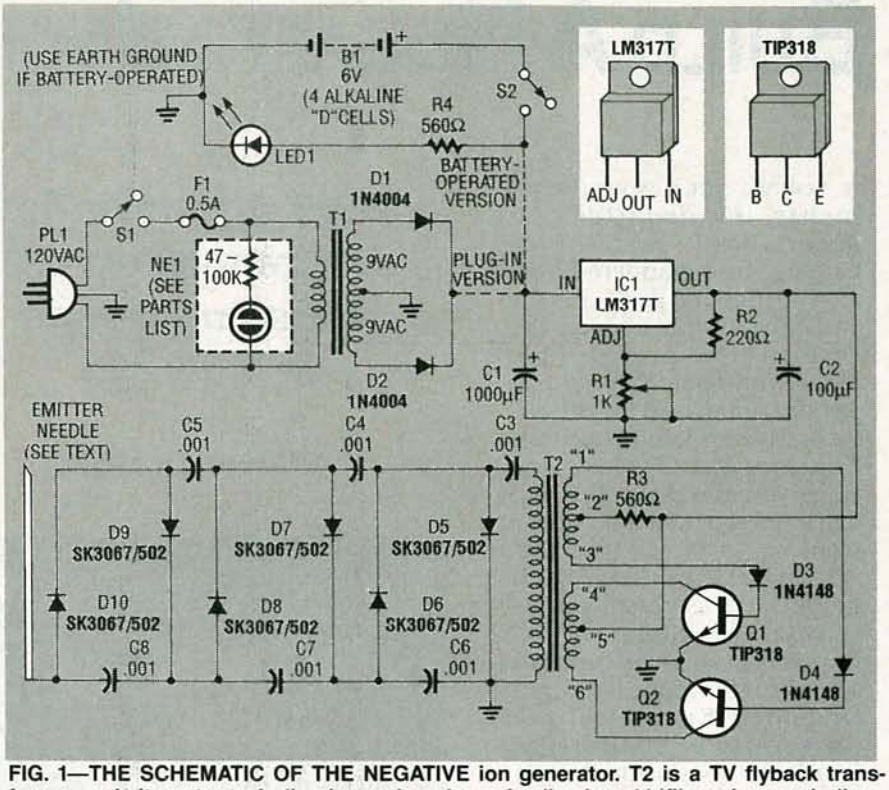


FIG. 1—THE SCHEMATIC OF THE NEGATIVE ion generator. T2 is a TV flyback transformer; only its output winding is used, and new feedback and bifilar primary windings are wound on the ferrite core. The bifilar primary winding goes to the collectors of astable Q1-Q2. Its square wave induces high voltage into the flyback transformer output winding, boosted followed by a ladder voltage-tripler −9 to −14 kilovolts.

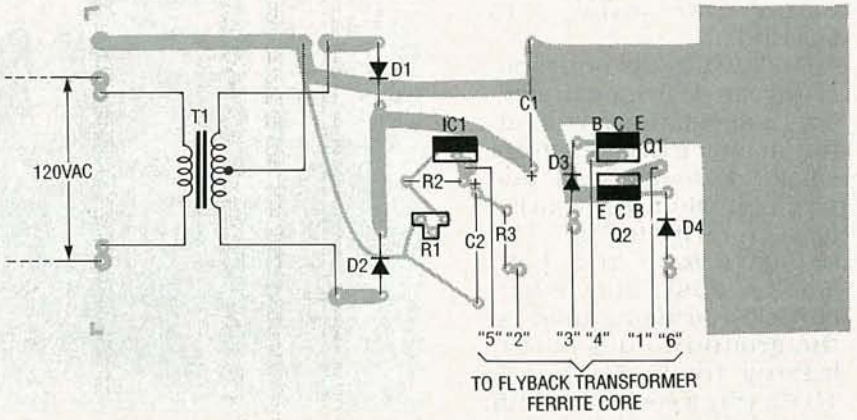


FIG. 2—THE PARTS-PLACEMENT DIAGRAM for the main PC board; Q1, Q2, and IC1 have U-shaped 1×1-inch copper heatsinks, with silicone grease for heat transfer; each goes on the main PC board without insulators. In the prototype, S1, S2, F1, and NE1 were omitted, and T2 was salvaged from a small-screen TV; note the new feedback and bifilar primary windings. Pin 7 had the highest resistance relative to the flyback transformer output lead, so it becomes ground.

fundamental frequency was 23.26 kHz, although higher harmonics greatly extend the total bandwidth. Also, the peak-to-peak bifilar primary winding voltage is four times that of the supply.

The astable square wave induces voltage into the flyback transformer output winding, proportional to the transformer turns ratio. A flyback transformer bifilar primary winding is normally quite small, while the flyback transformer output winding normally has about 2000–2500 turns, inducing −3 to −4 kilovolts.

Since the negative ion generator needs to produce −9 to −14 kilovolts DC, a ladder voltage-tripler with six diode-capacitor rungs is used to half-wave rectify and multiply the flyback transformer output voltage. Its operation is best understood in

PARTS LIST

All resistors are ¼-watt, 5%, unless otherwise noted.

R1—1000 ohms, PC-board mounted potentiometer
R2—220 ohms
R3, R4—560 ohms (the former for the astable-flyback transformer combination, the latter optional for the battery-operated version)
R5-R6—200- and 40-megohm series high-voltage focus divider, RCA SK3868/DIV-1, used for an optional high-voltage range extender for a conventional high-impedance (10-megohm) voltmeter (see text)
R7—2.7 megohms

Capacitors
C1—1000 µF, 25 volts, electrolytic
C2—100 µF, 16 volts, electrolytic
C3–C8—0.001 µF, 10 kilovolts, ceramic disc
C9—0.001 µF, 500 volts, ceramic disc, optional for aluminum can/neon bulb experiment (see text)

Semiconductors D1, D2—1N4004 silicon diode
D3, D4—1N4148 silicon diode
D5–D10—RCA SK3067/502 high-voltage diode, 12 kilovolts PIV
LED1—light-emitting diode for the battery-operated version
Q1, Q2—TIP31B NPN transistor
IC1—LM317T adjustable voltage regulator

Other components
F1—0.5-amp slow-blow fuse with holder
NE1—120-volt AC neon-bulb assembly with 47–100K built-in series resistor for the plug-in version (Radio Shack 272-712)
NE2—neon bulb, type NE2 (not the part number), optional for experiment (see text)
S1—SPST toggle switch
S2—SPST toggle switch
T1—18-volt center-tapped transformer (Radio Shack 273-1515)
T2—standard TV flyback transformer (see text)

Miscellaneous: Plastic case (7.5×4.25×2.25-inches, Radio Shack 270-224), enamel magnet wire, three-wire line cord, emitter needle (made from either straight pin or sewing needle), RTV silicon rubber, heat sinks, four alkaline "D" cells (optional for battery operation), 2-liter plastic soda bottle, and a sewing needle.

NOTE: The following are available from Anthony J. Caristi, 69 White Pond Road, Waldwick, NJ 07463: Two etched and drilled PC boards (one each for the main and voltage-tripler sections) for $15.95, IC1 for $3.25, Q1 and Q2 for $2.75 each. Please add $2.00 for postage and handling with each order; NJ residents please add 7% sales tax.

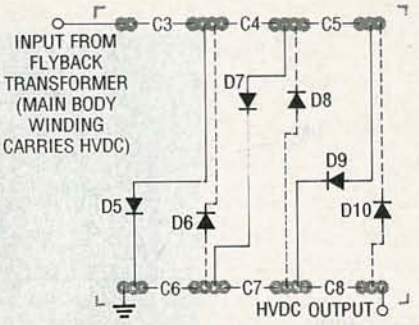


FIG. 3—THE PARTS-PLACEMENT diagram for the high-voltage PC board. The parts shown include high-voltage ceramic disc capacitors C3–C8, and selenium rectifiers D5–D10. D5, D7, and D9 go on the component side (solid lines), while D6, D8, and D10 go on the foil side (dashed lines).

segments. The AC waveform from the transformer is coupled to D5 and D6 via C3, charged through D5 acting as a clamp.

The peak-to-peak magnitude of the AC waveform at the anode of D5 equals that of the flyback transformer output winding, with a negative DC component of half the peak-to-peak value. The AC output waveform from the flyback transformer is coupled to the anode of D7 via C3 and C4, where D7 charges C4. The action is repeated again via D9, which charges C5. The DC potentials on C3–C5 add, tripling the voltage from the flyback transformer winding. The anode of D10 is the output of the negative ion generator, and should be at −9 to −14 kilovolts DC.

Power is supplied by either a standard full-wave rectifier followed by variable voltage regulator IC1, or four series "D" cells producing 6 volts DC. Although S1, S2, F1, and NE1 are shown in Fig. 1, they were omitted in the prototype. IC1 controls the DC voltage fed to the oscillator via R1. Since the negative ion generator output must be −9 to −14 kilovolts, and the exact flyback transformer turns ratio is normally unknown, adjusting R1 is mandatory. Once R1 is set, the negative ion generator output voltage will be stable.

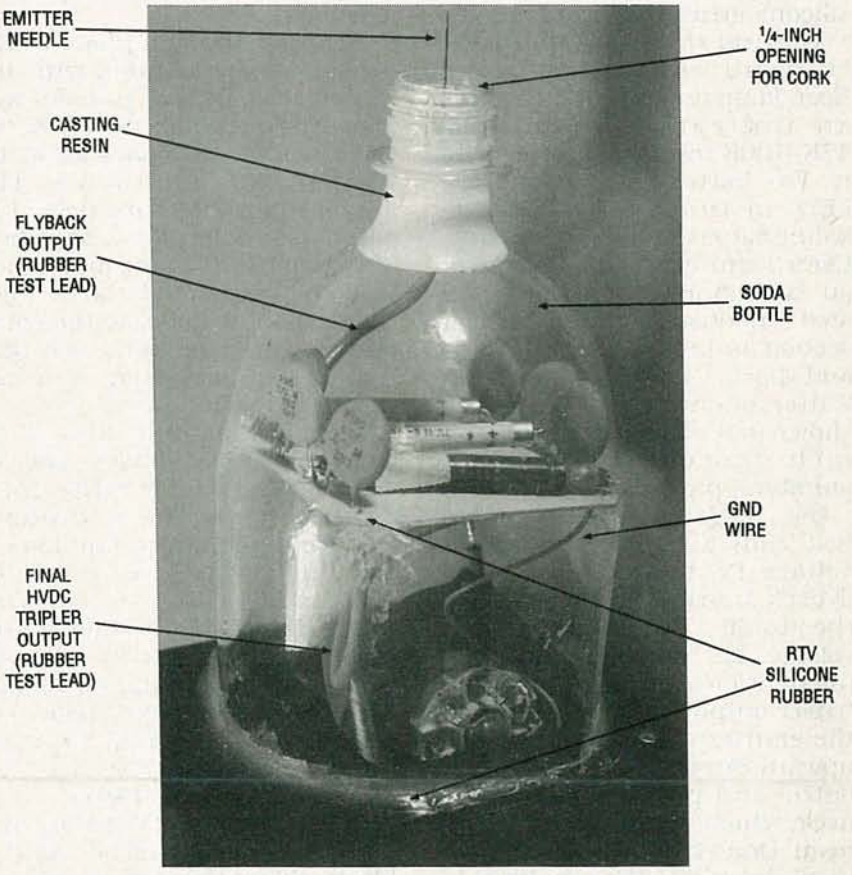


FIG. 4—THE NEGATIVE ION GENERATOR, showing the case, T2, plastic soda bottle, and the top of the high-voltage PC board, with D5, D7, D9, and C3–C8. Both the plastic soda bottle and high-voltage PC board are held in place with RTV. The neck is sealed with casting resin to within ¼-inch of the top; cover the needle with a cork when unused.

Construction

Next, we'll discuss construction, focusing on the main and voltage-tripler PC boards, the plastic cover for the voltage-tripler PC board made from the top third of a 2-liter plastic soda bottle, the emitter needle, and the cutout in the lid of the plastic case for the flyback transformer. Figure 2 shows the parts-placement diagram for the main PC board, and Fig. 3 the ladder voltage-tripler section. Remember to add S1, S2, F1, and NE1 off the main PC board, as shown in Fig. 1, if you want them.

The main section includes the regulated supply, oscillator, and flyback transformer, and goes on the single-sided PC board mentioned in the parts list, with the foil pattern shown here. The high-voltage PC board contains the ladder voltage tripler, connected to the main PC board by two leads, and the emitter needle is above the high-voltage PC board. In Fig. 2, Q1, Q2, and IC1 need heatsinks; you can buy them, or make them from 1×1-inch copper bent in a "U," with silicone grease for heat transfer.

The heat sinks go on top of the PC board without insulators. Neon lamp assembly NE1 acts as an indicator, and has a 47K–100K resistor in series with it. For battery operation, use LED1 in series with R4; use alkaline batteries, not carbon-zinc. Use a 3-wire cord with ground, or an earth ground in battery-operated versions. The voltage-tripler section is built to avoid arcing and shock. Cut the top third off a 2-liter plastic soda bottle, as shown in the lead photo, or use 4-inch diameter plastic PVC plumbing pipe.

Use 18-gauge rubber-coated test leads to connect the high-voltage PC board to both the flyback transformer output and the needle, to withstand high voltage, but not until indicated (more below). The heavy voltage-tripler output lead is soldered to the emitter needle, which goes upward through the plastic soda bottle and projects out of the neck, which is filled with casting resin. Don't fill the neck with resin all the way to the top; leave ¼ inch of the neck open, so you can cap the needle with a wine bottle cork when not in use.

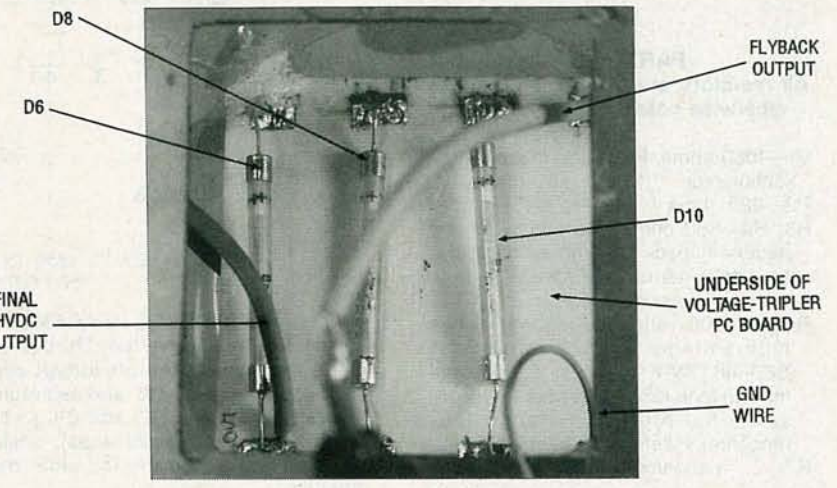


FIG. 5—THE BOTTOM OF THE HIGH-VOLTAGE PC board, showing D6, D8, and D10, and the attachment points of the ground lead and both high-voltage leads.

The voltage tripler shown in Fig. 3 consists of ceramic disc capacitors C3–C8, and high-voltage selenium rectifiers D5–D10. Note that D5, D7, and D9 go on the component side of the PC board, while D6, D8, and D10 go on the foil side. They're common to most TV's, so most TV repair shops should stock them; see the parts list.

Figure 4 shows a photo of the negative ion generator, with the closed case, flyback transformer, plastic soda bottle, and top of the high-voltage PC board showing D5, D7, D9, and C3–C8. The high-voltage PC board is held in place inside the plastic soda bottle top using RTV silicone rubber, and the plastic soda bottle goes on the top of the case the same way, for a water-tight seal that avoids condensation, and has good high-voltage attributes.

The markings and sizes of the high-voltage TV diodes used in the voltage tripler differ from those on standard diodes. They're much larger, and have a very high peak-inverse voltage (PIV) rating. Also, on a conventional diode, the cathode is normally marked with a band, whether a white band on a black body for such low-voltage rectifiers as the 1N4001, or a red band on a clear glass body, as with the 1N4148 or 1N914.

In high-voltage TV diodes, the body is generally either white, black, or see-through. In Fig. 4, D5 and D7 are white with a band of black "+" signs on the right end, while D9 is black with a dashed band of white "−" signs on the right end. The ends with the bands are the cathodes, for both diode body types; the reason for the "+" signs on D3 and D5 is that circuit power is normally considered as being extracted from the cathode ends in TV, and is called B+. In Fig. 5, D6, D8, and D10 all have bands of "+" signs on the cathodes.

A 3×3-inch hole was made in the case top for the flyback transformer; adjust yours as needed. Don't connect the voltage-tripler PC board to the main PC board until the final checkout below; put it aside and let the RTV dry overnight. The soda bottle and the high-voltage PC board are held in place using RTV. The rubber-coated test leads connect the flyback-transformer output to the voltage tripler and the voltage tripler to the emitter needle; the thin wire is the ground.

A flyback transformer is also called a tuned transformer, and consists of a ferrite core surrounded by a metal bracket, with a large coil of windings coated in plastic or ceramic with an *extremely* high dielectric breakdown voltage. Often, as with the flyback transformer used in the prototype, there are additional low-voltage output winding taps (seven, in that case) placed around a plastic ring on one side of the transformer coil, that have equally high-voltage breakdown characteristics.

That's all we have room for. Next month we'll finish up this project. **R-E**

BATTERY TECHNOLOGY

Here are some important Q&A's about batteries to enable you to use them more effectively.

MARK DEWEY

BATTERIES ARE BECOMING A BIGGER part of all our lives, and many innovative new products coming to market either use or contain them. Battery-powered products are no longer limited to just toys and handheld vacuums. Serious products—like handheld transceivers, portable scopes, or laptop computers—are often battery-operated. However, while batteries provide mobility, they're also often the culprits when a product fails.

Many of us still consider batteries to be the ultimate black boxes: mysterious devices that work only when they feel like it. However, they're really not that difficult to understand and use effectively. Here are some questions and answers to help you create better designs using them.

• I know there are many kinds of batteries. What's the best type for my application?

Choosing a battery type means knowing something about both batteries and how they'll be used in your equipment. Batteries are commonly classed as either primary or secondary. Primary cells include the disposable varieties such as carbon-zinc, alkaline, and lithium cells that can't be recharged.

Secondary cells include the varieties based on either nickel-cadmium (Ni-Cd) or lead-acid cell chemistries, that are rechargeable several times without degradation. So first, consider your equipment. Specific questions include: What is the drain rate? How often will the equipment be used? And, finally, is recharging feasible?

Low current drain, short duty cycles, and remote operation favor the use of primary batteries for watches, hearing aids, garage door openers, and retrofit smoke detectors. Obviously, the application parameters for secondary batteries are basically the opposite of those for primary cells. In applications involving high current drain or extended usage, the cost of replacement of disposable batteries may be prohibitive. Such applications are logical for rechargeable secondary batteries as long as recharging power can be provided.

• Based on drain rate and duty cycle, my application could go either way. What are the performance differences among various battery types?

Table 1 provides a comparison of various common battery types, both primary and secondary. The first point of interest is the nominal cell voltage; more sophisticated concepts like energy density will be covered later. Also, all batteries have one or more cells, operating at voltages fixed by the electrochemistry of a given cell. Note that the operating voltages are shown as decreasing in Table 1; the initial value refers to the fully charged state, while the final value refers to the end of runtime, or useful life.

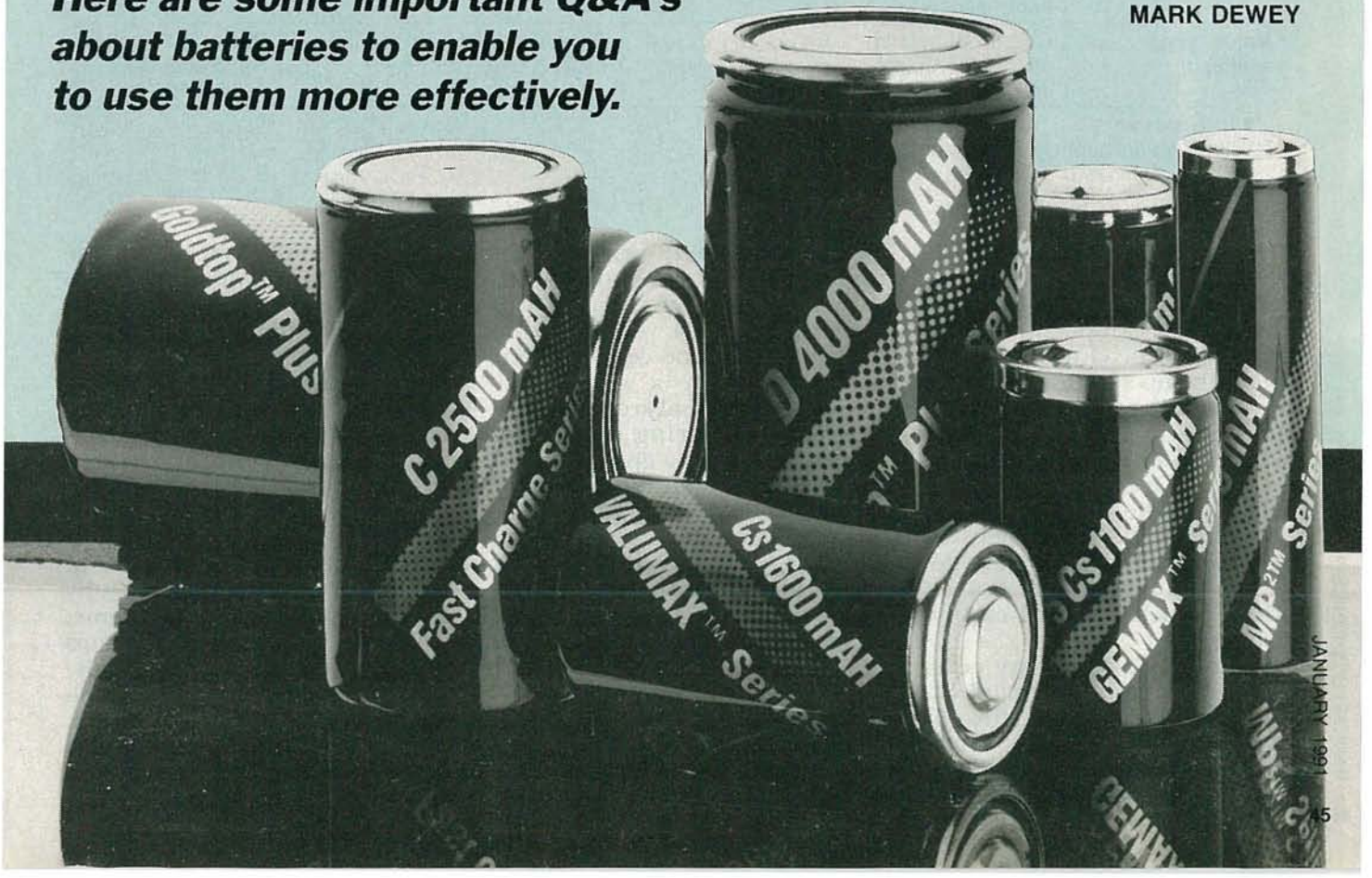


TABLE 1—CHARACTERISTICS OF COMMON BATTERY TYPES

Characteristic	Primary Cells		Secondary Cells	
	Carbon-Zinc (LeClanche)	Alkaline	Lead-acid (sealed (SLA), wound, gel.)	Ni-Cd (sealed, wound)
Chemistry:				
Anode	Zn	Zn	Pb	Cd
Cathode	MnO_2	MnO_2	PbO_2	NiOOH
Electrolyte (all aqueous solutions)	NH_4Cl and $ZnCl_2$	KOH	H_2SO_4	KOH
Cell voltage:				
Nominal	1.5	1.5	2.0	1.2
Open-circuit	1.5–1.75	1.5	2.1	1.25
**Operating	1.25–1.15	1.25–1.15	2.0–1.5	1.25–1.00
End	0.8	0.9	1.75	0.9
Operating temperature (°C)	−5–45	−20–55	−40–55	−40–70
Energy density (20°C) for cylindrical cells				
*Wh/kg	85	85	35	30
*Wh/liter	100	220	70	80
Advantages	Lowest cost; good for non-critical use under moderate conditions; variety of shapes and sizes; readily available	High capacity compared with zinc-carbon; good low temperature	Low cost; readily available; good high-rate, high- and low-temperature operation	Sealed, no maintenance; good low temperature and high-rate performance, long cycle life
Limitations	Low energy density; poor low temp., high-rate performance	Moderate cost	Relatively low cycle life; limited energy density; poor charge retention; hydrogen evolution	Higher initial cost than lead-acid
Major types available	Cylindrical bobbin cells to 30 Ah; flat cells	Button and cylindrical cells to 20 Ah	Prismatic, cylindrical, wound cells, 200-400 Ah	Button cells to 0.5 Ah; cylindrical cells to 10 Ah

*Wh: Watt-hour.
**Values are deliberately decreasing

The nominal voltages of all cells are fixed by their electrochemistry (more below). The two major primary cells, carbon-zinc and alkaline, both produce 1.5 volts, while lithium versions produce 3.0 volts. The carbon-zinc cell is referred to in Table 1 as a "Leclanche" cell, named after the French chemist George Leclanche, who discovered it in 1866. Under the Ni-Cd cell listings, one of the the cathode material has the unusual formula of NiOOH, which is nickel oxy-hydroxide.

Of the major secondary cells, Ni-Cd cells produce 1.2 volts/cell, and lead-acid cells 2.0 volts/cell. Higher voltages, up to 240 volts, are commercially available from series cells. In 12-volt car batteries, all cells are connected internally. However, certain cell potentials, like 4 volts, may be possible from one cell type, but not from others.

Cell chemistry also causes voltage "droop" during discharge, which may affect a given application. While flashlights merely dim as their battery voltage decreases, many electronic circuits are highly sensitive to even slight drops in input voltage. Figure 1 compares the performance of primary carbon-zinc and alkaline "D" cells with secondary Ni-Cd and sealed-lead cells, for a discharge current of 800 milliamps.

The carbon-zinc voltage profile falls rapidly with discharge, with a runtime under four hours. The voltage of an alkaline cell also falls off steadily, but its runtime is roughly quadruple that of a carbon-zinc cell. The Ni-Cd cell has a voltage profile that's nearly flat for most of its life, but only half the terminal potential of an alkaline cell. The Ni-Cd cell has a first recharge life that roughly equals the total life of an alkaline cell.

The stability of Ni-Cd cells at high current drains is why they're used in portable items; drills can draw up to 30 amps under load. The internal resistance of a Ni-Cd cell is 5–15 milliohms due to it's construction, making such high current drains possible. A spiral nylon separator

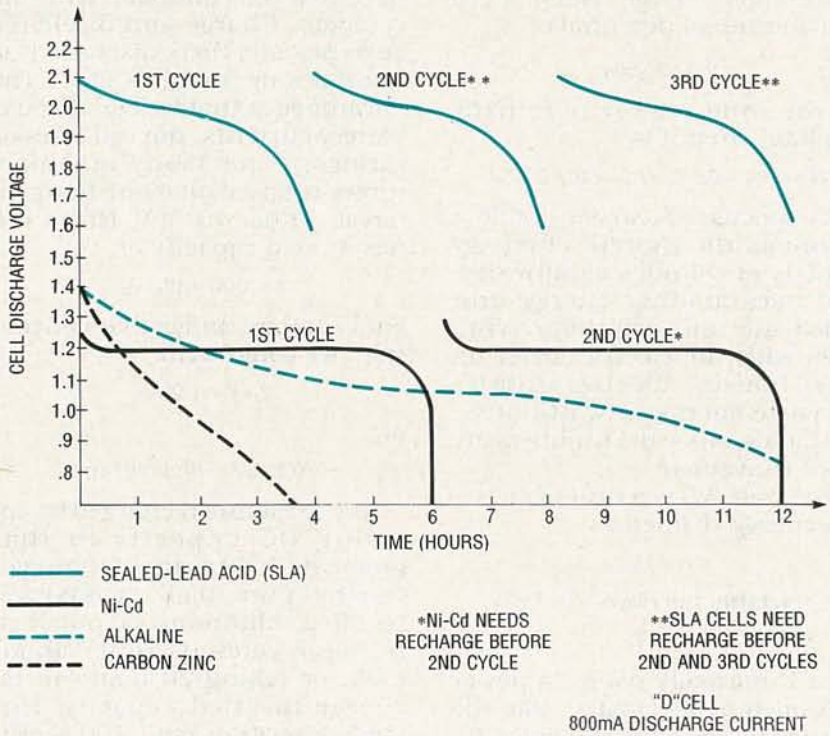


FIG. 1—THE VOLTAGE PROFILES OF PRIMARY and secondary D-cells are compared for a discharge current of 800 milliamps. The carbon-zinc voltage profile falls rapidly with discharge, with a runtime under four hours. Alkaline performance falls off steadily, but runtime is quadruple that of carbon-zinc.

isolating the electrodes goes in a steel can used as the negative terminal, and is filled with electrolyte that transmits mobile charge. The steel it's sealed in is used as the positive terminal, as shown in Fig. 2.

Whereas Ni-Cd cells have a large anode-nylon-cathode surface area due to their spiral design, alkaline cells have an annular (or doughnut-shaped) cross section. Powdered anode material fills an inner ring, and compressed cathode material fills an outer ring. They're isolated by a porous fiber separator as shown in Fig. 3, giving a higher internal resistance, and limiting the available current drain.

Note that in Fig. 3, the top positive electrode is the cathode, while the bottom negative electrode is the anode. At first glance, that might seem odd, since most of us are normally accustomed to the reverse usage encountered with diodes. However, since a battery is an electrolytic (or electrochemical) cell, the labels for the terminals of a battery follow chemical, not electrical usage.

Earlier, there was a reference to how the electrochemistry of a battery fixes its terminal potential; let's now examine that aspect in more depth. The chemical process in a battery is an oxidation-reduction, also called a "redox" reaction.

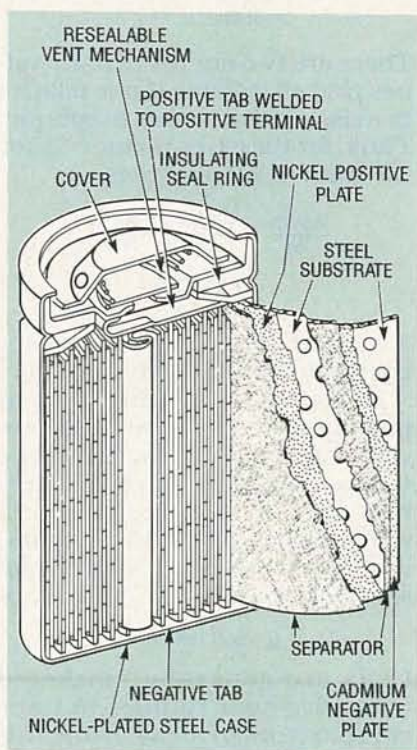


FIG. 2—NI-CD CELLS EXHIBIT an internal resistance of 5–15 milliohms due to their construction, making stable current drain possible.

The anode is the terminal where material is oxidized, or where electrons are removed from or given up, and is usually called negative or minus ("–"), or where mobile electrons exit into a wire. The cathode is the terminal where material is reduced, or where electrons are accepted, and is usually called positive, plus ("+"), or the terminal where mobile electrons enter from a wire.

An electrolyte is the wet (or at least damp) ionic medium, through which mobile free electrons released by oxidation at the cathode travel to the anode, to propagate the electrolytic reaction of a battery. Table 1 lists the materials used for all three parts of the most common batteries.

The term "electrolytic" has the same meaning here that it has for capacitors, with certain variations. An electrolytic capacitor is polarized like a battery, and may well explode if its DC working voltage (WVDC) is exceeded (especially for reverse polarity), just as many primary nonrechargeable batteries will if recharged.

A battery, by contrast, is basically a fuel cell, maintaining terminal potential by electrochemical means until its fuel is exhausted. That is, the very selection of electrode metals and electrolyte is what determines the terminal potential of a battery, and a battery thus supplies charge *without* having to be charged initially.

All an electrolytic capacitor can do is store a charge fed into it, and dissipate the charge by generating an exponential current into a resistance. It stores charge (whereas a battery generates it spontaneously), and its potential decays exponentially, just as with any other capacitor. However, the electrolytic medium used allows the packaging of larger capacitance values than would otherwise be possible for a given volume. Nonetheless, batteries and electrolytic capacitors are at least second (or maybe even first) cousins.

• What are cell capacity ratings based on?

Battery manufacturers rate cell capacities in amp-hours (Ah), a unit of charge, not energy. A 1-

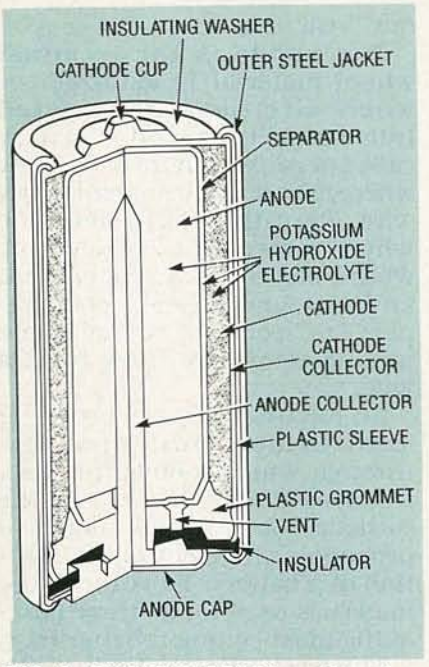


FIG. 3—THIS IS A CROSS section of an alkaline cell showing its annular construction.

amp current corresponds to the motion of 1 coulomb (C) of charge past a given point in 1 second (s), or

$$1 \text{ amp} = 1 \text{ C/s},$$

where,

$$1 \text{ C} = 6.25 \times 10^{18} \text{ electrons/s}.$$

The individual electron is often denoted by the variable e^-, so the above relation would appear as

$$1 \text{ C} = 6.25 \times 10^{18}\ e^-.$$

The metric unit of charge is the coulomb, while that of energy is the joule (J). The potential energy (or potential work) W contained in a battery is related to its total available charge q and terminal voltage V by

$$W = q \times V.$$

The variable W is used for energy to avoid confusion with E and V, normally reserved for voltage, although many texts use E for total energy (kinetic and potential) and V for potential energy as well, so you should know the context to avoid confusion. Thus, an "AA" Ni-Cd cell that can maintain a 0.6-amp load for one hour is said to contain

$$\begin{aligned} q &= 0.6 \text{ Ah}, \\ &= (0.6) \times \left(\frac{6.25 \times 10^{18}\ e^-}{\text{C}}\right)\left(\frac{1\text{C}}{\text{s}}\right)\left(\frac{3600\text{s}}{\text{hr}}\right)(1\text{hr}) \\ &= 1.35 \times 10^{22}\ e^-, \\ &= 2160 \text{ C} \end{aligned}$$

of available charge. Such a cell has a terminal potential of

$$V = 1.2 \text{ volts},$$

so the total energy nominally available from it is

$$W = q \times V = 0.6 \text{ C} \times 1.2 \text{ volts} = 0.72 \text{ J}.$$

As discussed earlier, Table 1 mentions the concept of energy density of cylindrical batteries, and uses another energy unit called the unit watt-hour (Wh), used with the electric meter on most houses. Electric utilities measure energy in watt-hours, not joules, since the numbers are more convenient.

