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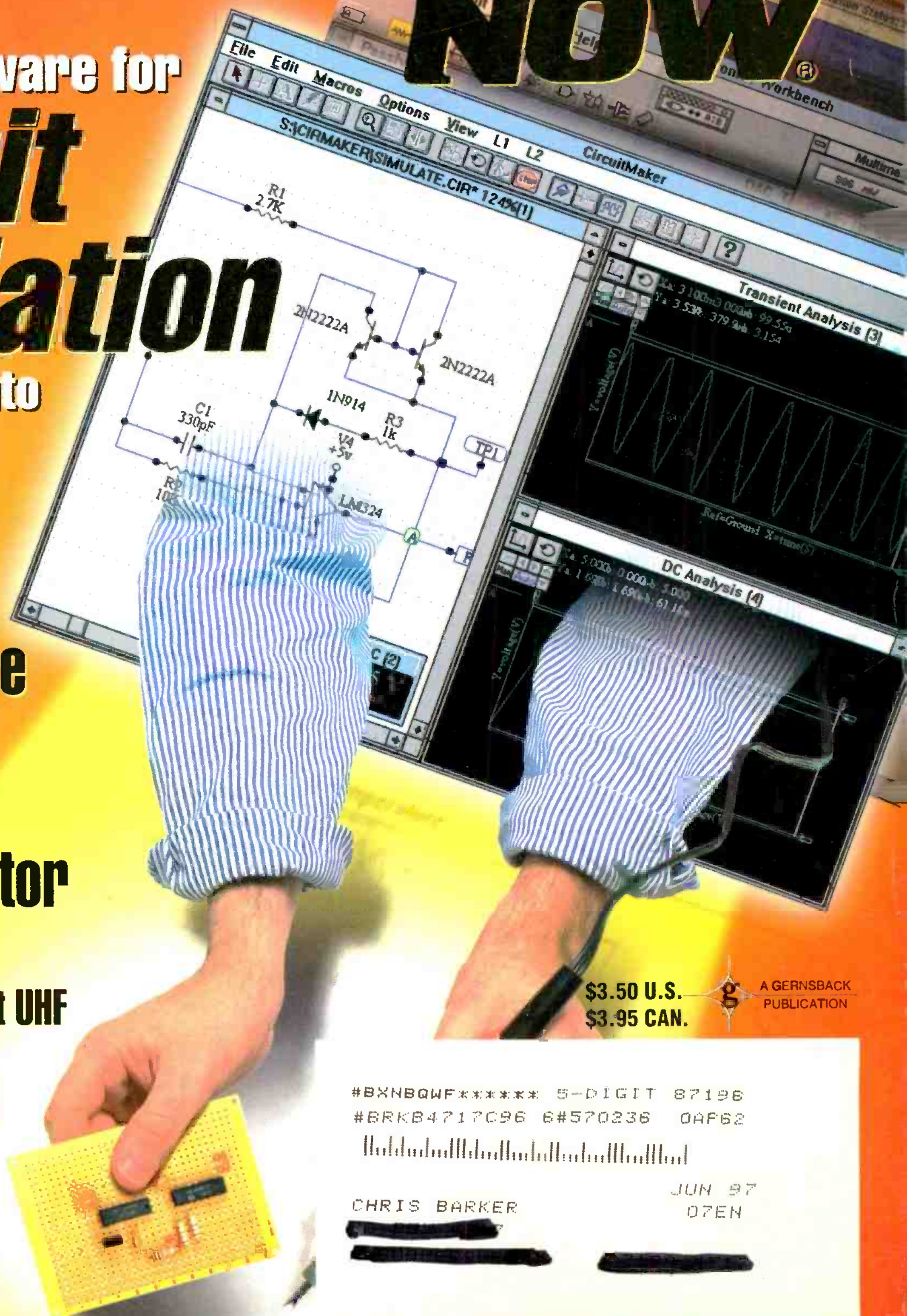

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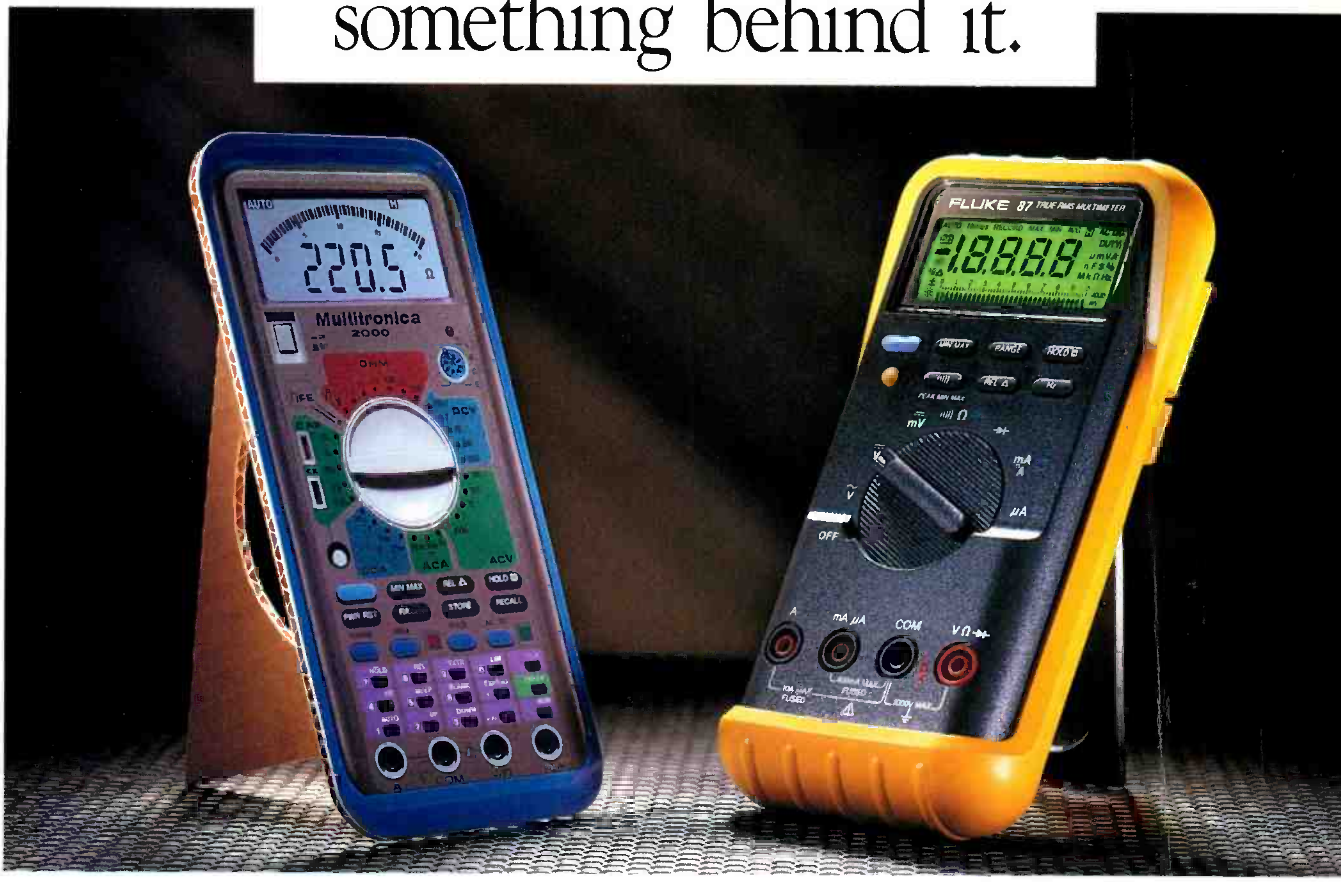

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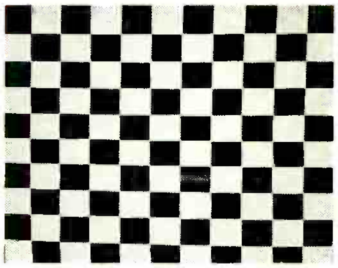

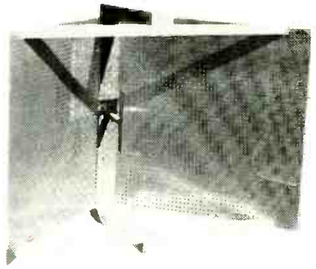

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WHAT'S NEWS

A REVIEW OF THE LATEST HAPPENINGS IN ELECTRONICS

Reversible optical switch

Researchers at the Georgia Institute of Technology, in a program sponsored by the National Science Foundation, are developing a light-activated optical switch that eventually could be the basis for a new type of rewritable three-dimensional data storage system. By using a small number of "trigger molecules" to induce a phase transition in liquid crystal materials, the system would write, read, and erase information using different forms of polarized and unpolarized light.

THE PHOTOMICROGRAPH of liqued crystals suspended in glycerol, viewed through an optical microscope, helps provide information about the properties of the crystals.

This type of optical storage system would offer major advantages over conventional computer floppy disks, magnetic tape, and compact discs, which use two-dimensional media to store data. The optical switch materials could also be used in spatial light modulators and in active coatings for optical fibers.

"The idea is that you would write to the liquid crystal with circularly-polarized light, read it with linearly-polarized light, and erase it with unpolarized light," explained Dr. Gary B. Schuster, professor of chemistry at Georgia Tech. "You can read, write, and erase information in liquid crystal materials using this system."

Schuster and his co-workers use "chiral" molecules to trigger changes in the liquid crystal. Chiral molecules exist in right-handed and left-handed forms. Each form is affected differently by circularly-polarized light, which also exists in right- and left-handed versions. For example, when right-handed chiral molecules are struck by left-handed light, they may be converted preferentially to left-handed molecules. If the chiral molecules are dissolved in a liquid crystal material, that structural change can be used to prompt a phase transition in the crystal.

The phase transition changes the optical properties of the liquid-crystal material. One way that change can be detected, or read, is by passing linearly-polarized light through the crystals. Because the linearly-polarized light can be at a wavelength that does not affect the chiral molecules, reading the stored information would not alter it.

Multiple phase transition "switches" could be used together to store digital information. That information could later be erased by shining unpolarized light through it, reversing the phase changes originally made by the circularly-polarized light. Because the molecules would be returned to their original state, the system would be truly rewritable.

The Georgia Tech team is developing trigger molecules made up of bi-cyclic ketones substituted with a styrene group. Those materials, which exhibit the greatest response to circularly-polarized light, satisfy most criteria needed for a two-dimensional switch.

However, the switches must be converted from two-dimensional layers to a true three-dimensional system before they become useful for optical data storage. "Furthermore, that would be useful only if you don't have to write information a bit at a time, which means writing it holographically," said Dr. Schuster. "If you could write three-dimensional holograms optically and read them, you would really have something worthwhile."

PHOTOMICROGRAPH OF THE leaf-shaped structures shows a phase transition in discotic liquid crystals doped with chiral triggers as viewed through cross polarization.

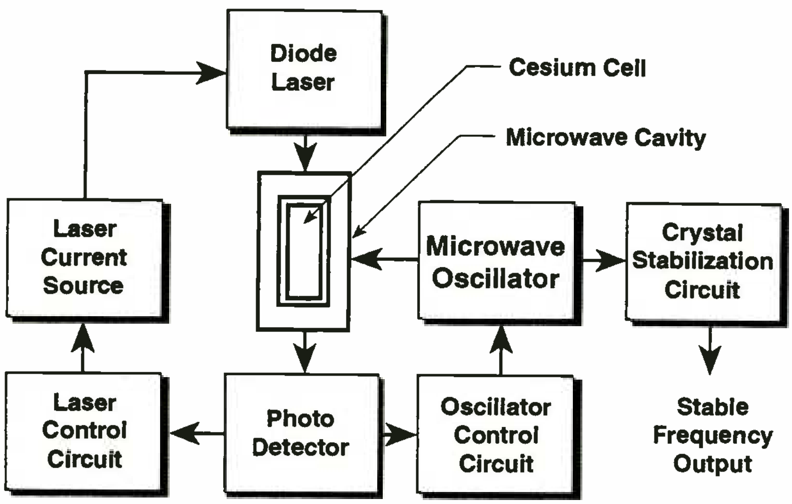
To make a three-dimensional system, the liquid crystals and their dissolved trigger molecules would need to be dispersed in a polymeric material. Once that was done, it would be possible to address micro-droplets of the liquid crystal individually or in groups.

Because the system would be optically based, multiple beams of light could be used to simultaneously write information to the data-storage media without interference. That optical advantage would allow large amounts of information to be packed into a relatively small space, opening the door for the creation of smaller computer systems.

Small, Low-Cost, Atomic Clock

A cesium atomic clock now under development is smaller, consumes less power, and will cost less than existing commercial atomic clocks. The clock, invented at Westinghouse Electric Corpora-tion's Science & Technology Center in Pittsburgh, is intended for precision timing in certain military and commercial systems where it is expected to replace the best crystal oscillators now available.

The Westinghouse clock is in a matchbox-size package containing a small cell filled with cesium vapor within a microwave cavity. A diode laser, which emits in the near infrared region at about 852 nanometers, raises the cesium atoms to a higher energy level. A microwave oscillator creates an electromagnetic field within the microwave cavity that excites the electrons in the cesium vapor.



THE CESIUM ATOMIC CLOCK. The time is kept precisely by the interaction between the diode laser and the microwave oscillator on the cesium gas.

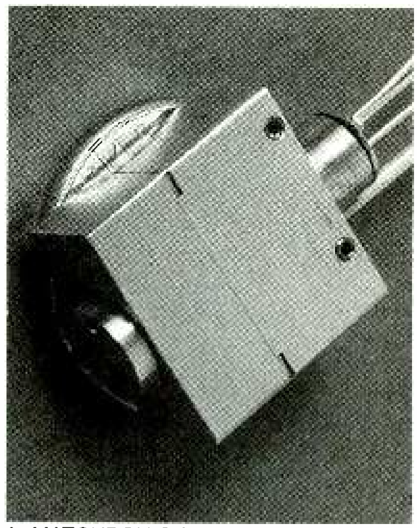
The magnetic field partially returns the atoms to their base energy level, altering the transmission of infrared energy through the cell but only when the circuit's frequency precisely matches the resonant frequency of the cesium atoms. This occurs at about 9.192 gigahertz for a cesium atom.

The microwave oscillator is locked to 9.192 GHz by a feedback signal from a photodetector and an oscillator control circuit. The microwave oscillator, in turn, stabilizes the internal quartz crystal that provides a stable frequency output of 10 megahertz, to better than 0.0001 hertz.

Westinghouse researchers believe the cesium atomic clock has a place in systems that can benefit from more precise and stable timing than offered from the best crystal oscillators today. They do not se it crystal oscillators that are now performing satisfactorily in computers and communications systems.

For example, the clock could become an important component in the aircraft location systems based on the Global Positioning System (GPS) that are being developed. They would replace other existing position-location systems. Military applications might include all-weather landing systems for aircraft and covert identification friend or foe (IFF) systems that would prevent accidental "friendly fire" on friendly aircraft, vehicles, ships, and troops.

Each of the 24 GPS satellites now contains an atomic clock, so it is believed that replacing the crystal oscillators in some GPS receivers with the atomic clocks would greatly enhance their accuracy. According to Westinghouse, the clocks would help to overcome the blocking of satellite signals due to nearby as well as interference from other radio frequency sources.



A MATCHBOX-SIZED CESIUM ATOMIC CLOCK is expected to replace crystal oscillators in systems whose performance will benefit from more accurate timing.

The final production model of the clock is expected to be one-tenth the size and have a weight that is about 1 percent of existing atomic time standards. Moreover, it is expected to draw only one-tenth the power — about a third of a watt. Projected cost will be about one-tenth that of existing atomic clocks. The latest prototype has an accuracy within a millionth of a second per day., about a thousand times more accurate than the best crystal oscillators.

CES/COMDEX mega-show

In response to the accelerating convergence of computer and consumer-electronic technologies in the retail marketplace, the Consumer Electronics Manufacturers Association (CEMA) and SOFTBANK COMDEX Inc. have formed a strategic partnership. As part of the new initiative, COMDEX/Spring '97 and the Spring Consumer Electronics Show (CES) will run at the same time, from June 2–5, 1997, in Atlanta, Georgia.

The two organizations also announced the creation of a new trade show and conference specifically developed to address the convergent marketplace. The as-yet-unnamed venture will be held alongside the combined COMDEX/ CES event in Atlanta.

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VIDEO NEWS

WHATS NEW IN THE FAST-CHANGING VIDEO INDUSTRY

BY DAVID LACHENBRUCH

"TV/PC" standard sought

Thomson Consumer Electronics, which plans to test a TV set with major computer features in 100 consumer homes later this year, has called for talks between TV and PC manufacturers looking toward standards on picture tubes, processing power, and other features of such hybrids. The call met with mixed response, some competitors claiming that Thomson was merely trying to create a market for its fine-pitch 36-inch picture tubes. Thomson, however, said that it hopes the industry will "determine what the consumers really want and then position that product accordingly."

Thomson officials said that the company's test of "Genius Theater" will probably use its new fine-pitch 36-inch tube and include a digital VCR, a 100-disc DVD-ROM changer, a 28.8 modem, and a receiver box that can both handle Digital Satellite System (DSS) feeds and provide access to the Internet. The tests could result in a product next year selling at about $5000, according to Thomson.

Other TV manufacturers—including Mitsubishi and Toshiba—are also introducing TV sets with some computer capability. As reported here, direct-market computer manufacturer Gateway 2000 has started sales of its Destination system, consisting of a computer and TV combination with a 31-inch screen for living room use. Other computer makers have announced or are preparing "network computers"—low-cost systems designed to access the Internet using the home TV as a display. And, of course, video and TV cards are readily available for installation in PCs. Whether a "standard" is necessary or desirable is still a subject of controversy.

HDTV station on the way

Construction of America's first high-definition TV station soon will be under way, with the transmitter and compression encoder due to be installed before this year is over and local program production equipment in place early next year. The station will be built in Washington, D.C., by broadcasters and equipment makers and will be used for demonstrations to important decision makers, in addition to serving as a testing ground for equipment and program production. The three-year project is expected to cost $6,000,000 and will piggyback on an existing Washington TV station, which has not yet been selected. It's expected to broadcast in HDTV virtually full time. One Washington station—PBS affiliate WETA-TV—has already announced independently that it plans to broadcast in HDTV, and it could be a candidate for the experimental station project.

Meanwhile, the Advanced TV Test Center in Alexandria, Virginia, site of the system's tests, will be rechristened the Advanced TV Technology Center to better reflect its revised purpose—helping broadcast and TV-receiver industries make the transition form analog to digital television. That also will be financed by broadcasters and equipment makers and will serve as a test bed for RF and systems development for digital broadcasting. At our press time, the non-profit center was backed by CBS, PBS, and Pioneer Electronics, with other sponsors expected to join soon.

DVD timetable snagged

Whether the new DVD system will be ready in time for its scheduled fall debut is still unknown, but the barriers continue to arise one after another. Technically, that introduction date appears to be feasible, but there are still problems in the path of this high-density optical system, which is expected to revolutionize video and audio recording as well as computer storage.

Some progress has been made on one of the stickiest problems—the issue of protecting copyrights in the video version. Movie companies generally have been reluctant to commit to recording their recent films on the new medium because its digital nature makes it possible to bootleg almost perfect copies. The movie industry, represented by the Motion Picture Association of America (MPAA), and the EIA's Consumer Electronics Manufacturers Association (CEMA) have agreed on an anti-copy system and hope to propose it to Congress for legislation. However, computer manufacturers were barely consulted—or even informed of the progress of the talks. In some cases their interests are completely different from those of the film companies—copying is desired, or even required, for computer programs.

At press time, this dispute was nowhere near a resolution, although talks with the computer industry have started. And even if there is an agreement, there is no assurance that Congress will pass

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the bill requiring anti-copy protection during this Presidential election year. Even if it is passed, another question is whether it will be passed in time for manufacturers to modify the specifications for the products and still get them on the market this year. And it's not known whether movie companies will release their product on DVD if there is no law by the planned introduction time.

In addition, the movie companies are demanding a "regional coding" system for DVDs to make up for the fact that any DVD can be played on any DVD player, regardless of the television system in use in the country where it's played. As we've reported before, the movie makers want an encoding system to make it impossible for a viewer in England, for example, to play an American movie before it's introduced in British theaters or while it's still on its first run. The most recent proposals envision encoding for five different regions worldwide. While this apparently is no great technical problem, it could mean another time-consuming change in the specifications.

MPEG-1 push for PCs

Even though DVD promises to produce better video pictures—on PCs as well as TV sets—four major companies have launched a joint effort to support the use of MPEG-1-based Video CD in personal computers. The companies are JVC, Matsushita (Panasonic), Philips (Magnavox), and Sony. They are urging computer program developers to incorporate "White Book" video in their programs, arguing that the population of MPEG-compatible computers already exceeds 5,000,000 in the United States and will pass 10,000,000 by the end of this year. The companies argue that whatever the shortcomings of MPEG-1, the White Book specifications are the first step toward MPEG-2, which will be available later via the DVD-ROM. EN

WHAT'S NEWS

continued from page 6

"As the crossover between the consumer electronics and computer industries has increasingly grown, so has the industry's need for one consolidated Spring event which will serve both industries," said CEMA president Gary Shapiro.

Jason Chudnofsky, president and CEO of SOFTBANK COMDEX, added, "By bringing together the power of COMDEX and CES, we will better service a global industry whose needs have become more diverse because of emerging technologies and merging channels of distribution. Clearly, by joining these two events, and creating this new show, we present the ideal venue by which to market and address the requirements of the consumer electronics, computer, and communications industries, collectively."

CES and COMDEX each will continue to market and sell their respective events, while the new trade show and conference will be marketed and sold jointly by both organizations. Operational aspects for all three events will be handled by SOFTBANK COMDEX.

Each of the three trade shows represented in this "mega-event" will maintain its individual focus while enhancing the others and providing exhibitors and attendees with new business opportunities. Attendees to any one of the trade shows will gain the full benefit of the combines events at no additional cost.

DVD copyright legislation sought

Representatives of the consumer-electronics and motion-picture industries have agreed to seek legislation concerning digital video recorders that would protect both intellectual property and consumers rights. The Motion Picture Association of America (MPAA) and the Consumer Electronics Manufacturers Associa-tion (CEMA) plan to submit to Congress a recommendation that will allow the marketing of digital video recorders that provide VCR-like features—such as the ability to time-shift TV programs for later viewing—while giving copyright proprietors additional control over some types of recording in the age of "pristine" digital copies.

The recommendation would assure consumers' unimpeded ability to make home video recordings of anything shown over broadcast or basic cable television, and allow consumers to make at least one copy of subscription or other "pay-cable" programming. Digital copies of that copy, however, may be prevented. And copyright holders would be allowed to prohibit consumers from copying from pay-per-view, video-on-demand programming and from pre-recorded media. Those provisions would apply only to digital recording devices and recordings made from digital sources with conventional analog VCRs. No royalties on recorders or blank media would be called for.

The recommendation also includes technical standards that assure compliance with the system. Manufact-urers of recording and other devices involved in the transmission and playback of video programming would be required to comply with those standards. Finally, the recommendation includes a proposal of updating the system to take advantage of new technology.

Semiconductor Orders Exceed Shipments

The Semiconductor Industry Association (SIA) San Jose, Calif., reported a book-to-bill ratio of 1.18 in October, up from September's 1.15 but below July's record of 1.23. The book-to-bill ratio compares orders with shipments and is a bellwether of industry health. A number of more than one indicates positive growth, and a ratio of 1.18 indicates that for every $100 of devices shipped $118 of devices were ordered.

SIA also forecast that the North American market would grow 40.2% to $47.1 billion by the end of 1995. One reason for the gain, according to SIA, is continued strength in personal computer sales, but data communications, telecommunications, consumer electronics, and automotive are also doing very well. EN

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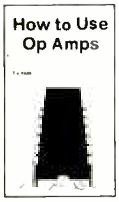

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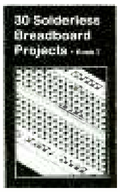

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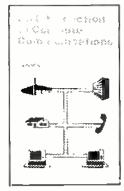

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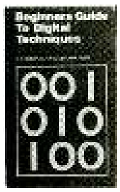

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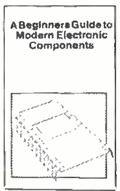

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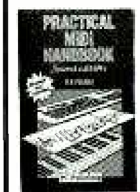

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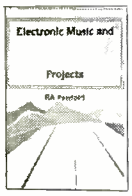

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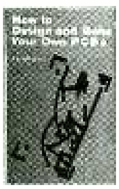

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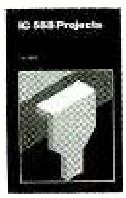

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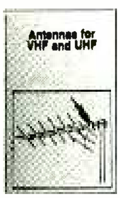
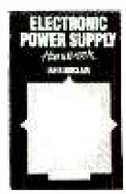
☐ **PCP109—Everyday Electronics Data Book ... $10.00.** An invaluable source of electronics information—the text contains sections that deal with the underlying theory of electronic circuits and a wide range of practical electronic uses for everyone.

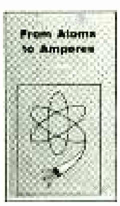


☐ **BP301—Antennas for VHF and UHF...$6.00.** From installing a TV or FM antenna to setting up a multi-antenna array for shortwave listening or amateur radio, this book explains the basics of VHF and UHF antenna operation and installation. The text describes in easy-to-understand terms the essential information about how antennas work, the advantages of different antenna types, and how to get the best performance.

☐ **BP297—Loudspeakers for Musicians...$6.25.** Contains all the information that a working musician needs to know about loudspeakers; the different types, how they work, the most suitable for different instruments, for cabaret work, and for vocals. It gives tips on constructing cabinets, wiring up, available fittings, finishing and how to connect multi-speaker arrays, etc. Includes ten enclosure designs with plans.

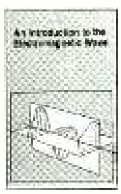


☐ **PCP110—Electronic Power Supply Handbook...$10.95.** All types of power supplies used for electronics purposes are covered in detail, starting with cells and batteries and extending by way of rectified supplies and linear stabilizers to modern switch-mode systems, IC switch-mode regulators, DC-converters and inverters. The devices, their operating principles and typical circuits, are dealt with in detail.



☐ **BP254—From Atoms to Amperes... $6.50.** Explains in crystal-clear terms the fundamentals behind the whole of electricity and electronics. Really helps you to understand the basis of the complex subject perhaps for the first time ever.

☐ **PCP101—Practical Digital Electronics Handbook...$9.95.** An introduction to digital circuits, logic gates, bi-stables, timers, microprocessors, memory and I/O devices. A special feature of the book is the section on digital test gear projects.



☐ **BP315—Introduction to the Electromagnetic Wave...$5.95.** A fundamental and easy-to-understand approach to a complicated theory topic. The beginner requires no more than elementary mathematics and basic knowledge of electronics.

☐ **#228—Essential Theory for the Hobbyist...$5.25.** Supplies to the hobbyist background knowledge tailored to the specific requirements of the hobbyist. Relevant material is presented it in a readable manner with minimum mathematics.

TEST EQUIPMENT SPECIALS

☐ **BP239—Getting the Most from Your Multimeter...$5.95**
Covers analog and digital gear, component and gear testing.

☐ **BP267—How to Use Oscilloscopes & Other Testing Equipment...$6.95**
Get with the next step to proficient troubleshooting.

☐ **PCP111—Electronic Test Equipment Handbook...$13.95**
The all-purpose, all-pro handbook that covers basics to in-circuit testing.

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☐ **BP85—International Transistor Equivalents Guide...$7.50**
The ultimate guide to replacing foreign and domestic transistors.

☐ **BP108—International Diode Equivalents Guide...$5.95**
Rectifiers, Zeners, LEDs, OCIs, diacs, triacs...all hobby types.

☐ **BP140—Digital Equivalents and Pin Connectors...$12.50**
A master reference for builders who design projects.