The watt (W) is a unit of power, not energy, defined as

$$1 \text{ W} = 1 \text{ J/s}.$$

The variable for power is P; if

$$P > 0 \text{ W},$$

then P normally refers to power expended or dissipated, like the loss from a resistor. Whereas, if

$$P < 0 \text{ W},$$

the reverse is normally true, that power is being supplied, rather then expended. Thus, a watt-hour is equivalent to

$$\begin{aligned} 1 \text{ Wh} &= \left(\frac{1\text{J}}{\text{s}}\right)\left(\frac{3600\text{s}}{\text{hr}}\right)(1 \text{ hr}) \\ &= 3600\text{J}, \end{aligned}$$

There are two energy density values per cell in Table 1, one relative to mass, and the other to volume. Thus, for the carbon-zinc cell, for the value relative to mass

$$\begin{aligned} \frac{65\text{Wh}}{\text{kg}} &= \left(\frac{65\text{Wh}}{\text{kg}}\right)\left(\frac{3600\text{J}}{\text{Wh}}\right) \\ &= \frac{2.34 \times 10^5\text{J}}{\text{kg}} \end{aligned}$$

A similar argument follows for energy density relative to volume.

However, the same cell, if providing less current, can provide more useful energy, since there's then less internal battery heat loss. If the same "AA" cell were discharged over five hours, it could sustain a 130-milliamp load, for an observed capacity of

$$q = 650 \text{ milli-Ah}.$$

Cells are generally marketed using five-hour ratings, but any comparison of cells from different manufacturers should use equivalent ratings.

Battery manufacturers define *C* as rated capacity; the italics are used to avoid confusion with the coulomb. Charge and discharge currents are then discussed as multiples or fractions of *C*. The advantage is that we can discuss battery currents, not cell sizes or ratings; *C* for many manufacturers is based on a one-hour interval. Thus, an "AA" Ni-Cd cell has a rated capacity of

$$C = 600 \text{ milli-Ah}.$$

For example, under that convention, we could write

$$2 \times C = 1.2 \text{ Ah},$$

or,

$$C/10 \text{ hours} = 60 \text{ milliamps}.$$

Ni-Cd cells are recharged by applying DC opposite to that generated during discharge, whether pure, half-, or full-wave rectified. Minimum commercial recharge rates used are about *C*/20, or taking 20 hours to recharge to rated capacity. But since charging isn't 100% efficient, especially when it's so slow, some 36–48 hours would realistically be needed.

• Is there a danger of overcharging a Ni-Cd battery?

Recharging efficiency decreases as it nears completion. The final few percent is returned as the cell approaches "overcharge," where Ni-Cd cells generate gaseous oxygen (O_2). At low recharge currents, continuous overcharge isn't damaging, since the cell electrochemically recombines the total oxygen volume, letting Ni-Cd cells be totally sealed.

For safety, venting is designed into the cell cover. If overcharged at current above a recommended limit, the oxygen is expelled via such a vent, which then reseals. Repeated venting does dry out water from the electrolyte, causing damage manifested as decreased lifetime for a given load.

Also distinguishing primary cells from Ni-Cd cells is the property of charge retention. Alkaline cells can maintain full charge in ambient environments for up to four years, especially if they're refrigerated, whereas most Ni-Cd cells will lose some 1–2% of their rated capacity per day. That's why many commercial Ni-Cd cell applications use trickle charging (as low 0.02*C*) when the battery reaches an overcharge condition.

• I've heard a great deal about charge rates, especially "quick" and "fast" charging. What's the distinction?

Battery manufacturers have met market demands for cells with faster recharge rates. "Standard" charging is at a rate of 0.1 *C*, or 16–20 hours. "Quick" charging is at a rate of 0.33*C*, or 4–5 hours. Cells are available that can sustain continuous overcharge, with 100% oxygen recombination, at up to 0.33*C*, eliminating the need for trickle charging. "Fast" charging has become the industry standard, being a rate of 1.0*C* or higher, up to 2*C*–4*C*; recharge shutoff is done to prevent oxygen venting, even though it does no damage.

• Explain how cells are configured to make batteries. Don't I need certain additional knowledge about performance?

Assembling cells into batteries can appear, at least superficially, to be a rather trite exercise. However, knowing correct cell performance doesn't necessarily guarantee uniform, successful battery performance. Experienced product designers and hobbyists alike are aware that battery assembly can involve some important concerns, not the least of which is cell reversal. Ni-Cd cells are typically series-connected for higher voltage, and capacity is achieved using cells of adequate size.

Ni-Cd cells are typically connected in series for batteries. Runtime, or capacity, is met by using cells of sufficient size to meet the requirement. Cells of even the same size and manufacture lot can exhibit actual capacities that vary up to 8% of a mean. In multicell batteries, such variances can cause some cells to give up the last of their usable capacity, while others are still viable. If the extent of discharge is deep enough to bring one or more cells to zero voltage, cell reversal can occur.

• Explain cell reversal.

The voltage of a cell is the stored potential or electromotive force (EMF) capable of driving current through a circuit. When a cell is reversed, its energy is expended to the point where any further current drain is into the cell, such that the circuit drives the cell, instead of the reverse, as shown in Fig. 4. During reversal, cell voltage can go as low as −1.4 volts, generating gaseous hydrogen (H_2), which doesn't recombine and has to be vented.

The solution to cell reversal is to understand and design for applications where cells have the potential for repeated reversal. Product designers can choose to use a cutoff circuit to terminate discharge based on battery voltage, to prevent cell reversal. Motorized products draw high current, so when their performance decays before the onset of reversal, they should be shut off. Modern Ni-Cd cells are more tolerant of cell reversal. Modern Ni-Cd cells repeatedly tested to 40% reversal at 10*C* have suffered no degradation.

Finally, if all Ni-Cd cells in a battery pack are overcharged, reversal is less likely since they all begin to discharge from the same point. Building batteries from cells of equal capacities reduces the effect of individual cell variation at the end of discharge, and minimizes the chance of reversal.

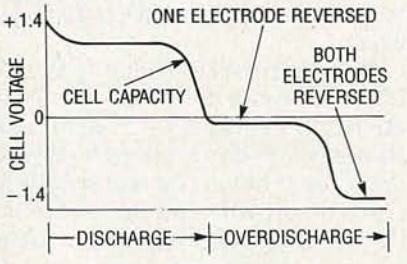


FIG. 4—IN CELL REVERSAL, the stored energy of a cell is expended to the point where the circuit drives the cell, instead of the reverse.

• Memory continues to be a much-discussed problem in Ni-Cd batteries. How is memory avoided?

No discussion of Ni-Cd cells would be complete without mentioning the "memory" effect. The term memory was coined in the early 1960's during early NASA satellite flights. Satellite batteries have strict discharge/recharge regimes and receive very little overcharge. Such precise regimes were the result of NASA computer-controlled energy management, and are seldom duplicated commercially.

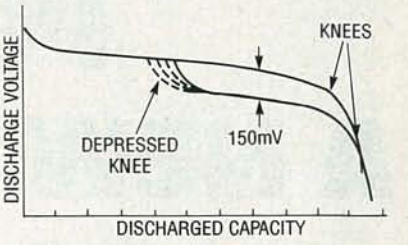


FIG. 5—IN NI-CD "MEMORY," cells repeatedly discharged only partially to the same extent, and then recharged soon won't discharge beyond the "memorized" level.

If Ni-Cd cells are repeatedly discharged only partially to the same extent (or thereabouts) and then fully recharged, they reach a point where they won't discharge further than the "memorized" location in their discharge profile. Today, the term "memory" is a misnomer, since it's now applied to a much wider range of similar problems.

Voltage depression and poor capacity are two common examples, often mistaken for memory, manifested as shortened runtime, as shown in Fig. 5. Devices frequently won't operate at voltages below a specific design value, or will exhibit reduced performance, at best. Causes include low recharging, excess recharge current, excess battery heat during recharge, improper recharge termination voltage, or wearout.

During standard or quick recharging, Ni-Cd cells need some overcharging, since recharging isn't 100% efficient. If they're not fully recharged, they can't deliver their rated capacity. Excessive overcharge currents can cause overheating in Ni-Cd battery packs. In overcharge, the energy provided to the battery is predominantly converted to heat, since the chemical conversions are complete, or nearly so. Such overcharging accelerates wearout or causes voltage depression or poor capacity, although improved Ni-Cd cell designs have lower sensitivity. Such improvements, along with careful application, insure long life.

• Does the electrolyte in a Ni-Cd cell ever leak?

Ni-Cd cells can undergo storage leakage, especially in radio applications, if left on. However, even if turned off, solid-state power supplies often allow leak-

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PUTTING A NEW SCOPE TO WORK

To get the most out of a new digital scope, you have to understand how it works, from the inside out.

ROBERT W. RAMIREZ

IF YOU'RE THINKING ABOUT BUYING A new oscilloscope, or your boss is putting a new one on your bench, you may be in for a surprise. Many of today's new scopes are vastly different from those of only a few years ago. That applies not just to exotic, state-of-the-art scopes, but also to low-cost, basic scope types. Becoming familiar with some key concepts behind the new scopes will give you a head start into understanding how these useful testing devices work.

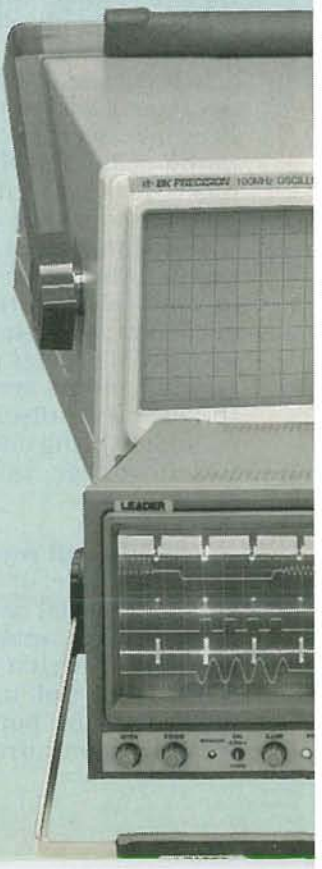
Oscilloscopes of today typically have far more features, yet cost about the same as—or even less than—yesterday's scopes. While they may have the same basic controls, and appear similar, they handle signals differently, and measurement techniques have changed dramatically. In some cases, a new scope can even be a PC board that plugs into a personal computer or a logic analyzer. Yesterday's exotic features have become today's norm. Let's start off by looking at some of the changes that have occurred in traditional analog scopes.

Scopes going digital

It's rare today to find a garden-variety analog scope that doesn't use some form of digital circuitry. Some things are easier and less expensive to implement digitally. In fact, most control functions in any scope are more effectively accomplished digitally. The only analog devices in some traditional scopes may be the actual test probes, amplifiers, and CRT.

The usual front-panel controls and buttons still are present in newer scopes, and operate in much the same way as in older scopes. The main difference is that they're digitally implemented, with a microprocessor or two keeping track of things.

Some newer scopes have banks of push buttons for selecting vertical (volts per division) and horizontal (seconds per division) scaling of waveform displays. Others may still use the traditional knob approach, but with a new twist—no numbers or mark-



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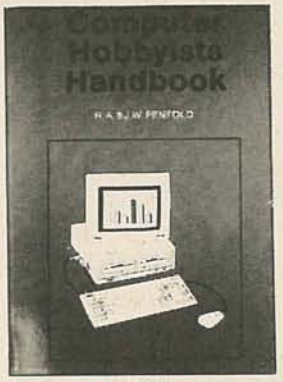

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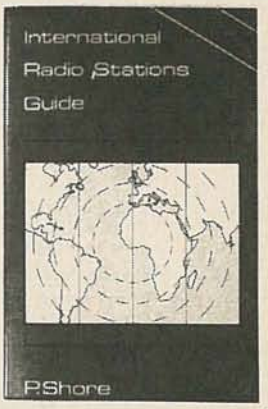

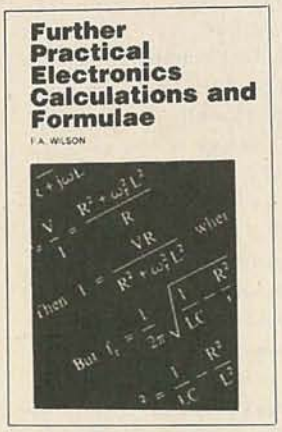

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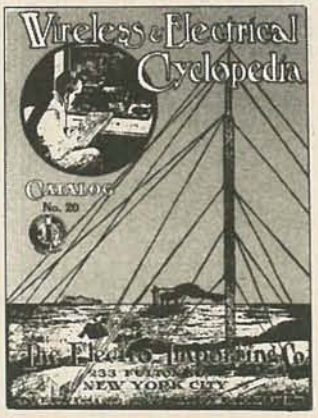

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RADIOS

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Sensitive all mode, AM, CW, SSB receivers for 3.5—4.0 or 7.0—7.5 MHz. Direct conversion design using NE602 IC as featured in QST and ARRL handbooks. Less than 1 µv sensitivity, varactor diode tuned, 250 mw audio output. Runs on 9VDC, has RF gain control. This kit is very easy to build, lots of fun and educational—ideal for the beginner or the old pro. The optional matching case kit features a rugged ABS plastic case with screened graphics. Included are machined aluminum knobs for a well-finished professional look.

20 MTR	40 MTR	80 MTR	Receiver
receiver kit HR-2 **$24.95**	receiver kit HR-4 **$24.95**	receiver kit HR-8 **$24.95**	case CHR **$12.95**

QRP TRANSMITTER KITS, 20, 40 & 80 METERS

Operate a mini ham shack. These little CW rigs are ideal mates to our 40 and 80 meter receivers. Features include smooth variable tuning, one watt output and excellent keying characteristics. Runs on 12 VDC and is VSWR protected. See how far you can stretch your signal with one of these mini rigs. Optional ABS cases are available.

20 MTR	40 MTR	80 MTR	Case
QRP Kit QRP-20 **$29.95**	QRP kit QRP-40 **$29.95**	QRP kit QRP-80 **$29.95**	kit CQRP **$12.95**

AIRCRAFT RECEIVER KIT

Hear exciting aircraft communications—picks up planes up to 100 miles away. Receives 110—136 MHz AM air band, varactor tuned superhet design with AGC, ceramic filter and adjustable squelch. Runs on 9V battery. 250 mw audio output, 1 µv sensitivity. Optional matching ABS plastic case lets you take it anywhere, features screened graphics and machined aluminum knobs for a real professional look. Compact—great for airshows or for just plain hanging around the airport.

Complete kit, AR-1 **$24.95** Receiver case kit, CAR-1 **$12.95**

SHORTWAVE RECEIVER KIT

A fantastic receiver that captures the world with just a 12' antenna! Receives 4—11 MHz in 2 MHz bands, varactor tuned, superhet design with AGC, RF gain control, and 250 mw audio output. Uses new Signetics mixer chip for less than a microvolt sensitivity, runs on 9V battery. This is a fascinating scout, school or club project, and will provide hours of fun even to the most serious DX'er. Add the optional case kit and you have a real nice looking shortwave set.

Complete kit, SR-1 **$24.95** Receiver case kit, CSR-1 **$12.95**

PACKET RADIO

Commodore C64/128 packet radio interface. Uses famous German Digicom software. Features EXAR IC chip set for reliable operation—runs HF or VHF tones. Includes FREE disk software, PC board, all necessary parts and full documentation.

Complete kit, PC-1 **$49.95**

FM COMMUNICATIONS/ 2 MTR, 10 MTR & 220 RECEIVERS

Sensitive superhet FM receiver tunes any 5 MHz segment of band. Listen to ham operations, high band police calls, weather or mobile phone calls! Easy to build receiver features varactor tuning, IC mixer stage, ceramic IF filters and dual conversion design with adjustable squelch. Less than 1 µv sensitivity, runs on 9 V battery, with 50 mw audio output. Optional ABS case with screened graphics and machined aluminum knobs provide a nice professional look.

2 MTR	10 MTR	220 MHz	Receiver
kit FR-7 **$29.95**	kit FR-10 **$29.95**	kit FR-20 **$29.95**	case kit CFR-7 **$12.95**

NEW MINIKITS—NEW MINIKITS

BROADBAND PREAMP

A sensitive all purpose preamp, ideal for scanners, TV sets, VHF, UHF rigs, counters, etc. Features low noise, 4 db NF, 20 db gain, 100 KHz—1 GHz operation. Runs on 9—12 VDC, 50 ohms input.

Complete kit, SA-7 **$14.95**

LIGHT BEAM COMMUNICATORS

Transmits modulated infrared light up to 30 feet without lenses, up to 1/4 mile using lenses. Uses 30 KHz carrier for hum-free operation, transmits thru windows, etc. Ideal for "bugs", or listening to IR remote controls. Transmitter has sensitive mike input, receiver uses PIN detector and drives speaker output. Units operates on 9—12 VDC.

Transmitter kit, LB-6 **$8.95**
Receiver kit, LB-5 **$9.95**

HIGH POWER FM WIRELESS MIKE

A high power unit that will transmit up to 1/2 mile to any FM broadcast radio. Sensitive input accepts any type of mike, will pick up normal voices 10 feet away using the available mini-electric mike cartridge. Operates on 9—12 VDC.

FM-4 kit **$12.95**
Sensitive microphone cartridge **$2.95**

RAMSEY ELECTRONICS

Quality Test Gear & Electronic Kits for Professionals and Hobbyists

$49.95 PR-2 COUNTER PREAMP

wired includes AC adapter
PR-2 kit **$39.95**

The PR-2 is ideal for measuring weak signals from 10 to 1,000 MHz • flat 25 db gain • BNC connectors • great for sniffing RF • ideal receiver/TV preamp • 3 db NF

$69.95 PS-2 AUDIO MULTIPLIER

wired
PS-2 kit **$49.95**

The PS-2 is handy for high resolution audio resolution measurements, multiples Up in frequency • great for PL tone measurements • multiples by 10 or 100 • 0.01 Hz resolution & built-in signal preamp/conditioner

$89.95 PS-10B 1.5 GHz PRESCALER

wired includes AC adapter

Extends the range of your present counter to 1.5 GHz • 2 stage preamp • divide by 1000 circuitry • super sensitive (50 mV typical) • BNC connectors • 1.5 GHz in, 1.5 MHz out • drives any counter.

COM-3

$2795.00 THE COMMUNICATIONS SERVICE MONITOR THAT WORKS HARDER FOR LESS.

Introducing COM-3... the new service monitor designed by service technicians for service technicians. It works harder for less... giving you advanced testing capabilities at a very affordable price.

FEATURES • Direct entry keyboard with programmable memory • Audio & transmitter frequency counter • LED bar graph frequency/error deviation display • 0.1-10,000 µv output levels • High receive sensitivity, less than 5 µv • 100 KHz to 999.9995 MHz Continuous frequency coverage • Transmit protection, up to 100 watts • CTS tone encoder, 1 KHz and external modulation

MINI KITS—EASY TO ASSEMBLE—FUN TO USE

TONE DECODER
A complete tone decoder on a single PC board. Features: 400-5000 Hz adjustable range via 20 turn pot, voltage regulation, 567 IC. Useful for touch-tone burst detection, FSK, etc. Can also be used as a stable tone encoder. Runs on 5 to 12 volts.

Complete kit, TD-1 **$5.95**

40 WATT 2 mtr PWR AMP
Simple Class C power amp features 8 times power gain 1 W in for 8 out, 2 W in for 15 out, 5 W in for 40 W out. Max output of 50 W, incredible value, complete with all parts, less case and T-R relay.

PA-1, 40 W pwr amp kit **$27.95**
TR-1, RF-sensed T-R relay kit **6.95**

COLOR ORGAN
See music come alive! 3 different lights flicker with music. One light each for, high, mid-range and lows. Each individually adjustable and drives up to 300 W. runs on 110VAC.

ML-1 Kit. **$8.95**

VOICE ACTIVATED SWITCH
Voice activated switch kit provides switched output with current capability up to 100 mA. Can drive relays, lights, LED or even a tape recorder motor. Runs on 9 VDC.

VS-1 KIT **$6.95**

VIDEO MODULATOR
Converts any TV to video monitor. Super stable, tunable over ch 4-6. Runs on 5-15V accepts std. video signal. Best unit on the market! Complete kit. JM-7 **$12.95**

LED BLINKY KIT
Alternately flashes 2 jumbo LEDs. Use for name badges, buttons® warning panel lights. Runs on 3 to 15 volts.

BL-1 Kit. **$3.95**

MAD BLASTER
Produces LOUD ear shattering and attention getting siren like sound. Can supply up to 15 watts of obnoxious audio. Runs on 6-15 VDC

MB-1 Kit **$4.95**

UNIVERSAL TIMER
Provides the basic parts and PC board required to provide a source of precision timing and pulse generation. Uses 555 timer IC and includes a range of parts for most timing needs.

UT-5 Kit **$5.95**

WHISPER LIGHT
An interesting kit, small mike picks up sounds and converts them to light. The louder the sound, the brighter the light. Includes mike, controls up to 300 W, runs on 110 VAC.

WL-1 Kit **$6.95**

FM WIRELESS MIKE
Transmits up to 300' to any FM broadcast radio, uses any type of mike. Runs on 3 to 9V. Type FM-2 has added sensitive mike preamp stage.

FM-1 Kit **$5.95**
FM-2 Kit **$7.95**

SIREN
Produces upward and downward wail. 5 W peak audio output, runs on 3-15 volts, uses 3-45 ohm speaker.

Complete kit, SM-3 **$3.95**

SUPER SLEUTH
A super sensitive amplifier which will pick up a pin drop at 15 feet! Great for monitoring baby's room or as general purpose amplifier. Full 2W rms output, runs on 6 to 15 volts, uses 8-45 ohm speaker.

BN-9 Kit **$5.95**

60 Hz TIME BASE
Runs on 5-15 VDC. Low current (25ma) 1 min/month accuracy

TB-6 Kit **$5.50**
TB-6 Assy **$9.95**

TELEPHONE TRANSMITTER
Low cost with professional performance. Features include: self phone line powered, tunable from 76 to 100 MHz, polarity antisensitive, compact size (3" x 1¼"), easily installs anywhere on the phone line or inside the instrument itself.

PB-1 KIT **$14.95**

FM RECEIVER
For built-in applications or hobby experimentation. Full fledged superheterodyne receiver, microvolt sensitivity, 10.7 MHz IF. Integrated Circuit detector, 50 mw audio amplifier, 9V external power source, operation on standard FM broadcast band as well as large portions on each side, compact (6" square), for bug detection or reception

FR-1 KIT **$14.95**

FM MINI MIKE
A super high performance FM wireless mike kit! Transmits a stable signal up to 300 yards with exceptional audio quality by means of its built in electret mike. Kit includes case, mike, on-off switch, antenna, battery and super instructions. This is the finest unit available.

FM-3 Kit **$16.95**
FM-3 Wired and Tested **19.95**

NEW

MICROWAVE INTRUSION ALARM
A real microwave doppler sensor that will detect a human as far as 10 feet away. Operates on 1.3 GHz and is not affected by heat, light or vibrations. Drives up to 100 ma output, normally open or closed, runs on 12 VDC

Complete kit, MD-3 **$16.95**

NEW

SPEECH SCRAMBLER
Communicate in total privacy over your telephone or radio. This scrambler kit features full duplex operation using frequency inversion. Runs on a 9 volt battery. Both mike and line or speaker output/inputs. Easy to connect to any radio—telephone use requires no direct connection! Easy to build, uses IC DBM circuitry. Can also be used to descramble most com. scramblers.

Complete kit, SS-7 **$29.95**
Case kit, CSS-7 **12.95**

FREQUENCY COUNTERS

Ramsey Electronics has been manufacturing electronic test gear for over 10 years and is recognized for its lab quality products at breakthrough prices. All of our counters carry a full one year warranty on parts and labor. We take great pride in being the largest manufacturer of low cost counters in the entire USA. Compare specifications. Our counters are full featured, from audio to UHF, with FET high impedance input, proper wave shaping circuitry and durable high quality epoxy glass, plated-thru PC Board construction. All units are 100% manufactured in the USA.

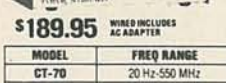
CT-70 7 DIGIT 525 MHz

$139.95 WIRED, INCLUDES AC ADAPTER

CT-90 9 DIGIT 600 MHz

$169.95 WIRED INCLUDES AC ADAPTER

CT-50 8 DIGIT 600 MHz



$189.95 WIRED INCLUDES AC ADAPTER

CT-125 9 DIGIT 1.2 GHz

$189.95 WIRED INCLUDES AC ADAPTER

ACCESSORIES FOR COUNTERS

Telescopic whip antenna—BNC plug	$ 8.95
High impedance probe, light loading	16.95
Low pass probe, audio use	16.95
Direct probe, general purpose use	13.95
Tilt bail for CT-70, 90 & 125	3.95
Nicad pack for CT-70, 90 & 125	8.95

MODEL	FREQ RANGE	SENSITIVITY	ACCURACY	DIGITS	RESOLUTION	PRICE
CT-70	20 Hz-550 MHz	< 50 mv To 150 MHz	1 PPM	7	1 Hz, 10Hz, 100Hz	139.95
CT-90	10 Hz-600 MHz	< 10mv To 150 MHz < 150mv To 600 MHz	1 PPM	9	0.1Hz, 10Hz, 100 Hz	169.95
CT-50	5 Hz-600 MHz	LESS THAN 25 mv	1 PPM	8	1Hz, 10Hz	189.95
CT-125	10 Hz-1.25 GHz	<25mv @ 50 MHz < 15mv @ 500 MHz < 100mv @ 800 MHz	1 PPM	9	0.1Hz, 1Hz, 10Hz	189.95
CT-90 WITH OV-1 OPTION	10 Hz-600 MHz	< 10mv To 150 MHz < 150mv To 600 MHz	0.1 PPM	9	0.1Hz, 1Hz, 10Hz	229.90

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Fordham

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FORDHAM
SIGNAL/AUDIO GENERATORS and COUNTERS

FUNCTION GENERATOR

MODEL FG-202
Our Price
$149.90

It's versatile and compact – capable of generating high quality sine, triangle, and square waveforms of high stability and accuracy. The sine and triangle waveforms can be amplitude and frequency modulated by applying external voltages at the VCA (Voltage Controlled Amplitude) and the VCF (Voltage Controlled Frequency) inputs. With these two inputs, the unit can easily produce amplitude modulated, frequency, sweep, ASK (Amplitude Shift Keying) or FSK (Frequency-Shift Keying) signal. **Frequency Range:** 0.5Hz to 500KHz (6 ranges).

SWEEP FUNCTION GENERATOR

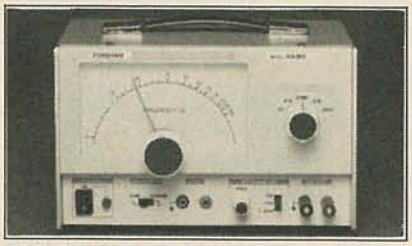
MODEL FG-801
Our Price
$219.95

Output: Square wave, triangle wave, or sine wave (selectable). Also TTL pulse, sweep output. **Input:** Voltage controlled frequency (VCF). **Frequency Range:** 0.2Hz to 2MHz (7 ranges). **Frequency Accuracy:** ±5% of length scale. **Frequency Multiplier:** 0.2 to 2.0. **VCF Range:** 100: min. for 0 to +10 V input. **Sweep Characteristics: Internal:** Linear. **Sweep Rate:** 0.5Hz (2 SEC period) to 50Hz (20mSEC period), continuously variable.

RF SIGNAL GENERATOR

MODEL SG-490
Our Price
$134.95

• Wide frequency range: 100KHz-150MHz • Portable, high stability • With 1KHz oscillator in inner part for the purpose of modulation. **Description:** Here is a compact solid state RF signal generator for checking and aligning the IF circuit and tuners in AM, FM and TV sets.

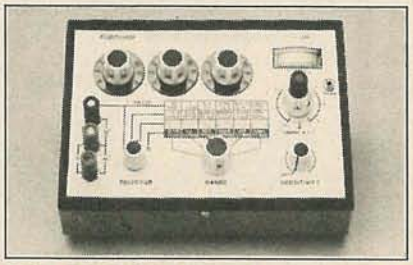


AUDIO GENERATOR

MODEL AG-260
Our Price
$134.95

• High frequency stability: within ±2 Hz
• Output voltage floating: within ±1dB
• Sine square wave output: > 8Vms.

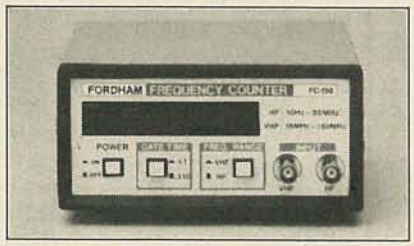
Description: A portable Audio Generator with 600 Ω input impedance, all band voltage floating ±dB, low distortion output wave from 0.05%, high output voltage, stable oscillation circuit loop and minimum frequency floating. The oscillation frequency range of the AG-260 is usually between voice and super voice frequency bands. Its main function is to measure the characteristics of an audio circuit. **Frequency Range:** 10Hz-1MHz 5 decade bands.



LCR BRIDGE METER

MODEL LC-340
Our Price
$149.95

A fully transistorized AC bridge meter, which allows for accurate measurement of resistances, capacities, inductances and the turns ratio of transformers. This unit is battery operated, small and handy, and has high mechanical and electrical stability. Besides the actual bridge circuit a 1KHz generator and a three-stage test-amplifier is inserted.



FREQUENCY COUNTER

MODEL FC-150
Our Price
$139.90

Frequency Range: 10Hz-150MHz. **Gate Time:** 1 Sec., 5 Sec. **Accuracy:** ±1 Count. **Max. Input:** 20 V p-p. **Voltage Sensitivity:** 25mV-100mV, 10Hz-30MHz; 100mV-300mV, 10MHz-150MHz. **Multiplication:** HF and VHF. **Imput Impedance:** HF-1MΩ, VHF-50Ω. **Max. Input Voltage:** < 3V effective. **Reference Time Frequency:** 2,500MHz.

100KHz-150MHz SIGNAL GEN./ COUNTER

MODEL SG-498
Our Price
$275.00

OSCILLATOR SECTION: Frequency Range: A 100KHz-320KHz, B 300KHz-1100KHz, C 1MHz-3.3MHz, D 3.0MHz-11MHz, E 10MHz-35 MHz, F 32MHz-150MHz, (up to 450MHz on 3'th harmonics). **Frequency Accuracy:** by counter section accuracy. **COUNTER SECTION: Frequency Range:** 10Hz-150MHz HF 10Hz-10MHz VHF 10MHz-150MHz. **Accuracy:** ±1 Count, ±Reference time Accuracy.

10Hz-1MHz/AUDIO GEN./ COUNTER

MODEL AG-298
Our Price
$275.00

OSCILLATOR SECTION: Frequency Range: 10Hz-1MHz 5 decade bands. **Accuracy:** with Counter Section Accuracy. **Output Impedance:** 600Ω, unbalance. **Output Control:** 0dB/-20dB/-40dB and Fine adjuster. **Sine Wave Output: Range:** 10Hz-20KHz. **Output Voltage:** 8 Vrms, max. **COUNTER SECTION: Frequency Range:** 10Hz-150MHz HF 10Hz-10MHz VHF 10MHz-150MHz. **Accuracy:** ±1 Count, ±Reference time Accuracy.

GLOBAL SPECIALTIES FREQUENCY COUNTER

MODEL MAX-1300
Our Price
$249.95

Description: Can measure any frequency from subsonic through the 1.3GHz ham band.

• 8 digit LED display • 5Hz-1300MHz response • Dual gate times • Tilt stand included.

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$ 51 - $100 — $7.50	$401 - $ 500 — $14.00	$1251 - $1500 — $22.00
$101 - $200 — $9.00	$501 - $ 750 — $16.00	$1501 - $2000 — $27.50
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REGULATED TRIPLE POWER SUPPLY

Assembled and tested . . . and it's short circuit proof!
Description: Benchtop power supply. Includes fixed 5 V at 1 amp, 5 V to 15 V at 0.5 amp, and -5 V to -15 V at 0.5 amp. All supplies regulated, short proof. Each supply has a power on indicator LED. Complete and ready for use in a durable (8 x 6 x 3½") metal case.

MODEL FM-6
Our Price
$139.95
Reg. $179.95

SINGLE OUTPUT/DUAL ANALOG METERS

DC Output: 0-30 volts, 0-3 amps. **Ripple:** 0.5mVrms. Over load and short circuit protection. Current can be limited from 0-3A.

MODEL PS-398
Our Price
$199.95

SCOPE
DIGITAL MULTI-METERS

3½ DIGIT LCD METER

MINI METER with MAXI SPEC's

• 0.5% accuracy • DC Voltage • AC Voltage • DC Current • Resistance • Diode Test • Battery Test • Battery Life 300 hours • Test Leads Included • Overload Protection: DC 500V, AC 350V, Ohms 250V DC / AC. **Ranges: DC Voltage:** 200Mv to 1000V. **Resistance:** 200 Ω to 2M Ω. **DC Current:** 200mA to 2A. **AC Voltage:** 200V & 750V.

MODEL DVM-630
Our Price **$32.50**

Model CC-30
Deluxe zippered carrying case **$4.50**

HAND HELD 3½ DIGIT LCR METER

This lightweight, portable meter is for measuring, capacitance, resistance and inductance of components. Idealy suited for field service applications. Also used in development and research applications. Overload Protected. Comes with test leads, test clip, battery, spare fuse. **Display:** 3½ Digit LCD.

CAPACITANCE Range: 200pF, 2nF, 20nF, 200nF, 2μF, 20μF, 200μF. **Accuracy:** ≥ 0.5μF ±2% ±1 digit > 0.5μF ±3% ±1 digit.

RESISTANCE Range: 20Ω, 200Ω, 2KΩ, 20KΩ, 200KΩ, 2MΩ, 20MΩ, **Accuracy:** ≥ 1M, ±1%, ±1 digit. > 1M, ±5%, ±1 digit.

INDUCTANCE Range: 2mH, 20mH, 200mH, 2H, 20H, 200H. **Accuracy:** 2mH-2H, ±3%, 2H-200H, ±5%. **Power Requirements:** one 9V battery. **Size:** 6.9"H x 3.5"W x 1.6"D. **Weight:** 13.8 oz.

MODEL LCR-680
Our Price **$129.95**

HAND HELD DIGITAL MULTIMETERS

8 function, 37 ranges incl.: transistor & capacitance measurements.

MODEL DVM-636
Our Price **$59.95**

11 function, 38 ranges incl.: logic level detector, audible visual continuity, capacitance & conductance measurements. • 10M imput impedance • Overload Protection • Auto decimal LCD readout • Polarity Indication • 300 hr. battery life with 9V transistor battery • Low battery indication.

MODEL DVM-638
Our Price **$69.95**

Model CA-92
Deluxe Padded Case for DVM meters . . **$9.95**

Model TL-216
Transistor and Capacitance Test Leads . **$9.90**

Special! BEST VALUE FOR YOUR DOLLAR!

HITACHI 35 mHz DUAL TRACE OSCILLOSCOPE

Effective Area 8 x 10 div (1 div = 1 cm). **Acceleration Potential:** 12kV. **Focus Adjustment automatic. External Intensity Modulation — Effective Bandwidth:** DC to 2 MHz. **Imput Impedance:** 47Ω (typ). **Max. Imput Voltage:** 30V (DC + AC peak). **Voltage:** 5V p-p or more. **Vertical Deflection Sensitivity:** 5mV / div to 5V / div ±3%, 10 calibrated steps, 1mV / div to 1V / div, ±5% (when using x5 amplifier) Uncalibrated continuous control between steps 1: > 2.5 (provided with lock positioning). **Uncal Lamp:** Front panel lamp indicates the uncalibrated condition. **Frequency Bandwidth:** DC to 35 MHz, -3dB (at 8 div) DC to 7 MHz, -3dB (at 8 div) (when using x5 amplifier). **Risetime:** 8.8 ns (50 ns for x5 magnification). **Signal Delay Line:** Permits viewing leading edge of displayed waveform. **Max. Input voltage:** 500V p-p or 300V p-p (DC + AC peak at 1 KHz) **Imput Coupling:** AC, GND, DC (lever switch). **Input Impedance:** Direct 1MΩ approx. 30 pF. **Operating Modes:** CH1, CH2, ALT, CHOP, ADD. **Polarity Switching:** CH2 only. **X-Y Operation:** CH1: X-axis, CH2: Y-axis. **Sensitivity:** 5 mV / div to 5 V / div (when using x5 magnifier: 1 mV / div to 1V / div). **Phase Difference:** DC to 50 kHz within 3°. **X-axis Bandwidth:** DC to 500 kHz, -3 dB. **Dynamic Range:** 8 div or more. **CH1 Output:** Provided to enable frequency measurement using an external frequency counter. **Output voltage:** 20 mV / div or more. **Frequency Bandwidth:** 50 Hz to 5 MHz, 1 3 dB. **Output Impedance:** Approx. 50Ω. **Horizontal Deflection Trigger Modes:** AUTO, NORM, TV-V, TV-H. **Trigger Source:** INT (CH1, CH2, V-MODE), LINE, EXT. **Trigger Coupling:** AC. **TV Sync Internal:** 1 div or more (vertical sync signal). **External:** 1 VP-p or more (vertical sync signal). **Trigger Sensitivity Frequency:** 5 to 35 MHz. **Internal:** 1.5. **External:** 800mV. **Auto Low Bandwidth:** 25 Hz. **Trigger Slope:** +. **External Trigger Input — Input Impedance:** Approx. 1M, Approx. 30pF. **Max. Input Voltage:** 300 V (DC + AC peak at 1 kHZ). **Sweep Time:** 0.2 us / div to 0.2s / div ±3%, 19 calibrated steps, Uncalibrated continuous control between steps 1: > 2.5 (provided with lock-positioning). **Uncal Lamp:** Front panel lamp indicates the uncalibrated condition. **Sweep Time Magnifier:** 10 times (±5%). **Max. Sweep Time:** 20 ns / div. **Calibrator Waveform:** Approx. 1 kHz squarewave (duty cycle: 48:52 or more). **Voltage:** 0.5 V±3%. **Power:** AC 100 / 120 / 220 / 240± 10% connector selectable, 50 / 60 Hz Approx. 45W. **Size:** 12.2"W x 5.1"H x 14.6"D. **Weight:** 14.3 lbs. **Accessories:** 2-AT-10AK, 1.5 probes 10:1 1:1, 1-Power Cable, Instruction Manual.

FREE DVM-630
with purchase of the V-355

DESCRIPTION: The model V-355 provides an unbeatable combination of lightweight scope and high performance. Its thin, light, compact design features a large 6 inch rectangular, internal graticular CRT, with percent calibrations, autofocus, condition lumination and photographic bezel.

MODEL V-355
Our Price **$598.00**
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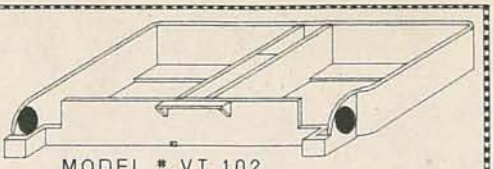

MODEL # VT 102

NEW UPDATED 1991 VERSION
outdates all others

Works on ALL VCR's with VHS & SUPER VHS formats. Front loaders, top loaders, side loaders, slimlines uprights, & camcorders

Many VCR problems are simply due to dirty heads, slipping belts or wheels or minor adjustments. With the diagnostiic tool & instructions you can quickly isolate simple problems without special tools or equipment

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GREAT FOR BEGINNERS

Dig out that old VCR & get it going again.

EIGHT PAGES OF FULLY ILLUSTRATED INSTRUCTIONS SHOW HOW TO:

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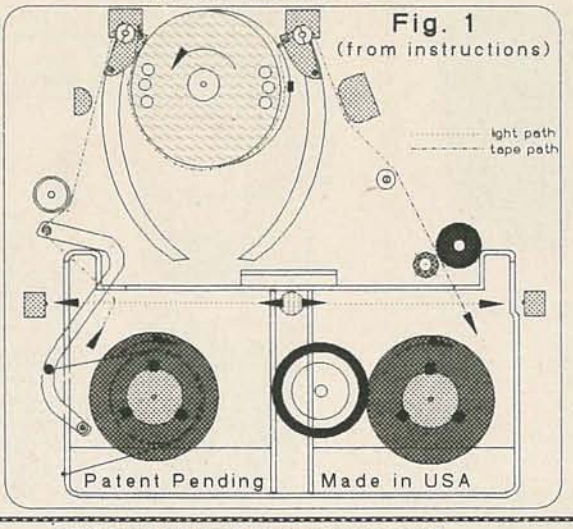

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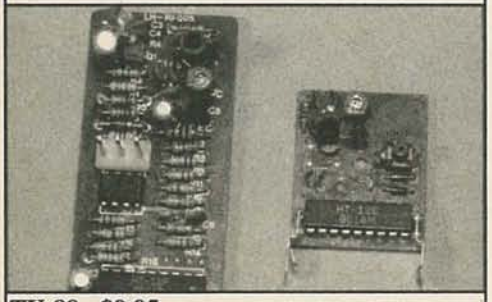
REMOTE CONTROL MODULE



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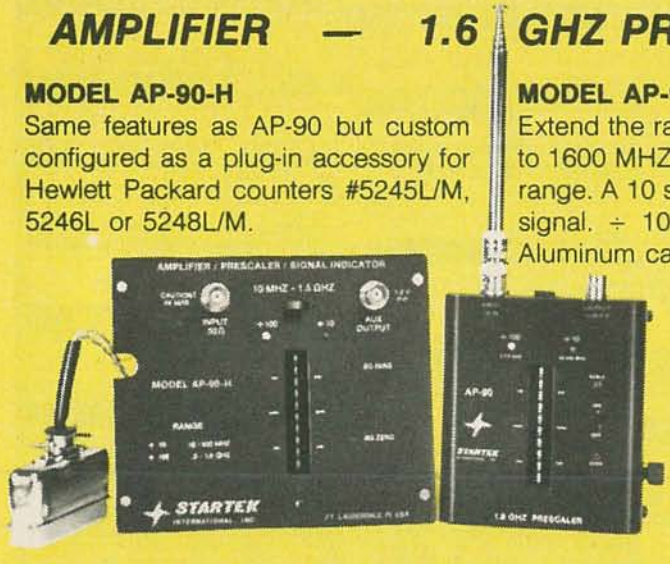

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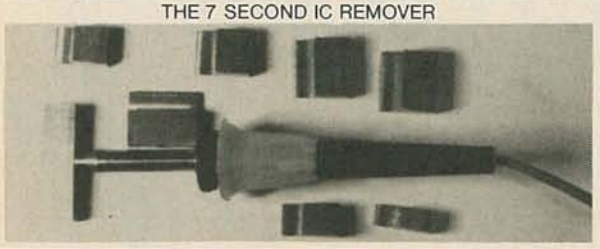

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Step 1. Heat IC from top or bottom side. Remove one side of IC at a time, like you would open a book.

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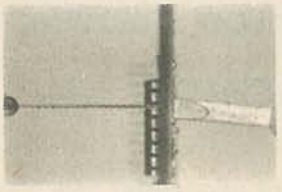
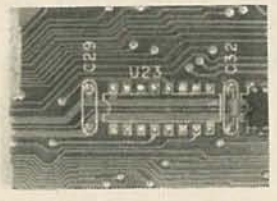


Step 4. Remove solder from plate through holes rapidly and cleanly by heating the holes and ramming a cold straight pin or safety pin of the appropriate diameter through the hole. This will give you a smooth clean hole to put the new IC or socket back into.



Step 5. Brush away solder flues left by pin and insert IC or socket. IC is **not damaged** by removal process and can be reused if it is not found to be the problem. Note what a nice job it does and no damage to the board. For simple anti-static operation for CMOS IC removal, a bare wire can be wrapped around the iron and clipped to your anti-static work station.

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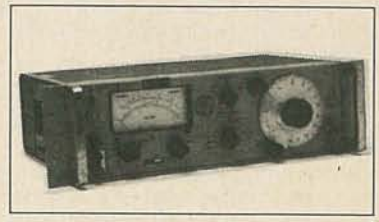

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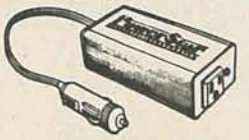

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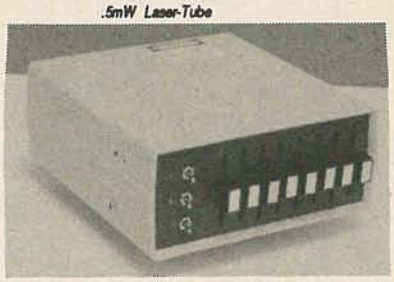

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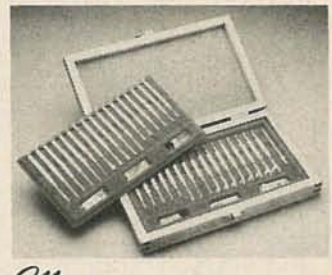

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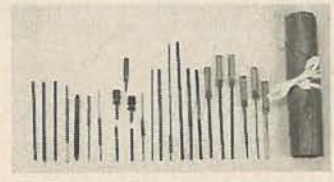

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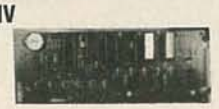

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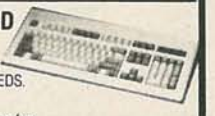

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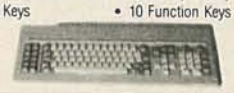

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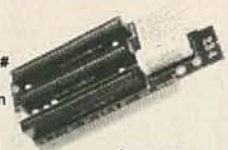

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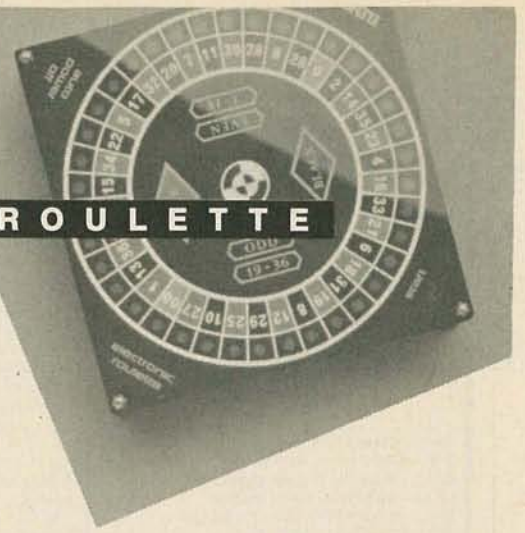

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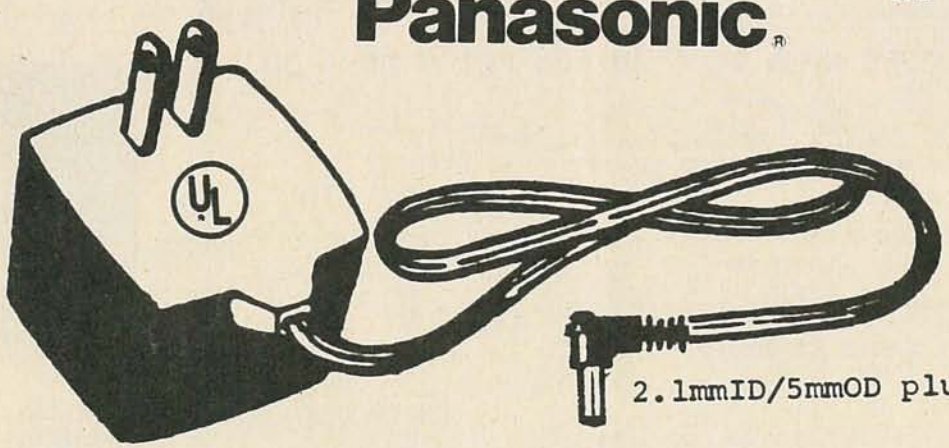

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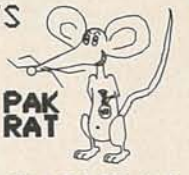

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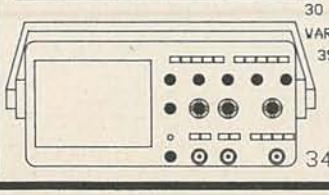

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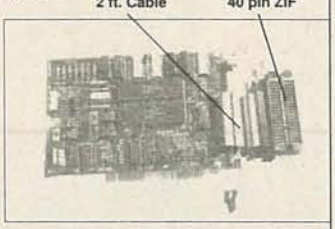

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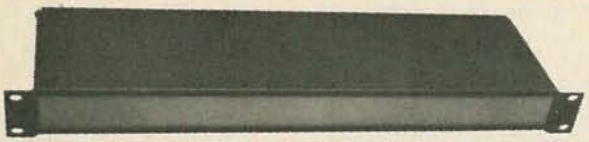

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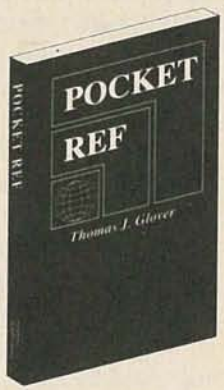

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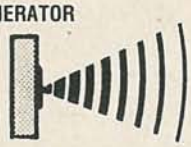

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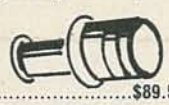

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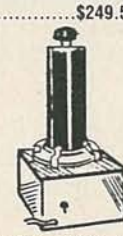

- Spectacular and Fascinating
- A real attention getter!
- Energy passes through windows!
- Great for science projects, displays, stores advertising.
- Featured in Spring '84 Special Projects by Radio Electronics

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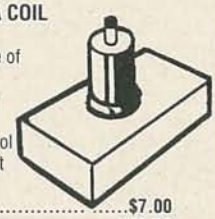
WORLDS SMALLEST TESLA COIL



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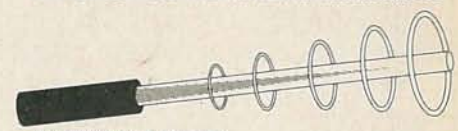

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Gell Cell style. Brand New fresh units. 4x3x2 inch. Tabs on top. **$6.95 ea**

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7812	$0.49	LM317T	$0.69
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6000	Replacement Toner Kit for Ricoh 6000 laser.	$16.25ea/6
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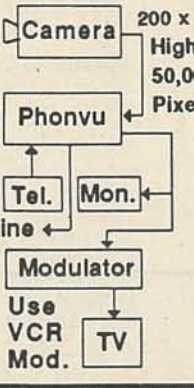

Videophone Chip and Schematic	48P DIP $59.95
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Cabinet (uncut)	$12.75
Power Pack	$ 8.75
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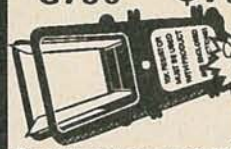

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G761 49¢ each.

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G757 $9.00

New

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G758 T2103V MODEM

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The T2103V contains a Bell System 103 modem that operates at 300 baud full duplex or 1200 baud half-duplex. It has error checking and is an intelligent modem, which conforms to EIA standards for data communications and interface signal characteristics. Has standard RS232C connector and modular phone jacks. These appear to be new and come with wall adapter and manual. Mfg. by TENERON. Use with almost any communications software program.

COMPUTER CONNECTOR/ ADAPTORS

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TYPE 2 – is a male DB25 to 36 pin female centronics.

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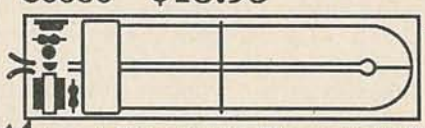

- ★ Operates from any 6V Battery Source (not incl.)
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Remember, all of our kits contain all parts, PC board and instructions!

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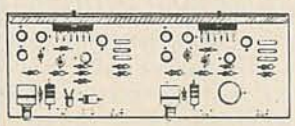

- ★ Boost Car Stereos, Tape Players, Portable Radios, etc.
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- ★ Operates on Std. 12V Car Battery
- ★ Skill Level 2

C6442 $19.95

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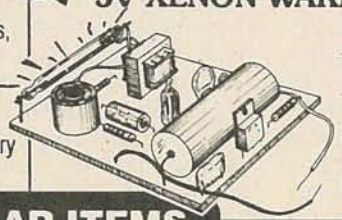

- ★ Bright white flashes of light
- ★ Requires only 2AA or C cells
- ★ Skill level 2

C3207 $10.00

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Sale

New

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Discover the targets professional snoopers seek out! The prey are stock brokers, arbitrage firms, manufacturers, high-tech companies, any competitive industry, or even small businnesses in the same community. The valuable information they filch may be marketing strategies, customer lists, product formulas, manufacturing techniques, even advertising plans. Information thieves eavesdrop on court decisions, bidding information, financial data. The list is unlimited in the mind of man—especially if he is a thief!

You know that the Russians secretly installed countless microphones in the concrete work of the American Embassy building in Moscow. They converted what was to be an embassy and private residence into the most sophisticated recording studio the world had ever known. The building had to be torn down in order to remove all the bugs.

Stolen Information

The open taps from where the information pours out may be from FAX's, computer communications, telephone calls, and everyday business meetings and lunchtime encounters. Businessmen need counselling on how to eliminate this information drain. Basic telephone use coupled with the user's understanding that someone may be listening or recording vital data and information greatly reduces the opportunity for others to purloin meaningful information.

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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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To obtain the information contained in the video VHS cassette, you would attend a professional seminar costing $350-750 and possibly pay hundreds of dollars more if you had to travel to a distant city to attend. Now, for only $49.95 (plus $4.00 P&H) you can view ***Countersurveillance Techniques*** at home and take refresher views often. To obtain your copy, complete the coupon below or call toll free.

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For computer related equipment, Input 120V AC, 60Hz, 30W; Output =5V DC, 1000MA, +/- 12V DC, 200MA

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WATERTIGHT ALARM BELL **$19.95**
By Henschel Corp., Type IC/BID3, size 3", 24V DC

5 LB. SOLDER **$25.00**
Wire, Rosin Core, Tin/Lead 60/40, Flux 2.2%, Dia. .036 (20Ga)

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AMP OPTIMATE FIBER OPTIC CABLE ASSEMBLY **$49**
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VISIBLE LASER DIODE SCANNER **$899**
Hand-held point-of-sale bar code scanner manufactured by Symbol Technologies, Inc.

ORIGINAL IBM MODEL 1130700
COMPUTER PC POWER SUPPLY **$19.95**
63W 115VAC.

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COMPUTER PC-XT POWER SUPPLY **$29.95**
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Can be used for research, design, and engineering in the medical, industrial, and educational sectors. An experimenter's dream in the fields of holography, interferometry, graphic arts, light shows, and projection. The Laser Deck Consists of:

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- ❑ The *laser power supply* (NEC Part #GLS5281A) powers the laser tube and has an input voltage of 115 to 120 VAC. Output sustaining voltage is 2800 to 3300 VDC.
- ❑ This unit sits on an 18.5 lb precision cast aluminum plate.
- ❑ The *acoustic-optic modulator* (NEC Part #OD8813A) is a 140 Mhz broad band amplifier and will take TTL and video signals. The A-O driver is on the deck also and requires 24 volts to operate.
- ❑ The *polygon motor unit* (Mfr: Japan Electronics) is a ten-sided first surface mirror mounted on an electric motor that spins at approx. 26,000 rpm. The driver for the polygon unit is on the deck and requires 24 volts to operate.
- ❑ In addition to the main items above, there are (5) *special surface mirrors*, (2) *beam splitters* and (3) *special lenses* all attached by optical mounts which guide the laser beam to various sensors and places to give the desired result, a reproduced copy of information.
- ❑ We have available an excellent 24 volt LAMBDA™ power supply at 49.95 that will power both the Acoustic-optic modulator and driver and polygon motor unit and driver.

Laser Beam Modulator $398
(Acoustic-Optic Modulator and Driver)

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These lasers emit visible blue and green lines. Power output is 110mW. They are re-built with brand new tubes and power supplies. Manufactured by a major laser company, they are excellent for laser shows and holography. These lasers are guaranteed for one year.

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Bikor Corp. LBA 5-6, Input 115/230VAC, 47-440Hz, Output 5V DC at 6.o AMPS.

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HP 10-ELEMENT BAR GRAPH ARRAY **$2.00**
HDSP-4820 (red)

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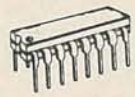
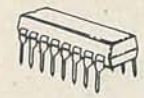

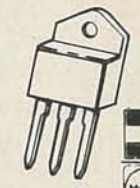

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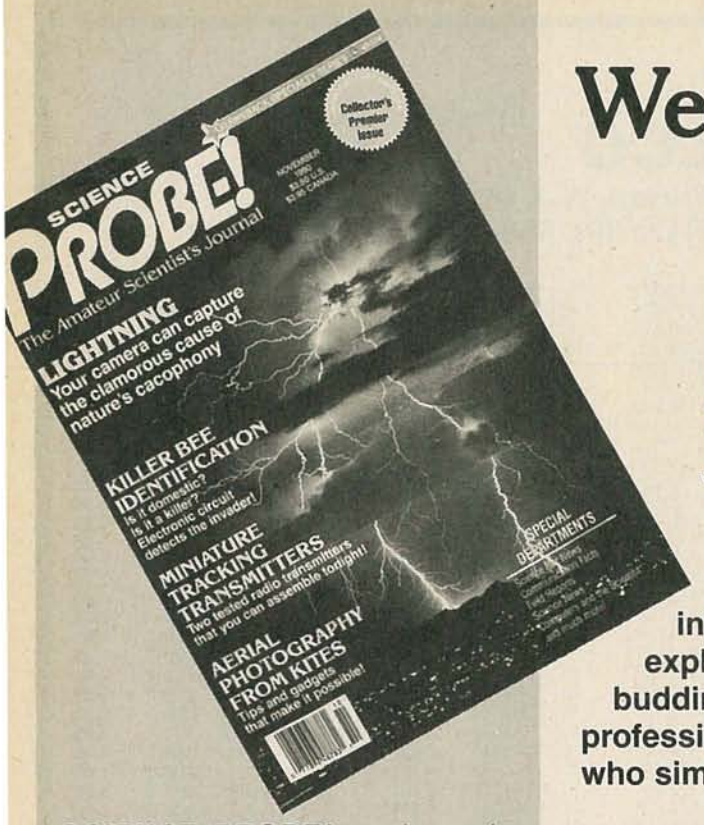

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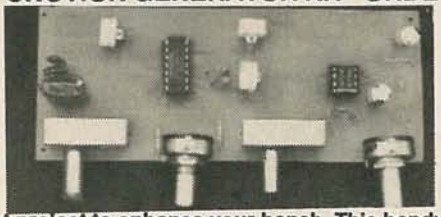

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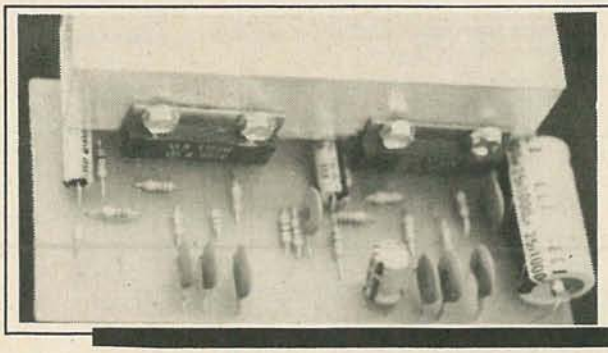

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Parallel Printer Cable, Centronic to Centronic, 6' 5.95
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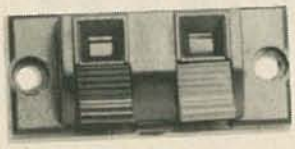

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Passive radiators can be used in conjunction with smaller woofers to produce improved bottom end without the added expense of large low frequency drivers.

#RN-260-405 **$5.90**

6" X 9" BRIDGELESS SPEAKERS

Polypropylene woofer with 20 oz. magnet. Bridgeless design for better bass punch. 3" midrange and 1-1/4" tweeter. Power handling capability: 60 watts RMS. 4 ohm impedance. Sold in pairs. Net weight: 7 lbs. per pair.

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8" THRUSTER

Made in U.S.A.

Heavy duty ribbed paper cone with poly foam surround. 20 oz. magnet. 6 ohm. 50 watts RMS. 1-1/2", 4 layer voice coil. fs = 26.5 Hz. Frequency response: 22-2,700 Hz. Net weight: 5 lbs.

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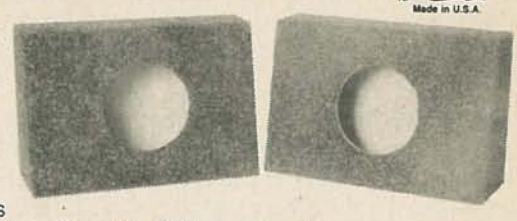
Made in U.S.A.

These quality, carpeted truck boxes are made of high density acoustical grade particle board. Each box is cut to accept an 8" woofer and port. Speaker terminals and handles are included. Dimensions: 19" x 13" x 5" (tapered front). Sold in pairs. Net weight: 22 lbs. per pair.



#RN-260-455 **$39.95**

18" EMINENCE WOOFER

Ribbed paper cone with treated cloth accordion surround. Giant 100 oz magnet. 250 watts RMS, 350 watts max. 3", 2 layer voice coil. 8 ohm. fs = 30 Hz. Frequency response: 27-3,500 Hz. Net weight: 26 lbs.

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100 WATT "L" PAD

Allows you to adjust the relative volume of individual drivers in a speaker system while maintaining a constant 8 ohms impedance. Complete with faceplate, knob, and instructions.

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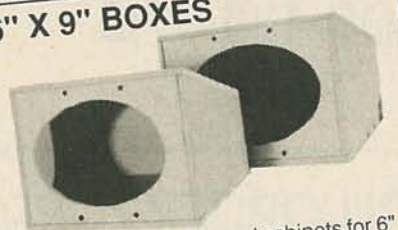
6" X 9" BOXES



High density particle board cabinets for 6" x 9" speakers. Unfinished so that you may paint or cover to your liking. Deep enough for large magnet speakers. Net weight: 9 lbs. per pair.

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Soft vinyl covered foam earpads make these headphones comfortable to wear, and they sound fantastic. 7-1/2 ft. cord is the perfect length for use with home stereo systems. 1/4" to 3.5mm adaptor is included for use with your portable stereo as well. 1 year warranty.

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Ribbed paper cone with foam surround. 20 oz. ferrite magnet. 1-1/2" voice coil. 60 watts RMS, 90 watts max. 8 ohm. 30-2,500 Hz frequency response. SPL: 92 dB. Net weight: 5 lbs.

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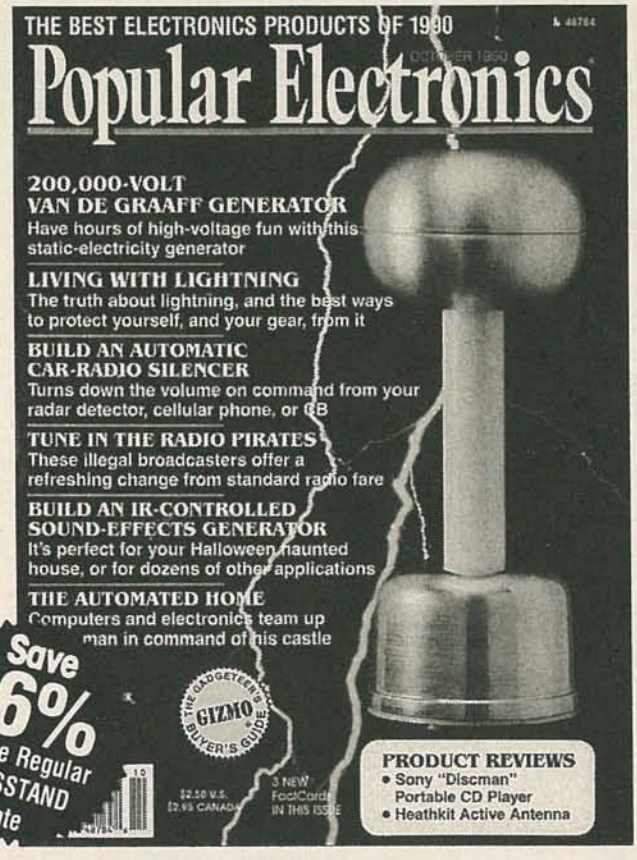

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NEW PRODUCTS

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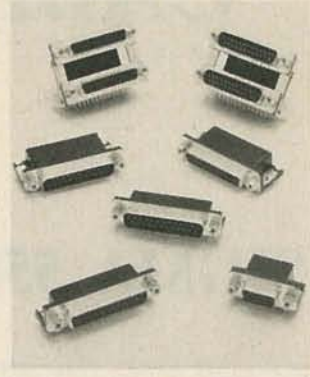
To ensure reliable electrical contact, all have sealed backs to protect against solder and flux entrapment. Each connector has a tin-plated metal shell for high-quality shielding. In addition, friction dimples on the male connector's metal face provide ground continuity with the mating connector for effective EMI shielding. The dual-wipe, clover-leaf contact design assures a good connection, and rigid tin-plated solder tails eliminate bending and aid in alignment with PC board hole patterns. Optional features include inside or outside ground straps, board locks to hold the connector securely in place during wave soldering, and 4–40 inserts to offer still more design options.

The 25-position right-angle female connector with



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metal face and 10-microinch gold plating costs $1.80 each in quantities of 5,000. (Contact 3M for pricing details on other styles and quantities.)—**3M Electronic Products Division,** P.O. Box 2963, Austin, TX 78769-2963; Tel: 800-225-5375.

WAVEFORM RECORDER SYSTEM. For use in laser physics, high-voltage switching, material testing, NDT testing, ultrasonics, telecommunications, and speech analysis, *Rapid System's R1222* waveform recorder system has a 2-MHz sample rate at 12-bit

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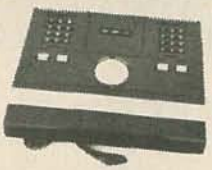

Atari 5200 Trak-Ball Controller

Use with your 5200 game or build your own computer mouse. Unit comes with heavy snooker ball running on five precision bearings. Two opto-isolators translate the rotary motion into *x,y* coordinates. IC's are: LM339, CD4011, CD4013, CD4030, CD4538. Unit also has two twelve-button keypads in addition to a bank of two buttons below each keypad. New, in original carton, with instructions.