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Q & A

READERS QUESTIONS, EDITORS ANSWERS

Negative resistance

Q *When working with parallel circuits, I was taught that the total resistance is always less than the smallest of the resistances in parallel. However, I recently ran across a reference that said this is not true if one of the resistances is negative in an active circuit. What is meant by this?—K. S., Brooklyn, NY*

A As you surmise, there is no such thing as a negative resistor—that is, there is no component which, without an external power source, will "help electrons along" and undo the effect of a positive resistance. Even a battery doesn't have negative resistance in this sense, because it produces a constant voltage rather than a voltage proportional to current.

Negative resistance in electronic theory refers to either of two things. First, some components have a negative dynamic resistance. That is, under some conditions, the component suddenly "breaks down" and begins to conduct heavily, so that the voltage across it can decrease while the conduction is increasing—the opposite of what happens in a resistor. Another way of looking at negative dynamic resistance is to say that the component's (real, positive) resistance suddenly drops when a particular voltage is reached. The familiar neon lamp oscillator (Fig. 1) is an example.

Second, some op-amp circuits are set up so that the current in a particular place is the exact opposite of what it would have been if a simple resistor or capacitor had been there. Circuits of this type are called negative-impedance converters (NICs). They are useful because they make capacitors act like inductors, eliminating the need for coils in filter circuits.

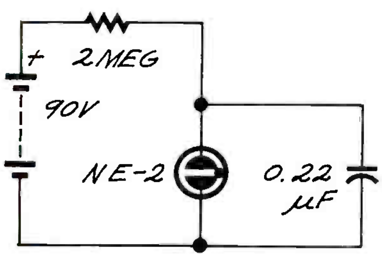


FIG. 1—NEON LAMP HAS NEGATIVE DYNAMIC RESISTANCE—the voltage across it falls while conduction is increasing. As a result, it flashes on and off.

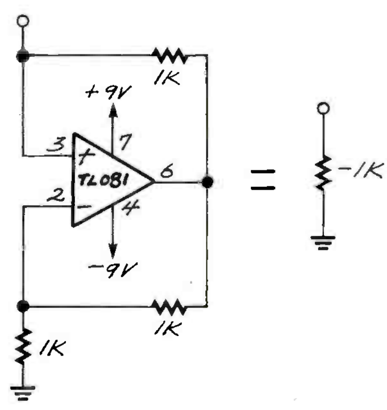


FIG. 2—NEGATIVE IMPEDANCE CONVERTER (NIC) behaves like a negative resistor. Apply a voltage, and it sends a current back into the voltage source.

Figure 2 shows how to make a –1000-ohm NIC. It's essentially a voltage-controlled current source. Recall that a resistor is a voltage-dependent current consumer; this circuit does the opposite. If you connect a battery to its input, the battery will get charged, with exactly the current that the battery would have delivered if you had connected it to a 1000-ohm resistor.

If you put a 1000-ohm resistor in parallel with a –1000-ohm NIC, you'll get what looks like an infinite resistance. No matter what voltage you apply (within limits), the NIC will match it, and all the current flowing in the resistor will come from the NIC, not from the externally applied voltage.

Remote Sensing of Driveway Gates

Q *I have a 200-foot driveway with electric gates at the end of it. I cannot see the gates from the house and cannot tell if they are open or closed. My thought is to install a magnetic reed switch on one gate and a magnet on the other, but I need a circuit that uses low power and will light a bulb that will not get hot if the gates are left open several hours. The wiring is already installed from the gates to the house. For a power source, I would like to use a door bell transformer (24 volts AC) that is used for my gate doorbell/intercom. Could you come up with a circuit for me?—G. Holst, Los Gatos, CA*

A Figure 3 shows the circuit that you need. Light emitting diodes (LEDs) run cool and last practically forever. With an AC power source, you'll need two LEDs wired back-to-back as shown in the diagram; each LED protects the other one from reverse voltage. You can use red, yellow, green, or blue LEDs; you can even get a bi-color LED (red and green) mounted together in the same lump of plastic, and when they're both lit, the combina-

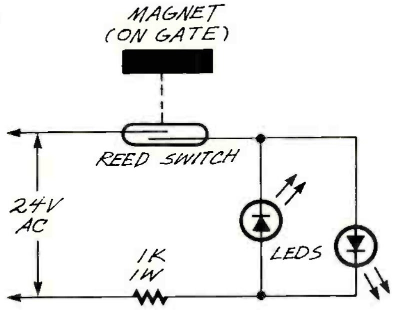


fig.— 3 LEDS INDICATE POSITION of read switch. use 2 leds for ac.

tion looks yellow. The 1000-ohm, 1-watt resistor limits the current through the LEDs; it will run moderately warm.

Where to Take Audio Output

Q *I'm thinking of increasing the power output of my integrated amplifier by adding a separate power amplifier. However, my integrated amplifier does not have preamp-output terminals. Can I connect the power amp to the integrated amplifier's headphone jack? — E. A. C., Calgary, Alberta.*

A Yes. The signal at a headphone output is equivalent to line-level (i.e., about 1 volt peak to peak); the main difference is that headphone outputs can drive heavier loads than ordinary line-level outputs.

However, any noise or distortion originating in the final stages of the integrated amplifier will be present in the headphone signal. An amplifier with pre-out terminals would let you bypass the final stages and get somewhat higher quality. The difference may or may not be significant depending on whether your main need is for higher fidelity or just more sound (to fill a large room or overcome background noise).

HOW TO GET INFORMATION ABOUT ELECTRONICS

Books: Several good introductory electronics books, including *Building Power Supplies*, are available at Radio Shack.

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

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

Copies of past articles in *Electronics Now*, *Radio-Electronics*, *Popular Electronics*, and *Hands-On Electronics* are available from our Reprint Bookstore, 500-B Bi-County Road, Farmingdale, NY 11735 (1-516-293-3000).

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

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

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

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

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

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

Writing to Q&A: We welcome your questions. The most interesting ones are answered in print, usually within 9 months. Please be sure to include plenty of background information (we'll shorten your letter for publication). *If you are asking about a circuit, please include a complete diagram.* We regret that we cannot give personal replies.

AM receiver sensitivity

Q *After much research on automobile radios I have determined that the performance of all recent radios is specified only for FM reception. As far as AM is concerned, "you get what you get" and it is far from satisfactory as far as sensitivity is concerned. Can you offer any suggestions as to how AM reception can be improved with present-day AM car radios? — R. E. S., Lambertville, N.J.*

A The car radios that we've used lately have excellent sensitivity on AM, at least as good as their counterparts of 30 years ago. The reason sensitivity isn't specified is that all good AM radios are sensitive enough to pick up atmospheric noise, and there's no point in adding more sensitivity beyond that point.

You might want to compare the car radio to a good line-powered radio at the same location. If the car radio is disappointing, there are two obvious opportunities for improvement. One is to reduce engine noise by using standard techniques (see the *ARRL Handbook for Radio Amateurs*). The other is to install a longer antenna. Almost all car radio antennas nowadays are 30-inch whips tuned for optimum FM performance. Older-style, 5-foot antennas pick up AM noticeably better.

Of course, if the radio has an AM antenna trimmer, it should be adjusted for best performance at the frequency of most interest to you. This is typically a screwdriver adjustment which you access by pulling off a knob, as described in the radio's instruction book. Not all radios have them, however.

TV Manual Needed

Q *Where can I get schematics of Curtis Mathes TVs?—W. Loving, Beech Island, SC*

A Try Howard W. Sams & Co. at 1-800-428-7267, or Curtis Mathes at P. O. Box 112, Athens, TX 75751, 1-903-675-6886

Switching colors

Q *I need to drive a bi-colored LED in such a way that if an SPST switch is closed, you get one color (green), and if the same SPST switch is open, you get the other color (red). Yes, the switch must be SPST and I'm using the three-terminal (common-cathode) version of the LED. — A. M. K., Branford, Conn.*

A Figure 4 shows one way to do it. The problem is complicated by the fact that the cathodes of the LEDs must be connected together (we've drawn them separately, but you can use two LEDs in a single package).

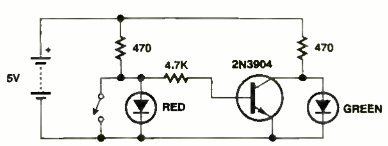


Fig. 4—A single-pole, single-throw switch controls which LED is on.

The solution is to turn off the LEDs by shorting across them rather than by opening the circuit. The transistor is biased "on" and shorts across the second LED whenever the switch is not shorting across the first LED.

Care and feeding of lead-acid battery

Q *I have replaced my camcorder's aging and pesky nickel-cadmium battery with a 12-volt, 2-ampere-hour sealed lead-acid battery, together with some circuitry to reduce the voltage to about 6.3 V. What is the correct float charge voltage for the battery, and should the charger be connected to it through two paralleled 12-volt 1-amp light bulbs? — W. A. E., North York, Ont., Canada.*

A The correct float charge voltage for a 12-volt lead-acid battery is about 14.1 volts. Whether you need light bulbs or other current limiting components depends entirely on the design of your charger; the two light bulbs, as you suggest, will do fine if you are charging from a regulated power supply that can deliver 2 amps. If you want to limit the charging current to a maximum of 1 amp, use just one light bulb.

Since you need 6.3 volts, it might be simpler to use a 6-volt lead-acid battery, which will give exactly 6.3 volts under normal conditions.

Power-hungry?

Q *I built a two-channel portable guitar amplifier with two TDA2006s based on a circuit in your April 1990 issue. I'm using four 9-volt alkaline batteries, but they get hot and run down fast. What can I change? Should I use car batteries? — W. E. B., Newport News, Va.*

A Four nine-volt batteries just don't contain enough energy to provide more than a few minutes of room-filling music, especially if the music includes lots of bass, which requires a lot of the energy to reproduce. (Little transistor radios get decent battery life because their audio contains very little bass.)

All of the power delivered to the speakers has to come from the batteries. Each TDA2006 can deliver as much as 10 watts. When it's doing that, your battery pack has to supply *at least* 20 watts, five watts from each of the four batteries. To deliver five watts, a 9-volt battery has to produce a current of 555 milliamperes . That's enough to run it down in minutes.

There *is* something you should check. With no audio input, how much current does the amplifier draw? It shouldn't be much more than 60 milliamperes per channel. If it is, you have an oscillation problem. To counteract oscillation, make sure that you've included a 1-ohm resistor in series with a 0.22-µF capacitor across the output of each TDA2006, and a 0.1-µF capacitor across the power supply pins; these components should be as close to the chip as possible.

Rather than use bigger batteries, you might want to build a line power supply. For guidance, see Radio Shack's book, *Building Power Supplies*

Complicated timer/controller

Q *I am trying to design and build a timer/controller with a programmable timer to allow it to activate at 4 or more selected times of day. I would also like the controller to respond to light (sunrise and sunset), and I'd like to remotely activate it from a distance of 500 yards. Can you recommend a set of ICs and a schematic that will produce these results? — D. R., Houston, Tex.*

A You don't need a *circuit*, you need a *computer*. That is, the way to build your timer/controller is to write a suitable program for a microcontroller.

Once programmed, the microcontroller runs on battery power with just a few support components. Many microcontrollers include analog-to-digital converters (to which you could connect a photocell); all of them have digital output ports that can be used to control relays, motors, and the like.

The easiest microcontroller to get started with is probably the Parallax "BASIC Stamp," described in Don Lancaster's column in this magazine in several recent issues (starting May 1995). It costs $29 and is programmed in BASIC. The manufacturer is Parallax, Inc., 3805 Atherton Road, Rocklin, CA 95765. If you can handle assembly language, you may prefer a Microchip PIC or Philips 87C750, each of which costs only a few dollars.

Your 500-yard remote-control requirement is tougher. Can you use a long cable? If so, an RS-232 link to a PC, at a low baud rate, should work fine. Radio control is not so easy; nobody has come up with cheap and easy homebrew radio modems yet.

TRANSISTOR DATA BOOKS

Q *Can you recommend the most up-to-date books or manuals that contain the operating curves and characteristics of most all transistors (domestic and foreign)?—A. Wiegand, Helena, MT*

A Unfortunately, there is no comprehensive book of that type, as far as we know. Fortunately, it isn't necessary. Unlike a tube, a transistor doesn't have a well-defined set of characteristic curves; two transistors of the same type may differ in gain by a factor of 10 or more. The only characteristics of a transistor that you can rely on are the polarity (PNP vs. NPN), material (usually silicon), packaging, pinout, and maximum ratings.

The simplest way to find out about a transistor is to look it up in the ECG or NTE substitution directory, and read off the characteristics of the corresponding ECG or NTE substitute. The maximum ratings for the original transistor might be slightly lower than those of the substitute.

Many popular industrial transistors are described in books published by Motorola, National Semiconductor, and Philips. You can get directories of Japanese transistors from MCM Electronics (call 1-800-543-4330 and ask for a catalog). EN

LETTERS

SEND YOUR COMMENTS TO THE EDITORS OF ELECTRONICS NOW MAGAZINE

THE FUTURE IS NOW

Magnetically-propelled trains operating on conventional rails ("What's News," Electronics Now, January 1996) are not new. Such a system has been operating here for the past 10 years. SkyTrain, as it is called, operates on a 28-kilometer, mostly elevated guideway serving the cities of Surrey, New Westminster, Burnaby, and Vancouver.

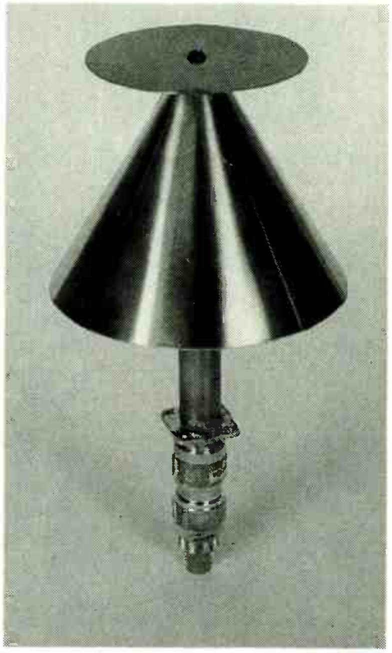
On-board linear induction motors push against a central reaction rail, consisting of a series of aluminum plates located on the side of the guideway. The cars are driverless, controlled by on-board computers linked to a control center. The top speed is about 80 kilometers per hour, or 50 miles per hour. That does not seem particularly fast, but it appears quite rapid compared to the snail-paced, gridlocked automobile traffic over which it passes. The route, including 20 station stops, is covered in 39 minutes. Trains run every five minutes.

Just because the cars are driverless does not mean the system is unmanned. On-board personnel check tickets and maintain order. As a result, the system is virtually graffiti-free and as safe, or safer, than any similar conventional system. Most of the public complaints about SkyTrain come from those who are not served by it and would like to see the system extended to their areas.

Similar, smaller systems using the same technology operate around downtown Detroit and also in the Toronto suburb of Scarborough.
DAVE ELEY
Surrey, British Columbia, Canada

KUDOS FOR THE ATV TRANSMITTER

I just finished reading "Amateur TV Transmitter" in the May issue, and would like to thank you for publishing William Sheets and Rudolf Graf, who write the most interesting articles in *Electronics Now*.



HERE'S A PEEK at the UHF discone antenna. It's made from copper and brass parts that give it a golden appearence. You can build it from plans that will appear in the August, 1996 issue of Electronics Now.

I look forward to the upcoming article on the downconverter, and, I hope, a few more details on the corner reflector and other antennas used on this project. Perhaps expanding on the few alluring references to airborne remote-control models would make for another interesting series of articles ... which would, in turn, more than justify my subscription for another year or two!
JAMES M. FOSTER, KD6GEJ
Cardiff by the Sea, CA

Check out page 57 in this issue to discover the complete plans for a matching UHF corner-reflector antenna for the ATV transmitter and downconverter projects.

In the August, 1996 issue we'll present plans for a UHF discone antenna that's easy to build and functions perfectly.

NO MORE MAC ATTACKS!

Randy Jones' letter titled "Sorry, Mac" (*Electronics Now*, May 1996) was a hoot! Those poor Mac users out there! They can't find any software at the local Walmart; they can't go down to the gas station and get a new fan belt for their "Daimler Benz" Macs; and, worst of all, they can't call Microsoft and bask in the superb tech support for Windows. What a joke! He even trotted out the tired old Betamax analogy (never heard that one before).

The fact is that people have been using those lame arguments to predict the imminent demise of the Mac ever since it was first rolled out in 1984. And, like the Energizer bunny (to use another tired analogy), they keep going, and going, and going. My advice to Mr. Jones is to get out of the "break rooms" and obtain some first-hand information.

I receive about a dozen different Mac-only mail-order catalogs each week. Last week, after researching the products in three different Mac magazines, I called one of the companies at 7 PM and ordered a third-party Mac peripheral. I received the merchandise at 9 AM the next day (at no extra charge).

Here is what happened next: I opened the box, attached the power cord and SCSI cable to my Mac, turned it on, and began using it immediately! Sorry, I can't tell you how good the tech support was because I didn't need any. In fact, I haven't called any tech support hot lines since I stopped using Microsoft QuickBasic and switched to FutureBasic. I do miss the Microsoft DJ though" "Average hold time in the Windows group is 47 minutes. Now back to the hits!" Ha, ha, ha!

"You can't get any software for the Mac," is the oft-heard argument, yet the average Mac user has (and uses productively) more applications than the average PC user. Installing new applications is no big deal on the Mac, and neither is learning how to use them. Maybe there are only 5000 Mac software products out there, instead of 20,000 (I don't know the real numbers), but the only ones that really matter are the ones you actually use productively.

The real question is why the PC world feels so threatened by the Mac, and why is it so obsessed with stamping it out? I read PC magazines, too (including Jeff Holtzman's column in *Electronics Now*), and it is always Mac this, Mac that. Yet the Wintel platform is rarely mentioned in the Mac publications.

The truth is, we don't care, we go happily about our business, immune from the multitude of hassles faced by the average Wintel user. Does the PC community really think their interests will be served if the Mac goes away and personal computing really becomes a Bill Gates monopoly? Actually, I think Bill has bigger fish to fry—watch out Unix!

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

ERRATA SHEETS AVAILABLE

A full-page ad for our books, "Communications Licensing and Certification Examinations," and "Practice Tests for Communictions Licensing and Certification Examinations" recently appeared in *Electronics Now*. We regret, however, that some errors were published in the books.

We are offering errata sheets to anyone who has purchased one or both books. Those wishing to receive the errata sheets should send a stamped, self-addressed envelope to the address that follows.

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P. O. Box 2077
Melbourne, FL 32902-2077

EQUIPMENT REPORTS

Ramsey Electronics FM-25 Stereo Broadcasting Kit

Put a signal out on the air!

CIRCLE 15 ON FREE INFORMATION CARD

The Ramsey Electronics FM-25 kit lets you build a FM stereo broadcaster and put your signal anywhere on the FM band. Why would you want to do that? Well, the reasons are numerous. How about using it as a kind of whole-house audio system? With the FM-25, you could listen to your CD changer anywhere in the house where you had an FM receiver. Better yet, you could listen to it outside with a portable radio. We find that it's a great way to enjoy commercial-free music when we have some friends over.

We also find the FM-25 a great way to let us listen to our favorite radio station on a personal portable when we're outside doing yard work. It just so happens that our favorite station has a low-power transmitter operating from a university about 30 miles away. We have no problem picking up the signal with a rooftop antenna, but we have almost no luck on a portable, Now, we can feed the output of our stereo receiver into the FM-25, and then re-broadcast it to our portable.

Building the transmitter

The FM-25 kit is relatively easy to build. All of the components are mounted on a single-sided printed-circuit board. The component side of the board is silk-screened with the location of all parts. The solder side of the board features a solder mask that help to reduce the chance of creating an inadvertent solder bridge across adjacent pads. An experienced builder should be able to assemble the kit in one evening; a beginner will probably require twice that to complete the 265 solder points.

The heart of the circuit consists of three integrated circuits: a Rohm BA1404 stereo transmitter IC, a Motorola MC145170 phase-locked loop (PLL) frequency synthesizer with serial interface, and a 68HC705 8-bit microcontroller.

The Rohm chip was originally designed for use in automotive CD systems, where it would allow signals from the CD player to be fed to the existing audio system throughout the antenna input. As it turns out, of course, the BA1404 also makes an excellent stereo broadcaster.

One potential problem with FM transmitters comes into play when a digital tuner is used to receive them. If the transmitted signal isn't exactly on frequency, the receiver won't be able to receive it. Analog radios, of course, can tune in an off-frequency signal without problems. A digital receiver, with its discrete tuning steps, cannot. The MC145170 PLL and the 68HC705 8-bit microcontroller ensure good on-frequency performance.

The microcontroller looks at the settings of three DIP switches to determine the frequency of operation. Each DIP switch has four positions, and they allow the frequency to be entered in binary-coded decimal format. For example, to set the transmitter to a frequency of 89.9 MHz, the switches would be set, in binary, to 8, 9, and 9 respectively. For frequencies above 100 MHz, the first switch would be set to a value of 10.

The microcontroller is smart enough to disallow any illegal frequencies. For example, only the first DIP switch can be set to a value of 10. Any other switch setting greater than 9 will be read as a zero. Also, and out-of band frequencies will not be allowed, and the transmitter will default to a frequency of 88.1 MHz.

After the microcontroller reads the switches, it sends the 16 bits of frequency information to the PLL frequency synthesizer serially. An additional 32 control bits of control information are also sent.

The PLL IC operates with a 4-MHz crystal. Under control of the microprocessor, it divides the 4-MHz clock by 40 to obtain a stable reference frequency of 100 kHz. The PLL also examines the output of the BA1404 FM transmitter chip and divides it by N, where N is the desired frequency in megahertz times 10.

Using the example frequency of 89.9 MHz, the PLL would divide the output of the transmitter chip by 899, and compare it with the 100-kHz reference frequency. It uses this information to increase or decrease the voltage across a varactor diode.

A varactor diode is a specially

manufactured diode whose capacitan varies with changes in its reverse-bias voltage. In essence, a varactor is a voltage-variable capacitor. In the transmitter, the varactor is placed in the tuned circuit that sets the operating frequency. The PLL in combination with the varactor perform create a rock-steady, drift-free output from the transmitter.

Under Part 15 of the FCC rules, it is perfectly legal to operate the FM-25 anywhere in the FM band of 88 to 108 MHz. However, you may *not* cause interference with any licensed FM broadcast stations or listeners. You must stop transmitting immediately if any interference is detected.

When choosing an operating frequency, for example, you can't casually tune across the band with a cheap radio and assume that there's no signal available just because you can't hear one. You should really use a quality receiver and rotatable antenna to determine which frequencies are truly open.

In our location outside of New York City, there are few open frequencies. Plus, the population density is high enough that there are a lot of people within the range of the FM-25 transmitter. Unless we were careful, operating the transmitter could cause great interference to someone who was using a good receiver and antenna to pull in what might usually be considered an out-of-market station.

The FM-25 also provides a high-power option. Adding a single jumper across a resistor increases the output power of the FM-25, making its operation illegal in the U.S. However, in some countries it would be perfectly legal to operate in the high-power mode. According to Ramsey, some entire Caribbean islands are served by radio stations using the FM-25 as their transmitter.

All in all, the FM-25 is a quality kit that is designed to work the first time you throw the switch on. It is supplied with a plastic case, a whip antenna, an AC power adapter, and a well-written assembly manual. The kit is available from Ramsey Electronics, Inc., 793 Canning Parkway, Victor, NY 14564; tel: 716-924-4560. The price of the kit is $129.95. EN

TIPS FOR MAIL ORDER PURCHASE

It is impossible for us to verify the claims of advertisers, including but not limited to product availability, credibility, reliability and existence of warranties. The following information is provided as a service for your protection. It is not intended to constitute legal advice and readers are advised to obtain independent advice on how to best protect their own interests based upon their individual circumstances and jurisdictions.

1. **Confirm price and merchandise information** with the seller, including brand, model, color or finish, accessories and rebates included in the price.

2. **Understand the seller's return and/or refund policy**, including the allowable return period, who pays the postage for returned merchandise and whether there is any "restocking" or "return" charge.

3. **Understand the product's warranty.** Is there a manufacturer's warranty, and if so, is it for a U.S. or foreign manufacturer? Note that many manufacturers assert that, even if the product comes with a U.S. manufacturer's warranty, if you purchase from an unauthorized dealer, you are not covered by the manufacturer's warranty. If in doubt, contact the manufacturer directly. In addition to, or instead of the manufacturer's warranty, the seller may offer its own warranty. In either case, what is covered by warranty, how long is the warranty period, where will the product be serviced, is there a charge for service, what do you have to do to obtain service and will the product be repaired or replaced? You may want to receive a copy of the written warranty before placing your order.

4. **Keep a copy of all transactions**, including but not limited to cancelled check, receipt and correspondence. For phone orders, make a note of the order including merchandise ordered, price, order date, expected delivery date and salesperson's name.

5. **If the merchandise is not shipped within the promised time**, or if no time was promised, within 30 days of receipt of the order, you generally have the right to cancel the order and get a refund.

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7. **If you have a problem with your order or the merchandise**, write a letter to the seller with all the pertinent information and keep a copy.

8. **If you are unable to obtain satisfaction from the seller**, contact the consumer protection agency in the seller's state and your local Post Office.

If, after following the guidelines, you experience a problem with a mail order advertiser that you are unable to resolve, please let us know. Write to Advertising Department, Gernsback Publications Inc., 500B Bi-County Blvd. Farmingdale, NY 11735.

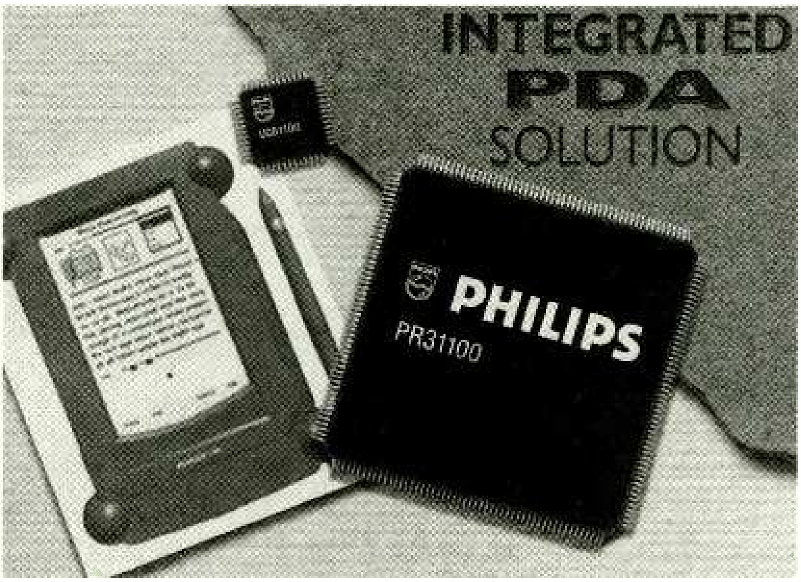
Be sure to include copies of all correspondence.

NEW PRODUCTS

USE THE FREE INFORMATION CARD FOR FAST RESPONSE

INTEGRATED PDA SOLUTION

PHILIPS SEMICONDUCTOR'S PR31100 and UCB1100 with software fax/modem represent a two-chip solution for personal digital assistants (PDAs), personal intelligent communicators (PICs), and other smart communication products. The chipset offers size, cost, and power-consumption improvements, and, according to Philips, "will bring device prices low enough to change the way people think about PDAs."



CIRCLE 20 ON FREE INFORMATION CARD

Because the chipset provides virtually all the functionality needed for a PDA or PIC in just two IC's, most such devices will require only the addition of memory. Competing solutions require a processor and other off-the-shelf chips in addition to one or more custom chips. That approach makes PDA/PICs large and expensive, shortens battery life, lengthens the hardware design cycle, and requires customized software.

In contrast, the PR31100 and UCB1100 allow designers to create various types of wired or wireless PDAs, PICs, screen phones (which allow users to handle phone-related information and over-the-line data on a computer-like display), or Internet access terminals (low-cost, plug-and-play devices that use a TV as a display), simply by taking advantage of different chipset functions. Those applications share the common feature set of LCD display, input via touchscreen and optional keyboard, and communication via telephone lines.