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Starter Kit — PC board, microprocessor, documentation **$12.95**
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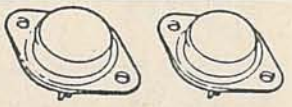

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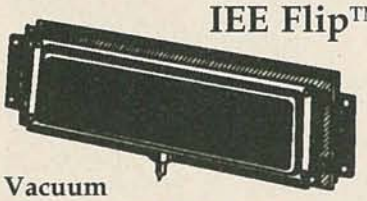

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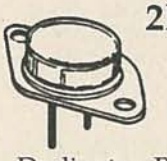

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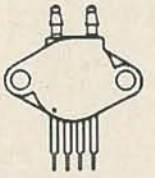

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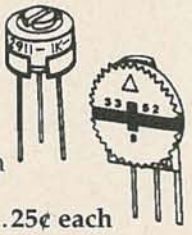

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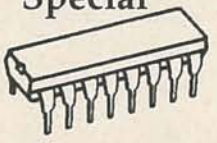

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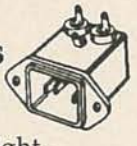

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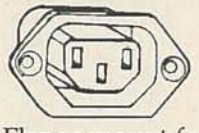

Flange mount female connector. Tab terminals rated 6 amps/250v.
6ESRF-3 .....**69¢**

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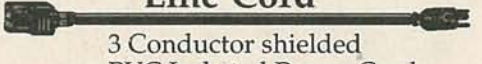

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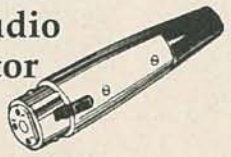
Switchcraft "Q-G" Audio Connector

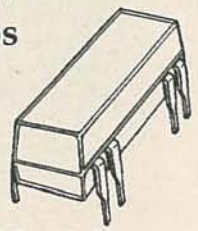


Stainless Finish, 3 contacts,
female P/N A3F and QGP-3-22
Compare at $5.95 reg price
ACP price Only ..... **$2.75 each**
Stock Up! Buy 10 .... **$1.95 each**

Aromat Relay

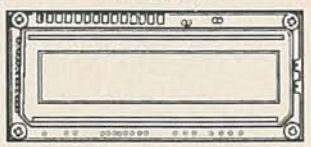
Normally open
3A 250 volts DCSV
#AE822908 (5leads)
ACP Only **$2.99 each**

Gordos Dip Relay



Standard Dip Relay
P/N F81-1359-2
ACP Only ..... **1.99 each**
Qty 10 Only ..... **1.79 each**

Hitachi



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8 lines x 40 characters
4 1/2" x 10 3/4"L
Same as used
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RG 59 Cable

Male to Male 20ft
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Infared Emitting Diode

T-1 3/4 Infared LED
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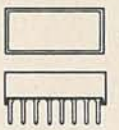
Qty 10 Only .....**19¢ each**



LED Bar Graph

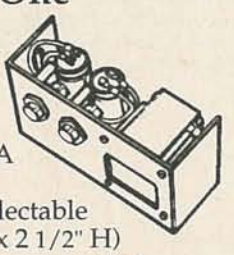
8 segment. Popular
Hewlett Packardtype
HP P/N HLMP-2785
Bar (Yellow) ..... **69¢**
Buy 25 pieces ..... **49¢**

Right Angle LED's

T-1 3/4 LED. Available in
single on a bank or 4.
Single (Red) ..... **69¢**
Bank of 4 (Red) **$1.79**

Power One

Series Power Supply



5V @ 4A
12V @ 2.5A
110/220
jumper selectable
(5 x 8 1/4 x 2 1/2" H)
ACP Only **$16**

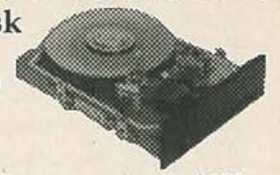
Slotted Optical Switch

Transistor
Outputs
1.7 V @ 20 mA
standard style
SPX1879-15

ACP Only .. **69¢ each**
Qty 25 Only **49¢ each**

MASS STORAGE

Hard Disk Specials All New!



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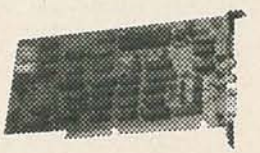
20MbST225 ..... $189
30Mb ST238R $215
40Mb ST251-1 .....$259
80Mb ST4096 .....$549
40MB IDE ST157A $279
100Mb IDE ST1144A .....Call
Imprimis 330Mb, CDC/Wren
150Mb, Toshiba 150Mb in stock
at special price Call ACP
10Mb Hard Drive Blow-out!
Densi 10Mb FH 5.25" $69

Western Digital

Hard Disk Controller



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2/3rd size card. New!
Reg price $99.00
ACP Only **$24.95**

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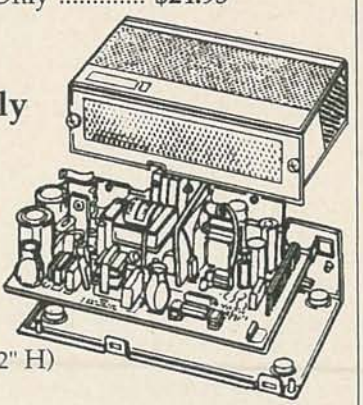
230V @ 1.2A
50/60 Hz

Output 1 128W	**Output 2 86W**
+5V @ 10A	+5V @ 10A
+12V @ 2.5A	+12V @ 1.0A
+12V @ 3.5	+12V @ 1.5
-12V @ 0.5A	-12V @ 0.5A

(10 1/2 x5x2 1/2" H)
ACP Only **$29**



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without soldering for on-site repairs and provide a more secure contact than snap-together probes. A distinctive, sawtooth-shaped center conductor eliminates microphonics. That design offers superior resistance to breakage from pulling and bending. The cable that is used is thinner and more flexible than those with straight conductors.

The 300-MHz probe assures precise measurements with less than 3% overshoot and 1.2-nanosecond risetime. Some models have an activator pin for readouts and automatic scale factoring that can be used on scopes having that feature.

List prices for the 30-MHz TPI probes begin at $74.00.—**Test Probes Inc.**, 9178 Brown Deer Road, San Diego, CA 92121; Tel: 619-535-9292.

TOROID TRANSFORMER TESTER. *Atlantic Magnetics'* model *3500A* toroid transformer tester can be used for in-process testing and incoming inspection of transformers and inductors wound on donut-shaped toroid cores. The tester can handle just about every available size toroid, ranging from small-signal, 0.060-inch core-inside diameter transformers for communications, up to large, 8-inch core-inside diameter trans-

RAINBOW KITS

RADAR SIGNAL DETECTOR

If you think that a sensitive radar detector is a complicated piece of equipment, take a look at this new kit. This simple, yet effective, detector circuit can be built in less than an hour and can be tuned to respond to signals between 50MHz to 500GHz. It's a fun kit to build and play with. A cigarette lighter plug is included. Size 1"x¾" operates on 9 to 15v DC.

KIT RSD-1 **$12.95**

STROBE LIGHT

If you need an attention getter, or warning light, you need the strobe light kit. Use it for emergency light for autos, for model planes or radio towers. Even use it on your bicycle. Operates on 6 or 12v DC and has a variable strobe rate.

KIT ST-1 **$8.95**

DIGITAL THERMOMETER

Have you ever wanted to tell temperature changes fast & accurately? The DT-1 kit will turn your digital volt meter into an accurate digital thermometer with .1 degree resolution. It gives you a 250 degree window with a range from -40F to 300F degrees. It has a remote sensor .25" sq. that can be mounted many feet from the meter if need be.

KIT DT-1 **$8.95**

BLINKEY LIGHTS

Want to attract attention? These kits are perfect for decorating name tags, lighting up your hat, or flashing lights for your model trains. Some people use them to simulate a burglar alarm for autos. Put it in a box, set it on your dash and it looks like the real thing. Each kit contains two LEDs that alternates flashing. Operates on a 9v battery. Size .5"x.5"

KIT RB-2 **$3.45**

CAPACITANCE METER

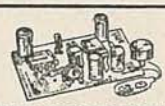
This easy to build kit will turn your digital volt meter into a CAPACITOR METER. Turn that junk box of unmarked capacitors into a fortune. Measures capacitors from (2pF to 2.2uF. Operates on a 9v battery. Size 1.75"x2"

KIT CA-2 **$12.95**

WIRELESS FM MIKE

Small but mighty .8"x1" PCB, will really stomp out a signal well over 400 yds. This is a buffered wireless mike that operates on 80 to 120 MHz FM. Comes complete with a microphone, and 9V battery connector. Operates on 6 to 12v DC.

KIT WM-1 **$12.95**



SUPER SNOOPER-BIG EAR

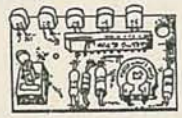
Use this BIG EAR amplifier to listen through walls, hear conversations across the room. Beef up the sensitivity with a parabolic reflector and hear blocks away. Due to the size, the BIG EAR can be hidden about anywhere. Use the earphones from a pocket transistor radio to listen. Makes an ultra-sensitive intercom. Can also be used as a general purpose 1.5W amp. We supply a mini-microphone in the kit. You can also use any 8 to 45 ohm speaker. Operates on 6 to 12v DC. Size 1"x1.75"

KIT AA-1 **$10.95**

AC LINE MONITOR

This is something every computer user, photographer, or anyone that must maintain a safe usable AC line voltage should have handy. Monitor the voltage of your motor home's 110v AC generator inside the motor home. Every technician's bench needs this item. The AC line monitor will indicate, with multi-color LEDs, what voltage is being distributed to your equipment at that particular outlet.

KIT LM-110 **$10.95**



12V BATTERY MONITOR

Have you ever been in your car, boat, or camper — you try to start your motor but the battery is dead? The BATTERY MONITOR kit uses the cigarette lighter plug outlet to monitor the true battery voltage. Multi-color LEDs indicate the voltage in 1v steps from 11v to 15v, green means great, yellow is good, and red — call the tow truck or get out the oars. Size 1.2"x1.75"

KIT LM-12 **$5.95**

PHONE TRANSMITTER

Small but mighty, so small it fits anywhere. Telephone line powered, never needs batteries. Transmits both sides of a phone conversation loud and clear, wireless, to any FM radio at great distances away. Variable tunes 70MHz to 130MHz. It can also be used to make any phone a speaker phone. Size .55"x1".

KIT TEL-B1 **$10.95**

PHONE RECORDING SWITCH

This telephone line powered switch is small enough to install anywhere only .9"x.6". Every time someone picks up the phone the tape recorder will record both sides of the conversation automatically. Use it in your office to record all phone conversations so you don't lose that important address you wrote on the back of an envelope.

KIT TEL-SW 1 **$10.95**

BUSY PHONE LIGHT

Add this little kit to any or all of your phones. When any extensions are in use the LED will light. Uses a 9v battery. P.C. Board 1"x½". Complete with etched & drilled PCB, all parts and schematics.

KIT TEL-LIT-1 **$9.95**

VOICE ACTIVATED SWITCH

This vox can be used to operate a tape recorder, ham radio, CB radio. Use it to turn on an alarm. The output can operate a load up to 100ma. It will operate a relay, lights, motor, or LEDs. What could you do with a sound activiated switch? Size 1.5"x1.25"

KIT VOX-1 **$6.95**

LIE DETECTOR

This kit can be great fun at parties. Lie and an audible tone will change, the more you lie the more the tone changes. When you lie your palms & forehead sweat. This kit allows you to measure these changes. Only a very slight amount of change will cause the tone to increase in frequency. Operates on 6 to 12v DC. Size

KIT LD-1 **$9.95**

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WARNING: Use of this device to duplicate copyright material may be against certain federal & state laws.

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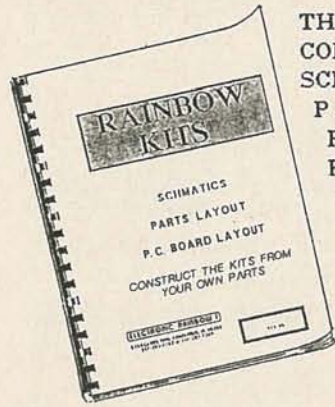

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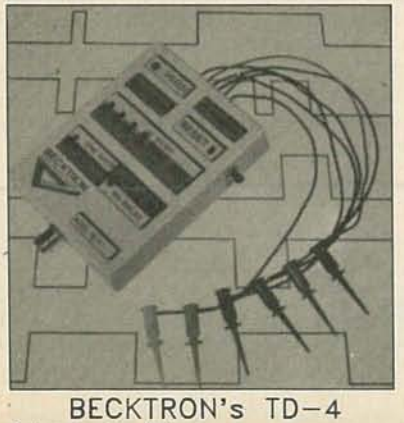

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						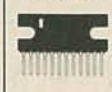				
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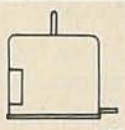	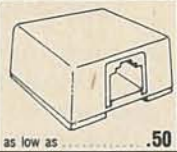	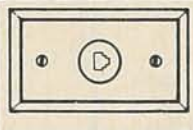			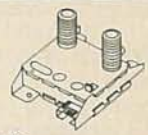
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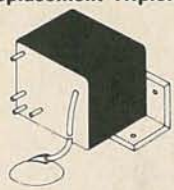

Order#	Replaces	1-9	10+
61-500	500A	8.57	7.34
61-521	521	9.22	7.90
61-522	522	10.29	8.82
61-523	523	8.70	7.45
61-526	526A	8.71	7.47
61-528	528	8.79	7.53
61-529	529	8.79	7.53
61-530	530	8.80	7.54
61-531	531	10.11	8.67
61-532	532	9.33	8.20
61-533	533	9.34	8.02
61-534	534	9.81	8.42
61-535	535	9.81	8.42
61-537	537	9.93	8.99
61-538	538	8.62	7.38
61-539	539	8.73	7.48
61-549	549	11.22	9.61
61-550	550	11.76	10.08
61-556	556	10.85	9.30
61-557	557	9.70	8.31
61-559	559	10.38	8.90
61-561	561	10.57	9.06
61-564	564	9.28	7.98

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REPLACES MFR#	ORDER#	1-4
0432140021	62-810	18.47
0432140071	62-825	22.16
0432140081	62-830	18.60
0432200111	63-0122	31.72

GOLDSTAR

REPLACES MFR#	ORDER#	1-4
154-040	63-409	17.59
154-040A	63-410	17.30
154-040B	63-412	19.39
154-041A	63-411	17.55
154-056A	63-415	17.14
154-074A	63-450	15.00
154-074E	63-451	18.51
154-074N	63-0102	18.52
154-122E	63-460	15.30

HITACHI

REPLACES MFR#	ORDER#	1-4
2432471	63-0104	23.15
2432811	63-0105	23.15
2432944	62-840	35.24
2433171	63-0118	30.94
2434391	62-850	18.47
2434401	62-860	18.60
2434651	63-0103	20.37
7334021	63-0101	28.40

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REPLACES MFR#	ORDER#	1-4
101-214-004-03	62-170	17.33
101-214-005-03	62-180	17.34
101-214-009-03	62-190	17.34
101-220-002-03	62-200	23.16
101-220-003-03	62-210	20.87

PANASONIC

REPLACES MFR#	ORDER#	1-4
TLF-6041F	62-485	28.28
TLF-69965	62-510	26.97
TLF-14401F	62-570	20.78
TLF-14503F	62-580	22.16
TLF-14617F	62-490	27.27
TLF-14706	62-601	27.16
TLF-69983	62-520	26.97
TLF-70012	62-740	18.60
TLF-80802-1	62-530	9.42
TLF-80843-1	62-540	9.42

SAMPO

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8FT-024D	63-880	8.06
8FT-043B	63-900	9.01
8FT-046	63-870	8.06
8FT-063A	63-890	8.06
FB-1053	63-210	18.27
FB-1061A	63-0109	19.42
FB-3005	63-0110	21.62
FB-01166	63-0121	29.76

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REPLACES MFR#	ORDER#	1-4
FBC-1215AL	62-650	12.24
FCM-2015BL	62-680	18.47
FMD-1235BL	62-760	12.24

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4-2751-48500	63-105	8.00
4-2751-48600	63-110	8.00
4-2751-60108	63-115	7.59
FO-192A	63-135	15.70
FO-239	63-150	15.71
FO-240	63-155	17.10
FO-241	63-160	15.57
FO-243	63-170	19.86
FO-260	63-180	15.94
F-1108	63-220	15.74
F-1117	63-225	25.86
F-1119	63-240	17.15
F-1123	63-250	15.55
F-1125	63-252	15.91
F-1129	63-255	25.85
F-1133	63-260	21.51
F-1148	63-270	20.88
F-1177	63-280	19.45

A.O.C.

REPLACES MFR#	ORDER#	1-4
79A 302-1	63-0107	22.68

SHARP

REPLACES MFR#	ORDER#	1-4
RTRNF 0003PEZZ	63-810	22.50
RTRNF 0009PEZZ	63-820	22.86
RTRNF 0014	63-830	20.50
RTRNF 0015	63-840	20.50
RTRNF 0016	63-850	20.50
RTRNF 0059	63-860	20.50
RTRNF 1335CE	63-1335	34.22
RTRNF 1431CEZZ	63-910	24.93
RTRNF 1452CEZZ	63-920	24.93
RTRNF 1477CEZZ	63-930	24.93
RTRNF 1588C	63-0106	25.00

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1-439-238-11	63-0111	21.17
1-439-254-13	63-0112	17.64
1-439-273-12	63-0113	21.17
1-439-351-22	63-0115	22.05
1-439-351-13	63-0119	29.58
1-439-357-12	63-0120	29.58

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FTB-174	63-0117	21.62

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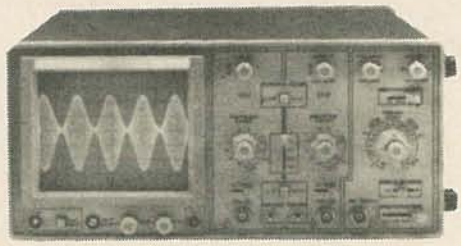

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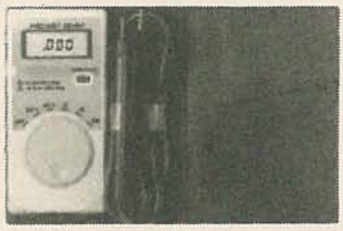

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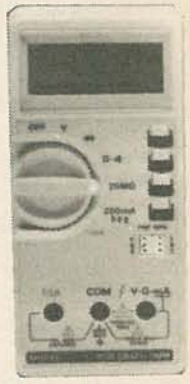

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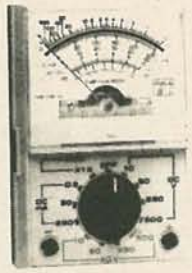

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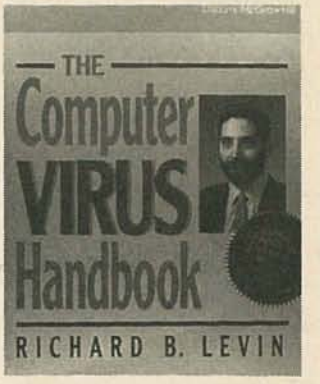
The author presents an overview of how viruses and other types of "rogue" software operate, and then presents tips on preventing the spread of computer viruses. Complete coverage of antiviral policies for the workplace includes advice on evaluating and using antivirus software, identifying and eradicating viral infections, implementing viral defense mechanisms, hard-disk management techniques, and personnel policies.



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T12-2	.125"	48	.35	.30	T44-6	.440"	42	.70	.60	T200-2	2.00"	120	4.00	3.60
T12-6	.125"	17	.35	.30	T50-2	.500"	49	.80	.68	T200-6	2.00"	100	4.75	4.25
T12-17	.125"	7.5	.40	.35	T50-6	.500"	40	.80	.68	T200-52	2.00"	900	3.00	2.40
T16-52	.160"	150	.35	.30	T50-17	.500"	18	.90	.78	T225-2B	2.25"	215	6.00	5.40
T25-2	.255	34	.40	.35	T50-26B	.500"	420	.90	.78	T225-6	2.25"	100	6.00	5.40
T25-6	.255"	27	.40	.35	T50-52	.500"	350	.80	.68	T300-2	3.04"	114	6.00	5.40
T25-17	.255"	12	.40	.35	T68-2	.690"	57	.80	.68	T300-2D	3.04"	228	13.00	12.
T30-2	.307"	43	.40	.35	T68-6	.690"	47	.80	.68	T300-52	3.04"	850	8.00	7.20
T30-6	.307"	36	.40	.35	T68-52	.690"	420	.80	.68	T400-2	4.00"	180	13.00	12.
T30-17	.307"	16	.40	.35	T80-2	.795"	55	.95	.82	T400-2D	4.00"	360	22.00	20.
T30-52	.307"	73	.40	.35	T80-6	.795"	45	.95	.82	T400-52	4.00"	1400	12.00	11.
T37-2	.375"	40	.60	.50	T80-52	.795"	500	.85	.72	T520-2	5.20"	200	22.00	20.
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BUY BONDS

A-BUS™ NEWS

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Alpha Products proudly announces two new product lines: **C·Net** serial communications devices, and **Alpha Box** interfaces. These new products are not merely A·Bus accessories, but complete sets of products for all of your interfacing needs.

All the products are used to connect different types of devices to your computer. Our communications devices help you connect devices that have computer interfaces already built in. **C·Net** provides the option of connecting many different RS-232 devices to a single serial port on your computer. We also carry converters to other standards, including RS-422, RS-485 and IEEE-488.

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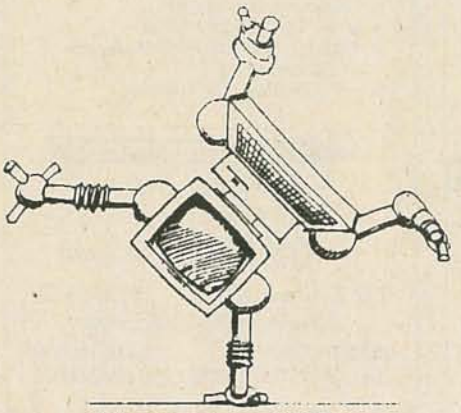

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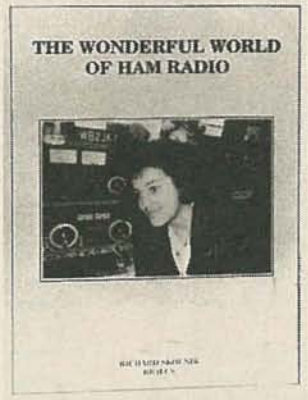
THE WONDERFUL WORLD OF HAM RADIO: AN INTRODUCTION FOR YOUNG PEOPLE; by Richard Skolnik, KB4LCS. MFJ Enterprises, Inc., P.O. Box 494, Mississippi State, MS 39762; 601-323-5869; for orders, 800-647-1800; fax: 601-323-6441; paperback; $7.95.

If you're considering buying a youngster a ham radio this Christmas, consider including a copy of this fun-to-read book that describes what ham radio is all about and why it can be a valuable part of his or her life. The book explains how hams can use radio communications to learn about computers, electronics, geography, and more. It illustrates how hams provide valuable communications services during emergencies, and even includes an actual emergency QSO. Finally, it explains how to get a ham license at set up a station to talk to other hams around the world. The book is filled with photos of radios, ham stations, Field Day setups, and students learning about and using ham radios. **R-E**



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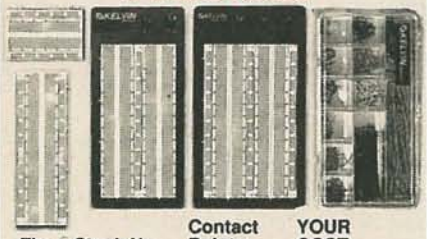

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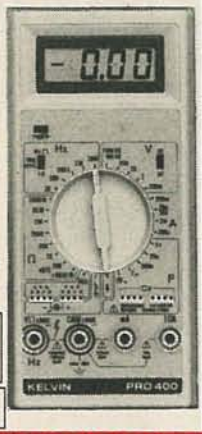

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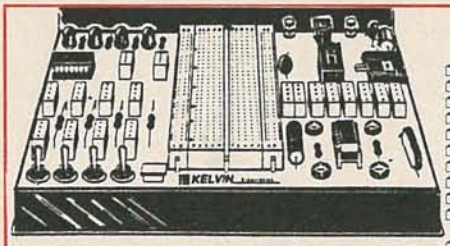

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- ☐ **NAND** GATE
- ☐ **INVERTER**
- ☐ **AND**
- ☐ **OR** GATE
- ☐ **NOR** GATE
- ☐ **EX - OR** GATE
- ☐ DOUBLE **INVERTERS**
- ☐ **NAND** GATE AS INVERTER
- ☐ **NOR** GATE AS INVERTER
- ☐ CREATING **NAND** FUNCTION, USING **AND** GATE & TWO INVERTERS
- ☐ CREATING **AND** FUNCTION, USING **NAND** GATES
- ☐ CREATING **OR** FUNCTION , USING **NOR** GATES
- ☐ CREATING **AND** FUNCTION , USING **NOR** GATES
- ☐ CREATING **OR** FUNCTION USING **NOR** GATES
- ☐ CONSTRUCTING A **FREE RUNNING OSCILLATOR**, USING A RESISTOR, CAPACITOR & INVERTER
- ☐ CONSTRUCTION OF A **GATED OSCILLATOR**
- ☐ **R - S** FLIP-FLOP
- ☐ **R/ - S/** FLIP-FLOP
- ☐ **D** FLIP-FLOP
- ☐ **J - K** FLIP-FLOP
- ☐ **T** FLIP-FLOP, USING **J - K** FLIP FLOP
- ☐ USING THE **HEXADECIMAL DISPLAY** WITH THE BUILT-IN LATCH DECODER & DRIVER
- ☐ COMPARING THE DECIMAL, HEXADECIMAL, BINARY & BINARY CODED DECIMAL NUMBERS
- ☐ 4 BIT **COUNTER**
- ☐ BINARY **ADDITION**
- ☐ EXPERIMENT WITH BUILT-IN CLOCK GENERATORS: ADJUSTING THE FREQUENCY & DUTY CYCLE
- ☐ . . . AND MUCH, MUCH MORE!

Trainer Manual gives detailed instructions on the topics listed. An excellent tool covering topics for High School (Beginner - Advanced), Trade School (Beginner - Intermediate) & College.

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- ■ 5 Digit Multifunction Dual Display
- ■ Selectable Reading Rates & Resolutions
- ■ True RMS AC Voltage, AC Current
- ■ .02% Basic DC Voltage Accuracy
- ■ DC Current to 10A
- ■ RS-232 Interface
- ■ Touch Hold, Relative & Min/Max

Stock No.	Model	YOUR COST
710035	45	*SPECIAL* $579. *PRICE*

TIMER - LM555

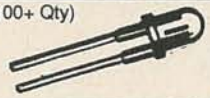
Stock No. 600021

20 ¢ ea. (in 100+ Qty)

L.E.D. RED (in 100+ Qty)

Stock No. 260020

6 ¢ ea.



Transistors (in100+ Qty)

2N2222 18 ¢ ea.

PN2222 .08 ¢ ea.

Project BUZZER

6-9V DC, 80 dB

Stock No. 680089

$1.59 ea $1.39/10+ ea.

9V Battery Snap & Holder

Snap .15 ea. .10ea/100+

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LAPEL MICROPHONE

Stock No. 850306

YOUR COST $2.95 ea

CADMIUM SELENIDE PHOTO CELL

450 ohms @ 2 ft., C minimum dark resistance 225 ohms
Max voltage 170V peak. Peaks at 6900 angstroms.

No. 260017 YOUR COST $ .99 ea

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1.5K ohms @ 2 ft., C minimum dark resistance 75 ohms.
Max voltage 170V peak. Peaks at 5500 angstroms.

No. 260018 YOUR COST $ .99 ea

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Silent action red push button molded housing.
Requires 1/4" panel hole. Overall length including solder lugs is 1".
Rated 115 VAC, 1 AMP.

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990002	Red	$ .35 ea	$ .28 ea

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1.5 to 6VDC

Stock No.	YOUR COST	20+
852211	$ .50 ea	$ .45 ea

SOLDERING EQUIPMENT

WELLER

MARKSMAN SOLDERING GUN

Model SP23

Featherweight 1-3/4 oz., 25 watts for PC work. Ideal for reaching into those hard to get spots. Replaceable tip.

Stock No.	YOUR COST	6+
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Soldering stand with base, sponge, and receptacle.
For W60P, WP25P, WP40P, and irons with barrel diameters up to 15/32".

Stock No.	Description	YOUR COST	6+
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810042	Replacement Sponge	$ 1.89 ea	$ 1.80 ea

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RESIN CORE SOLDERS 1 LB. ROLL

Non-Corrosive Flux Resin Core

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580005	1/32"	.031	21	60/40	$9.95 ea
580001	1/16"	.062	16	60/40	$8.95 ea
580011	3/32"	.093	13	60/50	$11.75 ea

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USE R-E SHOPPER CLASSIFIEDS

READ BY MORE THAN 100,000 ELECTRONICS BUYERS AND SELLERS AND TRADERS

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.

We cannot bill for classified ads. Payment in full must accompany your order. We do permit repeat ad or multiple ads in the same issue, but in all cases, full payment must accompany your order.

WHAT WE DO

The first two words of each ad are set in bold caps at no extra charge. No special positioning, centering, dots, extra space, etc. can be accommodated.

RATES

Our classified ad rate is 40¢ per word. Minimum charge is $6.00 per ad per insertion (15 words). Any words that you want set in bold or caps are 10¢ each extra. Bold caps are 20¢ 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 **R-E Shopper** 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 10 will appear in the July, 1991 issue that is on sale June 4. Shopper ads will appear Jan., Mar., May etc. 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: 40c per word, Minimum $6.00.

Send your ads with payment to:
Radio-Electronics SHOPPER, 500-B Bi-County Blvd. Farmingdale, NY 11735

CATEGORIES

100 — Antique Electronics
130 — Audio-Video-Lasers
160 — Business Opportunities
190 — Cable TV
210 — CB-Scanners
240 — Components
270 — Computer Equipment Wanted
300 — Computer Hardware
330 — Computer Software
360 — Education
390 — FAX
420 — Ham Gear For Sale
450 — Ham Gear Wanted
480 — Miscellaneous Electronics For Sale
510 — Miscellaneous Electronics Wanted
540 — Music & Accessories
570 — Plans-Kits-Schematics
600 — Publications
630 — Repairs-Services
660 — Satellite Equipment
690 — Security
710 — Telephone
720 — Test Equipment

CLASSIFIED AD COPY ORDER FORM

Ad No. 1—Place this ad in Category # _____

1 - $6.00	2 - $6.00	3 - $6.00	4 - $6.00
5 - $6.00	6 - $6.00	7 - $6.00	8 - $6.00
9 - $6.00	10 - $6.00	11 - $6.00	12 - $6.00
13 - $6.00	14 - $6.00	15 - $6.00	16 - $6.40
17 - $6.80	18 - $7.20	19 - $7.60	20 - $8.00
21 - $8.40	22 - $8.80	23 - $9.20	24 - $9.60
25 - $10.00	26 - $10.40	27 - $10.80	28 - $11.20
29 - $11.60	30 - $12.00	31 - $12.40	32 - $12.80
33 - $12.80	34 - $13.60	35 - $14.00	36 - $14.40
37 - $14.80	38 - $15.20	39 - $15.60	40 - $16.00

Total classified ad Payment $ _____ enclosed.

[ ] Check [ ] MasterCharge [ ] Visa ($15.00 minimum credit card order)

Ad No 1—Total words _____ × .40 per word = $ _____

All Caps words _____ × .10 per word = $ _____

Bold words _____ × .10 per word = $ _____

Bold Cap words _____ × .20 per word = $ _____

TOTAL COST OF AD No. 1 $ _____

Card # _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _

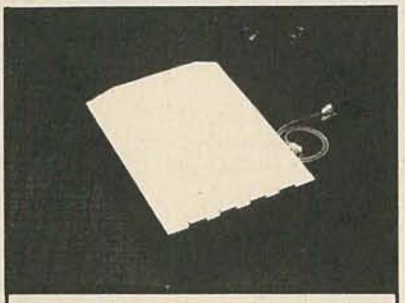
Expiration Date _ _ / _ _

Signature _____

Name _____ Phone _____

Address _____ City State Zip _____

ELECTRONICS Lesko's ELECTRONICS



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- The single Line Telephone System-with 100 NO. memory up to 40 digits in length.
- THE SPEED DIALING SYSTEM/with a dozen more features.
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- Last number redial-hold features-
- LOCK OUT UNWANTED 900 NUMBERS.

Requires no other parts when used with a single phone. Comes with battery backup and single adaptor.

PRICE ONLY $15.95

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84 Key XT Keyboard	$22.50
Multi I/O XT s/p/c/g/FD cont.	35.95
Multi I/O AT s/p/g	35.95
6' Printer Cable	8.95
Monitor Ext. Cable 6'	6.95
Keyboard Ext. Cable 6'	5.95
Monitor Adaptor Cord 6"	4.50
Apple II & IIE RGB Color Card	15.95
Replacement keyboard cable w/connector	4.00
CALL FOR OTHER ITEMS	

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SAW Filter CTI-80-134 70 mhz	1.95
Wavetek Filter 45 mhz	2.50
24 Pin Machine Sockets Gold	.65
Other IC Sockets in Stock	CALL
Oscilating Ceramic Heaters	43.95
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3/4 " Black Duct Tape 100"	1.50
Loran Amplifier	8.95
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22 Volt DC power supply	9.95
A/B Switch 70 ohm	2.50
Mitsumi RF Modulator	5.00
Toshiba RF Modulator	5.00

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EVER-TEK 286-12 MEG MB,G2 CHIP SET,AMI BIOS,0K.....$	115.95
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EVER-TEK Mono Graphic Monitor Card w/LPT1.....$	19.95
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PTI 65 MEG HD,RLL,3 1/2" w/WD-RA2 HD/FL Controller.$	329.95
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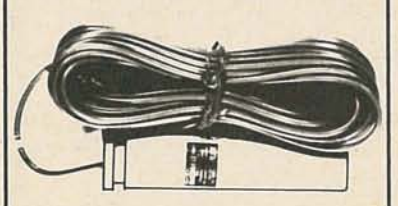
XT-FLOPPY CONTROLLER, 360,1.2,720,1.44 Drives.....$	49.95
TOCOMM 5503VIP-5507 TEST CHIPS (NO WI. SALES).....$	29.95
SUNSHINE EW984B EPROM PROGRAMMER 4 GANG w/software..$	129.95

ALL HARD DRIVES COME WITH 5 1/4" MOUNT AND 1 YEAR WARRANTY

MITSUMI RF MODULATOR

Crystal controlled, "RCA" phono style output connector. Used by Birdview for their Satellite receivers. Super for projects !

ONLY $ 5.00



LORAN ANTENNA MOUNT

This is a Loran antenna mount with builtin amplifier used to receive the Loran Navigational signals used on ships & boats to locate their position. The antenna mounts can be converted for "Ham or CB use. The built in amp is low freq. usable in the 40-400khz range. Comes with approx. 35 ft of cable.

A STEAL AT ONLY ! $ 15.95

GENIUS GM-6X MOUSE

Including Dr. Halo III Graphics Software.

ONLY $32.95 !

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TMS 4464-120 (np)	$ 3.00
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27256 Eprom (pe)	3.25
27512 Eprom (pe)	5.00
2708-2716-2732-2764	CALL
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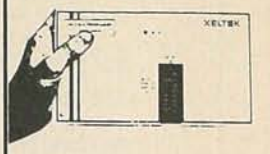
$585 UNIVERSAL PROGRAMMER



■ PROGRAMS

- E/EPROMs upto 4 MBits & 16Bit wide
- PALs from AMD, MMI, TI, NS, CYPRESS etc
- 22V10 from AMD, ATMEL, TI, SAMSUNG & CYPRESS
- EPLDs from ALTERA INTEL, TI
- GALs from LATTICE, SGS & NS
- FPLs from SIGNETICS
- PEELs from ICT, HYUNDAI & GOULD
- BIPOLAR PROMs
- SINGLE CHIPs (8748, 8751 & 87C51 series)

■ SUPPORTS

- 32Bit WORDSPLIT with 4 GANG adaptor
- PALASM2, CUPL, ABEL, TANGO, OrCAD, JEDEC files
- PAL VERIFICATION using TEST VECTOR
- GAL electronic signature recognition
- 87C451 63701 X, Y, V & 63705V with adaptor option
- Tests ICs (TTL, CMOS) & D.S. Memorys ICs with user definable test patterns

■ Package includes software, programming module, high speed interface card and Cable

■ OPTIONS

- Socket adaptors for PLCC, LCC, SOIC and FLAT FPK ICs
- 4 Socket adaptor for E/E PROMs
- Socket adaptors for micro controllers

TRACKER II & III REMOTE CONTROL UPGRADE KIT

These units will upgrade your Houston Tracker II & III Satellite Dish Controller. Control your dish from your armchair!! These units are UHF controlled and can be used for any projects, robots, airplanes, cars, or anything you want. Great for experimentors!!

PRICE ONLY $15.00

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Price is ONLY $5.00

4 WAY SPLITTER DC Passive

WOW ! ONLY $5.00

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Approx. 1mW * Tested Good * without power supply *

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6VDC @ 3Amp Hour * 5.5"x1.5"x2.5" * 2 Piece Minimum *

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From copy machine * by Fuji Optical* 2 1/4" Plano/Convex Lens *

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Rare earth * approx 1/2" x 1/2" x 1/32" * incredibly strong *

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For PC boards * .024" *

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14" * Sony CRT * Mod #360-1033-01 * MAC II HI-Res Compatible *

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20 MB Hard Disk * 1.44 Floppy * Modem * Carry Case * 1 MB RAM
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8088 * 8 MHz * 640K opt. *

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AT Compatible * 12 MHz * Baby *

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Dual Trace * TV Sync. Filter * 2 each x1, Ref., x10 Probes *

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Dual Trace * Delayed & Single Sweep Modes * 10n.s. Rise Time
* Z Axis Intensity Mod * 2 ea. x1, Ref., x10 Probes *

EPROM Programmers * w/Software * IBM Compatible * 2716 to 27512 *
One Gang (order #R/EPROM)·····$59.95
Ten Gang (order # R/EPROM-10)·····SALE!·····$149.95

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200 Watt Power Supply * AT Compatible * ·····$49.95

VGA Color Monitor (order # R/VGA Monitor)·····$295.00
14" * Tilt & Swivel Base * Relisys Mod #RE9513 *

CGA Adaptor (order #R/CG)·····$19.95
IBM Compatible * Great for video games!

Hard Disk Controller for XT Compatible (order #R/HDC)·····$29.95
Supports 10 Drive Types * w/Cables and Documentation *

RLL Hard Disk Controller for XT Compatible (order #R/RLL)·····$49.95
50% faster data transfer * Rom Resident Pre-Format * RLL Drives Only!

Hard Disk Drives Factory Refurbished * 1 Yr Exchange by Haltek
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40 MB Hard Disk * Seagate ST-251-1 * 28 ms *·····$249.00
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340 MB S.C.S.I. Package Deal (R/1578-PKG)·····$995.00
18ms * w/W.D.'s S.C.S.I. Controller & Cables * 1 Yr Warranty *

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18ms * w/W.D.'s E.S.D.I. Controller & Cables * 1 Yr Warranty *

49 MB Hard Disk.....SALE!.....$179.00
Seagate ST-157R * RLL * 3.5" * New * 1 Yr Exchange *

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Our refurbished inventory contains items that fall into one or more of the following catagories: 1) failed primary testing, 2) was sold and returned as failed, 3) cosmetically imperfect. In any case, the item was returned to the O.E.M. (original equipment manufacturer) and was reconditioned or fixed to original manufacturers specifications. HALTEK guarantees all refurbished products for 90 days from the date of purchase. Any item may be exchanged within that period. The management of Haltek Electronics requires that any returns be in the original packaging and be complete, including any and all manuals, cables, software, etc. and must be accompanied by the original sales receipt.
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- Accessories
- Major Brands
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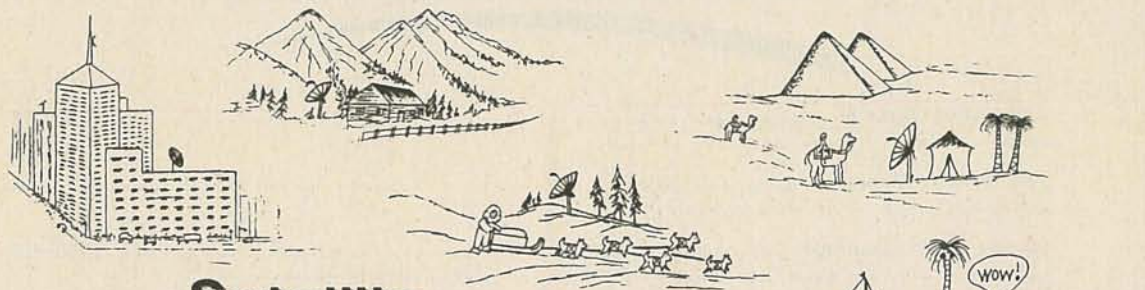


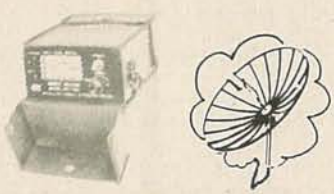
Satellite TV Anywhere

WORLD SATELLITE TV AND SCRAMBLING METHODS

"The Technicians' Handbook"

This thorough text is a must-buy for technicians, satellite professionals and curious do-it-yourselfers. The design, operation and repair of satellite antennas, feeds, LNBs, receivers and modulators are ex-examined in detail. An in-depth study of scrambling methods and broadcast formats including the VideoCipher II, Oak Orion, FilmNet, Sky Channel, EuroCypher, D2 MAC, BSB and Teleclub Payview III. Circuit and block diagrams of all components are presented and clearly examined throughout the handbook. This information is a prelude to the chapters on troubleshooting and setting up a test bench. This expert guidance on testing, servicing and tuning is complimented by a wealth of detailed illustrations.

340 pages, 8 1/2 x 10 3/8 over 200 photos, diagrams, wiring schematics and 16 tables / appendices / index
Order 0020013 .....S&H $4 (U.S.) $39.95



TUNE YOUR DISH TO ITS MAXIMUM!

"With The Pico Signal Meter"

A must for the serious dealer or satellite system owner. Saves time, frustration and money. Use when installing a new system, moving your dish, re-alignment of a dish that has been moved by wind, frost heaves etc., gets you right on the satellite belt for the best possible pictures! The PP-1450 Pico Peaker is a super sensitive signal meter used for antenna aiming, focusing, peaking and polarity alignment. The multi-purpose Peaker can be used on any receiver system with block down-converted frequencies between 70 and 1500 MHz. (Does not work with older single conversion receivers - Ask for Bulz-I-Meter) The Peaker comes in an attractive case with neck strap.

Order 0025003 .....S&H $5 (U.S.).....$89.95
Optional jump cable kit. Connects Peaker to LNB (Kit includes 2ea. 12' coax cables w/ splicer).
Order 0025007 .....S&H $3 .....$7.95

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System package Includes: ORBITRON 10 foot mesh dish, 50degree LNB,18" Jack Arm, Feed-horn and Receiver/IRD of your choice, plus a FREE detailed installation Video.

		IRD/Receiver	System
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ings are on the knob. For example, the knob setting of 5 volts per division appears as a readout directly on the CRT near the waveform display. You just turn the knob a little one way or the other to scroll up or down through the settings. The screen readout tells you where you are.

In the most advanced scopes, there may only be one or two knobs on the front-panel. That's it. You determine what a "soft" knob do by making selections from a screen menu, as shown in Fig. 1. If you want to adjust the vertical sensitivity, simply select VERT from the screen menu, then adjust the knob for vertical scaling. Select HORIZ, then POS, and the knob becomes a horizontal position control. There are two big advantages of displaying scope setup and control readouts directly on the CRT—the user can make quick measurements, without taking his or her eyes off the screen, and it helps with screen photographs, where all of the pertinent information about the measurement is displayed on the CRT.

The automatic setup feature makes setting up the scope easy and efficient. With an automatic setup button, the scope automatically senses key setup parameters from the waveform at the probe tip and sets itself up for a standard display of that waveform. The usual scope controls are also available to change settings or to set up special functions, such as delayed sweep or single-shot triggering. Single-button setup of initial displays is a definite advantage, and a convenience that's quite easy to get used to.

In addition to automatic setup features, many scopes also have front-panel controls that allow you to store and recall setup configurations. Such advanced features allow you to set the scope up one way for a waveform measurement and store the settings in a memory location. You'll then be able to set the scope up in a completely different way for another measurement, and store those settings in a different memory location. Switching between the measurements then becomes a piece of cake!

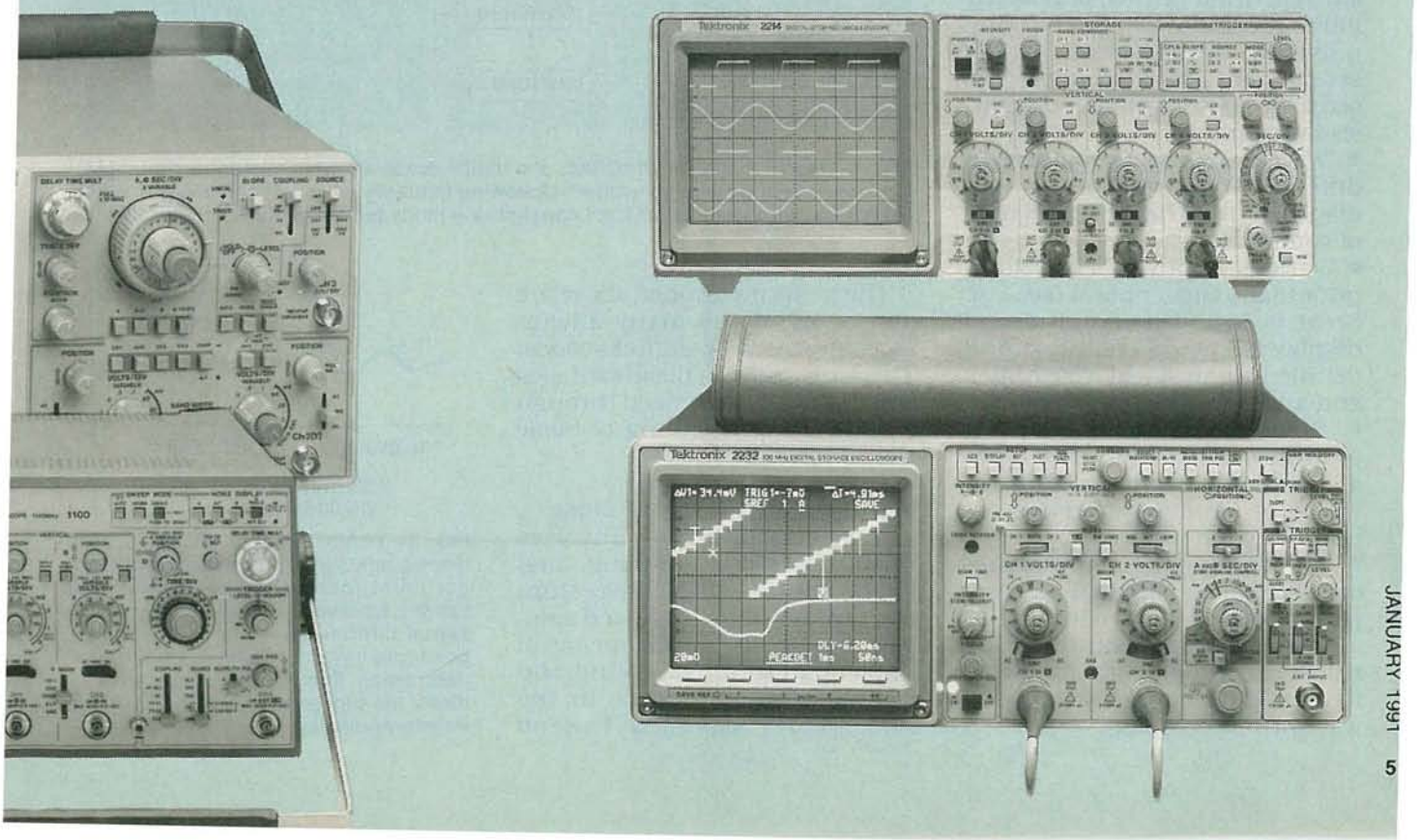
Automatic memory recall is particularly useful if you're tracing a waveform through various circuit stages and need to repeat several scope setups at each stage to check waveform parameters such as rise time, pulse width, and repetition rate. Simply push a few buttons for the setup you want.

The number of front-panel settings that are stored in a scope depends on the amount of memory provided for that purpose. Also, if the memory is non-volatile, the settings will still be there for recall the next time you turn the scope on.

Screen cursors and push-button measurements are still other features that are appearing more on analog scopes. Screen cursors are a set of lines or other markers that can be moved to any place on the screen (see Fig. 1). The screen location of the cursor, in terms of amplitude or time, appears numerically on a screen readout. By properly positioning two cursors on a waveform display, it's easy to measure peak-to-peak voltages or rise times.

The features discussed so far have been enhancements to the traditional analog scope; the waveform being probed, displayed, and measured has not been digitally altered in any way. Because an analog waveform is displayed in real time on an analog display, it must be repetitive in order to remain on the display long enough to be measured by counting divisions, placing cursors, or using push-button measurements.

Digital scopes offer many advantages and conveniences over typical analog versions. Let's find out why some prefer to use digital scopes over their analog counterparts.



Digitizing scopes

Some key elements of a digital scope are shown in the block diagram of Fig. 2. The analog waveform is sampled and digitized after the input signal is conditioned. The digitized waveform is stored in digital memory, from which it can be recalled at any time for processing, display, and measurement. All of that occurs automatically, and is set up using the same basic controls as a traditional scope. Additional controls are used to select memory locations for waveform storage, and any processing or analysis that occurs during or after waveform acquisition.

Waveform digitizing offers significant advantages to the traditional approach of waveform viewing and measurement. In terms of scope design and manufacture, a wideband-signal path to the CRT display no longer has to be provided. Also, the CRT speed requirements are reduced since waveforms can be reconstructed from digital memory. Some digitizing scopes even use LCD displays, which eliminate bulky CRT's and their associated power supplies.

Some primary advantages of waveform digitization are:

- Waveforms that would appear as a brief flash (single-shot or low-repetition pulses) or a slowly moving dot (low-frequency signals) on a traditional analog scope, can be frozen on the screen for observation and analysis later on.
- Waveforms can be captured at different times and places and displayed together for purposes of comparison.
- Various amounts of waveform prior to the trigger point (see Fig. 3) can be included in capture and display, allowing complete and detailed analysis of rise times and any waveform preshoot.
- Signal averaging, enveloping, peak detection, and other types of processing can be used to enhance or emphasize certain aspects of waveforms.
- A wide range of analysis procedures can be applied to compute waveform parameters either as built-in scope features or by transferring digitized waveforms to a computer for software based waveform processing.

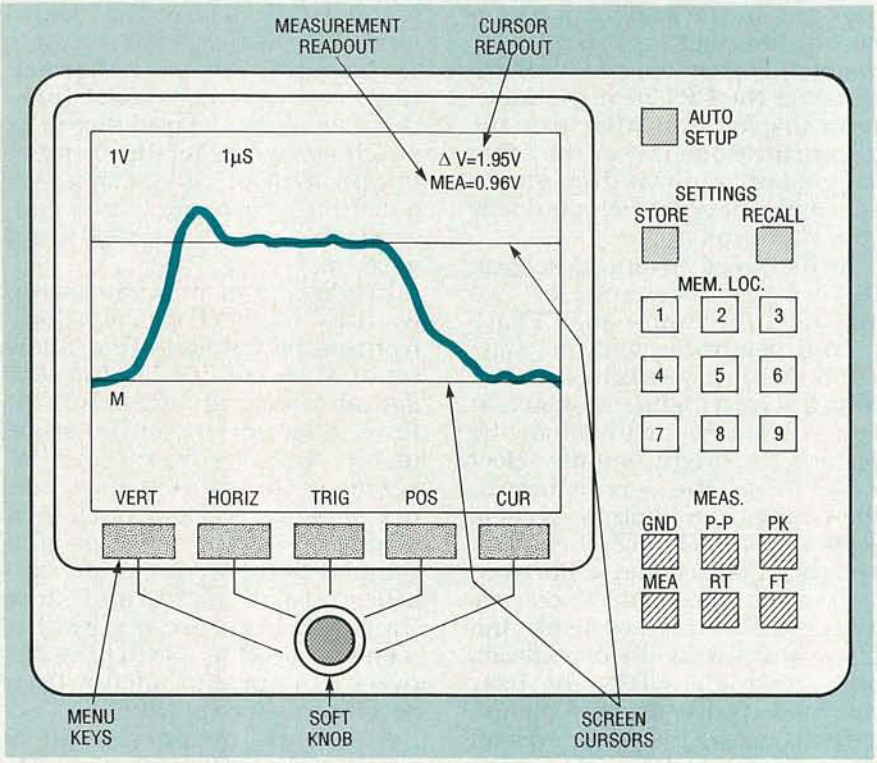


FIG. 1—SOME OF THE MANY features that are changing the face of traditional analog scopes, as well as digital scopes are screen menus, soft knobs, automatic setup, cursors, and front-panel settings with storage and recall.

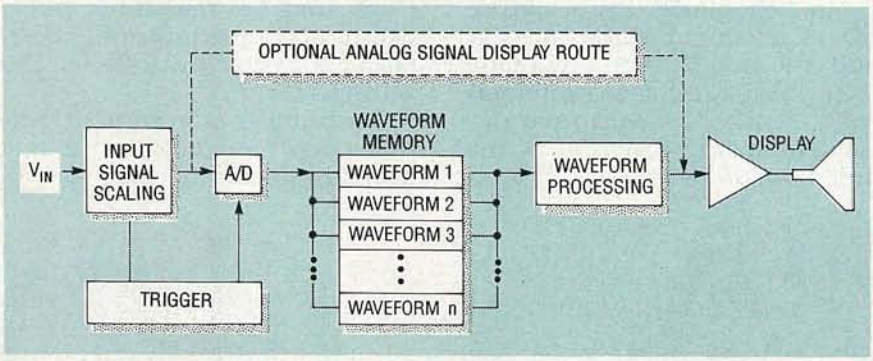


FIG. 2—THIS IS A BLOCK DIAGRAM of a digital scope showing analog-to-digital (A/D) conversion taking place immediately following input-signal conditioning. Some digital scopes may also have an optional nondigitizing mode for use in initial scope setup.

The items mentioned above are just some of the many advantages provided by digital scopes. There can also be disadvantages which can be minimized through a better understanding of basic waveform digitizing.

Waveform digitizing up close

Waveform digitizing involves three processes—sampling, analog-to-digital (A/D) conversion, and storage of the digitized samples. Depending on the means of implementation, sampling and digitizing may be done in the same step, or separately. The end

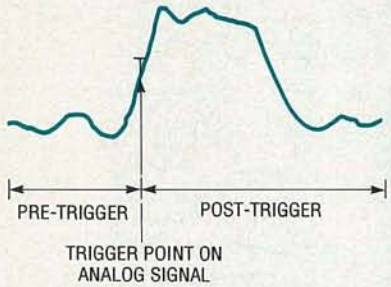


FIG. 3—TRADITIONAL ANALOG scopes display only the signal following the trigger point (post-trigger). Many digital scopes, however, can capture and display signal information prior to the trigger point (pre-trigger) as well as post-trigger information. Some digital scopes also indicate the trigger point with a "T" on the waveform display.

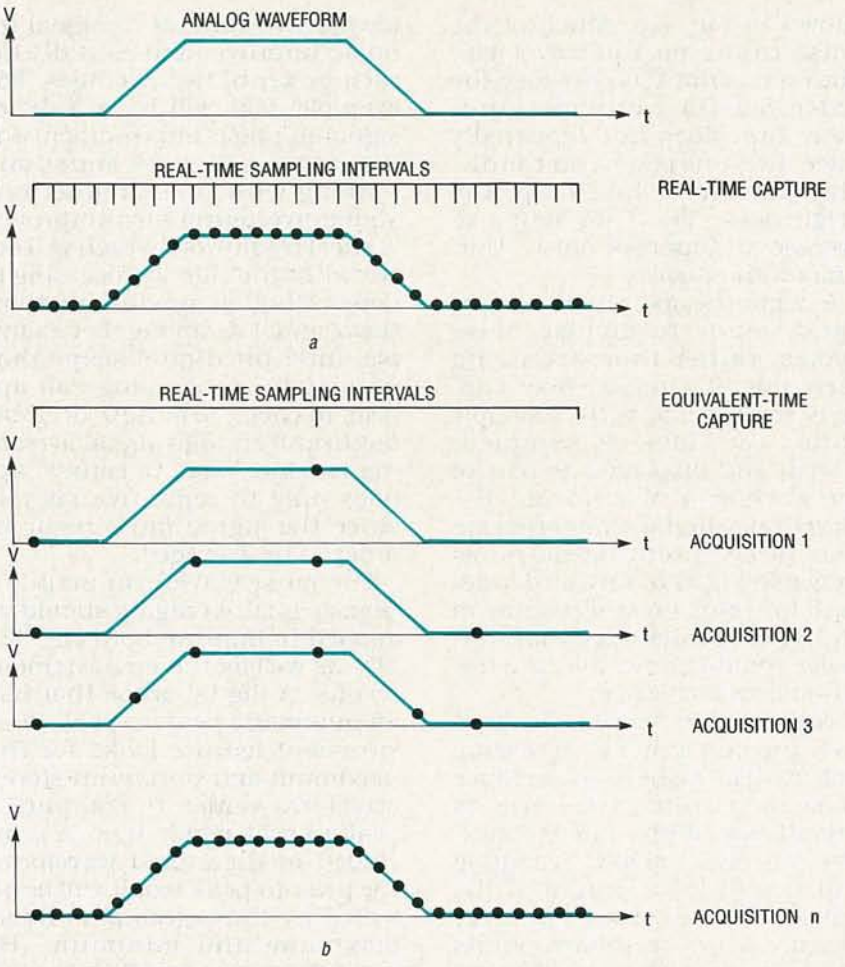


FIG. 4—REAL-TIME SAMPLING CAPTURES all waveform samples sequentially as the waveform occurs in real-time (*a*), equivalent-time sampling achieves the same apparent results as long as the waveform is repetitively triggered for sample build up over multiple acquisitions (*b*).

result, however, is a set of digitized amplitude samples representing the analog waveform.

The rate at which sampling is done determines the sample interval of the waveform and, therefore, the time resolution of the waveform representation. Depending on your needs, that can be looked at in terms of resolving rise times, or number of samples per cycle for overall waveform definition. For example, a 100-megasamples per second (MS/s) sampling equates to a sample interval of 10 nanoseconds (1/100 MS/s). That sampling rate is quite adequate for defining rise times of 500, down to 50 nanoseconds, but inadequate for rise times of 20 nanoseconds or less. In simple terms, a 100-MS/s sampling provides 100 samples per cycle for a 1-MHz sine wave, a 10-MHz sine wave is sampled 10 times per cycle, and a 50-MHz sine wave is sampled only 2 times per cycle.

Most digital scopes provide more than adequate sampling rates on all sweep-speed settings (seconds/division), as long as you are dealing with repetitively triggered waveforms. Just set the sweep speed, and the appropriate sampling rate is automatically set by the scope. That may not be the case, however, if you use single-sweep triggering for waveform capture.

With a single-triggered sweep, all samples must be taken sequentially in real-time, as the waveform occurs. The limit of effectiveness is determined by the digital scope's real-time sampling rate. Some digital scopes have very high real-time sampling rates, some as high as 500 MS/s or even higher. Others opt for the economy of a low real-time sample rate, 10 MHz for example, and use equivalent-time sampling to cover the higher sweep speeds. The real-time sample rate, however, determines the resolution limit for single-sweep waveform captures.

The differences between real-time and equivalent-time sampling are shown in Fig. 4. In Figure 4-*a*, real-time sampling takes all samples in sequence. The waveform is fully sampled in a single triggered acquisition. In Fig. 4-*b*, equivalent-time sampling builds up a full set of samples by combining samples from multiple-triggered acquisitions of the waveform. Because of the multiple acquisition requirement, equivalent-time sampling can be used only on repetitive waveforms.

Even if you only need to capture repetitive waveforms, the scope's real-time sample rate is still important. With a low real-time rate, it takes more triggered acquisitions to obtain a full equivalent-time set of samples. As a result, it takes longer to fully update the displayed waveform after any waveform change. The delayed waveform display can cause an annoying time lag between tuning a circuit under test or making a scope adjustment and seeing the waveform change completed on the screen. High-speed, real-time sampling and fast display update rates eliminate such display lag problems. Another approach used by some digital scopes is to provide an alternate analog signal path (non-digitizing mode) for real-time, nonstored displays in the traditional scope manner (see Fig. 2).

Regardless of the sampling method or speed, each amplitude sample must be digitized before it can be stored in the digital scope's memory. The number of bits used in digitizing determines the amplitude resolution used in representing the waveforms. For example, 6-bit sampling provides 64 digital levels (2^6) for describing a waveform captured at any selected vertical scale factor (volts/division). By contrast, 8-bit sampling provides 256 levels (2^8) of vertical resolution, which is an improvement of four times the resolution. Figure 5 graphically shows how 8-bit sampling more accurately represents the waveform amplitude than 6-bit sampling does.

With the resolution advantage of 8-bit versus 6-bit sampling,

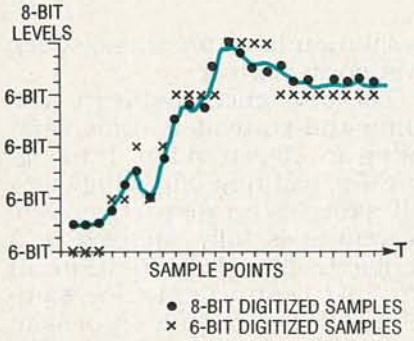


FIG. 5—RESOLUTION IS FOUR times better with 8-bit sampling (256 levels) than with 6-bit sampling (64 levels). The result is a closer representation of waveform amplitude details.

you might ask yourself why anyone would offer a 6-bit digitizing scope? For that matter, why settle for 8-bits? Why not go for 10-bit digitizing with 1024 resolution levels?

The answer simply boils down to speed and cost. It's easier and less expensive to get high real-time sampling rates with lower resolution. Thus, some scope manufacturers use 6-bit sampling, and emphasize price and sample-rate advantages in their product specifications. The truth is, high sample rates and time resolutions have little advantage without adequate vertical resolution. For example, to make rise-time measurements, you must first determine the 10% and 90% pulse amplitude levels before you can measure transition time, which is best achieved with 8-bit or higher resolution.

Waveform processing and measurements

When a waveform is displayed on both a traditional analog scope and a digital scope, it can appear to have distinctly different details. That is often due to ambient noise riding on the waveform and the differences in how it is captured and displayed along with the waveform.

A low-level repetitive waveform with noise presents a somewhat fuzzy trace on an analog scope display. The bright central portion of the trace represents the actual waveform on average, without the noise. The less bright, fuzzy edges of the trace are the result of trace blooming (edge glow or spreading) as well as some low-level noise elements, as shown in Fig. 6-*a*. Much of the noise riding on the waveform, however, is not seen because the noise occurs randomly and, therefore, does not repeatedly trace the same course on the display screen to build up any brightness. The CRT tends to average or suppress noise, blurring on the display.

A digital scope, on the other hand, tends to display noise spikes, rather than averaging them out. If a noise spike happens to coincide with a sample point, the noise is sampled, stored, and displayed as part of the waveform. Waveforms displayed on a digital scope often appear to be sprouting hairs, as shown in Fig. 6-*b*. You need to get used to seeing noise elements on digital scope displays that normally wouldn't be visible on a traditional analog scope.

Many digital scopes do, however, provide a signal averaging feature that can be used to reduce noise on a stored waveform by smoothing. With some scopes, you can select signal averaging and specify 16 averages of the waveform. The scope captures the first set of waveform points and stores it in memory. The second set of points is then captured and added to the first set in memory. That process goes on until 16 sets of captures have been summed in memory. The sum of the captures is then point-by-point divided by 16 to get the averaged waveform.

The advantage of averaging is that it reduces random noise. The amount of noise reduction increases with the number of averages selected, which correspondingly improves the signal-to-noise ratio of the waveform. Ideally, the amount of signal-to-noise improvement is 3 dB for each power-of-two averages. For example, you will have 3 dB of signal-to-noise improvement for 2 averages, 6 dB for 4, and so on.

Along with noise reduction, signal averaging also improves vertical resolution, which will occur when the signal processing is done at higher resolutions than the original sampling. For example, an 8-bit digital scope that uses 16-bit processing can appear, in effect, to be a 10- or 11-bit digitizer if enough signal averaging is done. That, of course, applies only to repetitive signals since the signal must recur in order to be averaged.

For most waveform acquisitions, signal averaging should be applied to improve both the display as well as the measurement results. A digital scope that has an automatic peak-to-peak measurement feature looks for the maximum and minimum stored waveform values to compute a peak-to-peak result. If noise is included in the stored waveform, the peak-to-peak result will be affected by the signal-plus-noise maximum and minimum. By averaging the signal first, you reduce the noise, and achieve a more accurate measurement of the signal peaks.

In other cases, signal averaging may defeat the purpose of the measurements, which would be the case in checking digital signal noise and timing margins. With that type of measurement, you want to see and measure the noise and jitter extremes; so don't use averaging.

Traditional analog and digital scopes display waveform jitter in different ways. An analog scope

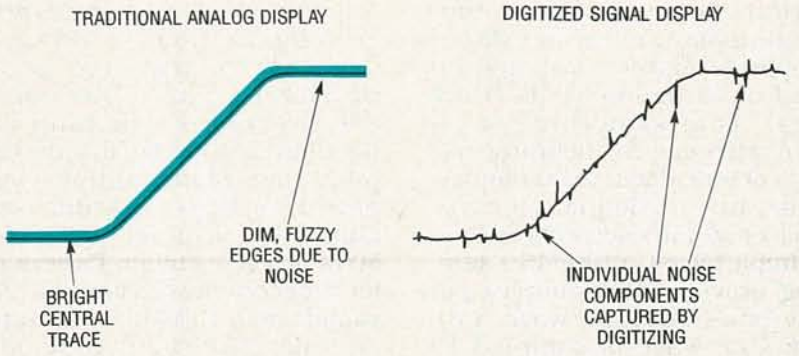


FIG. 6—A NOISY SIGNAL APPEARS on an analog display as a bright central trace with dimmer, fuzzy edges (*a*), whereas a digitized signal clearly shows all captured noise elements as part of the stored signal samples (*b*).

display shows most of the waveform jitter, but may miss the extremes because they are too infrequent to cause a visible trace. Figure 7-*a* shows a jittered-pulse edge display on an analog scope of moderate speed. That display has multiple vertical values for each point in time.

As far as digital scopes go, they can't give you a true representation of timing jitter because they normally capture and display only one vertical point for each sample point in time, as shown in Fig. 7-*b*. A digital scope can, however, show the full extremes of waveform noise and jitter variations by using the envelope mode. Figure 7-*c* shows how the displayed extremes are captured by enveloping multiple waveform acquisitions, which are actually two stored waveforms—one consists of maximum values of the overall acquisition points, the other consists of the minimum values.

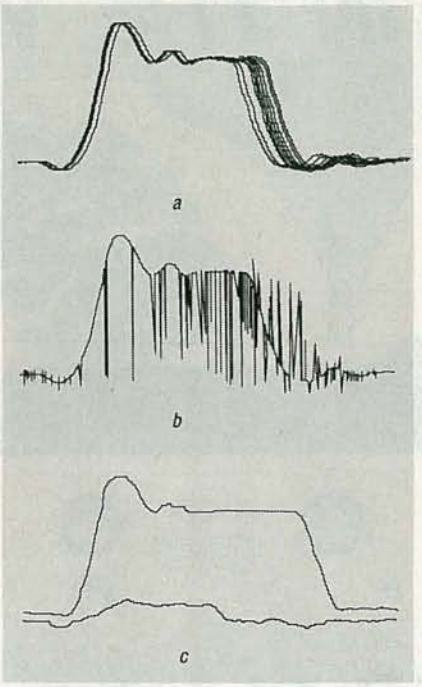


FIG. 7—WAVEFORM JITTER IS displayed differently, depending on the type of scope and capture mode being used; (*a*) is a display of waveform jitter on an analog scope of moderate speed, (*b*) is a display on a digital scope using equivalent-time sampling, and (*c*) shows clear representation of jitter and noise extremes obtained by long-term signal capture using a digital scope in a continuous-enveloping mode.

Thinking literally

What you should remember about digital scopes is that they tend to be much more literal in how they capture and display waveforms than an analog scope. Getting used to that requires some thought about what you expect, or need to see in a waveform capture. If you want to see a "cleaned up" version of the waveform for measurements such as peak, rise time, and fall time, use signal averaging. If you're troubleshooting a noise or timing problem, you'll want to see the actual waveform, so don't use averaging. Or you may just want to see the extremes represented by the envelope of point-by-point maximum and minimum values of a waveform.