To support those applications, the PR31100 contains an MIPS R3000 RISC core with 4 Kbytes of instruction cache and 1 Kbytes of data cache, plus a hardware multiply/accumulate unit to perform DSP functions. Those computing resources allow the PR31100 to run routines such as the V.32bis (14.4 Kbps) software fax/modem, voice recognition of about 100 words, echo cancellation for high-quality speakerphone performance, and handwriting recognition. Working with a 14-bit telecom codec in the UCB1100, the Philips-licensed software fax/modem eliminates the need for an external modem chipset, which would cost about \$30—almost as much as the chipset and software combined. The PR31100's other features include a complete video controller for both color and monochrome LCDs, along with several industry-standard communications channels.

In addition to the telecom codec, the mixed-signal UCB1100 provides a 12-bit audio codec, a touchscreen interface, four general-purpose analog-to-digital converter inputs (battery voltage measurement), and 10 programmable I/O lines. All of those resources are designed to minimize or eliminate external components.

Philips supplies low-level software drivers and reference designs for the main PR31100/UCB1100 applications. Complete development support is available.

The PR31100/UCB1100 chipset and the software fax/modem license costs \$38 in 100,000-unit quantities.

PHILIPS SEMICONDUCTORS INC.
811 East Arques Avenue
Sunnyvale, CA 94088-3409
Phone: 408-991-2000
Website: http://www.semiconductors.philips.com/ps/

TRIPLE-OUTPUT POWER SUPPLY

THE MODEL 1670 TRIPLE-output power supply from B+K Precision is designed for applications in the servicing, educational, and hobbyist markets where a low-cost solution to multiple outputs is desired. The power supply features a variable DC supply—0 to 30 volts at 0 to 2.5

CIRCLE 21 ON FREE INFORMATION CARD

amps—with variable current limiting, constant current or constant voltage operation, tight regulation, low ripple, and separate digital LCD current and voltage meters. Another fixed 5-volt, half-amp supply is provided for TTL projects, and a fixed 12-volt, half-amp supply is included for mobile electronics and digital CMOS projects.

The Model 1670 costs $199.

B+K PRECISION
6740 West Cortland Street
Chicago, IL 60635
Phone: 1-800-462-9832
Fax: 312-794-9740

HIGH-EFFICIENCY DMM

HC PROTEK'S MODEL D-980 is a highly accurate, 3-3/4-digit multimeter that meets UL standard 1244 specifications. It comes with a protective holster to guard against mishandling, and features an LCD readout and a 3200-count analog bar graph.

The Model D-980 measures AC/DC current from 300 μA to 12 amps, and resistance to 30 megohms

CIRCLE 22 ON FREE INFORMATION CARD

in six ranges. DC voltage can be measured in five ranges, from 300 mV to 1000 volts, with accuracy from 5%. AC voltage is measured in three ranges, from 30 to 700 volts, with an accuracy of ±1.2%. The D-980 also offers data, hold, range, and function select buttons, fused overload protection, diode test, a continuity buzzer, and a low-battery indicator. Test leads, three AAA batteries, and an instruction manual are supplied.

The Model D-980 costs $69.

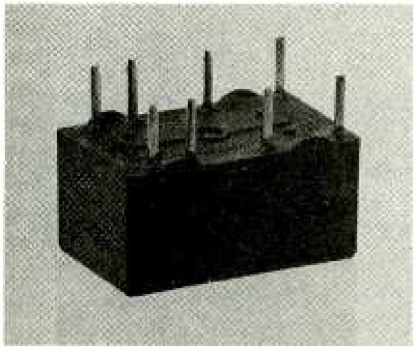
HC PROTEK, INC.
154 Veterans Drive
Northvale, NJ 07647
Phone: 201-767-7242
Fax: 201-767-7343
E-mail: hc protek@aol.com
Website:http://www.techexpo.com/www/hcprotek

TEST AND MEASUREMENT RELAYS

NTE'S R72 SERIES OF SUB-miniature 1-amp relays is specifically designed for use in office automation and test and measurement instruments. The series features high-sensitivity, low-power consumption, and fully sealed construction. The R72 series' operating features, plus the compact size and light weight (0.11 ounces) of the devices, make them well suited for OEM design and as replacement parts in a variety of automation and test equipment.

The series comes with a DPDT

contact arrangement, and is also available in a dual-coil latching type. The R72 relays offer coil voltages of 5, 6, 12, and 24 volts DC. The DC operating temperature range is –40°C to



CIRCLE 23 ON FREE INFORMATION CARD

+70°C. Dielectric strength is 1000 volts AC between coil and contacts, 250 volts AC (latching) between set and reset coils, 750 volts AC between contacts of the same polarity, and 1000 volts AC between contacts of different polarity. Resistance is 50 megohms maximum.

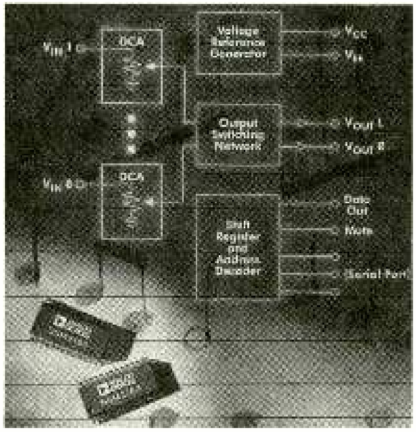
The R72 series costs less than $3 per piece in 1000-piece quantities.

NTE ELECTRONICS, INC.
44 Farrand Street
Bloomfield, NJ 07003
Phone: 1-800-683-6837
Fax: 1-800-683-3338
or 1-800-683-3292 to request QUICKFACTS Document #445

8×2 AUDIO MIXER-ON-A-CHIP

ANALOG DEVICES' SSM2163 IS A functionally complete 8-input audio mixer-on-a-chip. It accepts eight audio channels, provides user-friendly control of volume in 63-dB steps, and can mix individual channels to either the right, the left, or both outputs. It is well-suited for automating many computer audio systems, from high-end multimedia workstations to low-cost PC soundcards. Other applications include professional audio mixing consoles, broadcast equipment, intercom and paging systems, and musical instruments.

The device replaces expensive multichip solutions and improves audio fidelity in computer audio systems. With its industry-standard three-wire serial interface and one data output terminal multiple SSM2163s can be easily daisy-chained for high-end multi-track audio systems. A single mute pin, when driven by a microprocessor reset signal, will silence all eight audio channels simultaneously. No additional external components are needed for fully specified operation.



CIRCLE 24 ON FREE INFORMATION CARD

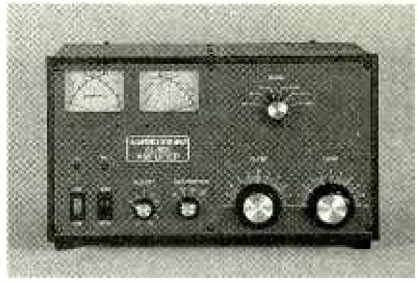
The SSM2163 is a companion to Analog Devices' family of stereo codecs. It signal-to-noise ratio is –82 dBu (0 dBu = 0.775 volts rms), with an additional 10 dBu of headroom, resulting in a total harmonic dynamic range of 92 dBu. Total harmonic distortion plus noise is a low 0.007% at 1 kHz with all levels set for unity gain. The mixer-in-a-chip can be powered by a single (+5- to +14-volt) supply or dual (±4- to ±14-volt) supplies and is available in 28-pin plastic DIP and SOIC packages.

The SSM2163 costs $8 each in quantities of 100.

ANALOG DEVICES, INC.
Ray Strata Technology Center
804 Woburn Street
Wilmington, MA 01887
Phone: 617-937-1428
Fax: 617-821-4273

LINEAR AMPLIFIERS

AMERITRON'S AL-800 AND AL-800H amplifiers provide all-band operation: 160–15 meters, including the WARC bands. They can be modified by the user for 12 and 10 meters. The AL-800H uses two Genuine Eimac 3CX800A7s tubes and boasts 1500 watts "plus." The AL-800 uses



CIRCLE 25 ON FREE INFORMATION CARD

one 3CX800A7 tube and powers up to 1250 watts.

Both amplifiers feature an adjustable slug tuned input circuit and a Pi/(Pi-L) output network, providing smooth tuning and a wide matching range. The amplifiers' grid current limits circuits and protects the tubes. Both display an adjustable front panel and true ALC control. Vernier reduction drives tune and load and make adjustments smooth and easy. A user-modifiable, 32-pound, grain-oriented, silicone steel-core transformer is supplied with high-capacitance computer-grade filter capacitors. Both amplifiers come with dual illuminated cross-needle meters that read peak forward power, reflected power, SWORE high voltage, grid current, and plate current. Other features include multi-voltage operation and air-cooled ventilation systems.

The AL-800H amplifier costs $2295.

AMERITRON
116 Willow Road
Starkville, MS 39759
Phone: 1-800-647-1800
or 601-323-8211
Fax: 601-323-6551

BREAK'R TRAC'R CIRCUIT TRACER

AMPROBE'S BREAK'R TRAC'R BT-100 circuit tracer allows the user to quickly and easily determine the 120-volt AC circuit breaker or fuse that supplies a receptacle or lighting fixture. Well-suited for residential applications, the BT-100 saves time by eliminating trial-and-error troubleshooting and allows breakers to be identified without shutting off power. The two-piece set consists of a small handheld receiver, the BT-100R, which emits an audible tone and displays and LED when the signal, pro-

CIRCLE 26 ON FREE INFORMATION CARD

vided by the transmitter (BT-100T), is sensed on the appropriate circuit breaker or fuse. Adjustable sensitivity on the receiver enables the appropriate breaker or fuse to be identified.

The Break'r Trac'r BT-100 carries a trade price of $39.85.

AMPROBE INSTRUMENT
630 Merrick Road
Lynbrook, NY 11563
Phone: 516-593-5600
or 1-800-477-VOLT
Fax: 516-593-5682

NOTEBOOK-COMPUTER CASE

THE CURTIS CASE FROM Rolodex is a cleverly designed carrying case for notebook computers. It features moveable, self-grip accessories that allow users to customize the case to suit their work habits. The case also features built-in wiring ports, allowing users to run cables through the bag and connect directly into an optional retractable-cord surge protector, in effect creating a portable workstation. The case comes with a key-chain, pen holder, and disk holder. Other self-grip accessories, including a note holder, an eyeglass holder, a cellular-phone holder, all-purpose pockets, accessory pouches and a disk wallet, are available separately.

CIRCLE 27 ON FREE INFORMATION CARD

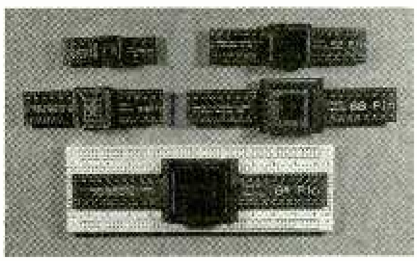
The lightweight Curtis Case features a protective shell over a frame constructed of durable polypropylene for extra strength. An internal flexible strap and shock-absorbing corners secure the notebook PC firmly inside the bag. The reinforced handle is fastened directly through the frame.

The Curtis Case costs $149 in black leather, or $119 in black vinyl. The retractable-cord surge protector, which fits neatly into the case's pocket, provides protection on the AC line and modem/fax lines, and includes a six-foot telephone cord, costs $9.95 with the purchase of the bag. Additional accessories have suggested retail prices of $4.00 each.

CURTIS BY ROLODEX
225 Secaucus Road
Secaucus, NJ 07094
Phone: 1-800-955-9514
or 201-422-0240
Fax: 201-422-0254

LEADLESS CHIP BREADBOARD ADAPTERS

AMAZE ELECTRONICS' SERIES of leadless chip breadboard adapters feature a streamlined, patent-pending design that fits on a single breadboard strip. The adapters are well suited for those who use leadless chips in breadboarding, wire-wrap, and prototyping applications. They are available with 28, 44, 52, 68, and 84-pins. Prices range from $6.95 for the 28-pin adapter to $18.95 for the 84-pin adapter.



CIRCLE 29 ON FREE INFORMATION CARD

AMAZE ELECTRONICS CORPORATION
10395 Mary Avenue
Cupertino, CA 95041
Phone: 408-996-8943
Fax: 408-996-0366

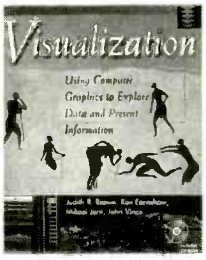
EN

NEW LITERATURE

USE THE FREE INFORMATION CARD FOR FAST RESPONSE

Visualization: Using Computer Graphicsto Explore Data and Present Information

by Judith R. Brown, Rae Earnshaw, Mikael Jern & John Vince
John Wiley & Sons, Inc.
605 Third Avenue
New York, NY 10158-0012
Phone: 1-800-CALL-WILEY
$44.95, including CD-ROM



CIRCLE 337 ON FREE INFORMATION CARD

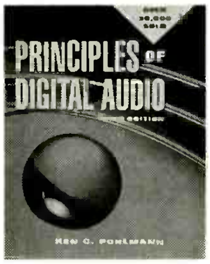
High-quality computer graphics can be used to create virtual rooms for architects or guided tours of human cells for students and doctors. But such computer visualization has been almost exclusively the territory of experienced designers with high-powered computers.

This book brings the magic of computer visualization to the desktop environment. Written in a clear, non-technical style, the hands-on guide helps users create advanced graphics using nothing more than a PC and commercially available desktop software.

Accompanied by a CD-ROM that features examples ranging from the basics of charting and graphing to the most advanced animation techniques, the book allow readers to create effects from two-dimensional drawings to 3D virtual worlds. With more than 100 full-color illustrations, the book explains the basics of computer graphics and visualization. It helps readers learn to combine images, video, and animation to produce original multimedia presentations; apply visualization to scientific, technical, business, and artistic presentations; incorporate online images from the Internet into desktop visualization; and simulate human motion, weather conditions, crash scenarios, and more.

Principles of Digital Audio Third Edition

by Ken C. Pohlmann
McGraw-Hill Book Company
11 West 19th Street
New York, NY 10011
Phone: 1-800-2-MCGRAW
$44.95



CIRCLE 338 ON FREE INFORMATION CARD

This comprehensive introduction to digital audio, now in its third edition, has been updated and expanded to introduce both audio and computer users to the many new technologies that are transforming the field. Aimed at both professional designers and engineering students, the book provides complete details on advances in such areas as optical disc reading, interfacing and networking, perceptual coding theory and applications, and digital audio broadcasting.

The book combines digital audio theory with examples of applications and provides an in-depth database of valuable digital audio information. It includes coverage of digital audio fundamentals, recording and reproduction, error correction, magnetic tape storage, optical storage and transmission, compact disc formats, satellite broadcasting, MPEG coding, digital audio workstations, and digital signal processing. The book reveals all the exciting breakthroughs in digital audio technology for the multimedia age.

Unique Accessories for Test & Measurement

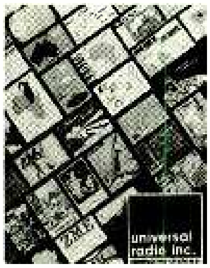
ITT Pomona Electronics
1500 East Ninth Street
Pomona, CA 91766-3835
Phone: 909-469-2900
Fax: 909-629-3317
Free

CIRCLE 339 ON FREE INFORMATION CARD

This catalog features test accessories intended to enhance test equipment from leading manufacturers. Leading off the newest products are complete "take-it-with-you" test kits in carrying cases designed specifically for use with Fluke, Hewlett-Packard, or Tektronix meters and oscilloscopes. The Test Companion kits also include high-quality Pomona test leads, probes, grabbers, and clips, all organized in lightweight, durable carrying cases. The catalog also features DMM test accessories and kits, oscilloscope probes, test clips, cable assemblies, coaxial adapters and kits, banana plugs, enclosures, and IC test clips for popular two- and four-sided devices including new solder-on adapters.

Communications Catalog 96-01

Universal Radio, Inc.
6830 Americana Parkway
Reynoldsburg, OH 43068-4113
Phone: 1-800-431-3939 or 614-866-4267
Fax: 614-866-2339
E-mail: dx@universal-radio.com
free by fourth class mail
$1 by first class mail

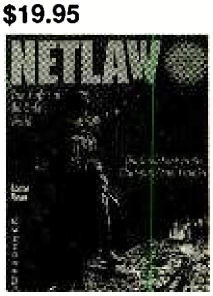


CIRCLE 340 ON FREE INFORMATION CARD

This 112-page catalog covers equipment for amateur, shortwave, and scanner enthusiasts, and also features an impressive selection of antennas, headphones, books, and accessories. Several new items premiering in this catalog include the Kenwood TS-870S transceiver, the Sangean ATS-909 portable receiver, the Lowe HF-250 receiver, the AOR AR5000 receiver, the Grundig Traveller II digital receiver, and the Sony ICF-SW1000T receiver/recorder. Many new antennas and accessories are also introduced. In addition, the catalog provides answers to frequently asked questions in comprehensive, one-page introductions to shortwave, radioteletype, and amateur radio.

NetLaw: Your Rights in the Online World

by Lance Rose
Osborne McGraw-Hill
2600 Tenth Street
Berkeley, CA 94710
Phone: 1-800-822-8158
$19.95



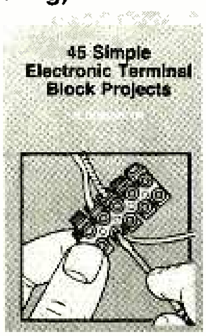
CIRCLE 341 ON FREE INFORMATION CARD

In the brave new world of cyberspace, online legal rights are continually evolving. Issues like privacy, copyrights, and freedom of speech don't necessarily work the same way in a digital environment, and rights to which you may be accustomed in print or broadcast media might not apply. System operators and BBS users alike need to know their rights, as well as the legal risks involved in online communications.

This book provides an introduction to the world of online law, explaining how everyday online behavior is protected or prohibited under the law. Using fascinating case studies, it covers the hottest and most widely debated topics affecting system users and operators, including commercial relationships, ownership of information, searches and seizures, and sexually explicit materials. The book discusses the potential demise of the copyright on the Internet, the legal risks faced by corporations online, how the First Amendment protects online systems and users, how to make an online contract, and how obscenity is defined and which laws apply to it.

45 Simple Electronic Terminal Block Projects

by R. Bebbington
Electronics Technology Today Inc.
P.O. Box 240
Massapequa Park, NY 11762-0240
$6.25 (plus $3 shipping and handling)



CIRCLE 342 ON FREE INFORMATION CARD

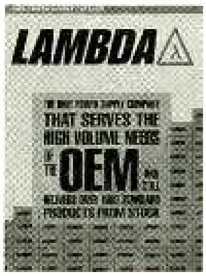
When soldering is off-limits(for absolute beginners in electronics, particularly youngsters(simple terminal block projects offer a safe introduction to the hobby. The 45 projects presented in this book not only do not require soldering, but also are powered by nothing more dangerous than a small battery. They meet the most stringent safety standards.

All of the projects can be constructed by complete newcomers to electronics, on terminal blocks using only a screwdriver and other simple hand tools. By following the layout diagrams, most of the projects can be finished in a matter of minutes. And they can be readily unscrewed, if desired, to make new circuits using the same parts. A theoretical circuit diagram is included with each project to help broaden the hobbyist's experience and knowledge.

The projects cover a wide range of interests. They fall under the chapter headings: Connections and Components, Sound and Music, Entertainment, Security Devices, Communication, and Test and Measuring.

1996 Power Supply Catalog

Lambda Electronics Inc.
515 Broad Hollow Road
Melville, NY 11747
Phone: 516-694-4200
Free



CIRCLE 343 ON FREE INFORMATION CARD

This 192-page catalog contains detailed specifications, mechanical drawings, and prices of more than 1000 power supplies, DC-DC converters, power systems, and accessories.

The catalog features more than 200 new products. Listed for the first time is the SV Series of low-cost, single- and multiple-output, power supplies from 100 to 300 watts; the PM Series of low-profile, low-cost 10-watt to 30-watt converters, specifically designed for telecommunications, computer, and data-communications applications; the Ultraflex Series of standard, modular power supplies for 400- and 600-watt applications with 1 to 10 outputs; and the FE Series of high-density distributed power front ends for 24- and 48-volt DC converters, intended for computer and telecommunications uses. The RM Series 12-watt to 100-watt DC-DC converters, which offer 90% efficiency and do not require a heatsink, are well-suited for telecommunications applications such as broad-band distribution, ATM exchanges, LANs, and multimedia systems.

FRAMM Technology Overview

Dynamem Inc.
22 Manchester Road
Derry, NH 03038
Phone: 603-432-1200
Fax: 603-432-0361
Free


CIRCLE 344 ON FREE INFORMATION CARD

Dynamem's patented Foldable Rigid Assembly Memory Module (FRAMM) technology, which can increase PC and workstation working memory by as much as 200 percent, is described in this four-page brochure.

The memory increase is achieved through the folding of the module's flexible, multi-layered circuit board, on which the memory chips are mounted. The resulting surface area and memory capability of the module are at least twice that of a standard module of the same dimensions. The brochure outlines additional benefits of FRAMM technology, including ease of installation and cost-effectiveness. (Please use a company letterhead when requesting the brochure.)

1996 Test & Measurement Products Catalog

LeCroy
Customer Care Center
700 Chestnut Ridge Road
Chestnut Ridge, NY 10977-6499
Phone: 1-800-5-LECROY
Fax: 914-578-5985
Free

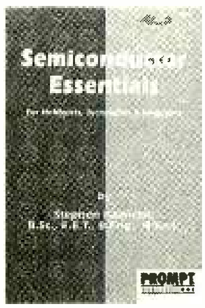
CIRCLE 345 ON FREE INFORMATION CARD

This 194-page catalog features LeCroy's complete lines of test and measurement products, including the 9300 Series portable digital oscilloscopes, software and hardware options, probes and accessories, waveform generators, and programmable pulse generators. In addition, the catalog provides a wealth of technical information, including in-depth tutorials on the fundamentals of digital storage scopes and creating waveforms.

Application notes cover digital storage oscilloscope (DSO) applications in high-speed electronics, finding intermittent faults in electronic signals, the benefits of long memory in digital scopes, new tools for wireless design, and the benefits of DSOs in communications and power-supply design and testing. A comprehensive glossary of technical and test-instruments terms is also included.

Semiconductor Essentials for Hobbyists, Technicians & Engineers

by Stephen Kamichik
Prompt Publications
2647 Waterfront Parkway, East Drive
Indianapolis, IN 46214-2012
Phone: 800-428-7267 or 317-298-5710
Fax: 317-298-5604
$16.95



CIRCLE 346 ON FREE INFORMATION CARD

This book represents the first course in electronics at the technical and engineering levels. The information it offers will help readers gain hands-on knowledge of semiconductor diodes and transistors. The book covers semiconductor and diode chemistry, rectifier diodes, Zener diodes, transistor chemistry, transistor DC and AC analysis, transistor biasing, and it details transistor and rectifier diode circuits.

Each chapter is a lesson in electronics, with problems at the end of the chapter to test the reader's understanding of the material presented. The generously illustrated book serves as a useful instructional tool for the student and hobbyists, as well as a practical review for professional technicians and engineers. EN

BY DON LANCASTER

Delta-wye transforms, and building your own Tesla coil

ONE OF OUR RECENT *TINAJA QUEST* WINNERS WAS D.C. COX FROM *RESONANCE RESEARCH*. THIS FIRM IS THE LEADING SUPPLIER FOR THE BIGGER TESLA COILS AND VAN DE GRAFF GENERATORS YOU FIND IN SCIENCE centers, museums, and planetariums. He is also newly offering his free do-it-yourself reprint on building up your own smaller Tesla coil.

A Tesla coil is nothing but a huge, resonant transformer that is intended to deliver high-voltage, high-frequency electricity—otherwise known as "lots of sparks." Sparks which literally can stand your hair on end, or light up an unconnected fluorescent tube you are holding in your hand.

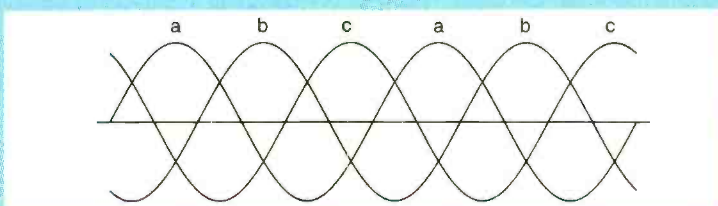
The key secret to Tesla coil design is a high-Q air-core transformer with precisely the right amount of input source coupling. The resonance buildup produces a "Q-multiplier" effect to generate the high voltage.

The ultra high voltages are usually safe because they are high-frequency alternating current. Thus, they exhibit the *skin effect*, a property of high-frequency AC currents which causes them to travel only on the *outside* of conductors. The higher the frequency, the smaller the skin effect depth. The output from a Tesla coil can often be routed along a person (or a chain of people) without significant shock hazards.

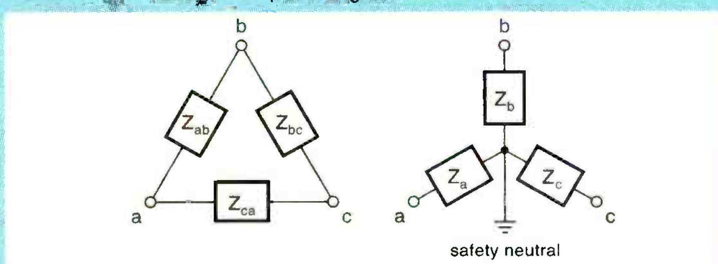
Amazingly, most of the Resonance Research machines still use a spark gap for their input switching. Above a certain power level, spark gaps still have compelling advantages over tubes or solid-state devices.

Needless to say, a Tesla coil is one really horrendous generator of radio frequency interference or

Three phase power consists of a triad of voltages spread by 120 electrical degrees. Advantages for higher energy users include a constant and a more efficient power flow, lower vibration machinery that starts and reverses easily, and rectifiers that are more economically filtered...



Two methods of connecting loads to a three phase system are the Delta and the Wye. Each has advantages and limitations. Note that currents in a Delta load are higher for a given input voltage...



For any Delta load, there is an equivalent set of Wye impedances, and vice versa. Here are the classic Delta-Wye transform pairs...

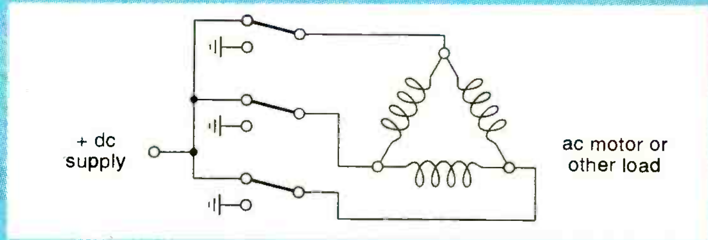
$$Z_{ab} = \frac{Z_aZ_b + Z_bZ_c + Z_cZ_a}{Z_c} \qquad Z_a = \frac{Z_{ab}Z_{ca}}{Z_aZ_b + Z_bZ_c + Z_cZ_a}$$

$$Z_{bc} = \frac{Z_aZ_b + Z_bZ_c + Z_cZ_a}{Z_a} \qquad Z_b = \frac{Z_{ab}Z_{bc}}{Z_aZ_b + Z_bZ_c + Z_cZ_a}$$

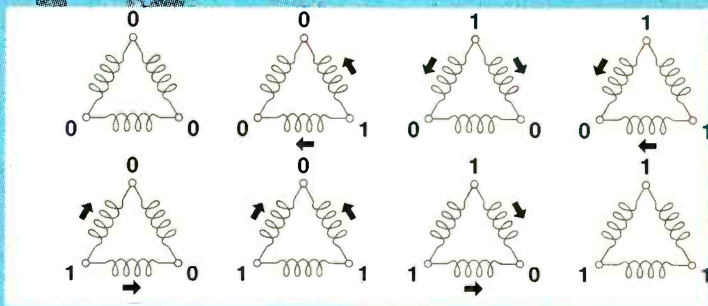
$$Z_{ca} = \frac{Z_aZ_b + Z_bZ_c + Z_cZ_a}{Z_b} \qquad Z_c = \frac{Z_{bc}Z_{ca}}{Z_aZ_b + Z_bZ_c + Z_cZ_a}$$

Fig. 1— SOME FUNDAMENTALS of three phase power.