Thinking literally also applies to many automatic measurement features. As an example, you wouldn't expect to find a DC component in a sine wave that's been passed through a coupling capacitor. The sine wave's mean value over time should be zero, however, the mean value of a sine wave on a digital scope probably won't be zero. Is the digitizing scope in error?

Not really when you stop and think about the waveform and how it's captured and processed. A pure sine wave has a zero mean value only when considering entire cycles. If you consider 1.5 cycles, the mean value includes the additional fractional cycle. You're rarely able to precisely display a sine wave on a scope so that you see only entire cycles, with absolutely no fractional cycle, except if you adjust the time/division control in the uncalibrated mode. So, if you're feeding it 1.5 cycles of a sine wave, that's just what it's going to compute the mean value of. It does exactly what it's told to do, from exactly what's given. Nothing more, nothing less.

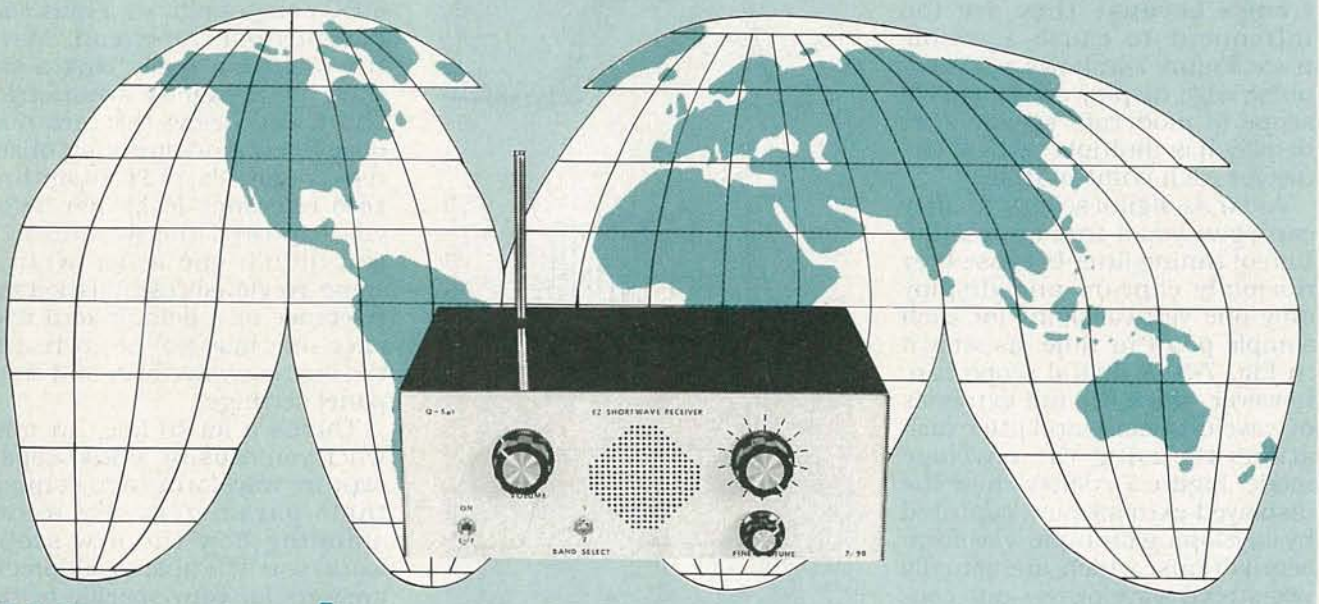
The scope's display is correct, it's just not what you expected because you were thinking in terms of the mean value over many cycles of the sine wave. If you apply about 20 or so cycles to the scope, a better result will be achieved because the computed mean over many full cycles will predominate, and minimize the error contribution from an extra fractional cycle.

If the digital scope's answer is still far from the expected zero mean, maybe you should take a closer look at the waveform you're examining. Maybe there really is a DC component, or a bias component from the circuit. Maybe the waveform really isn't a sine wave. Is it exactly symmetrical above and below the zero reference level? And speaking of zero reference levels, did you capture a zero reference level just before you captured the waveform? If you didn't, the scope will use some previously established zero reference or a default zero reference that may not be correct for the current waveform and front-panel settings.

There's a lot to keep in mind when you're using a new scope to capture waveforms and compute their parameters. By understanding how the new scopes work, you'll be able to get precise answers for your specific testing needs, and no longer have to glance at a waveform display and say, "that looks just about right."

R-E

TUNE IN THE WORLD



With R·E's EZ Shortwave Receiver

If you're looking for a fun project that won't break the budget, here's a shortwave receiver that's not short on performance.

RODNEY A. KREUTER WA3ENK

IF YOU'VE ALWAYS WONDERED WHAT you might hear on shortwave radio but didn't have the time or the money to get involved with it, then our simple, inexpensive shortwave receiver is the perfect project for you. It will have you tuning in on shortwave in no time—as a matter of fact, the first evening after the prototype was completed, stations from Germany, England, Cuba, Canada and France were easily copied.

The shortwave receiver is a no-crystal set with an audio amplifier. It's a true superheterodyne that tunes 8.5 to 11 MHz in two bands and includes a 455-kHz IF filter, automatic gain control (AGC), tracking RF tuning, and a very sensitive detector. It's sensitivity of under a microvolt puts it in a class with some high-performance receivers.

Theory of operation

The shortwave receiver takes a very straightforward approach to the classic superheterodyne receiver. The basic block diagram of our "superhet" is shown in Fig. 1, and the schematic is shown in Fig. 2.

The RF input tank, unlike many simple designs, provides "tracking," in that the input tuned circuit changes frequency when the oscillator is tuned. RF tuning is performed by D1, and oscillator tuning by D5. Both diodes are Motorola MV209 varactors, which act as voltage-variable capacitors. RF energy is coupled into pins 1 and 2 of IC1, the Signetics NE602 double-balanced mixer.

The mixer combines the incoming RF signal with the local oscillator and produces an intermediate frequency or IF of 455 kHz. Both mixer and oscillator functions are provided by IC1. Table 1 shows its specifications.

To simplify construction and enhance performance, a ceramic IF filter, FL1, is used instead of a more common tunable IF transformer. That results in a very clean IF that never needs tuning. The filters are available with bandwidths from 4 to 12 kHz to suit individual needs. The shortwave receiver will accept filters with input and output impedances of 2000 ohms.

Turning to the detector circuit, D2 and D3 provide a 1.2-volt bias for diode D4 and Q3. The bias keeps both D4 and Q3 slightly on, so only a small signal is necessary for detection, reducing the gain needed before the detector and improving sensitivity.

The signal at the base of Q3 contains two components. The AC component is the demodulated audio, and the DC component is proportional to the strength of the incoming signal. The DC component is filtered by R20 and C17 and is used to provide an AGC signal to Q2 via AGC amplifier Q4. That helps to reduce fading that is so common on the shortwave bands.

The audio output stage, IC2, is a Motorola MC34119 audio amplifier. It provides about ¼-watt of audio into speakers of 8 to 64 ohms. No large output-coupling capacitors are needed, but a large power-supply decoupling capacitor provides excellent stability.

The prototype operates on a 9-volt battery and, if you listen at moderate volumes, they give you reasonable service. For longer service, use a pack of 6 or 8 "AA" cells, or an AC supply.

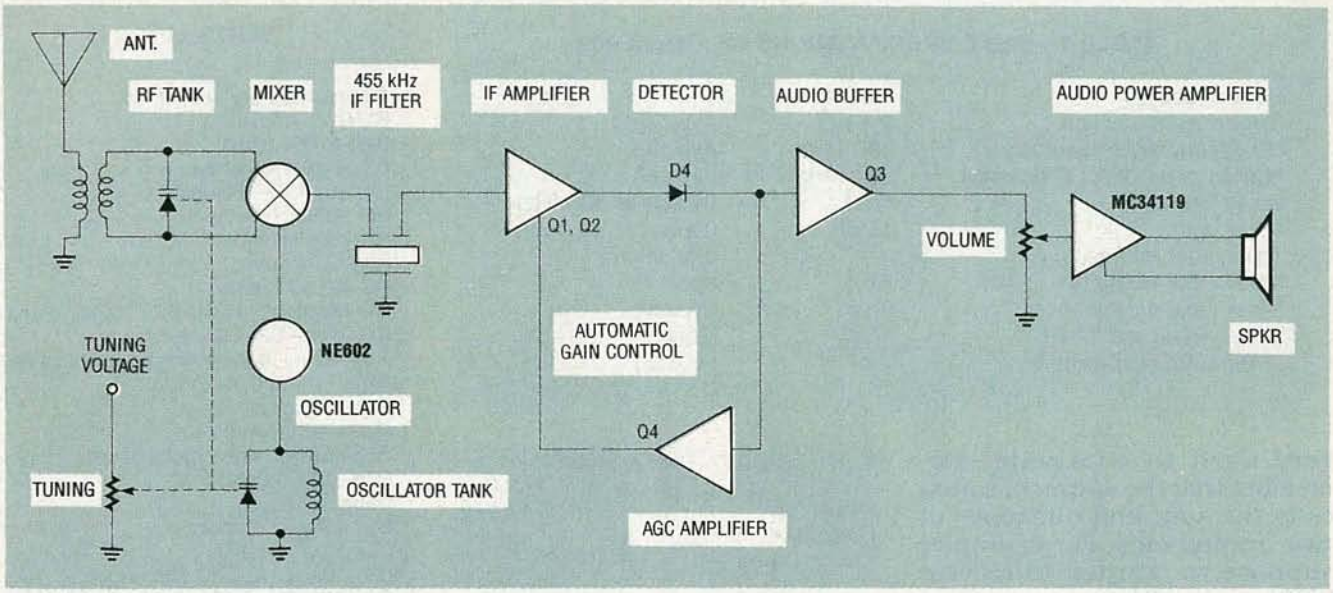


FIG. 1—BASIC BLOCK DIAGRAM of our superhet shortwave receiver. It's a true superheterodyne designed to tune 8.5 to 11 MHz in two bands.

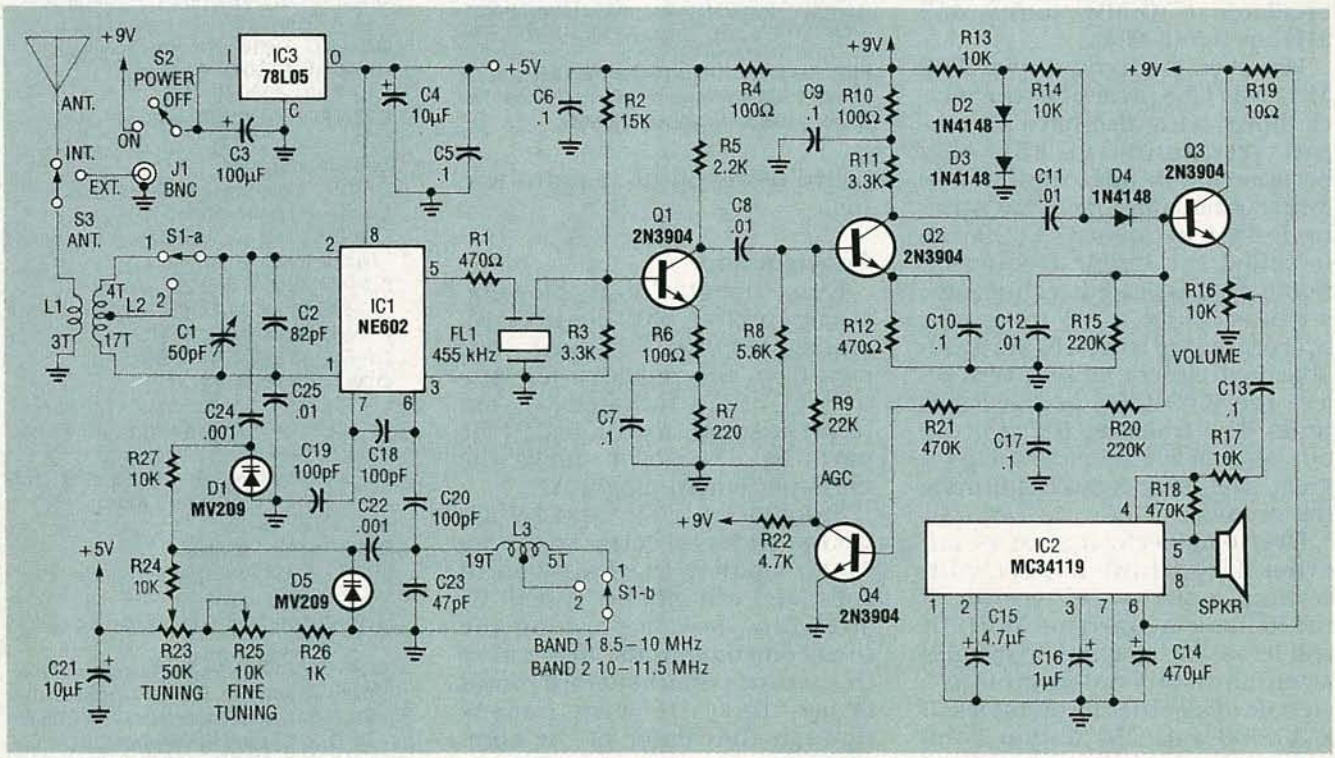


FIG. 2—SCHEMATIC FOR THE SHORTWAVE RECEIVER. The unit is powered from a 9-volt battery, making it very portable. It's sensitivity of under a microvolt puts it in a class with some very high-performance receivers.

Modifications and compromises

Every engineer learns early on that to design is to compromise. Usually performance is traded off for reduced cost. This design is no exception. The basic design philosophy was to produce a reasonable receiver at a reasonable price. In that regard we're very happy with the outcome. We did, however, omit some features, as a result.

Most modern shortwave receivers include a beat-frequency oscillator or BFO. The purpose of the BFO is exactly as its name implies, to beat a local oscillator (LO) signal against the incoming RF to produce a heterodyne frequency in order to copy code (CW) or single side band (SSB). That can be done at either the RF frequency or the IF, although IF BFO's are much more common.

The shortwave receiver's input coupling network provides tuning and impedance matching from the 50-ohm antenna input to the 1500-ohm input of the NE602. A really good receiver would use double or even triple tuning here, for better image rejection and overload performance.

Images, which are produced in the mixing of two signals, are

TABLE 1—BASIC SPECIFICATIONS OF THE NE602

Power supply	4.5V–8V	
Current consumption	2.4 ma.	(typical)
Maximum mixer frequency	500 MHz	(typical)
Maximum oscillator Frequency	200 MHz	(typical)
Noise figure	5 dB	(typical at 45 MHz)
Mixer gain	15 dB	(typical at 45 MHz)
Third order intercept	−17 dBm	(maximum)
Mixer input resistance	1.5k	(typical)
Mixer input capacitance	3 pF	(typical)
Mixer output resistance	1.5K	(typical)
Mixer output capacitance	3 pF	(typical)

very hard to eliminate. Remember that the output of a mixer is the sum and difference of two frequencies. For example, suppose we wanted to receive WWV on 10 MHz using an IF of 455 kHz. Using low oscillator injection, we would generate a local oscillator of 10 MHz minus 455 kHz, or 9.545 MHz.

However, if a frequency of 9.09 MHz was also present at the mixer input, we'd also have an output frequency of 455 kHz because 9.545 MHz minus 9.09 MHz equals 455 kHz. That other undesired frequency (9.09 MHz) is called the image frequency. Some sophisticated techniques, such as image-reject mixers or up-converting receivers are available, but almost all receivers reject the 9.09 MHz at the input tank. The tracking RF tank on our shortwave receiver helps a great deal, but doesn't eliminate the problem.

Overload performance is another important aspect concerning a shortwave receiver. If the RF tank is tuned to 10 MHz, it will let 10-MHz signals pass and attenuate—but not eliminate—signals of all other frequencies. If a 50,000-watt AM station is located close to the tank, *some* of the signal will get through. If enough of it does, you'll hear the AM station as well as the shortwave.

Tests on our active antenna (**Radio-Electronics**, February 1989) proved that an AM-reject filter was necessary to "clean up" our own local 50-kilowatt station. A high-pass filter that will attenuate AM stations by 40 dB is shown in Fig. 3; its low-frequency cutoff is about 2.2 MHz. The filter can be constructed on a piece of perforated construction board using point-to-point wiring.

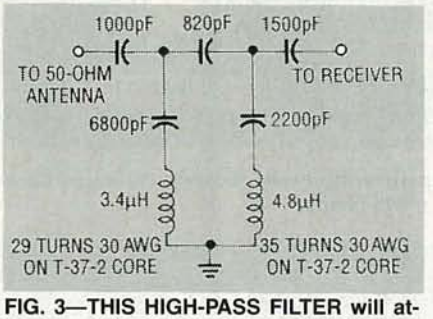


FIG. 3—THIS HIGH-PASS FILTER will attenuate AM stations by 40 dB. Its low-frequency cutoff is about 2.2 MHz.

Construction

Even though this is a low-frequency project, a PC board is recommended; you can make your own from the provided foil pattern or buy a finished version from the source mentioned in the parts list. Figure 4 shows the parts-placement diagram.

Inductors L1, L2, and L3 are wound on toroid cores, so they're much smaller than air-wound coils, and can still be "tuned" by stretching or compressing the turns on the toroids. Remember that a turn is counted on a toroid every time the wire passes through the center of the core. After you tune the coils, the wire can be held in place with epoxy.

Any speaker from 8 to 64 ohms will work with the MC34119. Expect slightly less audio output with higher-impedance speakers. The speaker leads should be twisted tightly and kept short.

If you use stereo headphones, don't connect the ground. Just feed the speaker output through resistors (you'll need to experiment with the value) to the left and right channels. Note that the MC34119 does not ground reference the speaker.

PARTS LIST

All resistors are ¼-watt, 5%.
R1, R12—470 ohms
R2—15,000 ohms
R3, R11—3300 ohms
R4, R6, R10—100 ohms
R5—2200 ohms
R7—220 ohms
R8—5600 ohms
R9—22,000 ohms
R13, R14, R17, R24, R27—10,000 ohms
R15, R20—220,000 ohms
R16, R25—10,000 ohms, potentiometer
R18, R21—470,000 ohms
R19—10 ohms
R22—4700 ohms
R23—50,000 ohms, potentiometer
R26—1000 ohms

Capacitors
C1—9–60 pF trimmer
C2—82 pF, ceramic
C3—100 μF, 16 volts, electrolytic
C4, C21—10 μF, 16 volts, electrolytic
C5–C7, C9, C10, C13, C17—0.1 μF (polyester or ceramic)
C8, C11, C12, C25—0.01 μF, ceramic
C14—470 μF, 16 volts, electrolytic
C15—4.7 μF, 16 volts, electrolytic
C1—1 μF, 16 volts, electrolytic
C18–C20—100 pF, NPO
C22, C24—0.001 μF, ceramic
C23—47 pF, NPO

Semiconductors
D1, D5—Motorola MV209 varactor
D2–D4—1N4148 diode
FL1—455-kHz ceramic filter (8-kHz bandwidth Toko HCFM2-455C)
IC1—Signetics NE602N mixer
IC2—Motorola MC34119 audio amplifier
IC3—78L05 5-volt regulator
Q1–Q4—2N3904 NPN transistor

Other components
L1—3 turns #30 wire on L2's toroid core
L2—21 turns #30 wire tapped at 17 turns on T-37-2 Micro Metals toroid
L3—24 turns #30 wire tapped at 19 turns on T-37-2 Micro Metals toroid
S1—DPDT switch
S2, S3—SPST switch
SPKR—8–64 ohm speaker
J1—BNC connector
Miscellaneous: PC board, metal cabinet, wire, solder, etc.

Note: The following items are available from Q-Sat, P.O. Box 110, Boalsburg, PA 16827. A PC board only (# EZSW-PCB) is $7 plus $1 shipping; a partial kit that includes a PC board (does not include potentiometers, switches, connectors, speaker, or case # EZSW-KIT) is $27 plus $2 shipping; a kit for the AM reject filter (# AMREJ-KIT) is $3 plus $1 shipping; a kit for the active antenna (# ACTANT-KIT, see text) is $15 plus $2 shipping. Pennsylvania residents must add 6% sales tax. Allow 3–5 weeks for delivery.

All receivers need a good antenna; this one is no exception. Although the first field trials were conducted in a state park with 30

feet of wire thrown over a tree limb, a good antenna will greatly improve reception. A dipole will give good results, but if you're cramped for space, try an active antenna (see **Radio-Electronics**, February 1989). A good ground also helps.

The receiver should be installed in a metal cabinet to reduce the effects of hand capacitance and provide some shielding from strong local AM stations. Figure 5 shows the prototype receiver. Note that the active antenna and the 2.2-MHz high-pass filter are used in the prototype, although they are not mandatory. The holes for the speaker were made using a neat trick: Draw the outline on a piece of perforated construction board, and tape the board to the cabinet. Then use the board as a drill guide.

Table 2 is a guide to let you modify the receiver for frequency ranges other than 8.5 to 11.5 MHz (actually 8.5–10 MHz for band 1 and 10–11.5 MHz for band 2) used in the prototype. Don't think of L2 and L3 as tapped coils, but rather as "selectable" coils. For example, L3 is specified as a 24-turn coil with a tap at 19 turns. What that really means is that a coil of either 19 turns or 24 turns is switch-selectable. You could even wind a 45-turn coil with taps at 14, 15, 17, 19, 24, 29, and 34 turns for L3. With the right switch (good luck finding one), you could tune 5 to 16 MHz in 8 bands. Remember that it has to switch the capacitors, as well.

Since the coils must be handwound, there will be some variation. Wire size was calculated for no. 30 wire. Other wire sizes may be used but you will find it hard to get as many as 45 turns on a T-37-2 core with larger wire. The spacing of the wire on the core will also change the tuning frequency. The values are given as reasonable starting points. If you wish to build the receiver for some frequency other than the prototype, follow these steps:

1) Build the unit completely except for the two coils.

2) Using Table 2, wind the oscillator coil. Tack the coil into the circuit from ground to the junction of C20, C22, and C23. (That way you won't need the band switch.)

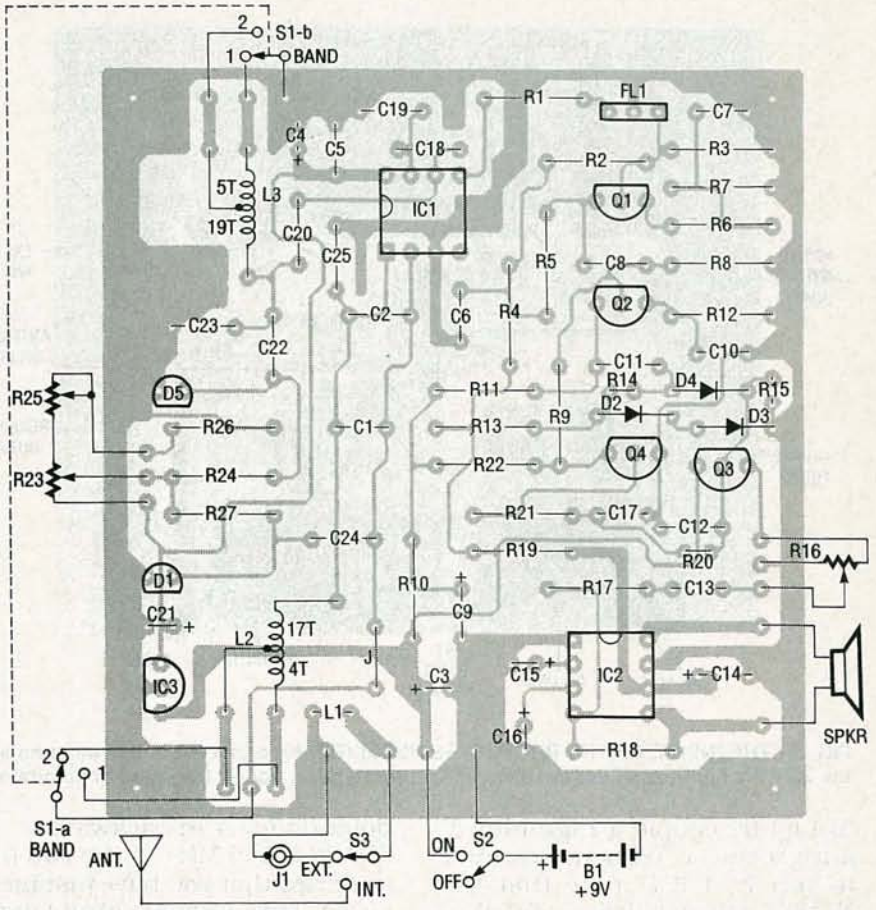


FIG. 4—PARTS-PLACEMENT DIAGRAM. Be sure to install the circuit in a metal project case to help reduce interference.

TABLE 2

Frequency (MHz)	C2 (pF)	C18, C19 (pF)	C23 (pF)	L1, L2 (Ant) (# of turns on T-37-2 core)	L3 (Osc)
5	100	120	68	5, 41	45
6	100	120	68	4, 30	34
7	82	100	47	4, 26	29
8	82	100	47	3, 22	24
10	82	100	47	3, 17	19
12	82	100	47	2, 15	17
14	68	82	33	2, 14	15
15	68	82	33	2, 13	14

TABLE 3

	NE602	MC34119
Pin 1	1.27 V	0V
Pin 2	1.27 V	4.15 V
Pin 3	0V	4.11 V
Pin 4	3.64 V	3.97 V
Pin 5	3.59 V	4.14 V
Pin 6	4.99 V	9.09 V
Pin 7	4.33 V	0V
Pin 8	5.05 V	4.20 V

	Q1	Q2	Q3	Q4
Emitter	0.95 V	0.80 V	0.27 V	0V
Base	1.61 V	1.45 V	0.82 V	0.58 V
Collector	2.56 V	3.30 V	9.17 V	7.41 V

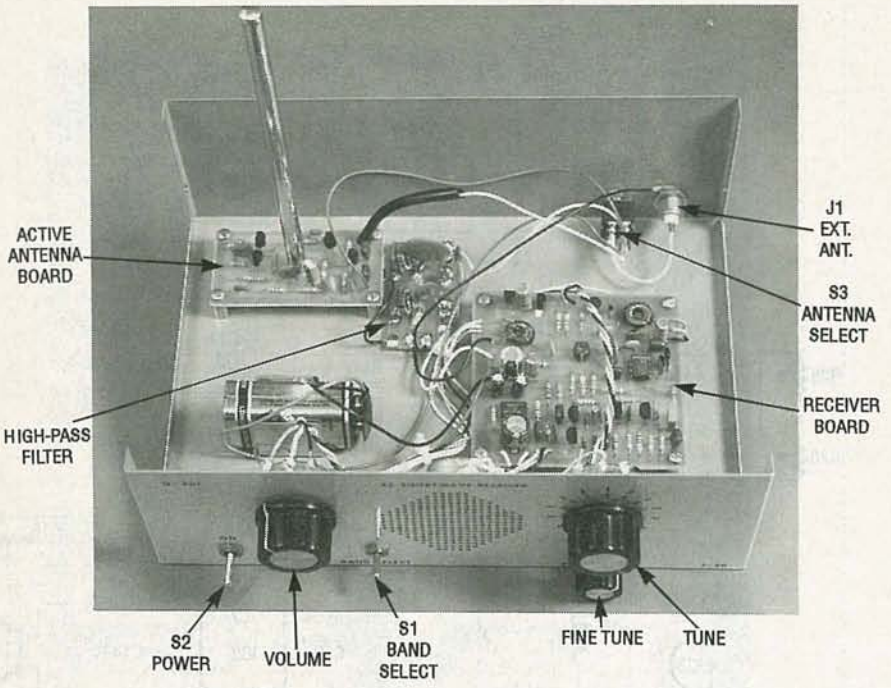


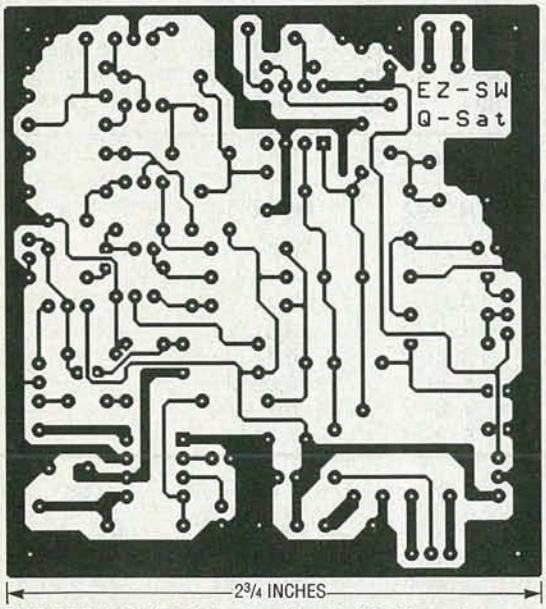
FIG. 5—THE INSIDE OF THE PROTOTYPE RECEIVER. Note that the active antenna and the 2.2-MHz high-pass filter are used in the prototype, although they are not mandatory.

3) Lightly couple a high-impedance scope or frequency counter to pin 7 of IC1; note that the NE602 will not drive a 50-ohm input without a buffer. A 10-pF series capacitor is therefore recommended.

4) Turn the tuning and fine tuning, if you are using one, completely counterclockwise and measure the frequency. Now turn the tuning and fine tuning all the way clockwise and measure the new frequency. If it's lower than the first frequency, you've got the potentiometer in backwards.

5) Add 0.455 MHz to the two frequencies that you have just measured. This is your tuning range.

If you are building the unit for a higher frequency range, say on the order of 14 or 15 MHz, you will find that the tuning range is 2 or 3 MHz. On the other hand, units built for 3 or 4 MHz will tune only about 0.5 MHz. That is caused by the rather small capacitance change of the MV209. Typically, capacitance vs. (reverse) voltage of the MV209 is 40 pF at 1 volt, 26 pF at 5 volts, 14 pF at 10 volts, and 9 pF at 20 volts.



THE FOIL PATTERN for the single-sided board.

Low-frequency tuned circuits require more capacitance than high-frequency tuned circuits. Since the change in capacitance of the MV209 is fixed, it becomes a smaller percentage change with low-frequency tanks than with high-frequency tanks. And you can forget about a series or parallel combination of MV209's. The percentage works out the same as a single one. If you require more tuning range, the best method is to provide a separate, stable tuning voltage of up to 20 volts. Since the current drawn by the diodes is in the microamp range, a separate 9-volt battery may be used. Just remember that as the battery ages, the tuning range will change.

6) If you are satisfied with the tuning range, wind the antenna coil with a turn or two less than the oscillator coil. This is necessary because the input tuned circuit operates at 0.455 MHz higher in frequency that that of the oscillator.

The varactors used in this receiver only need to vary by about 15 pF to cover 8.5 to 10.0 MHz or 10.0 MHz to 11.5 MHz. That can be from 25 to 40 pF, or 0 to 15 pF, or any combination that gives a change of about 15 pF. When the bias voltage is changed from 1 to 5 volts, the capacitance really changes from about 40 pF to 26 pF. If a well-regulated supply of higher than 5 volts but less than 20 volts is available, it may be used to increase the tuning range. Since we're running it on a 9-volt battery, we decided to regulate down to 5 volts. If you decide to operate the varactor on a higher voltage, remember that the NE602 is rated at a maximum of 8 volts. The high side of the tuning potentiometer can be connected to a higher voltage as long as the connection from the PC board to the high side of the potentiometer is left disconnected.

Tuning 1500 kHz with a single-turn potentiometer can be tricky. A "poor mans ten turn" can be made by putting a 10K potentiometer in series with the normal 50K potentiometer for fine tuning. Be careful with the leads going to the potentiometers; any AC signal will "modulate" the oscillator with disastrous results. Since the tuning of a varactor isn't linear with voltage, you may want to experiment with different potentiometers, such as linear, log, or audio.

Troubleshooting

If you have any problems, the DC voltages shown in Table 3 should help. All voltages were taken with a new 9-volt alkaline battery powering the receiver. The volume control is about ⅓ with no signal input. Total current is 22 milliamps. **R-E**

1990
ANNUAL INDEX
Radio Electronics® Volume 61
and
COMPUTERDIGEST Volume 7

1990 Annual Index Radio-Electronics Volume 61 and ComputerDigest Volume 7
Abbreviations: (ARE)Ask R-E; (AUD)Audio Update; (C)Construction;
(CC)Computer Connections; (CD)Computer Digest; (D)Department;
(DB)Drawing Board; (DN)Designer's Notebook; (EW)Editor's Workbench;
(ER)Equipment Reports; (HH)Hardware Hacker; (KR)Kit Report;
(LTR)Letter; (PCS)PC Service; (SR)Shortwave Radio; (VN)Video News;
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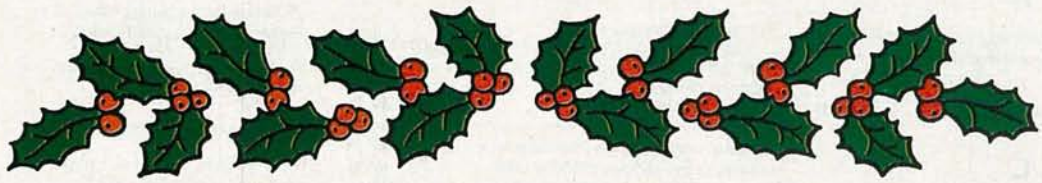

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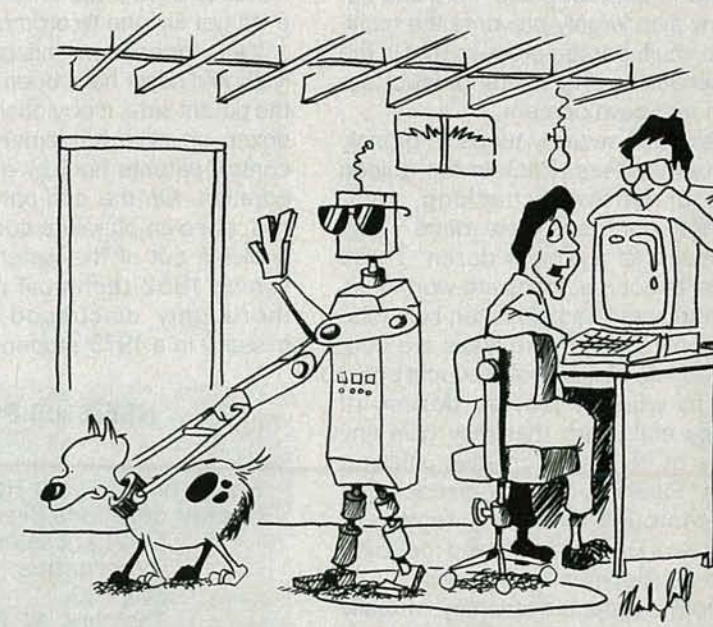
Where did you think robotic arms came from?



I haven't got the eyesight figured out yet

HARDWARE HACKER

A cold-fusion update, some alternatives to patenting, understanding decibels, wholesale surplus sources, and audio-level meters.

DON LANCASTER

As most of you already know, we now provide a no-charge *Hardware Hacker* helpline for you as shown in the box below. Here I can try to show you all the products, resources, publications, and consultant services that might be helpful to you. But every third day or so I get a call which starts off with "I can't tell you what I'm now working on or what it does..." and then goes on to request something totally absurd.

For instance (and no way could I have made these up), a phase detector with a 143-decibel dynamic range, a fishtank full of hot mercury, a microwave traveling-wave tube made from a fluorescent lamp, or a matched quad of high-power Zener diodes. Even a slow-blow fuse to get around a circuit that had an obvious short in it. To me, paranoid secrecy on any new idea is both asinine and monumentally stupid.

Paranoid secrecy obviously diverts time and energy from improving your product, besides being the inherently evil opposite of what shared hardware hacking is supposed to be all about in the first place. Paranoid secrecy also largely prevents the multi-step, multi-person process that is the essential core of useful product design and development.

Paranoid secrecy tends to grossly overvalue ideas. Back in the golden age of hardware hacking, well-thought-out ideas were once worth as much as a dime a dozen. These days, of course, ideas are worth less than ten cents a bale in ten-bale lots. It is only when those ideas are converted into actual final products being put to work or play by dozens of happy end-users that they gain any value at all. It ain't creative unless it sells. Paranoid secrecy discourages the thorough third-party testing of your working models and ongoing beta development prototypes.

Finally, paranoid secrecy virtually eliminates any possibility of selling your product. One of the hardest lessons for Hardware Hackers to learn is that *others must come to you* for your product to be successful. You can't sell to them; they *must* come to you. Always.

So, by all means, give me a helpline call *if* you are willing to tell me what you are doing and are willing to share it with others. On the other hand, if you want to attempt to lay a paranoid-secrecy fantasy on me, I'd suggest you try one of those 900-number kinky sex lines instead. They would be in a better position to help you out.

Patents again

As we've seen a number of times in past columns, any Hardware Hacker involvement with patents in any way, shape, or form, is *absolutely certain* to cause you a net loss of time, energy, money, and sanity.

I recently received yet another sad case for my overflowing patent-victim files. But this one's so appallingly bad that it forms a near-perfect example of everything *not* to do. This new patentee was wondering why Fortune-500 companies weren't beating his door down, and why he couldn't even get anyone to promote his idea.

Well, for openers, his patent clearly should never have been issued. On the patent side, it obviously violated a dozen or more fundamental optical-control patents held by a major corporation. On the non-patent side, it describes an obsolete concept totally blown out of the water by a well-known 1952 technical paper, and thoroughly discussed (and dismissed) in a 1973 student textbook.

NEED HELP?

Phone or write your **Hardware Hacker** questions directly to:

Don Lancaster
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Box 809
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While the idea purports to be a micropower one, it requires the continuous application of very precisely regulated high energy levels. While it is supposed to be microminiature, a complex mechanism is involved. And multiplication is introduced at crucial points in the circuit where outstanding linearity is an absolute must.

Despite it being something that any of you could easily beat out on the kitchen table, it is obvious that the idea was never tested in a final-use application. Nor could any possible end-user or builder of this product ever have been so much as contacted, let alone consulted.

I sorely wish this was an isolated example, but it is now one of hundreds in my victim files that collectively have cost all you hardware hackers many millions of dollars. *Not once* have I *ever* seen *any* example of anyone who has profited in *any* way from *any* patent involvement from within a small-scale hardware hacking environment.

So what are the alternatives? Figure 1 shows you some patent-avoidance guidelines that may help you.

We've plowed some of this ground pretty well in the past. But one thing I'd like to emphasize here is that you can *never* develop and market an idea as an outsider. To develop and sell something that's useful, you *must* be thoroughly familiar with that field's technical literature; its history; its marketing realities; the mainstream tools and techniques; and, above all, the insider trade journals involved.

For instance, there is absolutely no way you should be writing forest-fire simulation software if you have never sharpened a Pulaski. Working with active filters is pointless if you have never met Sallen and Key. And developing unfocused solar collectors without Winston is unthinkable.

I once had a long talk with a retired patent examiner who carefully went back over his thirty years of experience and tried to find out just how

1. Do not *ever* call yourself an inventor or behave like one. To do sets you up for interminable scams. Instead, you will want to become a product development engineer or a prototyping house.
2. Totally avoid any and all contact with anything even remotely patent related. In any way, shape or form. Do so religiously.
3. Don't bother creating anything in any field in which you are not evenutally *certain* to become an expert. An expert who is thoroughly familiar with the technical literature, the history of the field, the marketing realities, the insider trade journals, and the mainstream tools and techniques in use.
4. Publish all your key secrets and ideas in a major magazine, leaving out no detail, and omitting no insider secrets. This immediately can generate positive cash flow for you and safely tucks all your ideas away in the public domain, preventing most others from attempting to patent them. This also exposes your new ideas to the widest possible audience.
5. Try to set up some royalty arrangement with a small to medium firm in some position to market and distribute your invention. The tricky part: *They must come to you*, and *never* vice versa. That is why it is super important to publish your ideas and creations and expose them as widely as possible.
6. Your main defense against getting ripped off in any royalty setup is the expectation that you will be delivering newer and better stuff in the future.
7. Use the shotgun technique. There is no way that one single idea or product will hack it. To survive in this game, you'll need hundreds or even thousands of new ideas and concepts working for you on a total lifetime and total lifestyle basis.
8. Expect to be ripped off. That way, it will be far less of a rude surprise when this inevitably happens to you. And far less of a stress trip.
9. Be realistic. You don't create things to get filthy rich. You create things because you like to create things and have some compelling desire or need to do so. As long as there are enough nickels to keep going, that is all that should really matter.

FIG. 1—SOME THOROUGHLY TESTED and hacker-friendly alternatives to the patenting process.

many individuals *acting alone* were successful with a strategy of "patent an undeveloped and unproven idea as an outsider and then try to sell it somewhere." The answer: *Not one ever!*

For more on patents and patenting, see *The Case Against Patents* in the December 1990 *Midnight Engineering* (now in GEnie PSRT library as #162), or read my *Incredible Secret Money Machine* book.

An audio-level meter

As we've seen a time or two in the past, the new three-volume *Linear IC Databook* set from *Samsung* has been crammed to the rafters with top-notch hacker integrated circuits. For this month, I though we might take a look at some of their audio-level indicator chips.

But first, let's go over some fundamentals. You will often find two popular ways of dealing with any electronic or physical quantity, *linear* and *log*, short for logarithmic.

The linear scale has equal steps everywhere in it. Obvious examples include a ruler where the distance between 1 and 2 is exactly the same as the distance from 8 to 9. The channels on the AM-radio dial are also linearly spaced with frequency, each being 10 kilohertz above or below its nearest neighbor.

Now a linear scale sounds great, and it is the *only* way to go if you want to prevent any interaction, multiplication, or distortion when two or more quantities of something are present at once. But, if you attempted to go too far with a linear scale, one end or the other ends up far too cramped or way too spread out. Put another way, the *dynamic range* of a linear scale or system is often limited.

The log system instead works with *constant percentage* scales. Equal anythings are close together on the "low" end and farther apart on the "high" end. For instance, the notes on a musical instrument are usually a tad under six percent above or below one another. Or, more precisely, we are dealing with the twelfth root of two, or 1.059545, since the frequency of your notes doubles as you go up a twelve-note *octave*, or a ratio of 2:1 in frequency.

Log systems will often have a much higher dynamic range than the linear ones. And there's lots of places where "equal change" is more important than "equal steps." For instance, rank beginners are often mystified why standard resistors do not simply go 1.0, 2.0, 3.0, 4.0..., instead of 1, 2.2, 3.3, 4.7, 6.8...

Obviously, we are dealing with a log scale here. First because you'll normally want to cause a constant percentage change when you alter a resistor in an electronic circuit. And second, because stocking resistors in one-ohm increments in the megohm range would get out of hand.

Some physical systems are inherently logarithmic. In fact, anything linear over a wide range in the real world is usually the exception rather than the rule.

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The ear is logarithmic, allowing it to deal with everything from a whisper to a shout over an incredible dynamic range. And since radio began with audio, it is convenient to employ log systems to describe the differences between powerful transmitted signals and weak received ones.

All of which leads us around to *decibels*. Decibels are simply one convenient way of measuring things on a log scale with a potentially wide dynamic range. Since you'll usually measure voltage rather than power, most hackers typically use voltage decibels rather than the much rarer power ones.

A reading of so many decibels tells you the *relative* strength between two quantities. For instance, a one-decibel change is about a ten-percent change in amplitude. It is also roughly the smallest amplitude change you can usually pick up with your ear.

A two-decibel change is around twenty percent, and a three-decibel change is around thirty percent. More specifically, when one signal is at a −3-decibel level from another (or "three dB down"), you will be at 0.707 relative amplitude.

Now, since power is related to the square of your circuit voltage, and since 0.707 squared is 0.5, being three decibels down is also at *half power* from whatever your 0-decibel level happened to be.

Hi-fi components normally have their frequency responses specified between their upper and lower −3-dB points. Put another way, this is the range over which the available power remains over half of what you would get in the "middle" of whatever frequency range you're measuring.

Moving right along, a ten-decibel change is roughly a 3:1 amplitude ratio, twelve decibels is one quarter,

60 Decibels is a **1000:1 amplitude gain.**
40 Decibels is a **100:1 amplitude gain.**
20 Decibels is a **10:1 amplitude gain.**

18 Decibels is an **8:1 amplitude gain.**
12 Decibels is an **4:1 amplitude gain.**
10 Decibels is roughly a **3:1 gain.**
6 Decibels is a **2:1 gain.**

3 Decibels is about a **30 percent gain** and the **double power point.**

2 Decibels is a **20 percent amplitude gain**
1 Decibels is a **10 percent amplitude gain.**

0 Decibels is a **unity amplitude ratio of 1:1.**

-1 Decibels is a **10 percent drop.**
-2 Decibels is a **20 percent drop.**

-3 Decibels is about a **30 percent drop** and the **half power point.**

-6 Decibels is **half amplitude.**
-10 Decibels is around **one-third amplitude.**
-12 Decibels is **quarter amplitude.**
-18 Decibels is **eighth amplitude.**

-20 Decibels is a **10:1 attenuation.**
-40 Decibels is a **100:1 attenuation.**
-60 Decibels is a **1000:1 attenuation.**

FIG. 2—SOME SIMPLE RULES that make learning how to use decibels much easier.

eighteen decibels is one eighth, and twenty decibels equals one tenth. One hundredth is forty decibels, and one thousandth is sixty decibels. The 143-decibel phase detector asked for above is the ratio between one microvolt and fourteen volts, an almost impossible dynamic range to deal with gracefully at reasonable cost in the real world. I've gathered some of these "rule of thumb" decibel ratios into Fig. 2 for your reference.

Once again, almost all your decibel measurements are *relative* and will always refer to two different levels in two points in your circuit. Decibels usually answer the question "How strong is the present signal or response compared to another one?"

How strong is a six-decibel signal? Somewhere between a femtowatt and a gigawatt, at least sometimes. Maybe. It all depends. All we know for sure is that this particular signal is twice as strong in amplitude as some other one at some other time or

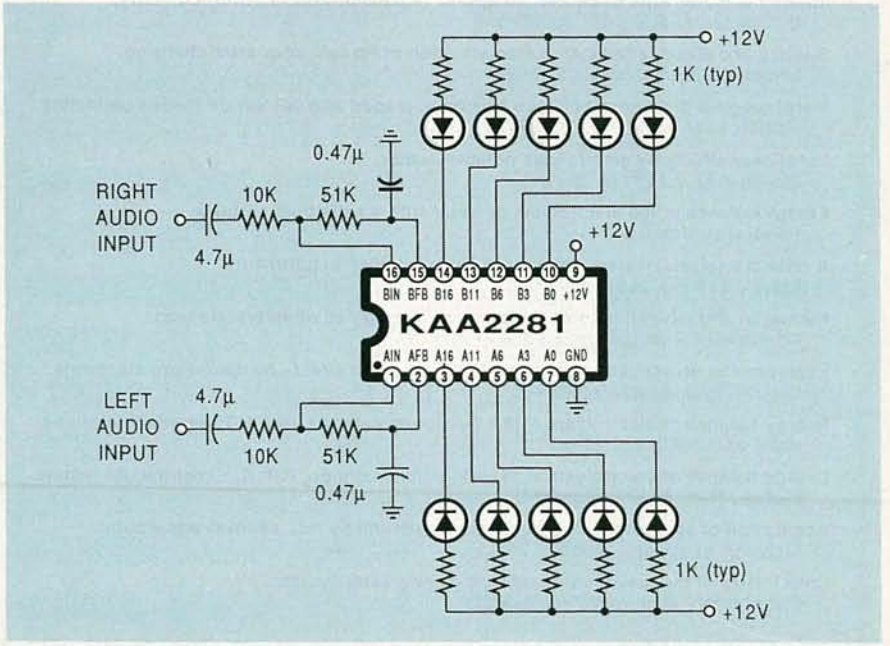

FIG. 3—A STEREO AUDIO-LEVEL METER using the Samsung KAA2281. Levels displayed are −16, −11, −6, −3, and 0 decibels. Input sensitivity is one millivolt.

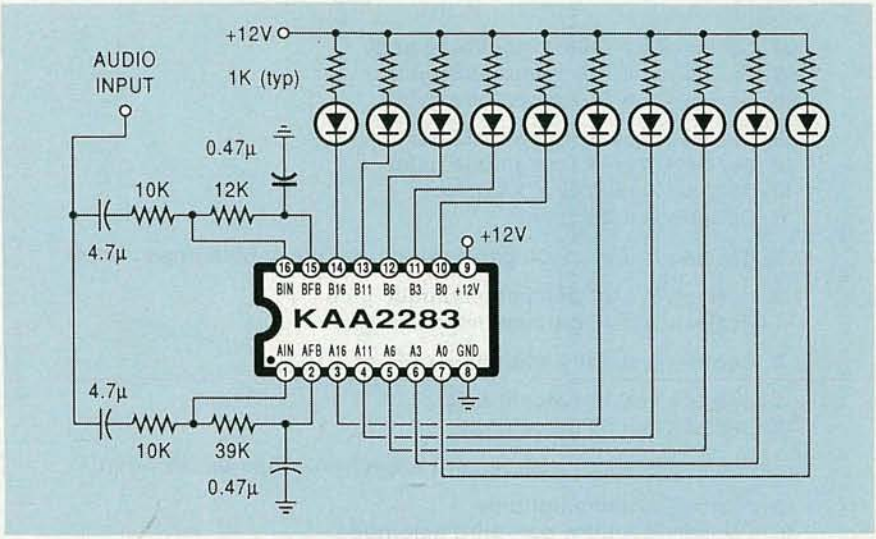

FIG. 4—A MONO AUDIO-LEVEL METER can be built by using both halves of the Samsung KAA2283. Levels displayed are −18, −16, −14, −12, −10, −8, −6, −4, −2 and 0 decibels. Sensitivity is from 0.1 to 0.9 millivolts.

Electrochemically induced nuclear fusion of deturium.
Fleishmann, Pons, Hawkins, vol 261 pp 301-308.

Examination of nuclear measurements in cold fusion experiments.
Abriola, et.al, vol 265 pp 355-360.

Observations of the surface composition of palladium cathodes after electrolysis.
Mebrahtu, et.al, vol 267 pp 351-357.

Electrochemical incorporation of lithium into palladium from aprotic electrolytes.
Dalard, et.al, vol 270 pp 445-450.

Production of tritium from electrolysis at a palladium cathode.
Packham, et.al, vol 270 pp 451-458.

A long-term calorimetric study of electrolysis using palladium cube cathodes.
Armstrong, et.al, vol 272 pp 293-297.

Tritium production during the cathodic discharge of deuterium on palladium.
Chene, et.al, vol 280 pp 199-205.

Electrochemical fusion: a mechanism speculation.
Lin, et.al, vol 280 pp 207-211.

Tritium separation during heavy water electrolysis: implications for cold fusion.
Corrigan, et.al, vol 281 pp 305-310.

Experimental investigations of electrolysis using palladium cathodes.
Zahm, et.al, vol 281 pp 313-319.

In-situ measurements of deuterium uptake in palladium using diffractometry.
Bennington, et.al, vol 281 pp 323-328.

Surface and electrochemical characterization of Pd cathodes after charging.
Ulmann, et.al, vol 286 pp 257-263.

Morphological difference between hydrogen-loaded and deuterium-loaded palladium.
Rolison, et.al, vol 287 pp 375-384.

Local heat effects by electrolysis of heavy water.
Ratkje, et.al, vol 273 pp 269-273.

Energy balance in the electrolysis of water with a palladium cathode.
Rock, et.al, in press.

A critical analysis of electrochemical nuclear fusion experiments.
Kreysa, et.al, vol 266 pp 437-450.

Hydrogen and oxygen recombination in calorimetry of water electrolysis.
Cunnane, et.al vol 269 pp 163-174.

Experimental investigation of thermal and radiation effects by deuterium discharge.
Chemla, et.al, vol 277, pp 93-103.

Energy balance of electrolysis with a palladium cathode, Part I, Theoretical relations.
Balej, et.al, vol 278 pp 85-98.

Energy balance of electrolysis with a palladium cathode, Part II, Experimental results.
Divisek, et.al, vol 278 pp 99-117.

Absorption of electrolytic hydrogen and deuterium by Pd: cyanide adsorption.
McBreen, et.al, vol 287 pp 279-291.

Calorimetry of the palladium-deuterium-heavy water system.
Fleischmann, et.al, vol 287 pp 293-348.

FIG. 5—SOME KEY PAPERS ON COLD FUSION that have recently appeared in the Journal of Electroanalytical Chemistry.

place. For an amplifier with a 20-decibel gain, we know that the output will be ten times as strong as the input amplitude, at least over whatever the intended working levels of your circuit are.

Audio engineers will sometimes refer decibels to a very specific voltage level over a specified impedance. They will then use the term dBm to specify such an absolute level. One milliwatt into a 600-ohm line is one possible absolute dBm level. In this case you are comparing the ratio of your signal against the standard reference, rather than comparing it to another signal.

But the stereo, hi-fi, and home-recording people have long since bastardized the meaning of the term dBm. Today, unless you are certain you are dealing with the professional studio audio standards, an apparent 0 dBm is just the maximum allowable voltage level at some point in some circuit above which the distortion levels are no longer acceptable.

Thus, while the VU (or *volume-unit*) display on your receiver or recorder does in fact measure some absolute voltage level, the chances are that your particular VU units have nothing to do with anyone else's. The VU display only indicates a reference level above which distortion will start to become unacceptable.

Samsung has a bunch of level-meter driver chips that are simple and easy to use. Note that the driver chips all differ from a "bargraph" driver in that the bargraph works in linear steps and the level meter driver works in log steps.

Figure 3 shows you the KA2281 which offers internal trip levels of −16, −11, −6, −3, and 0 decibels and gives you two stereo channels that can power five lamps each.

Note that some commercial units will cheat and assign a *pair* of light-emitting diodes to each output, giving you the *illusion* of ten steps when you really only have five.

Figure 4 shows you the similar KA2283 which uses levels of −8, −6, −4, −2, and 0 decibels instead. This time, I've shown you how to attenuate one side to make a single-channel ten-lamp display. You might want to make your lower level LED's green, a middle one yellow, and use reds for the upper ones for an additional effect.

In this particular circuit, less than 100 millivolts of input lights nothing and more than 900 millivolts lights everything. You can easily change the input attenuators to pick up other operating ranges. Note that the bottom half of the circuit has to attenuate ten decibels more than the upper one to keep all of the steps equal.

Cold fusion update

What ever happened to cold fusion? Well, Uh, Um, Er...Two years have gone by and cold fusion remains what it started out as...a largely unduplicatable lab anomaly in which some apparently excess unexplainable heat sometimes appears to get erratically generated. Since there seems to be an ongoing glut in the lab anomaly market, most interest in cold fusion has, to say the least, waned.

However, there remain bunches of dedicated true believers continuing to do high-quality research in the cold-fusion area. The leading source for professional papers on cold fusion is that *Journal of Electroanalytical Chemistry,* a Swiss publication. A few of the more important cold-fusion papers are listed for you in Fig. 5.

This month's contest

One thing I like to do every now and then is pick up a magazine on some hobby or industry that I'm not the least bit into. More often than not, you can find unusual ads, ideas, techniques, or mindsets that end up surprisingly relevant to your own trip.

For instance, we've seen in the past how *Model Railroader* is one outstanding source of unusual tools and techniques. I think that MR has by far the finest technical writing of any publication anywhere ever on any

level, and should be mandatory reading for any tech writer. Some day, I hope to eventually be able to write that good. Maybe with some more experience....

Another magazine which recently caught my eye was *Radio Control Modeler.* Again, lots of unusual tools and techniques. I'm wondering what happens when you use what these folks call a *heat-sealing iron* for *Kroy Color* or for circuit board dry-resist laminating. The R/C people are also into amateur-television stuff.

But what I noticed the most (and this is probably ancient history to an R/C buff), is that these hobbyists now are building models at *one quarter scale.* No, not quarter inch scale, but quarter scale.

Now, any quarter-size aircraft can hoist a respectable payload and carry it an acceptable distance. At costs that are ridiculously lower and far less regulated than "real" aviation.

Uses? For video obviously. But less obvious would be such things as cave hunting, either by the regular stereo photography for sinkhole searches in difficult terrain.

So for this month's contest, tell me what you would do with an aerial platform that can handle a respectable payload. Let's go well beyond chopping holes in the *Goodyear* blimp (as was recently done), the nudist colony jokes, and drug deliveries. Limit all your responses to largely legal and purportedly more noble endeavors.

There'll be all the usual *Incredible Secret Money Machine* book prizes for the top dozen entries, along with an all-expense-paid (FOB Thatcher, AZ) *tinaja quest* for two going to the very best. Be sure to send all your written entries directly to me at *Synergetics,* and not to **Radio-Electronics.**

Wholesale surplus sources

Have you ever wondered where the surplus houses go to buy their stuff? Few hackers realize there is a lean and mean collection of small outfits out there collectively known as *wholesale surplus dealers.*

All of the good news here is that outstanding prices are the norm. Two-cent integrated circuit sockets, three-cent LED's, quarter motors, and fifty-cent EPROM's are routine. The bad news is that you can only buy using stiff lot, line, or total-order minimums. There is also no technical sup-

WHOLESALE SURPLUS SOURCES

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World Wide
18 Stern Avenue
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port or hand holding whatsoever.

Our resource sidebar for this month shows you several of the better-known wholesale surplus sources. These and others often advertise in the classified sections of *Electronic News* and the *Electronic Buyer's News* magazines. Except for *Surplus Traders*, virtually none of them have catalogs. Some provide fax current availability lists, while others prefer to bid on your needs.

The foremost rule in dealing with these folks is *no messing around*. The preferred contact means is by fax, and most quotations are good only for twelve minutes or so. Quick cash sales are the norm.

New tech literature

Some ancient hacker construction projects on those solid-state vortex coolers we recently looked at include the November 1947 issue of *Popular Science*, and chapter 4 of the *Scientific American Amateur Scientist* reprint volume from the early 1960's.

Two interesting application notes are the *Introduction to Infrared Pyroelectric Detectors* from *ELTEC* on the subject of human-motion detection, and the *Best of the Trimmer Primers* from *Bourns* on the use of precision trimmer potentiometers.

Free samples this month include 1K serial EEPROM's from *International CMOS Technology*, and SCOPE octal drivers from *Texas Instruments*. TI also has a new three-volume set on *Digital Signal Processing Using the TMS320* available.

Turning to my own stuff, for the fundamentals of digital integrated circuits, check into my classic CMOS and TTL Cookbooks. I do have autographed copies on hand for you here at *Synergetics*.

Also, a reminder that I have this new PostScript PSRT roundtable and library up on *GEnie*. You'll also find lots of *Hardware Hacker* and all the *Midnight Engineering* reprints and other resources here.

Finally, I do have a new and free mailer for you which includes dozens of insider hardware hacking secret resources. Write or call for info.

As always, this is your column and you can get technical help and off-the-wall networking per that *Need Help?* box. The best calling times are weekdays 8–5 in *Mountain Standard Time*. Let's hear from you. **R-E**

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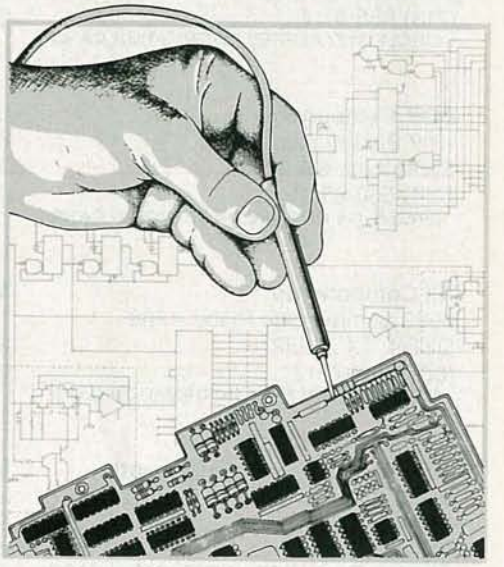

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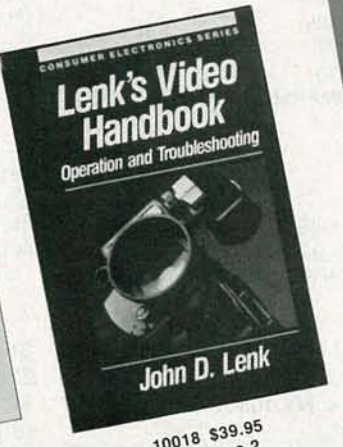

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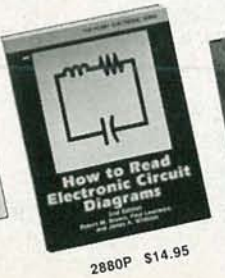

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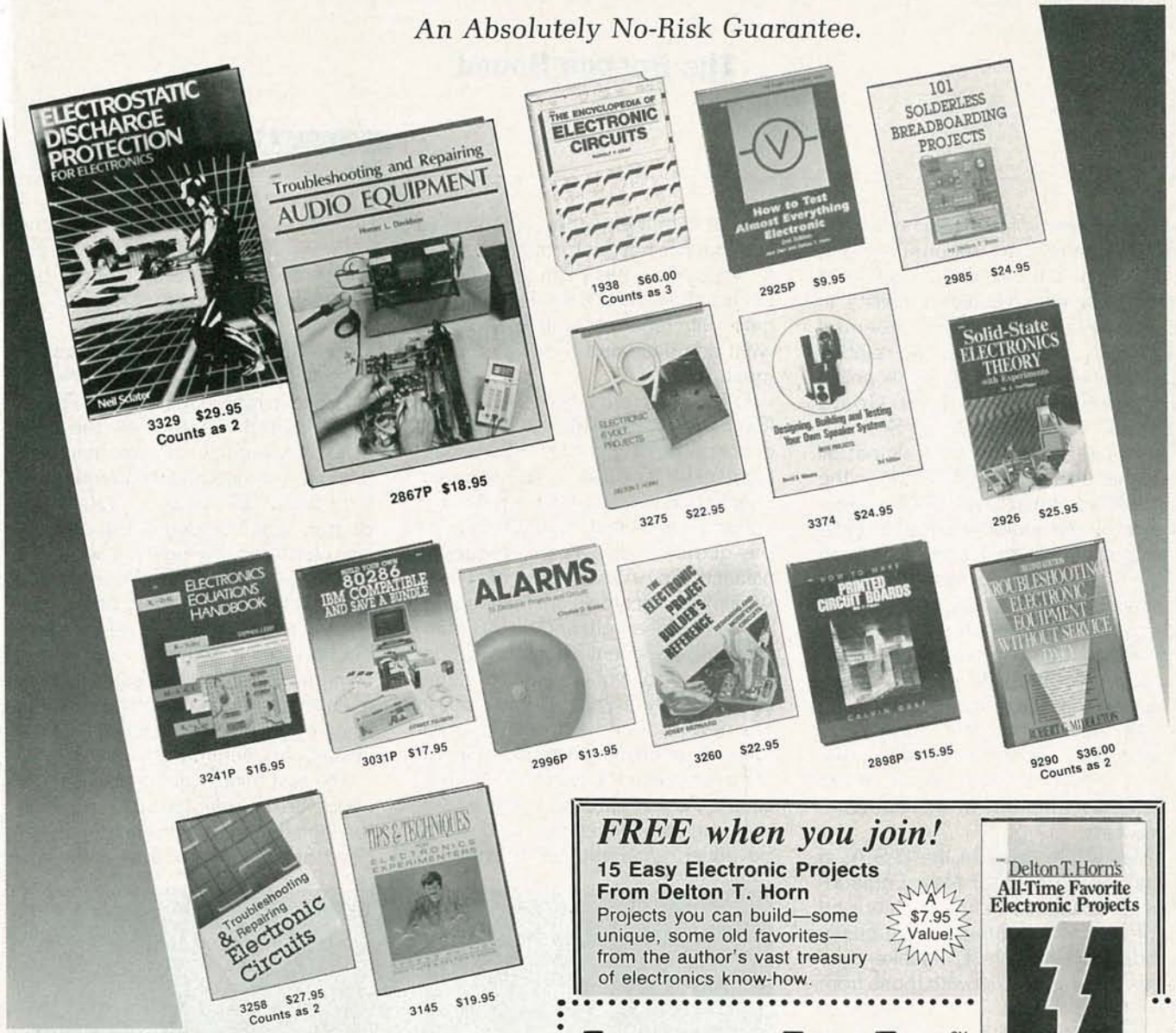

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RE191

AUDIO UPDATE

The Boston Sound

LARRY KLEIN

Followers of this column may remember my recounting of a mid-70's visit from a group of touring Japanese audio journalists. In our conversations, they seemed strangely interested in the relative popularities among U.S. audiophiles of speakers with "East Coast Sound" vs. "West Coast Sound." Years later I learned that almost all Japanese audio journalists are on the payroll (as consultants) of one or another of the major Japanese audio companies. At that point I realized that their questions were probably not simply prompted by editorial curiosity, but rather were part of a commercial fact-finding expedition. In any case, Altec and JBL speakers with their boosted mid-bass and strong upper-midrange were highly respected in Japan, and many Japanese products resembled them sonically and—in some cases—physically.

Meanwhile, back in the U.S.A., a small core group of New England-based academics and amateur and professional engineers were busily producing "bookshelf" speaker systems that, in contrast with those from the major West Coast manufacturers, had a smooth, flat, wide-range frequency response and exceptionally low bass distortion.

I think it's safe to say that "East Coast Sound" began with the work of Edgar Villchur, the developer of the acoustic-suspension speaker system. (I say developer, rather than inventor, in the same sense that Edison developed rather than invented the light bulb. In both cases, the idea was not new—but applied talent and knowhow made it work.)

The Source of the sound

In the mid-1950's, Villchur founded Acoustic Research in Cambridge to manufacture and market his acoustic-suspension designs. In the next five years, AR managed to take over at least a third of the speaker-system market with their various models—a feat that has not been equalled before or since. From this point on the story begins to resemble the Biblical "begats" with regard to who worked with what company and then went on to found their own.

Early on, Henry Kloss, who cofounded AR along with Villchur, left to become the "K" in KLH. Kloss manufactured acoustic-suspension speakers under license from AR, but differed somewhat with Villchur on the question of system frequency balance. Roy Allison, now of Allison Acoustics, became plant manager for Acoustic Research, and Andy Petite, presently president of Boston Acoustics, went to work for KLH. Petite subsequently left KLH to join Kloss in the newly formed Advent Corporation, where he ultimately became the chief designer of a series of successful Advent speaker systems. Advent ran into difficulties in the late Seventies, and Petite left to co-found Boston Acoustics, now one of the leading U.S. speaker companies. (Their products consistently get top ratings from Consumers Reports.)

A visit to Boston Acoustics

Last Fall, while in Boston, I called to say hello to my old friend Andy Petite. Andy invited me to visit the new Boston Acoustics speaker-manufacturing facility located in an industrial park about 20 minutes outside of Boston, and I jumped at the chance. Five years ago, during a previous visit to BA, I was struck by the extensive use of alignment jigs and other specialized tools. These allowed the production-line workers to apply the cements in carefully measured quantities to assemble the tight-tolerance voice-coil and cone assemblies to the basket and magnetic structure.