A three phase delta load is normally driven by three "half bridge" drivers. These usually require a total of six power switching devices...



When using digitally switched unipolar inputs, there are only eight possible bipolar motor winding current results...



Just as there are delta-wye transforms, we can list these eight pairs of unipolar delta input to bipolar motor coil forward and reverse transforms...

0 0 0	0 0 0
0 0 1	0 – +
0 1 0	– + 0
0 1 1	– 0 +
1 0 0	+ 0 –
1 0 1	+ – 0
1 1 0	0 + –
1 1 1	0 0 0

+ 0 –	1 0 0
+ – 0	1 0 1
0 + –	1 1 0
0 – +	0 0 1
– + 0	0 1 0
– 0 +	0 1 1
0 0 0	0 0 0
0 0 0	1 1 1

Further analysis easily proves that *any* motor winding magic sinewave bit sequence which has a zero third harmonic will end up fully delta friendly.

Fig. 2 — THREE PHASE "DELTA FRIENDLY" magic sinewaves require only simple input switches. Yet they produce positive, negative, or zero winding currents. Provided you use carefully chosen sequential commands.

RFI. These can be a most blatant violator of FCC Part 15 regulations and therefore *illegal!*.

There are several persistent *urban lore* type myths that Tesla coils are in some manner a "suppressed" or "lost" source of "free energy." The original myth can be traced to one of two sources: Either Tesla's really bad misunderstanding of differences between resonance stored energy and source converted energy. Or as something between too much hype and an outright scam to obtain lab funding.

Research carefully and objectively, and you will discover *there is not one shred of either actual or theoretical evidence that this sort of hogwash is even remotely possible.*

Tesla coils are closely related to TV flyback transformers and to all the UHV ultra high voltage power line transmission research. In spite of countless hours of formal research in these fields, not the least hint of any over-unity energy has emerged.

Another good source for hands-on Tesla stuff is *Lindsay Publications*. The *Tesla Bookstore* is another useful resource. But you'll be way better off limiting your readings to those books and the reprints *by* Tesla, rather than

```
1000000100100010101100110110111011110111111101111
    Hexadecimal:            $8122B36EF7EF
Fundamental Amplitude:      0.866208
    Transitions:            22
    Filter:                 secondorder2.0
Distortion 3-17:            0.0739%.
Relative Harmonics 3 through 17:
    0.0             -0.000591363    -0.000042485    0.0
   -0.000167379      0.000352492     0.0           -0.000206194

0010000000110001010100111011001111101101111111011
    Hexadecimal:            $203153B3EDFB
Fundamental Amplitude:      0.814612
    Transitions:            21
    Filter:                 secondorder2.0
Distortion 3-17:            0.0445%.
Relative Harmonics 3 through 17:
    0.0              0.000155364     0.000052628    0.0
    0.000139262     -0.000382276     0.0            0.000077191

0010000000100110000110101101001111101011011111110
    Hexadecimal:            $20261AD3EB7E
Fundamental Amplitude:      0.751198
    Transitions:            22
    Filter:                 secondorder2.0
Distortion 3-17:            0.0641%.
Relative Harmonics 3 through 17:
    0.0             -0.000198935    -0.000186813    0.0
   -0.000492521      0.000138928     0.0           -0.000273419
```

Fig. 3 — OF THE 281,474,976,710,656 possible 192-bit quadrant symmetric magic sinewaves, a scant 43,046,721 end up three-phase "delta friendly". Here are three of the more interesting examples

errant ramblings *about* him.

If you really want to get into all of the free energy Tesla hogwash, check *High Energy Enterprises*, or else the *International Association for New Science*, the *International Guild of Advanced Science*, or *Borderlands*. Check out the *KeelyNet BBS* for a mesmerizingly outrageous source for late-breaking pseudoscience information.

And, of course, for a back-to-earth reality check, be certain to read the *Skeptical Inquirer* instead.

I've been thinking about gathering all my pseudoscience info into a new book. Give me a call if you have any interest in this.

Watch that Q!

A recent caller had a brilliant but flawed idea on how to simplify his Tesla coil. He wanted to use a *Slinky* for his main coil, eliminating most of those messy winding hassles.

The only tiny oint in the flyment is that Tesla coils *must* have a high Q and nearly lossless. A steel Slinky won't hack it. But a gold plated one or a beryllium copper version might work.

In another time, long ago and far away, a student came to me hours before his Theremin project was due for a course final show-and-tell. The bright silver colored coils sure were pretty. It seems that the story he was copying clearly said to use #30 wire in his oscillator coils. While he found lots of No. 28 and No.34 copper wire, the only No. 30 he could find seemed to be made from Nichrome.

Three-phase power basics

Most of your utility electricity is generated as three-phase power. Pretty near all larger industrial and agricultural motors are three-phase. Ever wonder why?

Figure 1 shows a three-phase waveform. Three windings are spaced out 120 degrees around a generator's stator, thus producing three identical sinewave waveforms whose electrical phase is also 120 degrees.

Your first great advantage of three phase is that all *three phase power is continuous*. Go through the math, and you'll find that the instantaneous sum of the power on all three phases will always add to the same value.

In a single-phase system, there are times when very little power is being delivered to you. Other times, much more than average is delivered. Thus, three phase power is more efficient and has lower line losses.

Three phase motors also start a lot easier than single phase ones. Most of them are easily reversed, simply by swapping phases. Because of the continuous power, most vibration and noise ends up a lot lower.

Three-phase power sources can be easily rectified for DC. Its ripple is much lower and its ripple frequency is way higher. That's one of many reasons why a car alternator is a three-phase AC generator.

```
; Code module to provide a time delay of n instruction
; cycles. n can vary from 4 to 255 and is destructively
; read from COUNTER. There are 8 or 9 overhead cycles.

; The module is easily extended to 9 or 10 bits.

DELAY   BCF S,C             ; clear carry (if needed)
        RRF COUNTER,1       ; bit 0 into carry
        BTFSC S,C           ; stall one cycle?
        GOTO EQ1            ;  yes, one extra cycle
EQ1     BCF S,C             ; must clear carry
        RRF COUNTER,1       ; bit 1 into carry
        BTFSS S,C           ; stall two cycles?
        GOTO LOOP           ;  no, no extra cycles
        GOTO EQ2            ;  yes, two extra cycles
EQ2     NOP                 ;

LOOP    BCF S,C             ; 4*n cycle delay loop
        DECFSZ COUNTER      ; round and round
        GOTO LOOP           ; till done
```

Fig. 4 — CORRECTED VERSION of the PIC time delay generator.

It turns out there are two standard ways of connecting a transformer or motor or whatever to any three-phase power line. With a *delta* connection, one winding goes between phases *a* and *b*. A second goes between phases *b* and *c*. And the last one routes from phases *c* and *a*.

In the *wye* connection, one end of each motor winding is connected together and usually brought out to a fourth line called a *safety neutral*. The free end of each winding is connected to phase *a*, *b*, or *c*.

Under balanced loading, you have a safety neutral current of *zero*. Even with some major unbalance, the safety neutral current still stays low.

Delta and wye each feature unique advantages and disadvantages. Note that voltages are 1.732 times higher in wyes and the currents are 1.732 times higher in deltas. (1.732 = .) Thus, you could easily overload or underpower any load by making an incorrect choice of delta or wye—but that's what power engineering is all about in the first place.

It is simple to show that any delta has a wye equivalent and vice versa. This is called a *delta-wye transform* or else a *wye-delta transform*. I have also shown these in Fig. 1.

The major disadvantage of three phase power is that three times the wiring is needed, combined with far more expensive switches. Plus, you need three times as many transformers. Thus, single phase is used for home, shop, and other "low power" uses, while the advantages of three phase power are reserved for industrial and agricultural users.

Much more information on three phase is available in any college power textbook, such as my utterly ancient favorites of Skilling's *Electrical Engineering Circuits* or Fitzgerald and Kingsley's *Electrical Machinery*.

NAMES AND NUMBERS

Borderland Research
PO Box 429
Gaberville CA 95542
(707) 986-7211

Coriolis Books
7339 E Acoma Dr Ste 7
Scottsdale AZ 85260
(602) 483-0192

Scott Edwards Electronics
964 Cactus Wren Lane
Sierra Vista AZ 85635
(520) 459-4802

Gale Research
835 Penobscot Blvd
Detroit MI 48226
(313) 961-2242

High Energy Enterprises
PO Box 5636
Security CO 80931
(719) 475-0918

Intl Guild Advanced Sciences
255 N El Cielo Rd #565
Palm Springs CA 92262
(619) 327-7355

Intl Assn New Science
1304 S College Ave
Fort Collins CO 80524
(303) 482-3731

Johnson Smith
PO Box 25500
Bradenton FL 34106
(941) 747-2356

KeelyNet BBS
Box 1031
Mesquite TX 75149
(214) 324-3501 BBS

Lin-Wood Products
506 Oakland Avenue SW
Grand Rapids MI 49503
(800) 458-1578

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

Loose Ends
PO Box 20310
Salem OR 97307
(503) 390-7457

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

Parallax
3805 Atherton Rd #102
Rocklin CA 95765
(916) 624-8333

Resonance Research
E11870 Shadylane Rd
Baraboo WI 53913
(608) 356-3647

Skeptical Inquirer
PO Box 703
Buffalo NY 14226
(716) 636-1425

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

Tesla Book Store
Box 121873
Chula Vista CA 91912
(805) 646-3371

Three-phase magic sinewaves

As regular readers already know, I have been doing a lot of unique new *magic sinewave* research. Magic sinewaves are rather carefully chosen and ultra long sequences of repeating ones and zeros—sinewaves of precisely controlled amplitude and amazingly low distortion.

Compared to classic pulse-width modulation (PWM), these brand new magic sinewaves can offer elegant simplicity along with superb efficiency for such diverse applications as induction motor speed controls, solar-panel inverters, electric auto drives, power factor correctors, home energy-efficiency improvers, or for reliable uninterruptible power supplies.

A participant at one of our magic sinewave seminars did ask me a very embarrassing question, though, a real scary back-to-the-drawing-board one: "How can magic sinewaves be used with three-phase loads that use only *three* half bridge drivers?"

The original magic sinewaves used individual "H-bridge" drivers. These needed access to *both* ends of *each* winding phase. For the three winding currents of (+), (0), or (−).

All of which is just fine for single and two-phase users. But in the real world of big time three-phase power, we rarely have access to both ends of each winding. Especially doing some upgrade or retrofit. And we'd sure like to get by using a mere *six* active power devices. Instead of the twelve the full H-bridge route needs.

Well, for openers, the length of our magic sinewave sequence should be a multiple of three. Such that our three phases happen on bit boundaries. For simplicity and compact files, we'd also want a multiple of four. For that way, we'll need only work with and store one of four *quadrants*.

Next for something a tad subtle: Another factor of eight sure would be handy. This lets each one of the three sinewaves work out of the same *bit position* of each 8-bit stored quadrant

PRO AUDIO RESOURCES

B&H Pro Audio
119 W 17th Street
New York NY 10011
(800) 947-1182

Dale Pro Audio
7 East 20th Street
New York NY 10003
(212) 475-1124

Denon
222 New Road
Parsippany NJ 07054
(201) 575-7810

High End
Box 357
Sea Cliff NY 11579
(516) 676-2830

High Performance Review
Box 346
Woodbury CT 06798
(203) 266-0084

Home & Studio Recording
21601 Devonshire St #212
Chatsworth CA 91311
(818) 407-0744

Journal AES
60 E 42nd St Rm 2520
New York City NY 10165
(212) 661-2355

Journal ASA
335 E 45th St
New York City NY 10017
(212) 661-9404

MIX Bookshelf
6400 Hollis St #12
Emeryville CA 94608
(800) 233-9604

PAIA Electronics
3200 Teakwood Ln
Edmond OK 73013
(405) 340-6300

Pro Audio Review
5827 Columbia Pike 3rd Fl
Falls Church VA 22041
(703) 998-7600

Pro Sound News
2 Park Avenue 18th Fl
New York NY 10016
(212) 213-3444

Radio World
5827 Columbia Pk #310
Falls Church VA 22041
(703) 998-7600

Roland Digital
7200 Dominion Cir
Los Angeles CA 90040
(213) 685-5141

SMPTE
595 W Hartsdale Ave
White Plains NY 10607
(914) 761-1100

Studio Sound/BE
245 Blackfriars Road
London SE1 9UR, England
(071) 620-3636

sequence. And, last time I checked, $3 \times 4 \times 8 = 96$.

Thus, to be three-phase friendly, *a magic sinewave's length should be a multiple of 96 bits*. And several *very* interesting libraries of 384- and 768-bit magic sinewaves already exist.

What do we have to do beyond this to also become what I will call being *delta friendly*?

The delta-friendly sinewave needs only three leads. And each of those leads need only be connected to a positive supply or ground. Figure 2 should get us started.

With simple SPDT or "half bridge" drivers on each line, there are only *eight* possibilities here. Namely, the binary combinations of 000, 001, 010, 011, 100, 101, 110, and 111. We might define a "clockwise" winding current as (+) and "counterclockwise" as (−).

We immediately see that the eight combinations can give us our choice of (+), (0), or (−) currents.

Now for the tricky part: *For all of your possible input combinations, the winding currents always must sum to zero!* You could have zero current on all three windings (cases 000 or 111). Or have zero current on one winding, positive current on one, and negative current on one (as in cases 001, 010, 011, 100, 101, and 110).

Next, think about this really hairy concept: Not only do winding states *a*, *b*, and *c* have to occur together, but state *b* will occur *in* data stream *a* at *one third* of the way through the time sequence, and state *c* also happens *in* data stream *a* at *two thirds* of the way through the time sequence!

We already do know that our three states must sum to zero. But this also newly tells us that the three states are bits that are separated by one-third of their cycle distance in each sinewave sequence. Thus, the one-third spaced bits must *also* sum to zero.

Which tells us that *a delta-friendly magic sinewave must have a forced zero third harmonic!*

And that is all there is to it. To be both three-phase friendly and delta-friendly, just *select 96-bit multiple magic sinewaves that have their third harmonic forced to zero.*

Most power books also tell us that there can be no third harmonic line current on any delta connected three phase load—sort of an independent check on what we've discovered. Several examples of 192-bit delta friendly magic sinewaves are shown in Fig. 3.

You will find vastly more magic sinewaves than there are particles in the galaxy. Untold zillions versus a mere 1070. So finding the good ones gets real tricky. Indeed, there are lots and lots of highly useful and delta-friendly magic sinewaves. But magic sinewaves that are *not* delta friendly might perform better.

Just as there are delta-to-wye and wye-to-delta transforms, there's also simple math which gets you from the *"positive-ground-negative"* winding currents to the *"positive-ground"* line currents. I've also shown these back in Fig. 2.

When you want zero current on all three windings at once, you'll have your choice of using 000 or 111 input states. At first glance, either would work just fine. But it turns out one or the other might be more efficient and needs fewer transitions.

For instance, if your *previous* state was 000 and your *next* state was 010, use of a 000 would require only *one* transition. But use of 111 would need *five* transitions instead.

Obviously, you pick the one with the fewest transitions, because fewer switchings certainly means less high-frequency losses, and usually means higher efficiency. Sometimes a 000 is clearly better. Other times, 111 is the only way to go. Other times (such as a previous 010 and a following 101), it doesn't matter at all.

The bottom line: Magic sinewaves work just fine with half-bridge delta drives as long as you use only those which include (A) a forced zero third harmonic, and (B) bit lengths that are an integer multiple of 96.

As you may have guessed, this is a billion dollar new opportunity that is very much up for grabs. I'll be happy to send you a free tutorial on magic sinewaves when you call or write. You can also ask me for a formal proposal that explains in detail our seminars, PIC source code, and the new partners programs. Both reprint and proposal are also available at *www.tinaja.com*

Time-delay correction

The neat PIC time-delay utility I showed you a few columns back had one bug in it. A PIC spends *one* cycle if a skip is *not* taken, and *two* cycles if an instruction skip *is* taken.

The corrected version is shown in figure four. Sorry about that.

Professional Audio Resources

I have just picked up a free new subscription to *Pro Audio Review*. A trade publication that more or less reports what its name implies. It has detailed reviews of high-end amplifiers, mixers, and microphones for TV, video, CD, and radio.

For this month's resource sidebar, I've tried to gather together some of the other pro audio resources.

A second major magazine is *Mix*, which also operates an outstanding *Mix Bookshelf* where you will find just about any book on audio.

The leading technical audio organization is the *Audio Engineering Society*. The finest audio publication in the world seems to be the British *Studio Sound and Broadcast Engineering*.

Let me know if I've missed any of your favorites here. A free *Incredible Secret Money Machine II* if you tell me about any pro audio resource I don't already know about.

New Tech Lit

A real fine new collection of PIC-related data books is now offered by *Microchip Technology*. These include the *PIC 16/17 Microcontroller Data Book*; the *PIC 16C8X Data Book*; *PIC 14000 Data Book*; a *PIC 16C7x Data Book*; the *PIC 16C62X Data Book*; *ECHV Update I*; the *MPASM Assembler Guide*; *Third Party Guide 1996*; the *Non-Volatile Memory Products Data*; *Embedded Controller Handbook*; *Serial EPROM Tutorial Series I-III*; the *Development Systems Ordering Guide*; *BBS System User's Guide; MPSIM Users Guide*; and the *HCS300 Data Book*.

Their PIC, of course, is *the* finest microcontroller. Nothing else comes remotely close. Other PIC resources include *Scott Edwards Electronics*, and the superb *Basic Stamp* products offered by *Parallax*.

A unique collection of PC-related books is offered by *Coriolis Books*.

A new *CD ROMs in Print 1996* is freshly offered by *Gale Research*. It reviews over 9000 titles.

Free beta copies of *Acrobat Amber* can be downloaded from *www.adobe.com* This wonderment lets you view full technical reprints on line. Part of it plugs into *Netscape Gold*. Which you can find at *netscape.com*

I often like to check out the hobby and craft catalogs. These can be a great source for products and ideas. One example is the *Source Place for Creative Living* "owner's manual" by *Loose Ends*. Mostly on unusual hand made papers. Another is the *Wood Parts Catalog* from *Lin-Wood*. Who do make a bewildering array of small wooden items.

Or, just because it is there I guess, you should get your hands on the neat free *Things You Never Knew Existed* catalog from *Johnson Smith*.

For typical individuals and small-scale startups most of the time, any involvement whatsoever with patents is absolutely certain to turn into a net loss of your time, energy, money, and sanity. You find out why in my *Case Against Patents* package. It includes proven real world alternatives.

See my nearby *Synergetics* ad for more details. I've also got some great deals on Tektronix 1230A logic analyzers left over from my school buyout.

I'm still building my web site at *www.tinaja.com* Eventually, globally searchable reprints for my previous columns should be available here.

As usual, a no-charge tech helpline and online access is available per the *Need Help* box. Most of the resources mentioned in this column appear in our *Names and Numbers* or *Pro Audio* sidebars. EN

BY ED CARYL*

Making Time Measurements with a DSO

THE OSCILLOSCOPE IS THE TIME-HONORED TOOL OF CHOICE FOR MEASURING VOLTAGE CHANGES OVER TIME BECAUSE THE WAVEFORMS ON ITS SCREEN ARE GRAPHICAL REPRESENTATIONS OF THOSE CHANGES.THIS article will show you how to use your digital storage oscilloscope (DSO) to your advantage when you need to make highly accurate time measurements.

Time is measured on the oscilloscope's horizontal or X axis. You can adjust the time axis by using the scope's horizontal scale or time-per-division control. In this article, we will be discussing some of the more frequently made time measurements. A similar discussion of voltage measurements was presented last month.

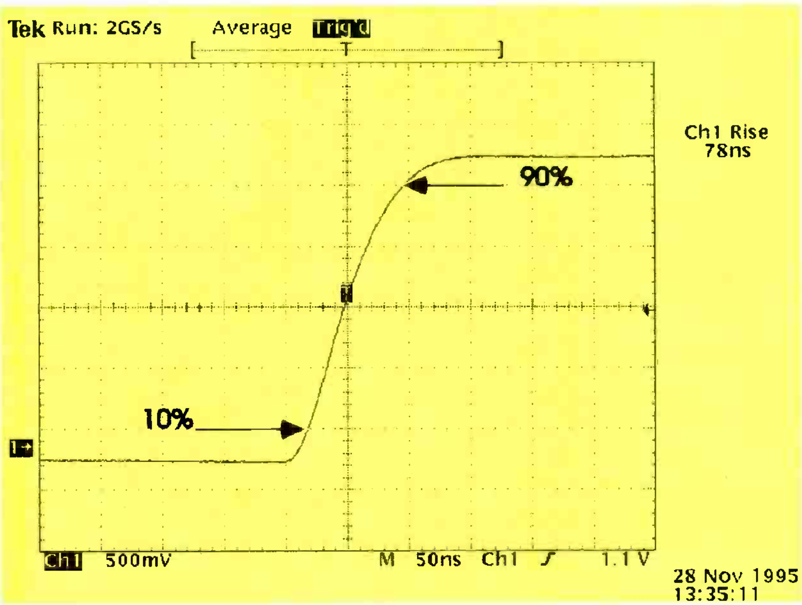
Common time measurements include the waveform period, frequency, pulse risetime, and pulse width. A period is the time it takes a repetitive waveform to complete one cycle or move through a series of amplitude values until the values begin to repeat. The frequency in Hertz is one divided by the period, or the period's reciprocal.

Pulse waveforms are encountered frequently. All pulses have a rising edge, a width, and a falling edge. The *risetime* is the time it takes the pulse to go from a low amplitude (voltage) to a high one. (See Fig. 1.) Risetime is usually measured from the 10% to the 90% point on the rising edge (Figure 1). Fall time is measured on the falling edge from the 90% point back to the 10% point. Pulse width is the width "at the waist line," that is, at the 50% point.

Another common time measurement is delay, sometimes called propagation delay. Propagation delay is the time it takes a waveform to travel from one point in a circuit to another, such as from the input to the output of an amplifier.

Delay measurements are made by using two channels of your oscilloscope. If a pulse at an amplifier input is applied to one channel, and the output is applied to another, you can measure the time from an edge on the first channel to the same edge on the second channel. This is the propagation delay through the amplifier, that is, the time it takes the signal to propagate from the input to the output.

Phase shift is a special kind of propagation delay measurement, usually using sine waves and measuring the delay in terms of the sine wave period. If the sine wave period is expressed as 360 degrees, the phase shift is 360 times the delay, expressed as a fraction of the period. If the delay is half the period, for example, the phase shift is 180 degrees.



Ed Caryl is an Application Engineer/Product Support Specialist at Tektronix, Inc.

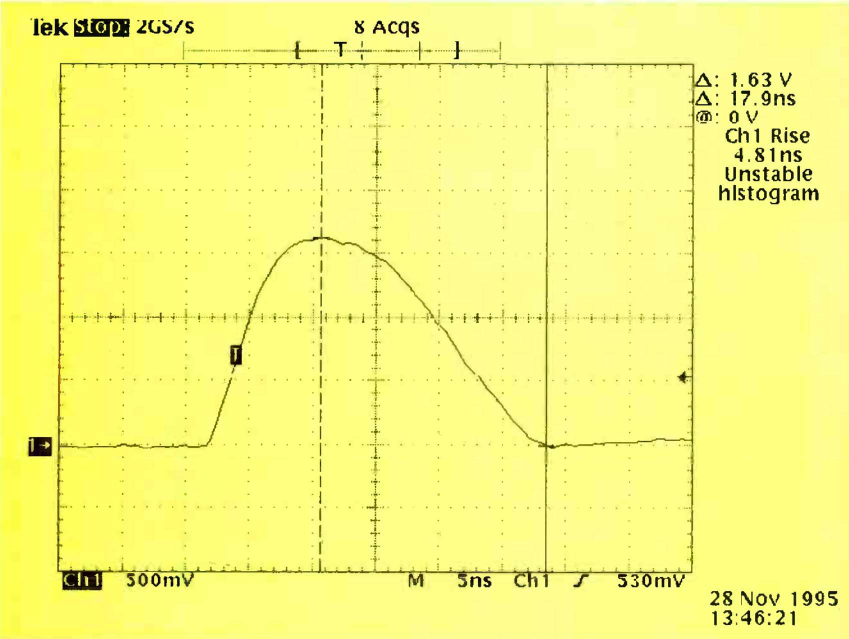


FIG. 2— THREE MEASUREMENT METHODS are illustrated here. First, the oscilloscope is making the risetime measurement. The warning message indicates that the 100% point may be doubtful because it is represented by just a few points. Second, the cursors are measuring the time from the peak value, 1.63 volts, to the point where the voltage returns to zero. This is 17.9 nanoseconds. Finally, from the graticule, you can see that the voltage is above 1 volt for about 14.5 nanoseconds, 2.9 divisions at 5 nanoseconds per division.

Maximizing accuracy

Many variables can affect the accuracy of time measurements, including the measurement method, the oscilloscope's vertical and horizontal resolution, its sample rate, trigger jitter and noise. The most important factor is the oscilloscope's horizontal resolution. Fortunately, that is also the factor that is most under your control.

In addition to the horizontal timebase/time-per-division control, many DSOs also have a *record-length* control. Record length is the number of data points taken or "acquired" on a waveform each time the oscilloscope is triggered. Both the horizontal timebase and record-length controls can be used to maximize the horizontal resolution on a time measurement. Use the longest record length available, then adjust the timebase control to use as much of this record length as possible. This will provide the maximum number of data points.

You may choose from three methods for time measurements (Figure 2). The easiest way, and, often the most accurate, is to let the oscilloscope perform the measurement. Most DSOs have automatic measurement functions that you can select from a menu. The DSO automatically calculates and displays the measurement result for each acquired waveform.

The second method is to use measurement cursors—movable horizontal and vertical lines—to manually make the measurement. You can individually control and align each cursor with the appropriate waveform feature in order to make time and voltage measurements. Cursors are often used when the automatic measurement definitions are not easy to set, or where you wish to make several closely related measurements. Your accuracy will depend on how well you set the cursors.

The third method is to "eyeball" the measurement, that is, to align the waveform features with the internal graticule markings and counting divisions of the display. This is the method you use when just looking at the waveform. With closer observation and using the "minor division" graticule markings on the display (located on the central vertical and horizontal graticule lines), you can be considerably more precise.

For time measurements beyond the normal record length, use the delayed-sweep feature of your oscilloscope to improve horizontal resolution. Follow the procedure as outlined below and as illustrated in Figure 3:

1. Set the first measurement point with the main sweep at the center ver-

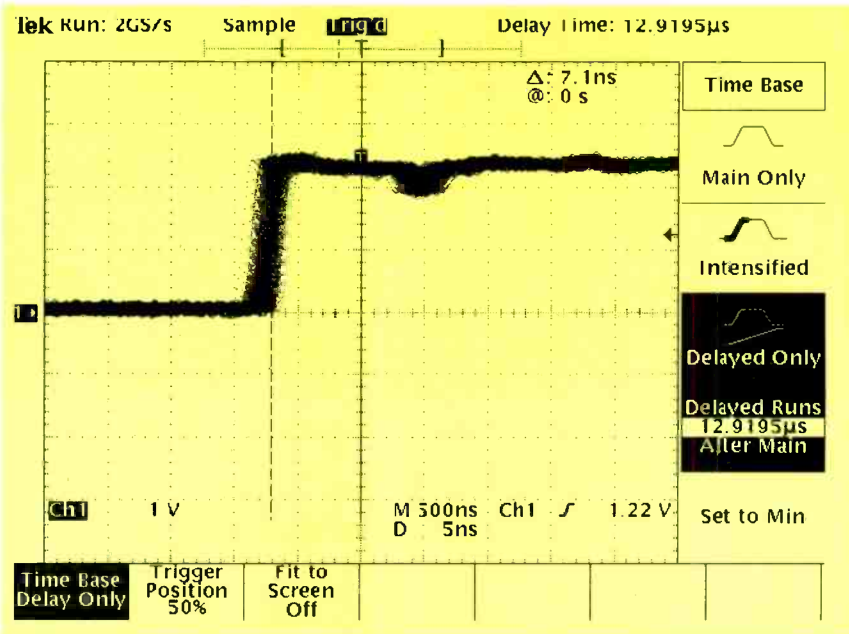


FIG. 3— IN A DELAYED SWEEP MEASUREMENT, the measurement is made from the center vertical graticule line on the main sweep display to the same line on this delayed sweep display. The delay is 12.9195 microseconds. To this delay, add 7.1 ns, the additional time from the center of the time jitter to the center graticule line. The total time is thus 12.9266 microseconds, plus or minus about 1.5 nanoseconds, the width of the jitter band.

tical graticule line by using the triggering and the horizontal position controls.

2. Select the delayed-sweep mode, then set the Delayed-Runs time to align the second time point to the same center graticule line.

3. Start with a delayed sweep speed only slightly faster than the main sweep, and then advance the delayed sweep for a more precise setting.

4. If the feature can't be aligned exactly with the center graticule line, read any difference from the graticule and correct the Delayed Runs readout.

Reducing noise

Noise can interfere with time measurements by blurring the waveform data at the time-measurement points. There are numerous ways to reduce noise. On repetitive waveforms, you can use the signal averaging capability of your digital scope to reduce random noise. At slower sweep speeds, a HiRes mode, available on some DSOs, will reduce high-frequency noise. A scope's bandwidth-limit feature also will help eliminate noise above the bandwidth limit.

Of course, you can learn to live with the noise and try to work around it. Set the measurement cursors to the center of a noise band to measure an average value. Your scope's persistence display feature can help in visualizing the noise-band center.

Another common problem is edge aliasing, often produced by high sweep speeds, fast risetimes and sample-rate limitations. Edge aliasing is identified by false overshoot, ringing, and a jittering edge position. This condition can happen in single-shot measurements or when Digital Real-Time (DRT) oscilloscopes treat all acquisitions as if they were single-shot. Edge aliasing may also occur if less than two samples are acquired during edge risetime.

There are several ways to correct edge aliasing. If the delay or period is being measured, risetime is not a factor, and bandwidth limiting will stabilize the measurement. In addition, some high performance DSOs have 100-MHz and 250-MHz bandwidth limits that can be limit risetime and stabilize very fast edges.

Trigger jitter can impact time measurements on repetitive waveforms. In this case, slow risetimes are the problem. Trigger jitter happens because the oscilloscope trigger cannot determine exactly when a slower moving signal passes through the trigger level. Fast edges have the least trigger jitter. By simply expanding the signal amplitude on the display, you can decrease trigger jitter. This is because the signal speed is increased through the trigger-level point.

Your DSO lets you "see" electrical signals that occur in a split second. By using your oscilloscope's features to "expand" that split second as much as possible, and then letting the scope make the measurements automatically, you'll have the highest degree of accuracy in time measurements. When automatic measurements are not available or appropriate, use the helpful tips provided above to ensure a higher degree of accuracy. EN

LOW-COST SOFTWARE FOR CIRCUIT SIMULATION

If you've been following this series on low-cost software for electronics, you know how your PC can ease the chores of drawing a schematic and designing a printed-circuit board. Did you know that it can also expedite the process of debugging a circuit design!

TJ BYERS

WE'RE SURE THAT SOME OF YOU REmember building experimental radios on old kitchen breadboards using nails and bare wire. As time passed, Grandma's breadboard gave way to phenolic terminal strips, which eventually evolved into today's solderless breadboards.

We all have fond memories of breadboarding simple circuits using a slab of plastic embedded with metal strips. But those days are shrinking into the past, too. Today's circuit designs are far more complex, run faster, and require a lot more than a plastic and metal breadboard to make them work. Now we do all of our circuit-design work using a PC-based software simulator—which is what this article is all about.

There are several different kinds of software circuit-simulators, each with its own purpose. The most popular is the analog simulator, used for wringing out linear designs such as audio amplifiers and filters. Digital circuits, on the other hand, have special needs that require a different set of rules that don't always coincide with those of analog circuits. Consequently, there's a separate category of digital-only simulators. However, because today's designs are often a mixture of digital processing linked with an analog interface, the trend is toward mixed simulators that do both. On the cutting edge is the burgeoning wireless telephone communications market, where frequencies range from 500 MHz to 5 GHz. These designs require special RF software simulators where every solder connection enters into the formula.

How circuit simulation works

Circuit-simulator programs are software applications that let you test your electronic brainstorms using your desktop PC. At the core of the circuit simulator is a number-crunching engine that reads a netlist file that contains a list of the circuit's components, their various voltage and current parameters, and how the components react when these values are changed.

Device models. Circuit simulation is done by applying mathematical equations, called algorithms, to a model of an electrical device such as a transistor, then solving the equation with different sets of numbers that you plug into the formula. For example, one of the formulas used in bipolar transistor simulation is

$$I_E = I_{EE}(e^{V_{E'B'}} - 1) + I_{BC}(e^{V_{C'B'}} - 1)$$

which describes the current flow through the emitter of a common-base amplifier.

Thankfully, you don't have to take a refresher course in advanced algebra or electrical engineering to use circuit-simulation software. Any company worth its salt has done the homework for you, and rendered the many formulas into compact code. All you need to supply are such variables as operating voltage or current.

As explained above, the simulator engine works from a netlist. Generally, the netlist is in ASCII format, which means that all you need to create a simulation netlist is a text editor. However, it's much faster and more accurate to extract the information from a schematic-capture program in much the same way PC-board layout programs convert schematics into solder pads and copper traces. Very often the simulation package includes a schematic capture front end.

Test instruments. Once the circuit parameters have been defined and loaded into the simulator, the design is stepped through its paces using a function generator. Sometimes the input is a simple sine wave, while other times it can be as complex as a frequency-modulated modem carrier signal or a word generator. The signal source depends on the design and what results you're looking for.

Of course, you need a monitoring device that tells you what's happening as you wring out the design with various inputs. Generally that's done using a software-simulated multi-trace oscilloscope. From what we've seen in the simulation software in this review, many of these simulated instruments far outpace their commercial counterparts, displaying transient activity that you'd never catch on the screen of a scope no matter how quick you are on the trigger. Most analog simulators also include a bode plotter that's used to study the frequency response of a circuit. And no simulator would be complete without a multimeter.

Digital circuits need specialized test instruments, like a pulse stepper, propagation delay viewer, breakpoint analyzer, and event counter. You're also likely to find a logic analyzer that shows the state of all the nodes in the circuit and their relative timing, and sometimes a logic converter that can convert between gate, truth table, and Boolean logic.

That said, let's begin our tour of the software packages that threaten to make your soldering iron obsolete. Before we begin, let me explain that we'll be looking at some of the same programs that appeared in the October 1995 issue of Electronics Now, which highlighted schematic-capture software. However, some of the features and prices have changed since the last time you and I looked at them. For example, some have been upgraded to 32-bit programming to make them compatible with Windows 95. Consequently, you may find brief comments on the new features in the text as we review the following eight programs.

Analog Simulators

Do you want to build a circuit that measures room temperature, ambient light, or which way the wind blows? If so, you need an analog simulator to test it. Analog simulators are used to check out any circuit that deals with voltages and currents that have analog values instead of digits. Typical analog applications include filters, oscillators, amplifiers, linear power supplies, and transmission lines.

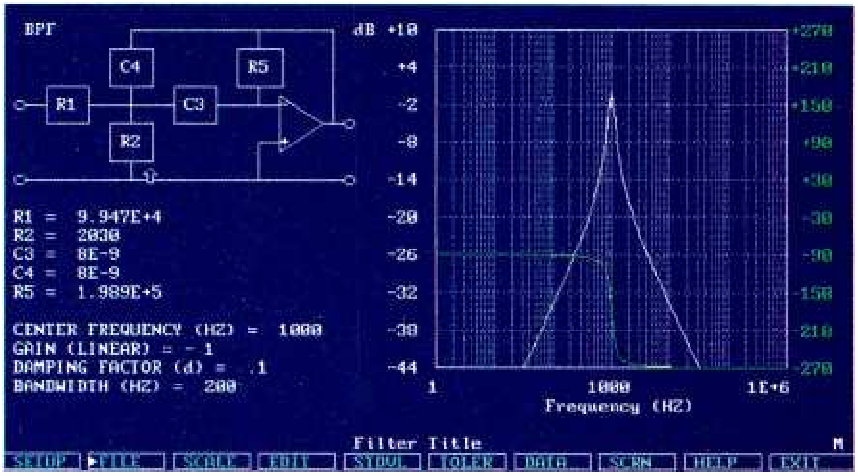


FIG. 1—EACH OF THE EE WORKS MODULES has its own canned schematic drawing. In addition to running a simulation using component values you plug into the circuit, EE Works can do the reverse and calculate component values for you when you enter the design parameters, like above.

Although it's possible to digitize some of these applications, any digital processor still has to talk to an analog world via input sensors such as a thermistor or photocell, and output transducers, including motors and loudspeakers. Even your computer's monitor, which you might think is digital, is basically an analog device—both inside and out. Hence, there will always be a need for analog designs, regardless of where the digital future may take us.

Product:	EE Works
Version:	5.0
Price:	$129.99
Platform:	DOS
Publisher:	Geoban Engineering

Before you begin using EE Works, you'd better dust off your old engineering reference books, because you'll need them. EE Works is the most exhaustive of any of the simulation programs tested, giving you answers to questions you didn't even think to ask—and the results are given in engineering language, not hobbyist jargon.

Unlike the other simulators in this review, which are integrated and work from a common schematic, EE Works is a collection of several DOS programs, each designed to do one thing, and one thing only. For example, there's a simulator module that tests your design for linear transient analysis, and another that does nothing but linear AC/DC analysis. Each simulation comes equipped with a canned "schematic" (Fig. 1) that electrically represents the design under test, such as an active filter. Unfortunately, the individual simulator modules aren't interactive. Each simulation runs on its own, and the results are exclusive of any other simulation. In other words, every time you start a different simulation, you have to restate your circuit's parameters.

You must be very precise—immaculate, in fact—when defining component and circuit parameters. For example, if you choose the power supply simulation routine—a power supply design/simulation program that's unique to EE Works—you even have to enter the permeability of the inductor and the capacitor's ESR value. If you skip any step, hoping the simulator will default to a standard value, you are thrown back to the main menu where you have to start the simulation all over again. It's the same with transistors, op-amps, and even resistors, where you have to specify the resistor's tolerance. So you better have those vendor specs in hand before you begin—or be a good guesser.

Continued on page 65

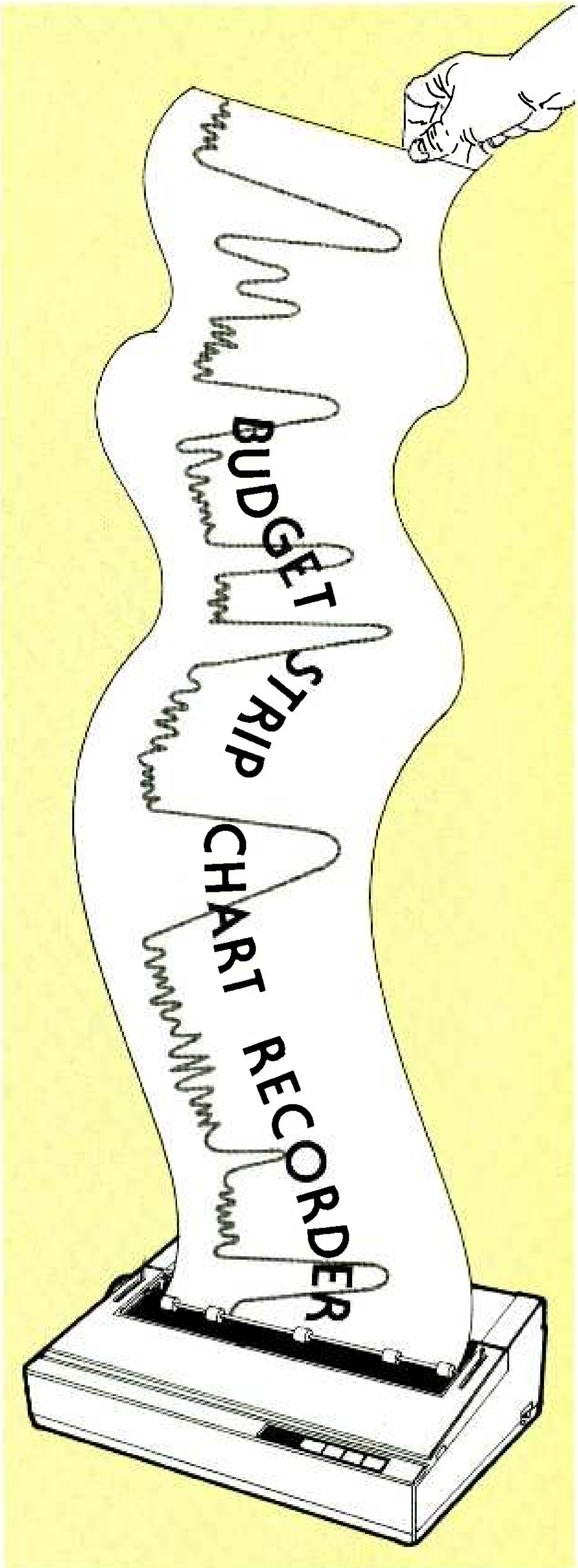
JACK WRIGHT

CONVERTING AN OBSOLETE computer printer into a strip-chart recorder is both easy and inexpensive. With about $40 in parts, construction of a simple circuit, and some minor mechanical fabrication, you can have a functioning chart recorder. We built the prototype as a weather station to record air temperature, but it could be used for any number of things ranging from seismography to radio astronomy.

The chart recorder works by comparing the voltage on a potentiometer to the voltage on a temperature-sensing thermistor. The potentiometer is mechanically connected to the printer carriage. A marking pen is also connected to the printer carriage. Any difference in the voltages on the potentiometer and the temperature sensor causes an op-amp to attempt to bring the voltages back in balance. In so doing, the print-head carriage moves left or right, thereby causing a mark on the paper. We drive the platen (i.e., pull the paper through the device) using a standard household timer.

How it works

Figure 1 shows the complete circuit. We use a standard 741 op-amp as a comparator. The comparator monitors the voltages at the junctions, marked TP1 and TP2 in Fig. 1, of two voltage-divider networks. The op-amp compares the voltages from the two networks at its inputs (pins 2 and 3). When the voltages are identical, the op-amp's output (pin 6) is zero, so neither driver transistor (Q1 and Q2) turns on, and therefore the motor does not turn.



Convert that old computer printer into a strip-chart recorder

But if thermistor R2's resistance changes because of a change in air temperature, a new voltage occurs at the op-amp's inverting input (pin 2). For example, assume the value of R2 decreases. The pin-2 voltage then increases, so the op-amp's output swings negative, thereby biasing Q2 on. That in turn starts the motor, which moves the carriage left or right.

Potentiometer R5 is also coupled to the carriage, so, as the carriage moves, R5's wiper moves, thereby varying the voltage on the non-inverting input of IC1. When the op-amp's input voltages become equal, the output goes to zero, both transistors turn off, and so does the motor. Now the circuit remains quiescent until the temperature changes again.

The potentiometer is a precision, 10-turn type with a value of 20K. A 50K device would provide a wider range, but with reduced resolution. You should be able to buy a surplus 10-turn unit from an electronics supplier for $1–5.

For temperature sensing, we used a common thermistor available from Radio Shack. (Internally, each device actually consists of two separate thermistors.) A thermistor is a device whose resistance changes with temperature. The thermistor is not linear; its resistance increases disproportionately fast at cooler temperatures. That nonlinearity restricts the range of the recorder. Also, the resistance range of your probe, be it a thermistor or some-

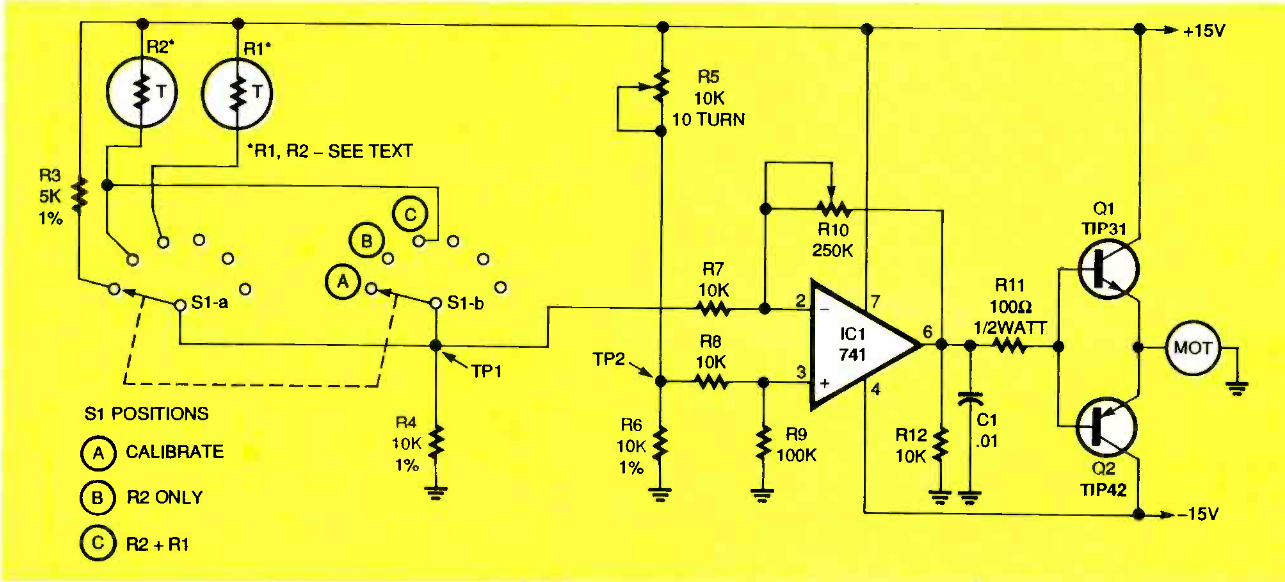


FIG. 1—COMPLETE SCHEMATIC of the strip-chart recorder. When the op-amp inputs differ, the motor turns. As the motor turns, R5, a precision ten-turn potentiometer, also turns. When R5's value equals the value across the temperature sensor (as chosen by S1), the motor stops.

thing else, must not exceed the range of the potentiometer, or the pen will try to run off the side of the chart.

We use precision resistor R3 in conjunction with S1-a and S1-b to calibrate the circuit. When R3 is in the circuit, the carriage will move to where the value of R5, the 10-turn potentiometer, equals the value of R3. That provides a reference point for the chart printouts.

By switching in either one or two temperature sensors, switch S1 allows the choice of two ranges. Position 1 of the switch is for calibration; only R3 is connected. Position 2 connects R2, for a range of 20–108 °F; and Position 3 connects both R1 and R2, for a range of −6–76 °F.

For the prototype, we picked up a derelict daisy-wheel printer at a local second-hand store for $5. Note that a dot-matrix printer would work just as well. If you live near a university, check whether it has an equipment-disposal unit, typically a warehouse with old, broken, and outdated equipment. Another potential source is a printer repair shop.

For marking the chart paper, we simply installed a pencil, using a rubber band to maintain tension against the platen, as shown in Fig. 2. We used several different colors of soft lead drawing pencils to track temperatures for several days on a single chart. You could even glue the chart into a multi-day loop if you wish.

Construction

To prepare the printer, first gut it, removing PC boards, the daisy-wheel mechanism from the carriage, the wiring harnesses, the fan, etc. Don't be too quick to dispose of the gutted parts; you may be able to use some of them, particularly the cables and connectors. You should end up with the frame, the platen, and a carriage and drive mechanism.

In most printers the carriage-drive motor has several wires attached. By trial and error you can determine which wires operate the motor. In our case, there were two red and black wires. We merely tried one red and one black wire and got the motor to turn. The motor should operate on a low DC voltage—the prototype begins to turn at about 2–3 volts—but you may want to determine low-voltage DC operation for certain before you buy.

Now affix the potentiometer to the carriage. Some printers use a cable to move the carriage back and forth; others use a rubber belt. Our unit used a cable drive, but because the cable is greasy and hard to get at, we did not attach to the cable directly. Instead, as shown in Fig. 3, we fixed the potentiometer securely to the carriage and then strung a length of strong, coated twine from one side of the printer frame to the other. A small coil spring keeps the twine taut. The twine wraps once around a spindle attached to the potentiometer shaft. The diameter of the spindle should be such that the potentiometer turns ten rotations (or a little less than ten) over the length of the carriage movement.

PARTS LIST

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

R1, R2—Thermistors, Radio Shack 271-110 or equiv.
R3—5000-ohms, 1%
R4, R6—10,000 ohms, 1%
R5—20,000 ohms, potentiometer, 10-turn
R7, R8, R12—10,000 ohms
R9—100,000 ohms
R10—250,000 ohms, potentiometer
R11—100 ohms, ½ watt, 5%

Other components

C1—0.01 µF
IC1—741 op-amp
Q1—TIP31 NPN Transistor
Q2—TIP42 PNP Transistor
S1—Rotary switch, 2 pole, 6 position

ORDERING INFORMATION

Precision 10-turn potentiometers are available from Ra-elco, Inc., 2780 South Main St., Salt Lake City, Utah 84115, 801-487-7749.

To calculate the diameter of the spindle, simply measure the total distance the carriage moves from left to right, and divide that value by ($\pi \times 10$). Anything that size or slightly larger will do. The spindle material is not critical; we used two hard rubber spacers bracketed by a couple of large washers, and brushed with paint to increase friction. You could also use a wooden spool, a small diameter pipe, or a stack of washers. Incidentally, the spindle must be wide enough to allow the string to worm its way across without jamming into the bracketing washers.

To drive the platen, we used a plug-in appliance timer, available at most hardware and variety stores. We glued the timer dial directly to the platen knob, giving a chart speed of about ⅙-inch per hour, which is satisfactory for temperature recording.

That type of timer is not intended to drive anything, so you should keep a close eye on it until you are certain it can do the job without overheating. We tried three different brands, old and new, and they all worked. Be sure to minimize the drag on your platen by removing all drive gears, stepper motors, etc. Also, because of mechanical slack in the system, it may take up to an hour for the timer to begin turning the platen. If you desire a faster chart speed, other drive arrangements can be constructed, possibly using the built-in mechanics.

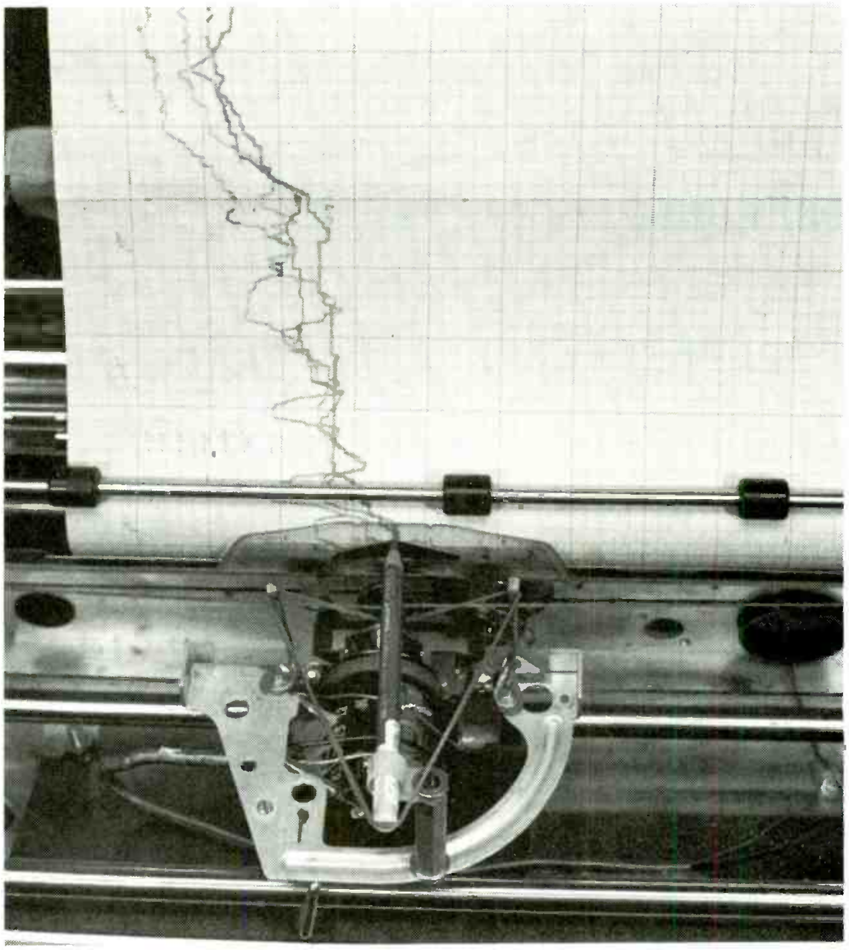


FIG. 3—STRIP-CHART RECORDER IN ACTION. Note how the rubber band holds the pencil against the chart. Chart speed here was about 17 mm/hr.

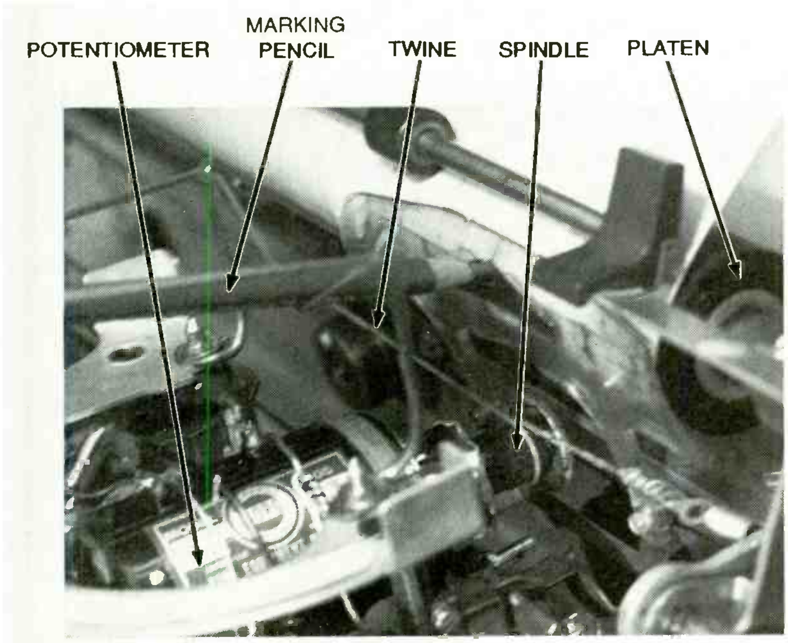


FIG. 2—MECHANICAL ARRANGEMENT of the strip-chart recorder. Note twine wrapped once around the spindle attached to the shaft of the potentiometer.

Your printer may have operable DC power supplies. Ours didn't, so we bought two wall-mount DC adapters. Anything in the range of 12–15 volts DC at 500 mA should work, but check the current draw of your carriage drive motor to be safe.

Calibration and testing

Switch R3 into the circuit, let the carriage settle down, and then mark that point as a reference. You may want to slip the twine to move the carriage assembly to a convenient location.