The first things that impressed me about the new plant were its size, and the high degree of automation on the driver assembly line. Most of the crit-

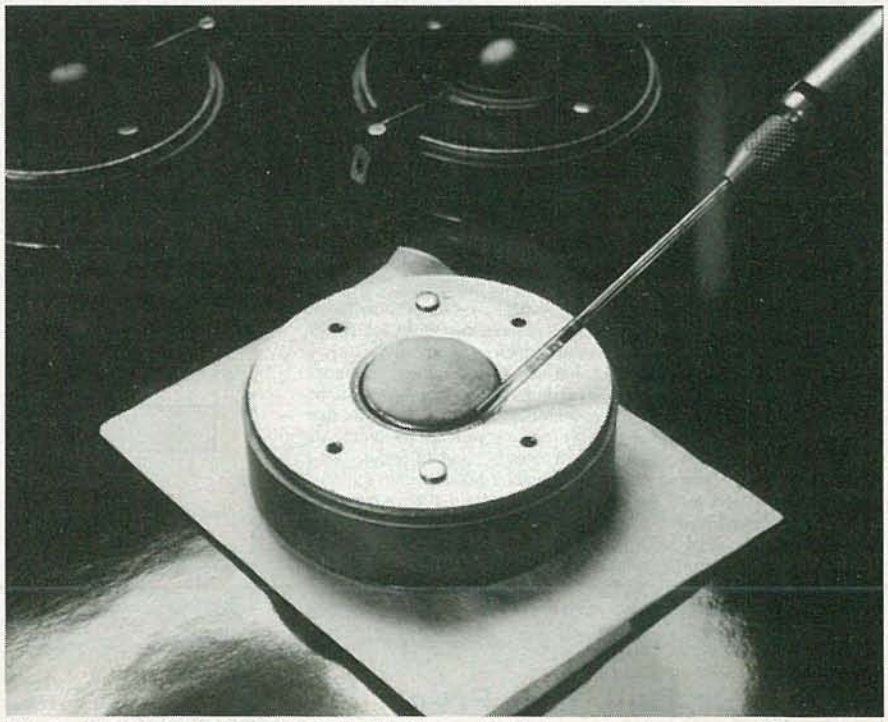

FIG. 1—IN ONE OF BOSTON ACOUSTICS' manufacturing procedures, a precise amount of ferrofluid is added to each tweeter magnet assembly.

ical assembly processes, formerly done by hand, were being performed by sophisticated specialized machines that were not only faster, but provided greater consistency in the finished product. That was reflected both in a lower reject rate and tighter performance specs.

Andy told me an interesting story in that connection. When they first started to produce woofers on the new line, the first batch had to be rejected for excessive efficiency. It seems that new automatic mechanisms were injecting precisely the amount of cement needed, which was less than what was applied with hand construction. The lowered mass produced a woofer that was more efficient than the crossover and enclosure had been designed for. Anyone who still believes that electronic equipment wired and assembled by hand is necessarily better made or more reliable than components made on an automatic line, simply doesn't appreciate the benefits of modern manufacturing technology.

Speaker facts

I've always felt that, at best, I was a "second-hand" hi-fi expert in that most of what I knew I had learned from those who were the real experts—those who were up to their elbows in the day-to-day design and manufacturing process. The engineers who most impressed me were those whose products were a cut above the average both in performance and cost effectiveness. For that reason, I've especially valued my relationships with people like Andy Petite who are willing to share information and opinions based on real-world experiences.

For most of the day, Andy and I talked about loudspeaker design and manufacturing. Below, extracted and paraphrased, are some of Andy's more interesting facts and opinions about loudspeakers in general, and Boston Acoustics loudspeakers, in particular:

- It's a lot more difficult to design a good $200 speaker than a $2,000 one. Any designer who knows his business should be able to put together a relatively good-sounding expensive system. One of my goals as a designer is to get the best possible sound at each price level using the most cost-effective approach. This frequently involves rethinking both the design and manufacturing and production process.

- We've found that it's important to make our own drivers for three reasons: quality, reliability, and price. When we were buying tweeters from outside vendors we always had to contend with inconsistencies in performance. Rejects had to be shipped back—an expensive and time-consuming task. And failures in the customer's home, due to manufacturing flaws, were even more problematic. We knew what the problems were, but our suppliers weren't willing or able to solve them.

For example, we could improve reliability using high-temperature voice coils. However, our supplier wasn't willing to use the new voice coils because his manufacturing procedure involved burning off the voice-coil lead insulation in a solder bath. High-temp insulation won't burn off—which would mean that his manufacturing procedure would have to be redesigned.

When you manufacture your own drivers and rejects occur, you can determine the source of the problem and, frequently, stop the assembly line and fix it then and there. Reject problems can be solved in hours, rather than weeks.

- We've found it worthwhile to individually test the performance of every driver after it comes off the line before it is installed in a system. This is feasible, because we have designed a separate computer test program for each driver and system we produce. Every test station has a carefully calibrated miniature anechoic chamber with a test microphone installed. The computer provides a test signal to the driver, instantly displays the curve and other data, and then assigns a pass/fail rating. Each driver must match the reference standard within ±1dB. The complete test is done in less time than it takes to describe it. Of course, every completed system undergoes equivalent testing.

We've run out of space for this month; in my next column I'll continue my conversation with Andy Petite discussing crossover design, the virtues of acoustic-suspension woofers, and other practical loudspeaker manufacturing and design matters. **R-E**

EQUIPMENT REPORT

continued from page 12

DC resistance.

When you have your circuit built, you can turn on the power and get out the test equipment to see how it works. The *Protolab* is equipped with a voltmeter, ammeter, ohmmeter, wattmeter, dual-trace oscilloscope, and sweep generator.

Since the *Protolab* is primarily a teaching tool, the manual is one of its most important components. Sixteen experiments guide the user through important AC/DC circuit-analysis concepts, and each experiment offers an "Observation and Implications" section that emphasizes the lessons that should be noted, along with the pages in popular textbooks where additional information can be found.

We wish we'd had the *Protolab* back in our college days. It would have made some of the important concepts easier to get a handle on thanks to the instant gratification it offers. *Protolab* does, of course, have some limitations, such as the inability to show parts values on the schematic, and the inability to support Hercules graphics. However, at $99.95 for the PC version and $129.95 for the Mac version—about the price of two or three college texts—it's certainly a good investment. We hope to see future versions that support active components and other more advanced topics. **R-E**

BATTERY TECHNOLOGY

continued from page 49

age current. In other words, the battery is not completely disconnected from the load circuit even when the power is turned off. Over a period of time, ranging from one week to two months, leading to minor battery leakage. Even if designed to prevent such an occurrence, a minor short may occur, insufficient to affect performance even when turned on, but resulting in what's known as "creep" leakage.

In the above cases, "creep" usually manifests itself as white fuzz around the top seal of a cell. To avoid it, turn power switches off when equipment isn't in use. In radios unused for extended periods, remove the batteries, and replace them when needed. Even if creep does occur, a Ni-Cd cell can be recharged, with proper care.

- **Ni-Cd cells have been around a long time, and yet the application of that technology is growing and changing. What technology improvements, if any, have occurred that we should be aware of, and is there anything better available on the horizon?**

Ni-Cd manufacturers are continuously seeking to improve product capabilities and quality.

Increased capacity means longer run times; for many years, makers have boosted capacity by over 10% a year, itself driving research into new electrochemical couples. Rechargeable lithium and Ni-metal hydride cells are prominent contenders, with significant increases in energy density over Ni-Cd cells, but their availability is still limited.

Safety continues to impede broad acceptance of lithium cells. Metal-hydride is progressing steadily, and is also equivalent in voltage to that of Ni-Cd cells. Broad acceptance of metal-hydride depends on its ability to be successfully used in several environments. Ni-Cd cells offer such flexibility today, at reasonable prices. Also, the prices of newer technologies will further impede broad acceptance. In our next article, we'll spotlight some recent ingenious and innovative applications of batteries. **R-E**

COMPUTER CONNECTIONS

Some predictions for the PC's to come during the next decade.

JEFF HOLTZMAN

This marks the first issue of 1991, so I thought I would take a look at where things in the PC industry are going. Much of the PC future revolves around a single product. Even though that product has been on the market for only a few months so far, it's fair to say that already it has permanently altered the course of the PC industry. You've probably guessed that that product is Windows 3.0.

Windows' success apparently exceeds even the most optimistic sales projections, and it has forced a complete redefinition of the relationship between IBM and Microsoft, along with a redefinition of the boundaries between OS/2 and Windows. For example, Microsoft has indicated that OS/2 2.0 will include a compatibility layer that will allow Windows applications to run with a slight performance penalty, and that OS/2 3.0 will run Windows applications directly, without a loss in performance. (Microsoft has already privately shown Windows programs running under the as-yet unreleased OS/2 2.0, the long-awaited 386-specific version.) In addition, it now seems that some of OS/2's most advanced features will migrate down (over?) to the Windows environment. So in a sense it seems that the two products are in the process of merging.

However, after months of rumors about troubles between IBM and Microsoft, the two companies recently announced that the two product lines will be developed separately. IBM will develop for OS/2 and Microsoft for Windows (and DOS). The two companies will cross-license each other's products, and Microsoft will also take responsibility for developing a "portable" OS/2, that presumably will run on non-80xxx family CPU's, including perhaps the 68K family used in the Macintosh line and many workstations, or some RISC family. If the latter occurs, a prime candidate would be IBM's RS6000 workstations, which were released last year, and which finally brought IBM some much-needed credibility in that market.

Although the companies' respective roles have crystallized, product differences still remain murky; most likely the product for which the best software is written first will win out in the end. And considering the difficulty of developing for both environments, Windows' head start may give it a clear long-term advantage. In the meantime, what about Windows 3.0 as it currently exists?

Beauty and brains

Some would call Windows 3.0 the most-hyped PC product to hit the market in years. Others, while acknowledging the hype, insist that there really are some brains behind the pretty face. I've been using Windows for several months now in a variety of modes, with a variety of display adapters, CPU types, and memory capacities, and with a variety of software, including regular DOS applications, the built-in Windows apps, and numerous large and small Windows apps. My overall conclusion? The hype is real, but the product is substantial. Windows is imperfect, but with the right hardware, it is both powerful and pleasurable to use.

Should you switch to Windows? No, if you don't have at least a 10-MHz 286. No, if you find learning new software (which really amounts to learning a new metaphor of the world) a pain in the you-know-what. No, if you still insist that your CP/M machine with 160K floppies does everything you need it to. (Yes, there really are people who still believe that.) No, if you're not willing to put up with some bugs. No, if you enjoy the idea of dropping anchor and watching the rest of the world sail on by.

But if you've got a sense of adventure, or if you would simply like to try a new way of doing things, or if you

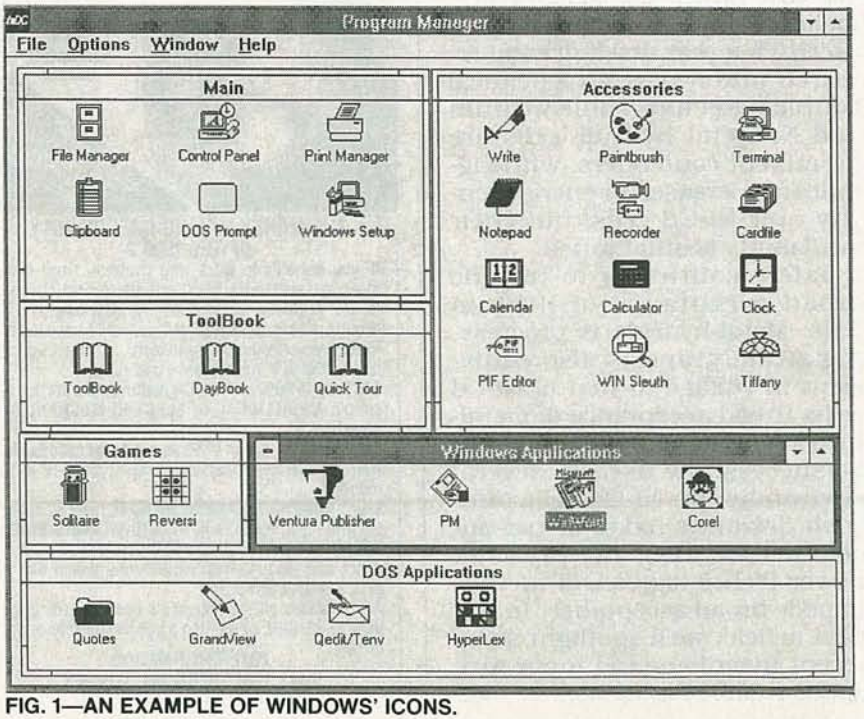

FIG. 1—AN EXAMPLE OF WINDOWS' ICONS.

require a new way of doing things, Windows is your ticket to the future. Just as surely as DOS replaced CP/M, a graphical environment is going to replace DOS. And although Windows is the first step into the future, it certainly won't be the last.

Even on optimal hardware, Windows has several problems, including its user interface, its lack of serious multitasking, and font management. The user interface problem is that Windows does nothing to simplify the MS-DOS file system metaphor. Although you can associate icons with programs, you cannot associate icons with files or directories. Thus, file management under Windows requires an abstract understanding of the hierarchical file system.

On the other hand, if icons were smarter and we could associate them with other types of objects, the icons could represent real-world objects. For example, you might have a project icon that would provide a way of organizing several different sorts of files (CASE diagrams, a desktop-published business presentation, CAD schematics, etc.). To work on one item in the project, you would "open" the project icon, click on, for example, the CAD icon, and up would come your circuit diagram. You can achieve that type of effect in a limited way with Windows now (see Fig. 1), but the product really needs a complete metaphor built on the way we work, not computers.

As for multitasking, Windows currently has what is called non-preemptive multitasking, which means that all programs must cooperate—i.e., give up use of the CPU periodically. In a preemptive multitasking system (UNIX or OS/2), the operating system itself periodically interrupts each task, so no task can hog resources. The effect of the latter system is much smoother coordination among programs.

A related issue is that of "threads". In a full multitasking system, a task can spawn subtasks, or threads, which perform processing independently of the main task. Threads are the only way to perform simultaneous background operations efficiently.

Who needs background operation? Maybe you don't, but your software does. Here are a few examples. A spreadsheet could recalculate while you enter data. A desktop publishing program could repaginate while you spruce up other pages. You could plot a PC board layout from your CAD program while transferring the parts data to a word processor. Your system could back itself up in the background with no intervention by you. Your system could perform automatic daily downloads of Email from your favorite on-line service, again without intervention.

Those things may sound fanciful, but some of them are available already, albeit in limited form. By the end of the decade, we will take those types of activities for granted.

Hardware issues

Some people say that Windows will never achieve really widespread popularity because it requires a 386 to run most efficiently. I believe that the converse is true. I think that people with less-powerful machines will try Windows, like it, want better performance, and thereby be persuaded to upgrade. Again, an analogy with CP/M is appropriate. In 1981, when the PC was introduced, 64K of memory and no hard disk were standard. Five or six years later, ten times the amount of memory and 20-MB hard disks were standard. Now, 1 MB of memory and 40-MB hard disks are minimum standards; I see more and more offices with 4 MB of RAM and 100-MB hard disks.

Of course video and printer technologies have evolved drastically in that time period, as well. For example, in 1980 I bought a Qume daisy-wheel printer for about $1000 more than what I paid for an HP LaserJet with 1.5 MB of memory, a font cartridge, and numerous soft fonts, in 1988. The trend will continue. You will be able to buy a laser printer, sooner than you think, without mortgaging

your grandmother.

Hardware capabilities will continue to evolve because people's needs are nowhere near being met. Presenting a respectable metaphor to the average user requires lots of CPU power, lots of video resolution, and lots of hard-disk space. I believe that by mid-decade, the average machine will be a 33-MHz 386 with 16 MB of memory, a 300-MB hard disk, video with resolution of about 1000 pixels in both directions, built-in sound/video compression and processing, modem/fax, and a 300-DPI hardcopy output device based on PostScript or some derivative thereof.

Many people will have some sort of optical storage capability. CD-ROM is a candidate, but its 550-megabyte capacity may turn out to be a limitation as the use of bit-mapped graphics, sound, and video data become more widespread. The video system will be NTSC-compatible, HDTV-compatible (if U.S. manufacturers ever get their act together), and will have a standard rasterizing mechanism, which again will probably be PostScript or a derivative. All I/O subsystems will be based on coprocessors controlled by a multitasking/multiprocessing derivative of Windows, OS/2, or both.

What will we be doing with all that hardware? Nearly everyone will be using a graphical operating environment (which will nonetheless maintain an optional command-line mode for power users). The operating system will provide a much more intuitive way of managing files. The concept of files will fade, to be replaced by compound documents that include all sorts of media. Multimedia technology will just be coming of age, now that a significant number of users have the requisite hardware.

Multimedia will be used extensively for educational purposes; computer-based training and on-line tutorials will have sound, video, and will be fully interactive so that the direction a course follows will depend on user responses. The emergence of serious PC-based multimedia will finally spur the educational market to embrace PC technology in a big way. Looking for an opportunity? Multimedia presentations of all traditional subject matters—language, history, math, and science—are going to be hot sellers, both to schools and to forward-looking parents.

Conclusion

Ignoring Windows' influence for the moment, it's impossible not to notice the inexorable trend toward technological improvement. Disk drives are getting bigger and faster. Video systems are getting bigger and faster—and smarter. CPU's are getting bigger and faster. The improvements in hardware are not part of Microsoft's plan to insinuate Windows into every nook and cranny of the computer-literate world. Hardware improvements are happening because real-world data requires it. Real-world data includes graphics, sound, and video, not just 80 × 25 screens of text. Windows may be the environment that helps erase the distinction between the computer and what we do with it—or it may not. Regardless, Windows, or something like it, will become a standard. Hardware is getting bigger, faster, and smarter—not to make money for the hardware manufacturers but because the real world is large and complex. The personal computer can do much more now than it could ten years ago, but the next ten years will see even more fantastic growth in capability. It's also going to be a lot of fun getting there.

Next time the discussion will be more practical, with hints about how to get the most out of Windows 3.0, along with discussions of particular programs. **R-E**

ITEMS DISCUSSED

- Windows 3.0 ($149), Microsoft Corp., 17011 NE 36th Way, Box 97017, Redmond, WA 98073-9717. (206) 882-8080.

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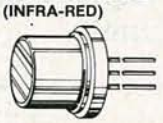

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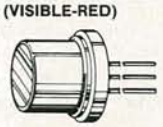
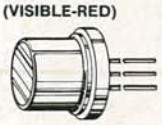


- Output: 5 mW (max.)
- Current: 65-100 mA
- Operating Voltage: 1.75-2.2V
- Wavelength: 780nm

STOCK #	PRICE
LS022	$19.99

LASER DIODE
(VISIBLE-RED)



- Output: 4 mW (max.)
- Current: 20 mA
- Operating Voltage: 2.2-3.0V
- Wavelength: 665nm

STOCK #	PRICE
LS3200	$129.99

POWER SUPPLY

- Input: 115/230v
- Size 7" L x 5¼" W x 2½ H
- Output: +5 volts @ 3.75 amps
- Output: +12 volts @ 1.5 amps
- Output: -12 volts @ .4 amps

STOCK #	PRICE
PS1003	$19.99

EPROMS

STOCK #	PINS	DESCRIPTION	1-24	25-99	100+
1702	24	256 x 4 1us	3.99	3.79	3.41
2708	24	1024 x 8 45ns	6.49	6.17	5.55
2716	24	2048 x 8 450ns (25v)	3.29	3.13	2.82
2716-1	24	2048 x 8 350ns (25v)	3.79	3.60	3.24
TMS2716	24	2048 x 8 450ns	6.29	5.98	5.38
27C16	24	2048 x 8 450ns (25v-CMOS)	3.99	3.79	3.41
2732	24	4096 x 8 450ns (25v)	3.79	3.60	3.24
2732A-2	24	4096 x 8 200ns (21v)	3.79	3.60	3.24
2732A	24	4096 x 8 250ns (21v)	3.69	3.51	3.16
2732A-4	24	4096 x 8 450ns (21v)	3.19	3.03	2.73
TMS2532	24	4096 x 8 450ns (25v)	5.79	5.50	4.95
TMS2532P	24	4096 x 8 450ns (25v-One Time Programmable)	1.99	1.89	1.70
27C32	24	4096 x 8 450ns (25v-CMOS)	4.19	3.98	3.58
2764-20	28	8192 x 8 200ns (21v)	3.99	3.79	3.41
2764	28	8192 x 8 250ns (21v)	3.79	3.60	3.24
2764A-20	28	8192 x 8 200ns (12.5v)	3.99	3.79	3.41
2764A	28	8192 x 8 250ns (12.5v)	3.29	3.13	2.82
TMS2564	28	8192 x 8 250ns (25v)	6.79	6.45	5.81
27C64	28	8192 x 8 250ns (21v-CMOS)	4.19	3.98	3.58
27128-20	28	16,384 x 8 200ns (21v)	5.79	5.50	4.95
27128	28	16,384 x 8 250ns (21v)	5.09	4.84	4.35
27128A	28	16,384 x 8 250ns (21v)	5.79	5.50	4.95
27C128	28	16,384 x 8 250ns (21v)	5.79	5.50	4.95
27256-20	28	32,728 x 8 200ns (12.5v)	5.29	5.03	4.53
27256	28	32,768 x 8 250ns (12.5v)	4.79	4.55	4.09
27C256	28	32,768 x 8 250ns (12.5v)	5.29	5.03	4.53
27512-20	28	65,536 x 8 200ns (12.5v)	7.49	7.12	6.41
27512	28	65,536 x 8 250ns (12.5v)	6.99	6.64	5.98
27C512	28	65,536 x 8 250ns (12.5v-CMOS)	6.99	6.64	5.98
27C1024	32	131,072 x 8 200ns (12.5v-CMOS)	17.99	17.09	15.38
68764	24	8192 x 8 450ns	13.99	13.29	11.96
68766	24	8192 x 8 450ns	14.99	14.24	12.82

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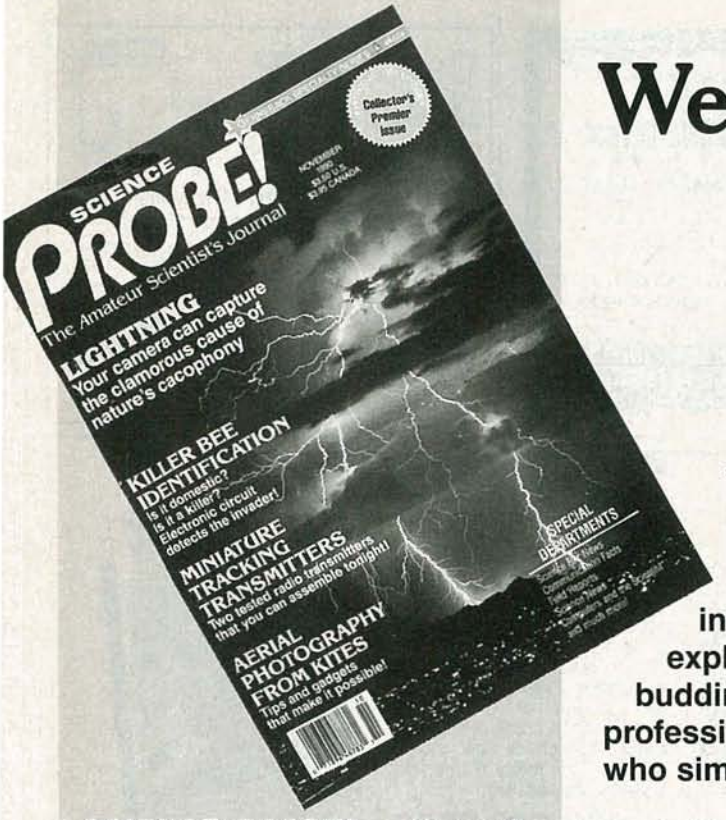

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Make and fix circuit board lines instantly. Valved pen with a specially formulated silver bearing thermoplastic polymer allows you to draw conductive silver traces. Can be soldered after 15 or 20 minutes with 350 degree iron. Each pen contains enough silver conductor for 100 feet of shielding, traces and connections. Traces are as narrow as 1/16" in width.
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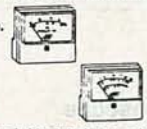

150 microamp full scale.
2.165" X 1.875" X
0.96" deep
Face is 1.965" X 1.1".
White background with black and red scale.
Two types. One is marked "Modulation" and has a 0 - 100 scale. The other has two scales, "RF" and "SWR". Otherwise meter are identical.

"Modulation" meter **CAT# MET-21** $3.50
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This white box with a blue button will drive you crazy.
Box measures 3 1/4" square X 2" high. When the button is pressed 4 LEDs light and a beeper pulses. Every 15 seconds one led goes out and the speed of the beeping increases. At the end of 60 seconds the unit gives off a long beep followed by a low squelch, all LEDs shut off and the unit stops. Unit requires a 9 volt transistor battery (not included) to operate.
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SPDT PUSHBUTTON
Marquardt# 1843
Rated 6 amps @ 125/250 Vac.
Black plastic pushbutton.
Switch body: .92" X .94" X .65".
CAT# PB-18 $1.65 ea. • 10 for $15.00

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1 pole 10 position decimal encoded switches which interlock to make up desired number or digits. Terminates to 11 pc pins (1 common and 10 poles). Each section measures .31" wide X .20" high X .78" deep. End plates can be added to form a .94" ; ·gh bezel.
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2 END PLATES - CAT# SW-9EC $1.00/Set

MINIATURE TOGGLE SWITCH
Rated: 3 amps @ 120 Vac
S.P.S.T. (ON-ON) solder lugs
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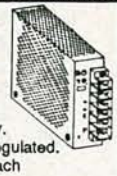
12 Vdc @ 500 ma. **CAT# DCTX-125** $4.50

12 Vdc 5 AMP POWER SUPPLY



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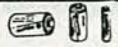

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1.2 volts 1200 mAh
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Aromat # RSD-6V
Super small relay.
Rated: 1 amp @ 30 Vdc, TTL direct drive possible, Operates on 4.3 to 14 Vdc. Coil: 220 ohms. 1 3/16" X 13/32" X 7/16". **CAT# RSD-6V**
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Miniature relay
fits standard 16 pin (dip) sockets or will directly mount to p.c. boards. GI Clare# LM44D00 • 280 ohm • 30 va switching.
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KUP style
11 pin base
can be socketed, direct soldered or quick connect terminals can be used.
1 3/8" x 1 1/2" x 2". 3.P.D.T. • 5 amp contacts • 470 ohm
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17 Vdc dual coil,
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with built in flashing circuit
5 volt operation. T 1-3/4 (5mm)
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0.182" dia. X .06"high. 0.18" long leads. **CAT# PRE-7** 2 for $1.00
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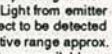

TRW/ Optron
OPB5447-2
Rectangular
w/ 28" wire leads
CAT# OSR-4 2 for $1.00

TRW/ Optron
OPB703A
Wedge shape
with PC pins.
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Rectangular
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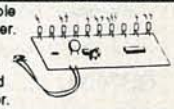
Two L.E.D.'s flash in unison when a 9 volt battery is attached.
This kit includes a p.c. board, all the parts and instructions to make a simple flasher circuit. A quick and easy project for anyone with basic soldering skills.
CAT# LEDKIT $1.75 per kit

LED CHASER KIT



Build this variable speed led chaser.
10 leds flash sequentially at whatever speed you set them for.
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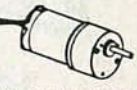

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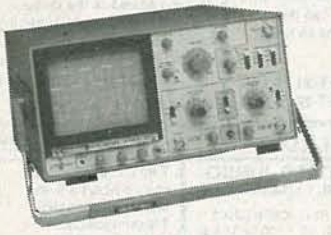

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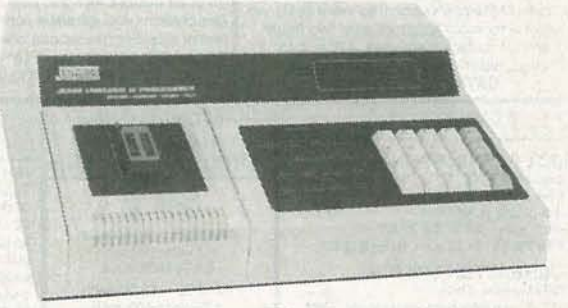

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• Compatible with TTL, DTL, RTL, HTL, HNIL, MOS and CMOS ICs. • 1MΩ Sync input impedance • Pulser mode output current: 10mA • Square wave current output: 5mA • Audible tone

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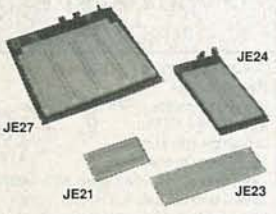

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EPROMs - for your programming needs

Part No.	Price	Part No.	Price	Part No.	P
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TMS2532	6.95	2764-25	4.75	27256-20	
TMS2532-35	7.49	2764-45	4.49	27256-25	
TMS2532A	7.95	2764A-20	4.25	27C256-15	
TMS2564	5.95	2764A-25	3.95	27C256-20	
TMS2716	5.95	27C64-15	4.49	27C256-25	
1702A	4.89	27C64-25	3.49	27512OTP	
2708	6.95	27128OTP	4.95	27512-20	
2716	3.49	27128-20	6.95	27512-25	
2716-1	3.95	27128-25	6.25	27C512-15	
27C16	4.25	27128A-15	6.95	27C512-20	
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ILS03	.25	.15	74LS156	.49	.39
ILS04	.25	.15	74LS157	.45	.35
ILS05	.28	.18	74LS158	.39	.29
ILS06	.59	.49	74LS166	.79	.69
ILS07	.59	.49	74LS169	.99	.89
ILS08	.28	.18	74LS173	.49	.39
ILS10	.25	.15	74LS175	.39	.29
ILS11	.29	.19	74LS181	1.39	1.29
ILS13	.35	.25	74LS189	3.95	3.85
ILS14	.49	.39	74LS190	.59	.49
ILS20	.28	.18	74LS191	.59	.49
ILS21	.29	.19	74LS193	.69	.59
ILS27	.35	.25	74LS194	.69	.59
'ILS30	.28	.18	74LS221	.69	.59
'ILS32	.28	.18	74LS240	.59	.49
'ILS38	.35	.25	74LS241	.59	.49
'ILS42	.49	.39	74LS323	2.49	2.25
'ILS47	.85	.75	74LS541	1.09	.99
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2N2222A	.25	C106B1	.49	1N270	.25

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You know that the Russians secretly installed countless microphones in the concrete work of the American Embassy building in Moscow. They converted what was to be an embassy and private residence into the most sophisticated recording studio the world had ever known. The building had to be torn down in order to remove all the bugs.

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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.

The Dollars You Save

To obtain the information contained in the video VHS cassette, you would attend a professional seminar costing $350-750 and possibly pay hundreds of dollars more if you had to travel to a distant city to attend. Now, for only $49.95 (plus $4.00 P&H) you can view ***Countersurveillance Techniques*** at home and take refresher views often. To obtain your copy, complete the coupon below or call toll free.

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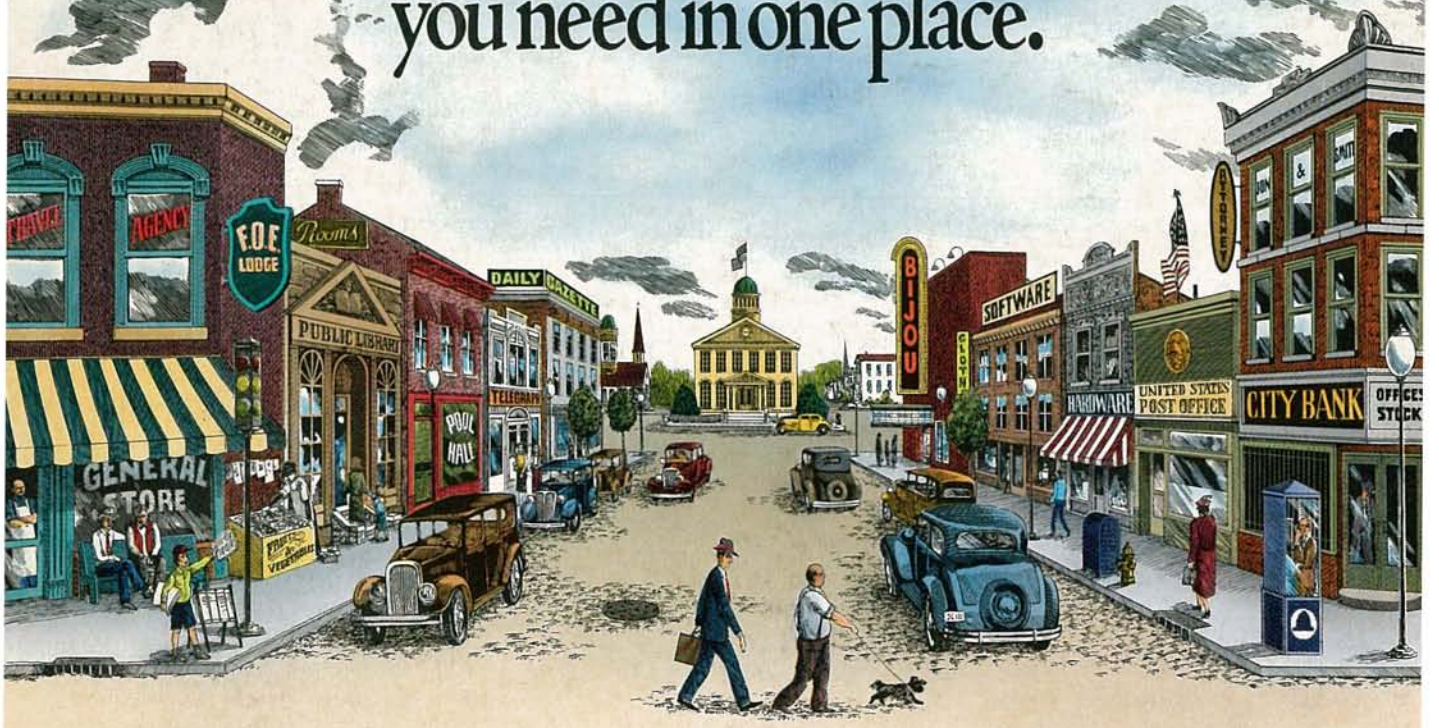

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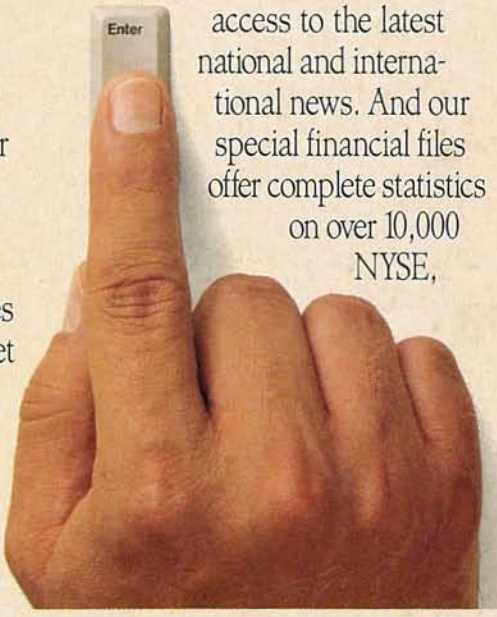

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