The simplest way to calibrate

Continued on page 50

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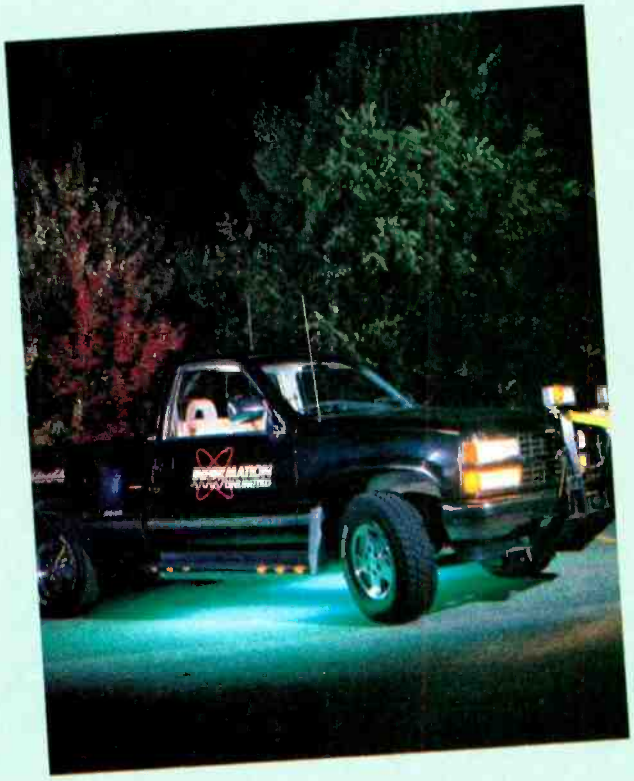
AUTOMOTIVE NEON

Build this driver circuit to illuminate your car's license plate, light up its underside for a glamorous "spaceship" look, or just create portable neon or argon light displays.

ROBERT IANNINI



JOIN THOSE PEOPLE WHO enjoy customizing their cars by adding a lighted frame to their license plates or illuminating the undersides of their cars in red, green, or violet to give it a "hovering spacecraft" look. This article focuses on the construction of a complete illuminated frame system for your car's license plate, but the battery-powered gas tube driver circuit described here will permit you to light up individual gas tubes mounted on the underside of your car.

The driver circuit will light up neon-filled tubes that glow with a rich ruby red or argon-filled tubes that can be prepared to glow in brilliant green, violet, or pink. If neither of those projects interest you, maybe you would be interested in making up battery-portable illuminated wands, signs, or arrows for parties, festivals or perhaps you'll build it just as unusual eye-catching home decoration?

The driver circuit

The driver circuit ionizes and sustains the illumination of neon or argon gas-filled tubes up to four feet long bent into any shape desired. The tube will remain illuminated as long as power is applied to the circuit. However, the driver circuit permits the tube's illumination level to be adjusted to maximize brightness or reduce brightness to conserve power depending on which is more important.

The driver circuit is a pulse-width modulation circuit that can illuminate a neon or argon gas tube in either a continuous or flashing mode. In that mode, the tube will blink on and off at an adjustable rate that permits it to act as an emergency beacon. The circuit is also suitable for driving battery-portable gas tubes fashioned as signs or wands for carrying around at carnivals or using as decorative conversation pieces.

A note of caution

It is illegal in *all* states to drive a car with an illuminated license plate frame that flashes while the vehicle is moving. However, the frame can serve as an attention-getting emergency beacon if the vehicle is stopped.

Also, it is illegal in at least one state to have an illuminated license plate frame on a car unless the gas tube is so masked that only the light reflecting from the plate is visible to the driver of any vehicle that is following behind the car with the lighted frame.

How the driver works

Refer to the schematic Fig. 1. An industry standard bipolar 555 timer, IC1, is configured as a duty cycle clock to control the on and off time of the circuit's high-frequency oscillator. With C2 switched into the circuit by switch S1, the output at pin 3 of IC1 will be a square wave with a duty cycle or pulse rate that is fast enough to sustain continuous illumination of the gas-filled tube.

Adjusting trimmer potentiometer R1 changes the brightness of the gas tube by altering the on-to-off ratio or the duty cycle of the squarewave that appears at the output of pin 3 of IC1. The squarewave output of IC1 appears at the base of NPN transistor Q1, which functions as a buffer amplifier. The output of Q1 then appears at the base of grounded-emitter NPN transistor Q2, which functions as the feedback element in a free-

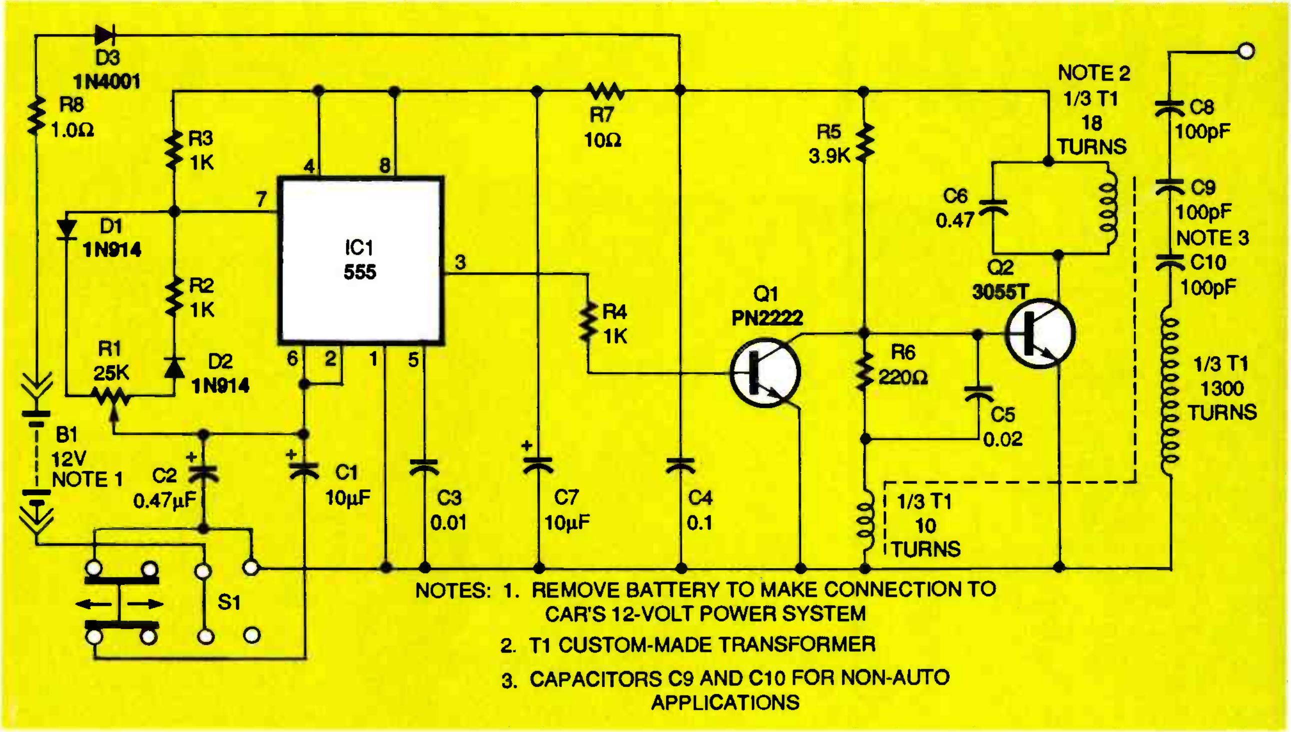


FIG. 1—DRIVER CIRCUIT SCHEMATIC. The circuit can be powered either from a battery pack or vehicle's 12-volt power system.

running oscillator circuit. Transistor Q1 acts as the switch to turn transistor Q2 on and off by clamping the transistor's base to ground.

The oscillator oscillates at a frequency of 25 to 30 kHz, and the output voltage at the top of the 1300-turn coil of T1 is approximately 2500 volts, peak-to-peak, sufficient to ionize the gas in the tube. The duty cycle pulse of IC1, as buffered by transistor Q1, controls the base of transistor Q2. The tank circuit that determines oscillator frequency, consists of capacitor C6 and the 18-turn primary coil of transformer T1.

Changes in the duration of the "on" cycle change only the brightness of the gas tube but do not affect the frequency of the oscillator. High-voltage ceramic capacitors C8, C9 and C10 correct for differences in the length of the gas tube being driven.

If switch S1 is set to the *flashing* mode, capacitor C1 is placed in parallel with capacitor C2, and the sum of their capacitive values will shorten the repetition rate of the squarewaves appearing at pin 3 of IC1. This will cause the tube to flash on and off at a rate slow enough to be seen as flashing (less than 50 pulses per second). The flashing time rate can be changed to a visually comfortable level by adjusting trimmer potentiometer R1.

Building the driver circuit

Whether you plan to operate the driver only from the battery pack or directly from an automotive 12- to 14-volt supply, it is recommended that provision be made to operate the circuit from the battery pack for testing.

If the illuminated frame is to be used on a vehicle (regardless of power source), attach a heatsink to the copper tab on the TO-220 case of transistor Q2. Omit capacitors C9 and C10 if you intend to install the system in a vehicle.

The driver circuit can be built on perforated board by point-to-point wiring method. Cut a 3¼ × 1⁵⁄₁₆-inch rectangle of prepunched circuit board (0.042-inch diameter holes in a 0.1-inch grid. With the exception of the high-voltage capacitors C8, C9 and C10 and transformer T1, all components are readily available items.

If you do not want to wind your own miniature transformer, you can purchase one from the source given in the Parts List. The neon or argon frame and plate cover assembly referenced in this article is also available from the same source. Also the high-voltage capacitors C8, C9, and C10 are available in a kit.

Refer to Parts Placement diagram Fig. 2. Before starting assembly work, cut out a rectangular relief hole in the circuit, as shown by the dotted line, to make wiring slide switch S1 easier. If you intend to install the system in a car, attach a heatsink to the tab of transistor Q2 before inserting it.

Insert all components in the approximate positions shown on Fig. 2. Insert all components in the approximate positions shown. Insert all axial-leaded resistors and diodes marked with an asterisk vertically to conserve circuit board space. A snap-on heatsink suitable for a TO-220 package is, but a satisfactory substitute can be made by cutting and folding a piece of 0.062-inch thick sheet aluminum 1 × 1½ inches. Drill a small hole in its center for mounting it to the hole in the heat tab of transistor Q2 with a nut and bolt.

Carefully fold back one lead of all axial components shown as vertically mounted over the body of the component so that both leads can be inserted in holes spaced 0.10-inch apart. Observe the polarities of the diodes and electrolytic capacitors before inserting them and be sure that you have identified the pin functions of transistors Q1 and Q2 before inserting them in the board.

Insert and bend all leads first before doing any soldering so that extra lead lengths can be used to form the specified connections between components.

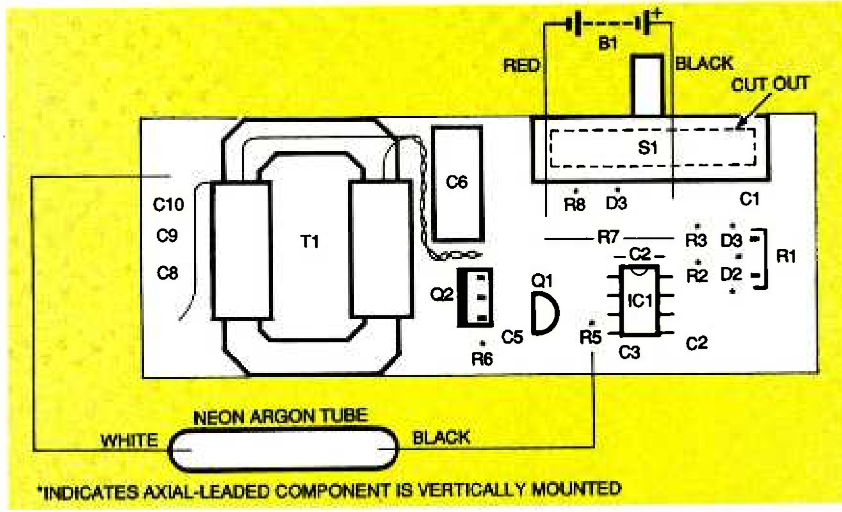


FIG. 2—DRIVER CIRCUIT PARTS PLACEMENT DIAGRAM. The circuit can be built by point-to-pont wiring on 0.1-inch grid perforated board. Transformer T1 is a non-standard component.

PARTS LIST

All resistors are ¼-watt, 10%, unless otherwise specified

R1—25,000 ohms, trimmer potentiometer, PC board mounting, carbon film
R2, R3, R4—1000 ohms
R5—3900 ohms
R6—220 ohms
R7—10 ohms
R8—1 ohm, ½-watt

Capacitors

C1, C7—10 µF, 35 volts, aluminum electrolytic, radial-leaded
C2—0.47 µF, 50 volts, aluminum electrolytic, radial-leaded
C3—0.01 µF, 50 volts, ceramic disc
C4—0.1 µF, 50 volts, ceramic disc
C5—0.02 µF, 100 volts, polyester
C6—0.47 µF, 100 volts, polypropylene, radial leaded
C8, C9, C10—100 pF, 3000 volts, ceramic multilayer, radial-leaded DIP (see text)

Semiconductors

IC1—555 timer, 8-pin DIP
Q1—2N2222, NPN bipolar transistor, TO-92
Q2—3055T NPN transistor, TO-220 package, National Semiconductor or equiv.
D1, D2—1N914 silicon diode
D3—1N4001 silicon diode

Other components

T1—transformer with 10-, 18-, and 1300-turn windings, (see text)
S1—slide switch, two-deck, three position (DP3T), PC mount, Mouser 10SL008 or equiv.

Miscellaneous: neon or argon gas tube frame assembly (see text); circuit board, (see text); circuit case (optional); 9-volt battery clip; eight-cell battery pack (optional); eight alkaline AA cells; No. 24 AWG insulated hookup wire; TO-220 heatsink, spade connectors, nut and bolt, solder

Note: Completely assembled systems, kits of parts, and individual parts for the neon/argon license plate frame with variable brightness and emergency flashing, are available from Information Unlimited: Box 716, Amherst, NH 03031, Telephone 1-603-673-4730; Fax 603 672 5406. Include $4 for shipping & handling per order. The following options are offered:

- Driver circuit transformer, T1 (28K087)—$9.50
- Printed-circuit board PC1—$4.50
- Kit of parts for system including all electronic components and PC board, but no gas tube or plastic frame (BATNEONK)—$19.50
- Ready-to-use aqua and purple neon tubes with plastic frames for flashing power supply (AQUA1)—$12.50; (PURP1)—$12.50
- Ready-to-install non-flashing purple license frame neon assembly (LICNPR)—$24.50
- Ready-to-install non-flashing green license-frame neon assembly (LICNGR)—$24.50
- High-brightness under-car neon assembly: Pink 4-tube kit (RG4K)—$124.50; Purple 4-tube kit (RG4L)—$124.50; Music driver for above kits (RG4M)—$39.50; Single tube kit (specify pink or purple) (RG1K)—$34.50

After soldering all components and trimming their leads, insert and solder the wires for the battery pack and vehicle's power system. Solder all the wires from transformer T1 to their specified terminal points. Connect and solder the hot and ground wires to the neon-tube frame assembly.

System assembly

Refer to assembly diagram Fig. 3. The neon or argon gas-filled tube has been bent to form a rectangle with an inside measurement of 11×5¼-inches so it can frame the license plates of all American and Canadian cars. The tube is embedded in RTV silicone within the lip around a transparent plastic cover that will protect the license plate.

Wires extend from both ends of the gas-filled tube for connection to the high-voltage output and ground wires of the driver circuit. Those wires can be soldered together or connected by soldering automotive spade-style connectors to their ends for more convenient connection and disconnection should it become necessary.

The battery pack needed for test purposes can also be the permanent power source, if desired. It consists of eight AA alkaline cells. If you intend to connect the system to a vehicle's electrical system, do it with approved automotive-style sol-

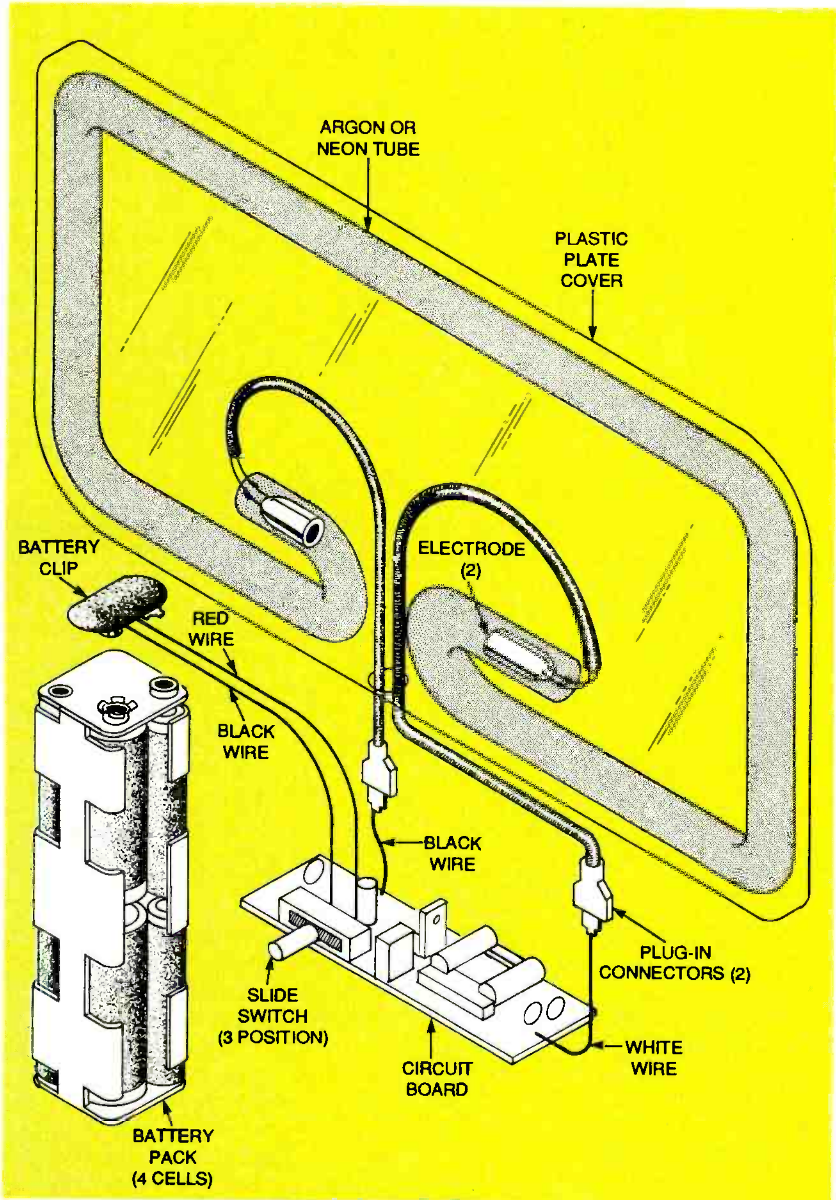


FIG. 3—NEON OR ARGON GAS TUBE LICENSE PLATE frame system showing driver circuit connections to the gas tube/ cover assembly.

derless connectors, and do as neat a job as possible.

After completing the driver circuit, it is recommended that the circuit be placed in a protective case to protect it from dust and moisture. A standard plastic project case is suitable. Drill or form holes in the case to permit the lever of slide switch S1 to be moved and permit the passage of external wires to the power source and the gas tube/ cover assembly.

Testing the system

Move the lever on the slide switch S1 to its full left OFF position. Place eight AA cells in the battery pack and snap the battery clip in position on the pack. Move the lever of S1 to the middle position and watch for ignition of the gas in the tube. Then move the switch to the right position and observe that the tube is flashing. If this does not happen, disconnect the battery power and examine the circuit for any error in parts placement or soldering and correct it.

The brightness of the glowing tube can be set by adjusting the wiper on trimmer potentiometer R1. This applies in both the continuous and flashing modes.

If the gas tube is to be run exclusively from the battery pack, you can expect about 10 hours of illumination from eight fresh alkaline AA cells before they must be replaced with a new set. Ω

STRIP CHART RECORDER

continued from page 45

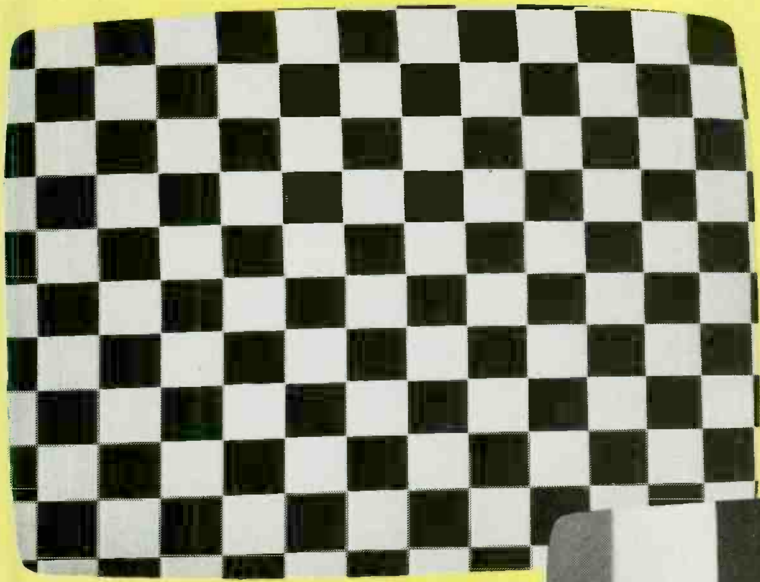
the recorder is to place a thermometer beside the temperature probe and mark pen positions and thermometer readings at various temperatures. Glue the marked-up calibration strip to a ruler or strip of plastic. You can then scale your charts by aligning the reference point on your ruler with the reference point on your chart.

Test the circuit by turning op-amp gain (R10) all the way up and setting S1 to Calibrate. The pen should move to the reference position and stop. If the carriage moves all the way to one side or the other, try reversing the wires going to the motor

If the carriage oscillates (hunts), gain is too high. so turn R10 down. When you get the drive working properly, switch to the thermistor, making certain that ambient temperature puts it within range of your chart recorder. Now verify the thermistor's resistance at different temperatures.

In addition to temperature, the author has recorded wind direction using a modified 10K potentiometer as a sensor. One planned experiment involves putting a probe in the ground and charting the relationship between soil temperature and tomato taste. If you come up with a novel project using an obsolete printer for a new purpose, let us know about it. A possible application idea is placing a signature on a check. There are other possibilities using otherwise obsolete computer components. Ω

Build This Video Pattern Generator



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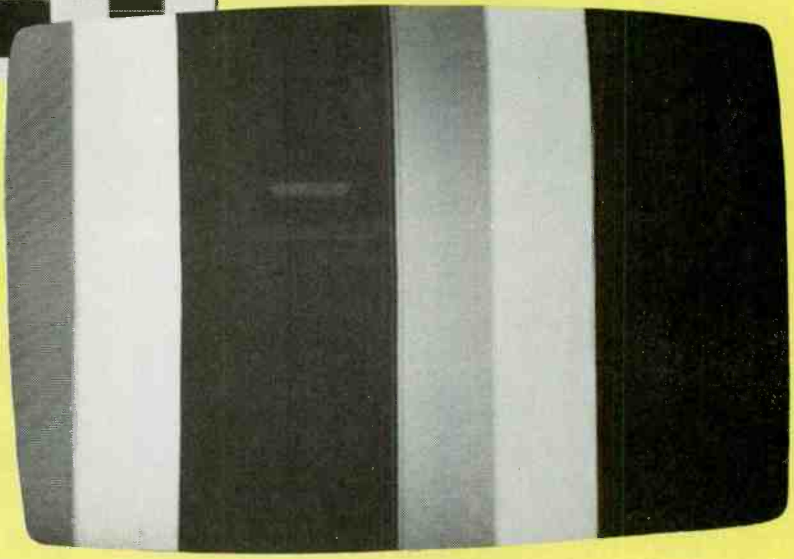

Build this EPROM-based video pattern generator and put it to work testing TV sets and experiment with the generation of video patterns.

THE MULTIFUNCTION VIDEO SIGNAL generator project described in this article produces three independent video test patterns: a black and white checker pattern, a color-bar pattern, and a programmable custom picture. When any one of those patterns is combined with a sync signal and sent to a television signal modulator IC, a video signal is formed.

How does it work?

Figure 1 is a block diagram for the video pattern generator. A clock pulse generator initiates the base time clock pulses. Those clock pulses drive a counter, which sends the address signals to an erasable programmable read-only memory (EPROM). The EPROM contains all of the previously stored sync and pattern signals. The outputs of the EPROM, as selected by a pattern-selection switch, are synchronized by a latch, and sent to the NTSC (television) modulator. The modulator combines the sync and pattern signals to form a video output signal.

Figure 2 is the schematic for the video signal generator. The main clock pulse signal for the generator is based on XTAL1, which has a frequency of 3.579545 MHz or a period of 0.279 microseconds. (Color television sets contain a 3.58 MHz color-burst oscillator.) A horizontal sweep period based on 227 clock pulses was selected. The period is calculated as 227 × 0.279 microseconds, which equals 63.33 microseconds, the length of time for a horizontal line scan in a receiver conforming to the NTSC (National Television System Committee) standard. The vertical deflection contains 262 horizontal sweep lines, so that one field consists of 227 × 262, or 59,474 clock pulses.

Four 74HC161 binary programmable counters (IC1 to IC4) form a 59,474 clock pulse counter. The two modes of the counter are controlled by its LOAD signal. If LOAD pin 9 has a logic 1 (high) state, the 74HC161 is in its normal counting mode. However, if LOAD pin has a logic 0 (low) state, the 74HC161 enters its load mode. The clock pulses will load the program data at input pins A through D (pins 3 to 6) of the four 74HC161 binary counters.

When all four binary counters

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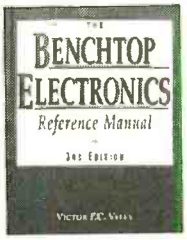

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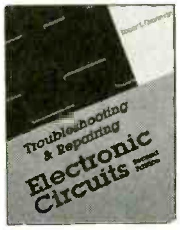

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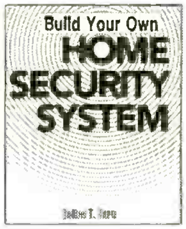

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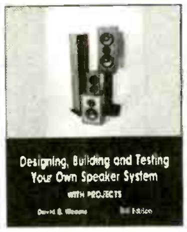

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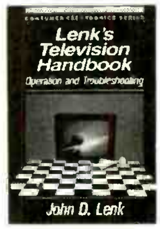

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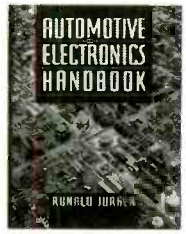

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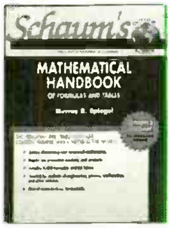

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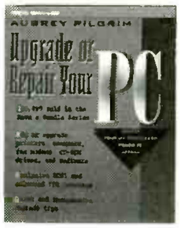

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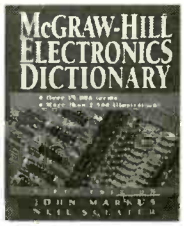

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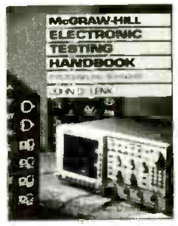

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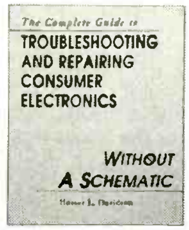

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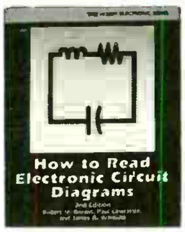

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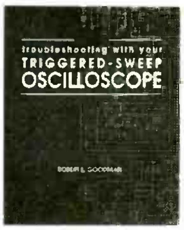

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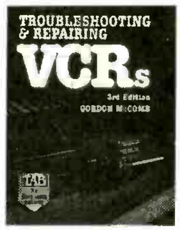

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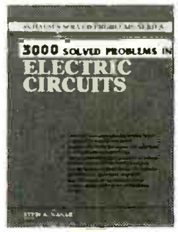

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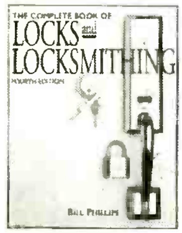

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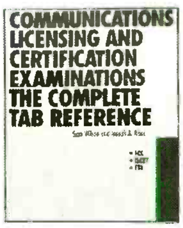

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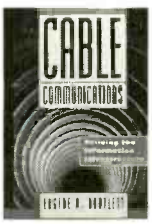

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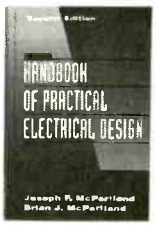

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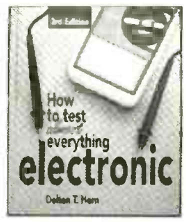

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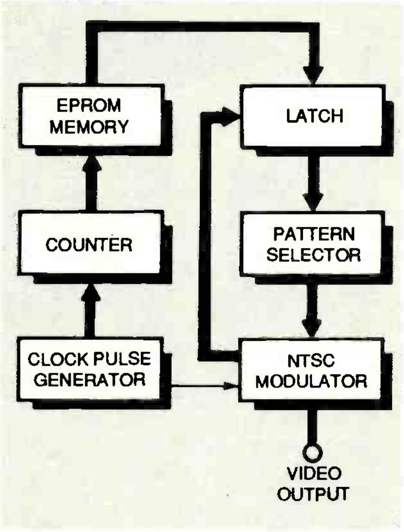


FIG. 1—FUNCTIONAL BLOCK DIAGRAM for the Video Pattern Generator.

count to logic 1 (FFFFH), IC4's ripple-carry output (RCO) pin 15 becomes a logic 1. This signal is sent to the four counters' load input pins after inversion by 74HC00 IC6-a. Then the counters load the data at their a to d inputs when the next clock pulse occurs. In this case, 0001 0111 1010 1110 equals 17AEH will be loaded into the counters. The binary counter, which counts from 17AEH to FFFFH, requires E851H or 59,473 clock pulses. This is the required counter sum after adding one more clock pulse for loading data.

The counters' outputs are sent to a 27C512-15 64K-×-8 CMOS EPROM (IC5) as address signals. For each address, IC5 provides an 8-bit output. These outputs are listed in Table 1.

Pins D0 to D2 of IC5 send the custom pattern signals red (R2), green (G2) and blue (B2). Pin D3 provides the black and white checker pattern. Pins D4 to D6 send the color bar red (R1), green (G1), blue (B1) signals. The sync signal that combines both the horizontal and vertical sync signals is obtained at pin D7.

The EPROM's outputs are latched by the 74HC273 (IC6) octal D flip-flops for synchronizing purposes. Three-pole, three-terminal switch S1 selects each of the three video patterns. As shown in Fig. 2 the S1 top position (1) selects the 14-×-18 B/W checker pattern. When this pattern is selected, the B/W signal is sent to the MC1377 television RGB-to-NTSC encoder (IC7) with equal red, green and blue values. As a result, the picture will be black if B/W is logic 0 and it will be white if B/W is logic 1.

TABLE 1—EPROM Outputs

D7	D6	D5	D4	D3	D2	D1	D0
Sync	R1	G1	B1	B/W	R2	G2	B2

The second pattern selected by the mid-position (2) of switch S1 is the color bar pattern. The order of the colors in the color bar pattern is *white, yellow, cyan, green, magenta, red, blue* and *black*, from left to right. The third video pattern selected by bottom position (3) of S1 is a custom picture which is composed of 237 lines, and each line contains 287 pixels. Thus, the total number of pixels in the custom pattern is 43,605. Each of those pixels can be programmed as one of the eight different colors in the color bar pattern.

The RGB to NTSC encoder MC1377 (IC7) performs all of the functions of a color TV encoder. These functions are: color subcarrier oscillator; RGB to R−Y and B−Y converters; voltage-controlled 90° phase shifter; and chroma modulators. The inputs required for the proper operation of the MC1377 are 1-volt peak-to-peak red, green and blue (R, G and B) signals, and a TTL-level sync signal. The MC1377 provides a 2.5-volt, peak-to-peak, composite-video output to jack J1.

Because IC-6 is a high-speed CMOS device, its output signal level will be very stable. This means that if the output is logic 0, the level will be close to zero volts. If output is logic 1, the voltage should be +5 volts. The selected pattern signals are divided by resistors R1 to R6 to meet the MC1377's input level requirements. Those resistors are specified as 1% to eliminate any error caused by different R G B levels that would cause color distortion. You can hand-select these from a group of 5% resistors by measuring and sorting them with a DMM.

PARTS LIST

All resistors are ¼- watt, 5%, unless other specified
R1, R2, R3—3900 ohms, 1% (See text)
R4, R5, R6—1000 ohms, 1% (See text)
R7—470,000 ohms
R8—75 ohms
R9—43,000 ohms
R10—2200 ohms
R11, R12—1000 ohms
R13—10,000 ohms

Capacitors
C1, C3—10-µF, 16-volts, aluminum electrolytic
C4—12-pF, ceramic disc
C5—20-pF, ceramic disc
C6, C7—220-pF, ceramic disc
C8, C9—0.01-µF, ceramic disc
C10, C11, C12, C13, C20—0.1-µF, ceramic disc
C14, C15, C17—1000-pF, ceramic disc
C16, C18—470-µF, 16-volts, aluminum electrolytic, axial leaded
C19—100-µF, 16-volts, aluminum electrolytic
C21—470-µF, 35-volts, aluminum electrolytic

Semiconductors
D1, D2, D3, D4—1N4001, silicon diode
IC1, IC2, IC3, IC4—74HC161N, 4-bit binary programmable counter (Motorola or equiv.)
IC5—27C512-15, 64K × 8 EPROM, AMD or equiv.
IC6—MC74HC273 octal D flip flops with clear (Motorola or equiv.)
IC7—MC1377P, RGB to PAL/NTSC encoder (Motorola or equiv.)
IC8—74HC00E, quad 2-input NAND gate (Motorola or equiv.)
IC9—MC7812T, +12-volt regulator IC (Motorola or equiv.)
IC10—MC7805T, +5-volt regulator IC (Motorola or equiv.)
Q1—2N3904, NPN transistor

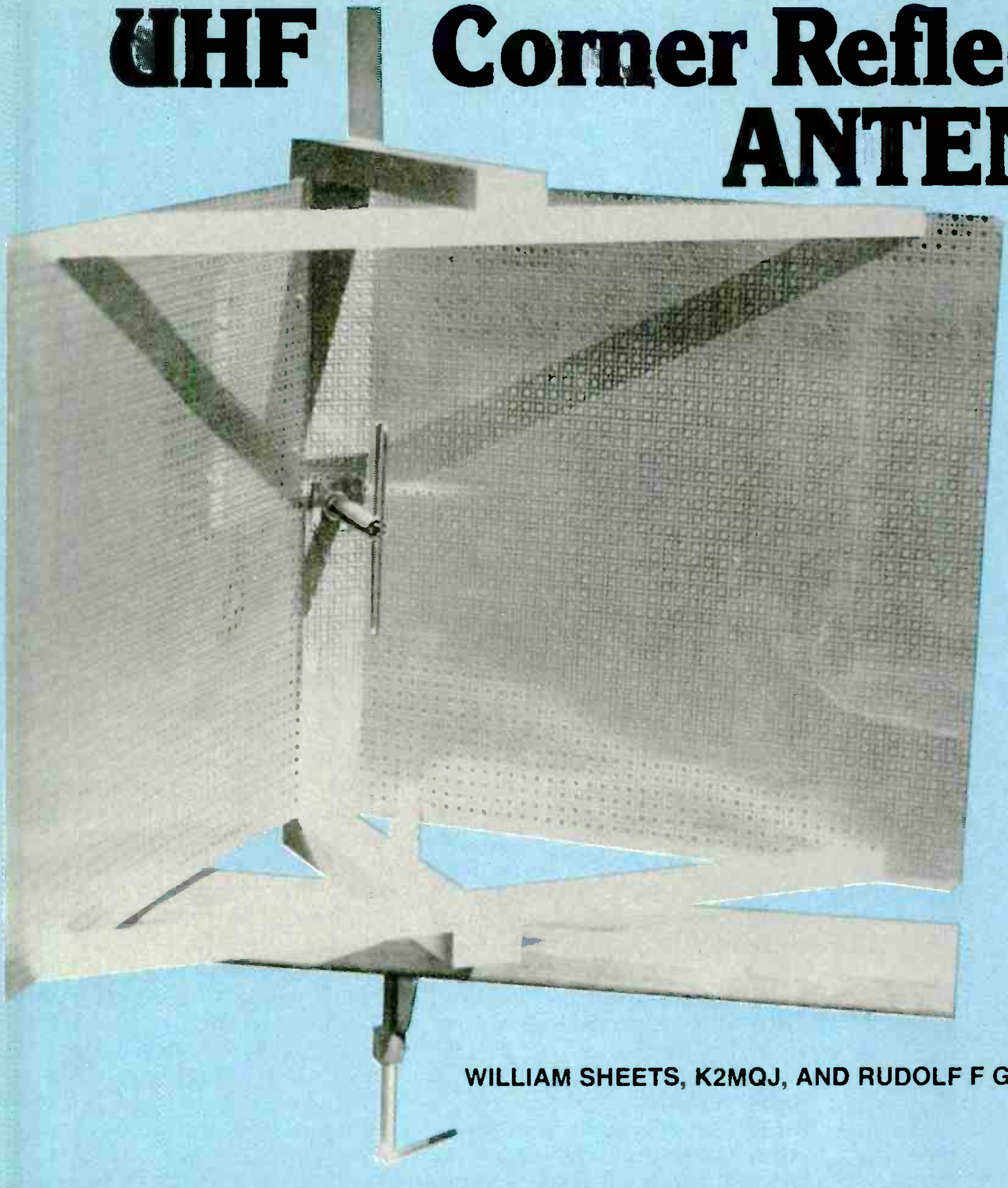
Other components
J1—Coaxial jack, F series, panel mount.
T1—Transformer, 120 to 15 VAC, 300 mA
XTAL1—3.579545 Mhz crystal

Miscellaneous: Circuit board (see text); project case (see text); DIP sockets: four 16-pin, one 14-pin standard width, two 20-pin narrow width, and one 28-pin wide of EPROM; knob for rotary switch; length of RG-58 coaxial cable (see text); line cord with plug, insulated hookup wire, four standoffs, ¼-inch; screws, nuts and washers; solder

The output of IC7 (the MC1377) is buffered by Q1, a 2N3904 NPN transistor, to improve its drive capability. To keep the circuit simple, the main clock pulses are generated by the MC1377. Because pin 17 of the MC1377 can provide only 0.1 volts peak-to-peak subcarrier output, the signal is ampli-

Continued on page 72

UHF Corner Reflector ANTENNA



WILLIAM SHEETS, K2MQJ, AND RUDOLF F GRAF, KA2CWL

Obtain outstanding performance from a home-brew radiator built from readily-available parts and materials.

SCANNER ENTHUSIASTS, AMATEUR radio operators, and UHF experimenters are interested in simple antennas that are more effective than ground-planes and whips. You can build a high-performance UHF corner-reflector antenna that is compact and easy to tune using readily available materials.

A corner-reflector antenna provides good performance radiation for directional UHF work since it has 8 to 10 dB gain, is fairly easy to build, and has reasonable bandwidth of 5% to 20%. Also, the corner-reflector antenna exhibits a good radiation pattern and front-to-back signal ratio.

The corner-reflector antenna consists of a balanced half-wave dipole placed in front of a conducting surface that is folded with an angle of 90 degrees or less. As the angle gets smaller, the gain tends to increase but the antenna structure tends to get larger and the dipole feed impedance becomes lower. The dipole may be constructed with thick dipole elements to increase bandwidth. The spacing of the dipole from the reflector can be adjusted to optimize the feed impedance.

The gain of a corner-reflector antenna with a reflector surface of one to two wavelengths is typically 8 to 10 dB over an isotropic radiator. Antenna gain can be made 14 to 15 dB or more with a large reflector (greater than 5 wavelengths) and a narrow (45 degree or less) angle.

However this is mechanically impractical at frequencies below 1000 MHz.

Dipole operation

A dipole is a balanced antenna and should not be fed directly with coaxial cable. Doing so would cause the outer conductor of the coaxial line to act as part of the antenna, and a large amount of signal would be radiated or received by the outer conductor. For casual reception this may not matter much, but the directional radiation pattern of the antenna is destroyed and reception/transmission results are no longer predictable.

In order to derive a balanced feed for the dipole some sort of a transformer is necessary. For the corner reflector described here a slot-fed balun is used (see Fig. 1). This is accomplished by splitting the outer conductor (made from a brass tube) lengthwise for a quarter wavelength and connecting the inner conductor (a much smaller diameter tube or rod) to the end of one segment, and to one dipole element. The other segment is connected to the opposite half of the dipole. This type of balun gives a 4:1 impedance transformation and can feed a simple dipole. A satisfactory impedance match was achieved (1.5:1 or better VSWR) by adjusting slot length and trimming dipole length, and adjusting dipole-to-reflector spacing. Dipole-to-reflector spacing affects the dipole's impedance (see Fig. 2).

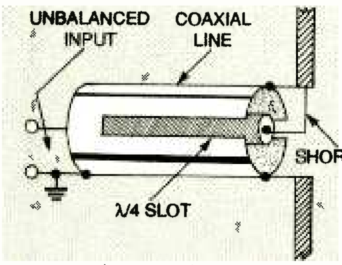


FIG. 1—METHOD FOR FEEDING a balanced dipole by a slot- fed balun.

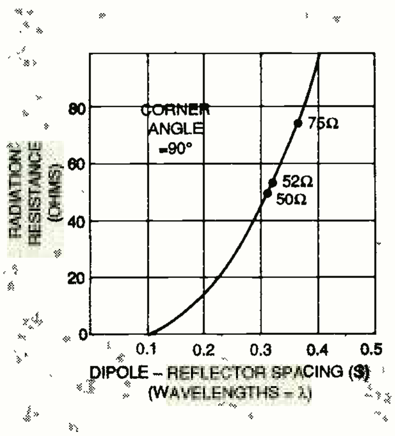


FIG. 2—PLOT OF RADIATION RESISTANCE in ohms vs. spacing of a dipole in wavelength from virtual apex of a 90° corner-reflector antenna.

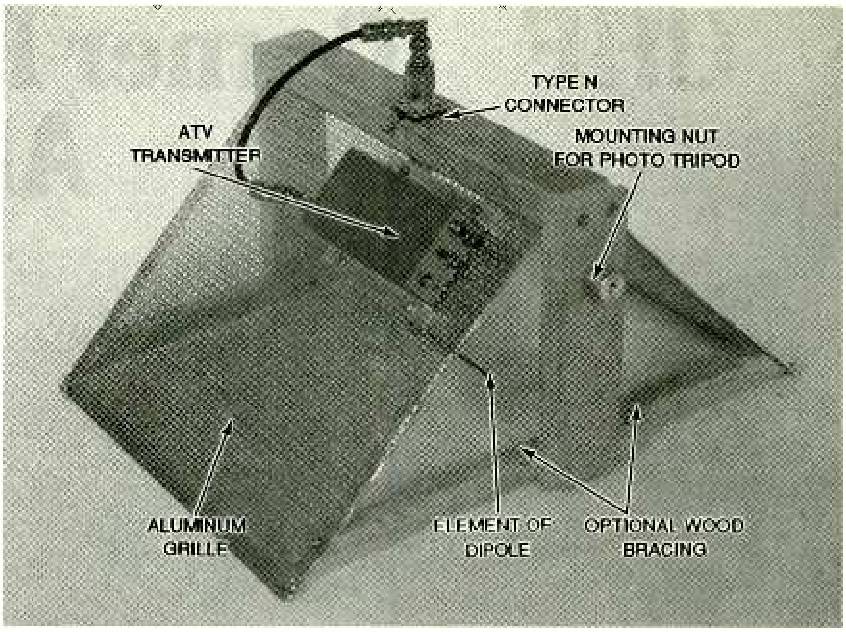


FIG. 3—THE BASIC PARTS of a corner-reflector antenna.

Construction

Fig. 3 shows some details of a corner-reflector antenna that you can build. Virtually all materials for the antenna are available at hobby shops and building supply centers. Total cost should be $20 or less. The corner-reflector antenna described here was designed for operation at 900-MHz. For other frequencies, the dimensions can be scaled from the information given in Table 1 and inserted into Fig. 4. However, at lower frequencies, the antenna is larger so some compromises have to be made to keep within practical mechanical size, weight and structural stability. A good idea from a performance standpoint is to keep the reflector as large as you can, up to a few wavelengths. This becomes impractical at 400 MHz, more so than at 1300 MHz, because of the antenna's overall size. As antenna size increases the extra gain may not be worth the mechanical difficulties and cost. Also, wind loading must be taken into account as this corner-reflector antenna presents a large wind surface area from all compass directions.

The antenna shown in Fig. 3 is fairly easy to construct with hand tools. Before you begin construction, review all the illustrations from Fig. 1 to Fig. 8, including Tables 1 and 2 to obtain a visual mechanical understanding of what is to follow.

Begin by cutting a 6.5-inch piece of ⅝-inch O.D. (outside diameter) brass tubing with a 0.015-inch wall thickness (available at well-stocked hobby shops). See Fig. 5. This length is the sum of half of a wavelength at the desired operating frequency, plus another 1 to 2 inches to allow for the connector and mounting flange as shown. Make sure the ends are squarely cut. A tubing or pipe cutter will provide a better cut than a hack saw. Cut a piece of ¼- inch tubing to a length about ⅛ inch shorter than the length of the ⅝-inch tubing. These tubes will form the dipoles feed assembly and balun.

Continued on page 75

BY JEFF HOLTZMAN

Disk-space management

JUDGING BY MY E-MAIL, DISK PARTITION MANAGEMENT IS A VERY POPULAR—BUT MUCH MISUNDERSTOOD—TOPIC. TO HELP DISSIPATE THE MIST, I'LL DISCUSS HOW PARTITIONING AFFECTS OVERALL SYSTEM RESOURCE availability. Then I'll talk about some products that help manage those resources in a more efficient manner than operating-system-only tools: Partition Magic, System Commander, Remove-It, and the OS/2 Boot Manager.

Should you care about disk partitioning? Not if you have a high-capacity hard disk with no danger of running out of space, and you run a single operating system. But if you want to run more than one operating system on a single machine, maximize space-utilization efficiency, provide better organization of data, or add additional hard drives, then you'll want to understand this discussion.

How partitioning works

Any given physical drive can be divided into several sections called *partitions*. A given drive may have as many as four partitions. There are two types of partitions: primary and extended. In general, you can think of primary partitions as bootable, and extended partitions as for data. You can subdivide the extended partition into logical drives, but you cannot subdivide a primary partition. Both types of partitions can be either hidden or visible. Hidden means that the partition will be ignored by the operating system when booting, and inaccessible thereafter. The main differences between primary and extended partitions are summarized in Table .

LISTING 1—DRIVE ASSIGNMENT ALGORITHM

```
For each drive
  If exists (visible primary partition) then
        Assign drive letter
For each drive
  For each logical drive
        Assign drive letter
For each drive
  For each unassigned visible primary partition
        Assign drive letter
```

All partition information (where it starts, where it ends, whether it's visible, its type, and so on) is stored in a data structure near the physical beginning of the disk. That data structure is called the *Partition Table*. You can view it using various utilities, including DOS's FDISK, the Disk Editor in the Norton Utilities, and several of the utilities discussed below.

In the past, only one primary partition could be marked visible. But recent versions of DOS (and Windows 95) can have multiple visible primaries (MVP's). However, some operating systems (such as OS/2) are confused by MVP's; consequently, data corruption can occur.

All versions of DOS, Windows, and OS/2 come with a utility called FDISK, which allows you to create, destroy, and (in a very limited way) modify partitions. Using only utilities supplied with the operating system when repartitioning a disk usually means backing everything up, repartitioning, possibly installing an operating system and restoration software, and restoring data to the new partitions.

A company called PowerQuest recognized that limitation and has developed an extremely useful partition-manipulation utility called Partition Magic, which allows you to create, destroy, move, resize, hide/unhide, and set active partitions. (Setting a partition active means designating it as the boot drive.)

Partitioning issues

When deciding how to divide up a hard disk, there are three primary issues: 1) Cluster size and disk efficiency; 2) The number of operating systems and their boot requirements; and 3) Drive letter sequences.

Cluster size. I discussed this issue in some detail in the January 96 issue, so I won't repeat it here. The bottom line is that when it comes to cluster size, big is bad. You can easily waste 150 megabytes or more on today's common 1-gigabyte drives. It is to your advantage to partition large drives in as small chunks as possible.

OS requirements. The questions to ask here are: How many operating systems do you want to run? How much space does each need? How much isolation do you want between them? Do they need to have access to each other's data? The cleanest, safest approach to running multiple operating systems on a single hard disk is to create four primary partitions, and mark only one visible at any given time. But then you can't share data among them. In addition, some operating systems "predatory:" On installation, a predatory operating system alters the partition table and the bootstrap loader on all drives so that only that operating system will be visible. Windows 95 is notorious in this respect. However, that's easy to fix using FDISK or Partition Magic.

Drive letters. When experimenting with different partitioning schemes, you quickly learn that partitions have a tendency to appear at different drive letters. That can be merely inconvenient or a major pain, depending on the types of applications you run. You can minimize this effect by understanding how drive letters are allocated. There are also utilities to help migrate applications from one drive to another, in the process updating all relevant system files.

The drive-letter assignment process works like this. Scan through all physical drives; for each that has a visible primary partition, assign a drive letter. Scan through all physical drives again; for each that has an extended partition, assign drive letters for all visible logical drives in that extended partition. Scan the physical drives again; for all unassigned visible primary partitions, assign drive letters. The process is represented in pseudocode in Listing 1.

In sum, think of the ordering process as active primaries, extendeds, and inactive primaries.

Examples

To understand how that works, let's try a few examples. Assume that our system has two hard disks with the layouts shown in Fig. 1-a. Each drive has a primary active partition and an extended partition containing a single logical drive, neither of which is hidden. In this case, drive lettering is straightforward.

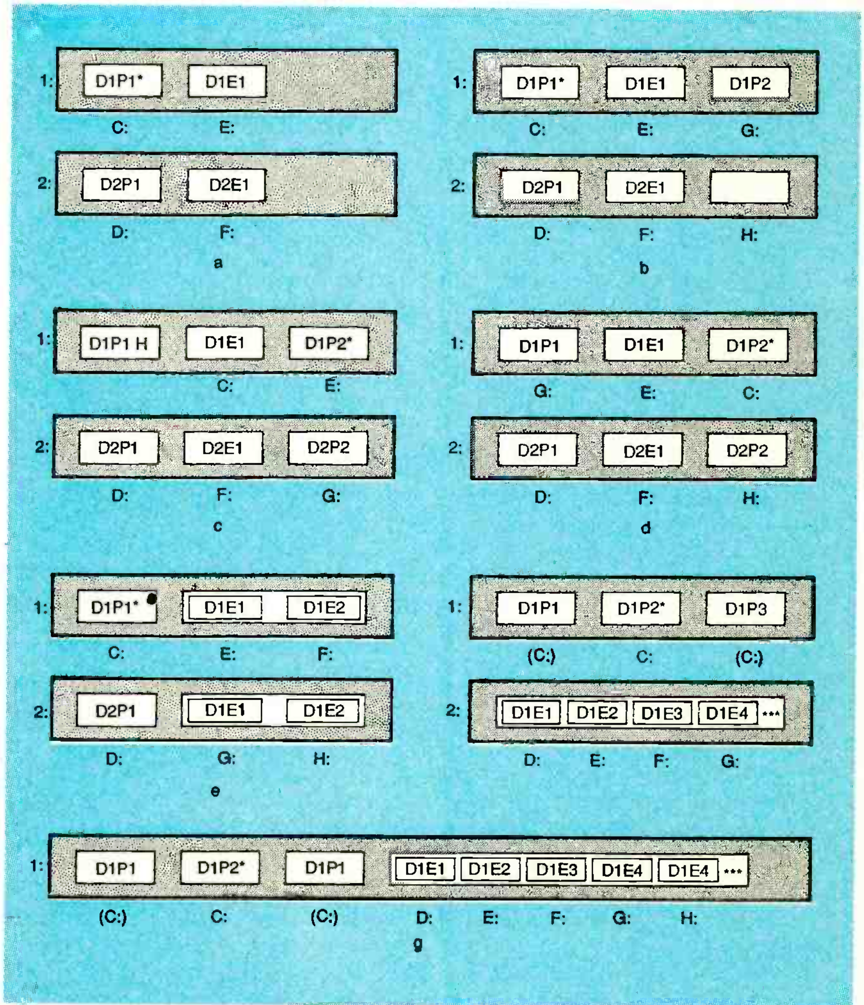
Figure 1-b adds an additional primary partition to both drives; both partitions are visible. Note the new primaries are added to the end of the letter sequence.

Now suppose we hide Drive 1, Partition 1, and make Drive 1 Partition 2 active; Fig. 1-c shows the results.

Under DOS, we could leave D1P1 visible, and simply make D1P2 active; Fig. 1-d shows how that would work. Note that our former C drive (D1P1) has now become the G drive.

Suppose now that instead of one logical drive in the extended partition, we have several. Figure 1-e shows how that might work. Figure 1-f shows one way of creating a clean multi-operating system scenario using two hard drives. Drive one might be a relatively small (500-megabyte) drive divided into several primary partitions. Each partition holds a different operating system, only one of which is visible at any given time. The second drive, perhaps a 2-gigabyte monster, might contain a single extended partition subdivided into eight 256 K logical drives.

A single-drive variant of that theme appears in Fig. 1-h, which consists of a single physical drive with three prima-



VARIOUS DISK PARTITIONING SCHEMES: Two drives, two primary partitions, and two extended partitions (a); additional primary partitions append drive letters (b); a hidden partition changes drive lettering (c); unhiding the partition but making a different one active produces a different sequence (d); multiple logical drives in the extended partition (e); one drive for booting operating systems, the other for applications and data (f); a single-drive variant of the preceding (g).

ry, bootable partitions (which would share the "C" designation), and a group of extended partitions that would remain at the same drive letters.

Disk management tactics

If you can accurately forecast your partitioning needs, great. But if you find this a slippery territory requiring occasional updates, you'll appreciate several tools for handling boot, partition, and application-configuration management.

Boot management

A boot manager helps you switch among several operating systems at boot time. If you need only a few operating systems, and don't mind some inconvenience, you can always use FDISK to set a partition active (bootable).

A step up in convenience is the Boot Manager that comes with OS/2. It allows menu-based selection, at boot, of several operating systems.

A product called System Commander, by V Communications, is probably the most versatile utility in this category. It allows you to select among more than 100 operating systems, broken down as follows: 56 in primary partitions on fourteen drives, 16 in logical (extended) partitions, and 32 in the primary DOS partition.

System Commander manages the latter by storing copies of crucial boot files (e.g., AUTOEXEC.BAT, CONFIG.SYS, and COMMAND.COM) in separate subdirectories, and then copying them to the root when you select the corresponding operating system at boot time.

One key point not noted in System Commander's advertising is that you cannot arbitrarily boot any operating system from any of those 104 slots. Flexibility may be limited by the operating system itself. For example, DOS and Windows 95 must be booted from a primary partition on the first physical drive. Other operating systems, such as Windows NT and OS/2 are more flexible, and may be booted from extended partitions and other drives. System Command also supports non-DOS operating systems including NetWare, Linux, SCO UNIX, Solaris, and many more.

TABLE 1—PRIMARY AND EXTENDED PARTITIONS

	Primary	Extended
Bootable	Yes	Some OSes, not DOS
Subdividable	No	Yes
Minimum no.	0 (1 for bootable)	0
Maximum no.	4	1
Hideable	Yes	Yes

I found that System Commander worked fairly well. At one point it got confused and mangled a copy of MSDOS.SYS, a text file that supplies boot parameters to Windows 95. Windows 95 would not boot, and gave a spurious error message about not being able to locate HIMEM.SYS. It took only a few minutes to figure out what was going on, but that type of thing could drive a novice bonkers.

Partition management

Partition Magic is a fantastic program. It's powerful, easy to use, and the price is right. The program gives you fine-tooth control over disk partitioning. You can easily add, delete, move, and modify primary and extended disk partitions on one or several drives from a nicely done OS/2-like interface. You can also convert partitions from DOS/FAT to OS/2's HPFS format. As long as you maintain a pool of free space, it's easy to move and resize partitions at will. You should absolutely back up before performing any operations with Partition Magic. Operating your computer from a UPS is also highly advisable. If something happened while Partition Magic was doing its thing, you could end up with garbage. My only criticism of the program is that if you have several partitions packed tightly together, and want to insert one between them, you have to move those to the right of the insertion point manually. An insert function would be welcome. Also, conversions among other formats (particularly NTFS) could be useful.

Application configuration management

If you repartition a large drive into smaller drives to increase cluster efficiency, applications may end up on different drive letters. For small command-line utilities and DOS (character-mode) applications, that's not usually much of a problem. But moving Windows applications can be tricky. The best way I've found of doing so is using the Move Application function in a program called Remove-It. The primary purpose of that program is to help you safely delete DLL's, INI files, Registry settings, and other system components that are no longer necessary. The program is slow, and its user interface is frustrating. But it can help you save both time and disk space.

RESOURCES

Partition Magic 2.0 ($49.95)
PowerQuest Corporation
1083 North State Street
Orem, UT 84057
(800) 379-2566
(801)226-8977
http://www.powerquest.com.

System Commander 2.26 ($99.95)
V Communications Inc.
4320 Stevens Creek Bl., Suite 120
San Jose, CA 95129
(408) 296-4224

Remove-It 3.0
Vertisoft Systems, Inc.
Four Embarcadero Center, #3470
San Francisco, CA 94111
(803) 295-5875
http://www.versoftsys.com.

OS/2 Warp 3.0
IBM Corp.
(800) 426-3333

The documentation for each of these programs is confusingly written, but loaded with useful tidbits, so if you're interested in this topic, well worth reading. Chapter 18 of the *User's Guide to OS/2 Warp* has the clearest discussion of booting and partitions. The System Commander manual does not give a good overview, but does provide detailed scenarios for installing various operating systems. Partition Magic's manual has a pretty good overview, but falls short on operation and particularly the error messages it presents. The Remove-It manual is a joke. EN

BY CARL J. BERGQUIST

Experiments with your laser

Detect earthquakes and other vibrations, build an optical seismometer, and experiment with a laser listening device.

NOW YOU CAN PUT YOUR LASER TO USE AND TRY A COUPLE OF EXPERIMENTS. THE FIRST ONE WILL MEASURE GROUND MOVEMENT. THE BEST KNOWN DEVICE FOR DOING THIS IS CALLED A SEISMOMETER.

You can build a laser-based seismometer that is simple, yet remarkably sensitive and accurate.

Seismometers are best known for their use in measuring the intensity of earthquakes. However, they can also detect other vibrations, such as those from highway traffic, trains, explosions, lightning bolts, or any other source that causes earth movement. Even if such movements occur some distance away, you will still be able to detect them. The heart of the seismometer device is the sensor unit. It incorporates a variation of the speaker modulator described in the last column (*Electronics Now, June 1996, page 51*).

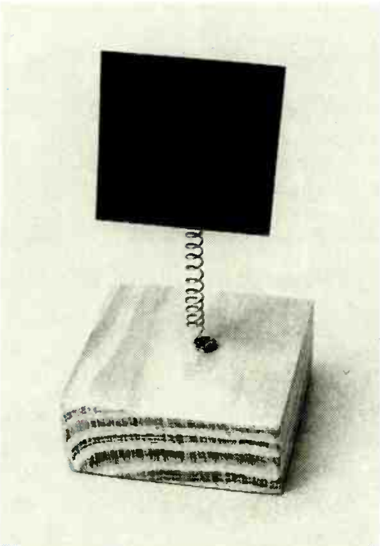


FIG. 1—SIMPLE VIBRATION SENSOR has only three parts — a small square of mylar, a spring, and a block of wood.

Figure 1 shows all three parts of the sensor unit. It is simply a $1^{1}/_{2}$-inch square of rigid, aluminized mylar attached to one end of a 2-inch length of medium tension spring. Epoxy, silicon, or hot-melt glue will do the job. Fasten the other end of the spring to a 2-inch square block of 1×2 pine. This assembly, when mounted to a very stable foundation, will vibrate in response to any shock waves traveling through the earth.

For an indoor location, use an upright stud or pillar that is sunk into your home's foundation. Such a spot in your garage or basement will work well. Outdoors, a 6- to 8-foot fence post, or an antenna ground rod that has been driven 4 to 6 feet into the earth, will provide the needed stability and coupling to the earth.

Once you have determined the location, mount the sensor assembly firmly. If you select an outdoor spot, place a small box around the sensor to protect it from air currents and wind. Leave a 1- or 2-inch opening in the box for the laser beam. With the sensor in place, aim the laser at the mylar square. Adjust the laser beam angle so the reflected beam shines into the detector described in the previous column. Adjust the volume and gain of the receiver until you are able to obtain a uniform sound signal.

Your unit is now in its monitor mode, and the signal will remain unchanged until it detects vibrations. Strike the foundation gently and notice the change in the audio output. Drop a heavy object near your detector and again note the change in the audio output. Experiment with a variety of different objects and actions that causes the sensor to react. You will soon see a pattern develop that will let you estimate shock intensity by hearing the change in the sound.

If you have a frequency meter, you'll be able to draw some interesting graphs based on a plot of the

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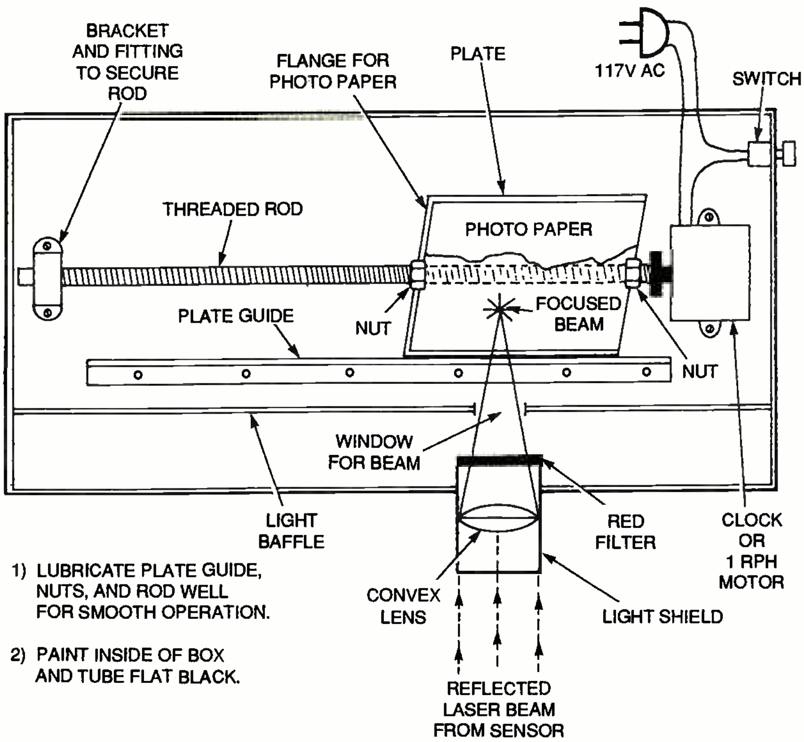


FIG. 2—FOLLOW THIS PLAN TO BUILD YOUR OWN photographic recorder. It makes a permanent record of vibrations and other earth movements over a 24-hour period.

actual frequency readings. If you connect a peak meter, an LED bargraph, an analog meter, or even a lamp and relay, you will be able to obtain all kinds of different data. If you want an alarm, use a relay to trigger a lamp or some other alarm device based on the sensor's output frequency.

Building a seismograph

While all of these demonstrations are interesting and informative they do not produce any record of the result. So for a more ambitious effort, you can build the simple seismograph based on the photographic recorder shown in Fig. 2. This device will receive the modulated laser beam, collimate it to a pinpoint of light, and record it on ordinary photographic print paper (the kind used to make black and white copy prints or enlargements).

In the prototype a threaded rod is coupled to a clock motor, which rotates the rod. Nuts that match the thread of the rod are cemented to a plate that holds a strip of photographic paper. This plate assembly is then threaded onto the rod, through the nuts. As the motor rotates, the plate moves from right to left. A metal guide is positioned at the bottom to keep the plate from spinning around the rod; a Teflon strip attached to the metal guide reduces friction. As the plate moves, it passes through the laser beam. This exposes the paper to whatever pattern is present.

With normal activity, the beam will create a rather straight line with a little background noise. But when the sensor detects significant movement, the line will break, and peaks will be displayed on both sides of the center line. This movement will be in direct proportion to the intensity of the vibration.

The project is not as simple as it sounds. Your detector will have to housed in a light-tight box as shown. Note the baffle that runs the length of the box, to further reduce stray light. The way it is set up, only laser light enters the lens and is sharply focused on the photo paper. The window in the light baffle must be kept as small as possible—mine measures only 3 inches by $^1/_2$ inch. Notice the medium-red filter on the inside end of the collimator (lens tube). It helps keep ambient white light out of the box.

The rate at which the plate carrying the photographic paper moves is determined by the number of threads per inch that the rod has. The greater the number of threads per inch the slower the plate will move. If you use a rod with 20 threads per inch, the plate will move about 1-1/4 inches in a 24-hour period.

The unit is shown set up to record vertical (up-down) movements. To detect horizontal (side-to-side) movements, simply set the recorder on its end. Either way you'll have an accurate and permanent copy of the movements you monitor.

When your unit is complete, load it with a piece of photographic paper (in total darkness or under a red photographic safe light). Then seal the box and you are almost ready to go. Line up the laser and the recorder and turn on the motor. Come back the following day and retrieve and develop your photographic paper. It's simpler than it sounds and you should have a lot of fun with this simple device.

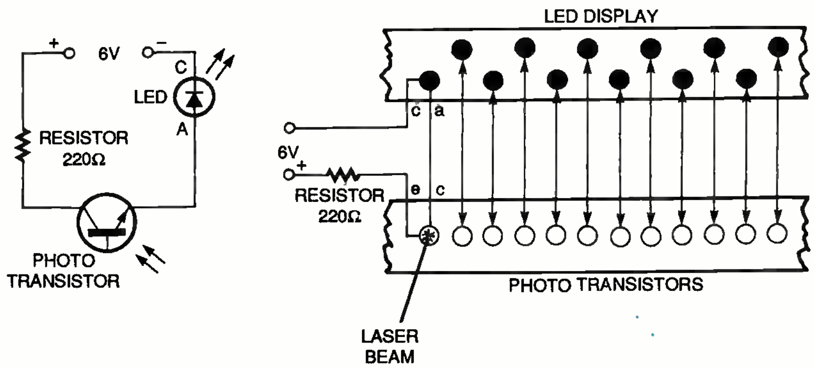


FIG. 3—PHOTOTRANSISTOR SENSING STRIP is easy to make and can be coupled to an LED display panel. Complete details are in the text.

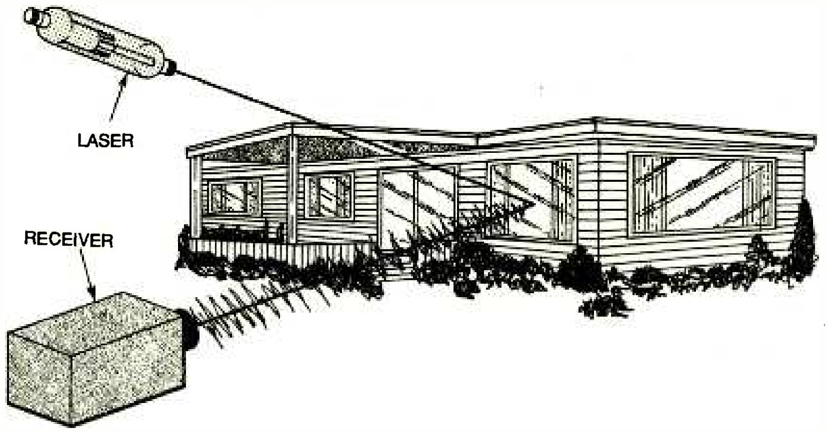


FIG. 4—BOUNCE A LASER BEAM OFF A GLASS WINDOW and pick up the reflections with your receiver. You can convert the vibrations in the glass to hear what is being said on the other side on that window.

Detecting small or slow movements

You can also put lasers to work to detect an object's small or slow movements that might otherwise escape the naked eye—the growth of a plant, for example, or the settling of a new building's foundation. This kind of study requires long-term monitoring.

One method to try is to attach a small piece of reflective mylar to the object being observed, and to reflect a laser beam off the mylar at a slight angle. The position of the return beam can be marked on a scale. As the object moves, the angle of the reflected beam will change and the spot will appear at a new location on the scale. Note these changes at regular intervals and you can chart the movement.

To perform this kind of measurement you will need a collimator, a convex lens, to concentrate the laser beam into a small spot to make the markings more accurate. If an electronic display is needed, take a look at Fig. 3. On a strip of plastic or some other mounting material, set up a row of phototransistors edge to edge, keeping them as close together as possible. The miniature plastic types will let you squeeze in about 10 to the inch. Connect a 220-ohm resistor to each phototransistor's collector. Then tie the anode of a standard LED to each phototransistor's emitter. Make sure that the LED cathodes are all connected to the negative side of a 6-volt DC power source. The free end of each resistor connects to the positive side of the supply. Whenever the laser beam hits one of the phototransistors, the corresponding LED lights.

Let's use a clock's hour hand as a specific example—it will provide results quickly. As the hand moves around the dial, mark the reflections on a piece of graph paper. Then draw a curve using the points you have plotted. Remember, this is only an example to let you see results quickly. If you come up with an interesting test procedure, let us know.

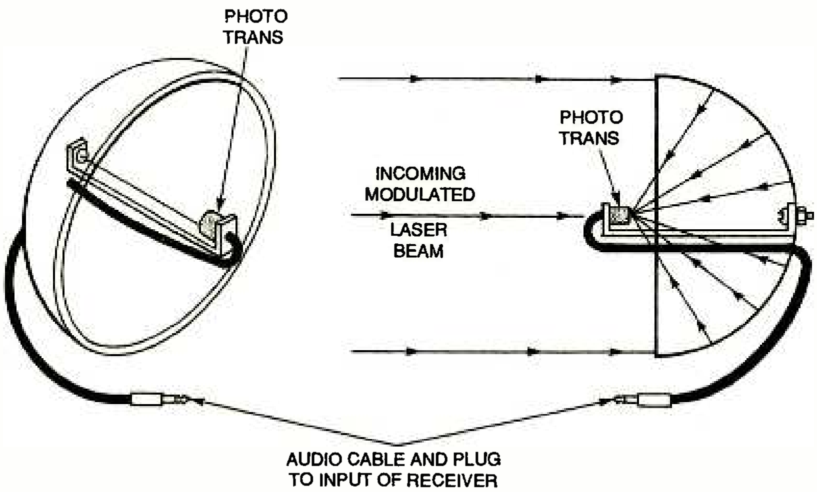


FIG. 5—A SIMPLE PARABOLIC DETECTOR noticeably increases the sensitivity of the detector.

Reflected sound modulation

The last experiment in this section uses the high-gain amplifier described in the laser column in the June 1996 issue of *Electronics Now*, as a receiver. It demonstrates how sounds can create vibrations in solid materials. The degree of movement depends upon the volume of the sound present and is usually unnoticeable to the human eye. Yet it is there, and the receiver is sensitive enough to detect it. To illustrate this principle, aim your laser at a surface on a nearby building and align your receiver so it can pick up the reflected beam as shown in the diagram of Fig. 4.

Glass or metal surfaces are best, as both tend to vibrate better than more solid materials. When you bounce the beam of a pane of glass, only part of the light comes back, while the rest passes on through to strike whatever surface it finds. For more detailed information about the process see the article *Laser Listener* by Richard Pearson, in the October 1987 issue of Radio-Electronics magazine.

Adjust the receiver's gain and volume and you should be able to hear sounds within or around the building. Scan the beam around the structure to find the points of best reception. This type of system has been employed for clandestine eavesdropping, and such use is illegal.

It is interesting to note the sensitivity of the equipment and the variety of sounds received. For the best possible reception, try using a metallic parabolic dish to increase the concentration the incoming light and maximize the strength of the incoming audio signal (see Fig. 5) at the dish's focal point. EN

CIRCUIT SIMULATION

continued from page 42

In addition to circuit simulation, EE Works comes with a healthy helping of circuit-design routines, like the filter design in Fig. 1, that calculates the value of the various components after you enter the desired response. There's a schematic-capture routine, of sorts, that lets you build your own design and submit it to the rigors of this cruel simulator.

Because of the modular design, though, EE Works' myopic view of the world results in very fast simulations. It can do in 10 seconds what it takes a Spice-modeled simulator three minutes to do. Moreover, it delivers more information than you can possibly digest in a single session. While the graphics are a bit skimpy, what graphics it does have are dynamite — if you know how to read the results. In addition to an X-Y plot, you're given a table of values that created the plot, plus a list of the DC parameters at each sampling. These can then be used to optimize the circuit.

Fast, accurate, and thorough are the trademarks of EE Works. However, it's a real nut-buster program that requires a lot of preparation to work and an engineering background to use to the fullest.

Product:	Analyser III
Version:	1044C
Price:	$149
Platform:	DOS
Distributor:	BSOFT Software, Ohio Automation

Analyser III is a DOS-based, non-SPICE analog simulator from Number-One Systems Ltd., the same people who make the Easy-PC line of schematic-capture and PC-board layout software. Analyser III is an AC-only analyzer, specifically measuring magnitude, phase, and delay times. It doesn't do DC analysis or operating-point analysis. However, it can display these values by gain, input impedance, or output impedance of the circuit under test.

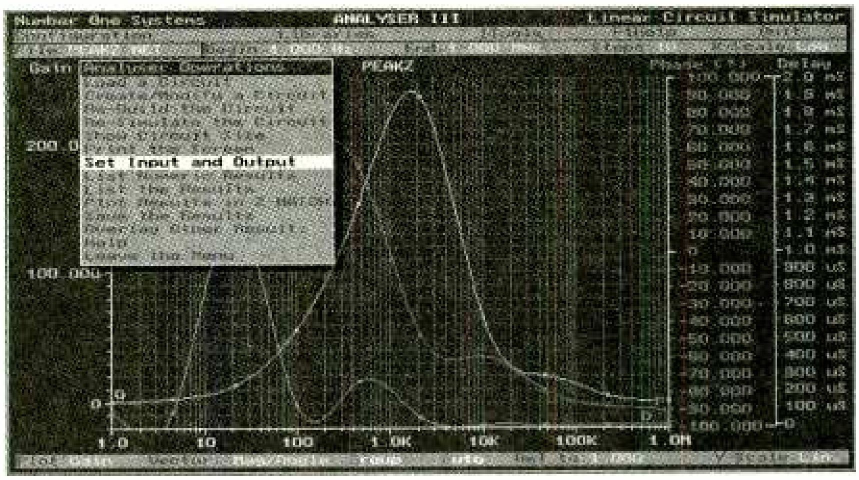


FIG. 2—ANALYSER III IS AN EASY-TO-USE analog simulator that measures magnitude, phase, and delay times well into the GHz range.

At the heart of Analyser III is a sweep generator with a frequency range of 0.001 Hz to 1,000 GHz. To do a simulation, you load the circuit, set the desired frequency sweep, and press the "go" button. Analyser III does everything else for you by automatically setting the input voltage level and adjusting the X-Y scales so that the waveforms fill the display area (Fig. 2).

You can either import the design from a schematic you drew in Easy-PC Professional, or you can create the circuit with Analyser III's assistance. Because Analyser III doesn't have a schematic-capture function, though, you have to "build" the circuit as an ASCII netlist using Analyser III's text editor. You simply list the components, and use node numbers to identify their interconnections. Analyser III then translates the list into the proper netlist format. Unfortunately, the process isn't intuitive; it's not easy to keep track of the many nodes used in a complex circuit. Consequently, you'll find it a lot easier if you sketch a diagram of the design before you begin the netlist building process.

Analyser III comes with a library of 100 components and includes a good mixture of bipolar transistors, field-effect transistors, and operational amplifiers. Additional components can be added to the library using a text editor and information gathered from the device data sheets.

For straightforward gain-versus-frequency analysis, there's nothing faster or easier to use than Analyser III. Moreover, it can do simulations well into the GHz range, making it ideal for evaluating transmission lines, open stub filters, and stripline filters.

Product:	B²Spice for Windows
Version:	1.1
Price:	$149
Platform:	Windows
Publisher:	Beige Bag Software

By the time you read this, the B² Spice for Windows program reviewed here will be replaced with a newer version. Unfortunately, we couldn't get the beta version of the new simulator (version 2.0) to work without it crashing our system. So rather than rake it over the coals, we went with what works—Version 1.1. We are told the look and feel is about the same in V2.0, but more about that later.

Unlike most SPICE simulators, which easily run from an ASCII netlist, B² Spice for Windows has to run from a schematic-capture program. It cannot import SPICE decks. Fortunately, the schematic-capture function is included in the $149 price. Unfortunately, it's not the best-looking drawing program, and the nomenclature is always expressed in scientific notation (Fig. 3).

TABLE 1

	Analyser III	B^2Spice	CircuitMaker	EE Works	Electronics Workbench	ICAP/4Lite	SuperSPICE	TurboSIM
Price	$149	$149	$299	$129.99	$299	$40	$149	$149
Format	DOS	Windows	Windows	DOS	Windows	Windows	Windows	Windows
RAM required	640K	2MB	2MB	640K	4MB	4MB	2MB	4MB
Math processor req.	N	N	N	N	N	N	Y	Y
Schematic capture	Y(1)	Y	Y	Y	Y	Y	Y(1)	Y
Berkeley SPICE	N	Y	Y	N	Y	Y	N	Y
Mixed mode	N	N	Y	N	Y	Y	N	N
BBS file	analyser.zip		cmdemo.zip	ee_works.zip	ewb_demo.zip	intusoft.zip	supercad.zip	turbosim.zip
Analysis support								
DC operating point	N	Y	Y	Y	N	Y	Y	Y
DC sweep	N	Y	Y	Y	N	Y	Y	Y
AC sweep	Y	Y	Y	Y	Y	Y	Y	Y
Transient	Y	Y	Y	Y	Y	Y	Y	Y
Noise	N	Y(2)	N	N	N	Y	N	Y(4)
Distortion	N	Y(2)	N	N	N	Y	N	N
Sensitivity	N	Y(2)	N	N	N	N	N	Y(4)
Fourier transfer	N	Y(2)	N	N	N	Y	N	Y(4)
Pole zero	N	Y(2)	N	N	N	N	N	Y(4)
Signal sources								
Exponential	N	N	Y	N	N	N	Y	Y
FM generator	N	N	Y	N	N	N	Y	Y
Function generator	N	Y(3)	Y	Y	Y	N	Y	Y
Piece wise	N	N	Y	Y	N	N	Y	Y
Monitoring devices								
Ammeter	N	N	Y	N	Y	N	Y	Y
Bode plotter	Y	Y	Y	Y	Y	Y	Y	Y
Logic analyzer	N	N	N	N	Y	N	N	N
Logic converter	N	N	N	N	Y	N	N	N
Multimeter	N	N	Y	N	Y	N	N	N
Oscilloscope	N	Y	Y	Y	Y	Y	Y	Y
Voltmeter	N	Y	Y	N	Y	N	Y	Y
Word generator	N	N	N	N	Y	N	N	N

1) Separate program
2) Version 2.0 only
3) Separate instruments
4) Advanced version only

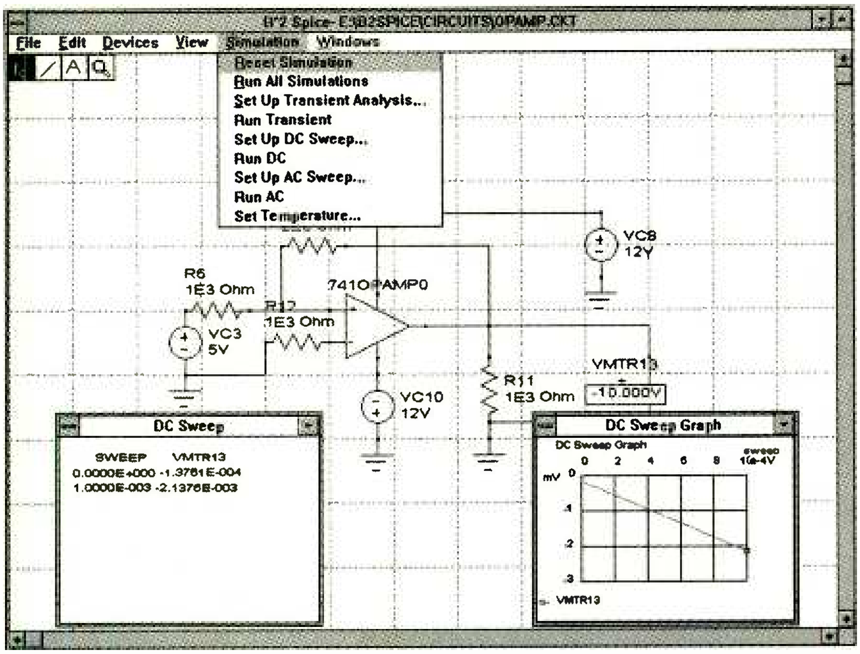


FIG. 3—THIS SCREEN SHOT B² SPICE is from version 1.1; by the time you read this, version 2.0 will be shipping.

The schematic itself is easy enough to draw. And the component library is extensive enough to cover almost any analog design. To describe the component, though, you almost need an engineering degree. For example, to define a germanium general-purpose diode, like a 1N34A, you need to know its forward current transfer, TT time, CJO and EG parameters—plus its temperature transfer function. It's not clear if all semiconductor manufacturers include all these parameters in their SPICE models, and if they do, whether that model fits into B² Spice's scheme of things. That we won't know until version 2.0 is debugged.

The simulator is fast, accurate, and fully featured. From a Windows pull-down menu, you can either select a specific simulation or go for the whole enchilada. The simulations for version 1.1 include four types of analysis: DC operating point, DC sweep, AC sweep, and transient. Version 2.0 will add noise analysis, distortion measure, sensitivity, and pole/zero analysis to that list.

Beige Bag tells us that the reason they're having problems with version 2.0 is because it's a 32-bit program. That means you need Windows 95, Windows NT, or Microsoft's Windows 3.1 32S driver before it'll work. However, we're told that version 1.1 won't be dropped; so all you I'm-not-ready-to-upgrade-to-Windows 95-yet readers still have a chance to take advantage of this slick piece of software. Check out our BBS (516-293-2283, v.32, v.42bis) for the most recent B² Spice news and newest demos.

Product:	SuperSPICE
Version:	V1.1
Price:	$149
Platform:	Windows
Publisher:	Mental Automation

SuperSPICE is a demanding simulation program that barely makes it under our $350 cap. No, the program itself is not pricey—SuperSPICE costs only $149. But it has to be linked with SuperCAD for Windows, Mental Automation's $149 schematic capture program, before it'll work. It also requires a math coprocessor, which means you'll probably have to be running at least a 486DX2 processor on your PC.

When you install SuperSPICE into your system, it upgrades your existing SuperCAD models to include SPICE parameters. Also loaded into the SuperCAD libraries by SuperSPICE is an amazing assortment of test instruments. The signal sources includes a sinewave, pulse, FM modulated, and AC sweep generator. The list of sources also includes a piece-wise generator that lets you create your own customized waveforms—an instrument that's found in only one other simulator, Circuit-Maker. The monitoring devices include a multiple-trace oscilloscope, Bode frequency analyzer, curve tracer, and an unlimited number of voltage and current meters (Fig. 4).

To start a simulation, you first start SuperCAD for Windows and load the desired schematic design. The netlist is created by SuperCAD when you click on the Simulate option. The current version of SuperCAD only allows one kind of primary analysis at a time. The three analy-

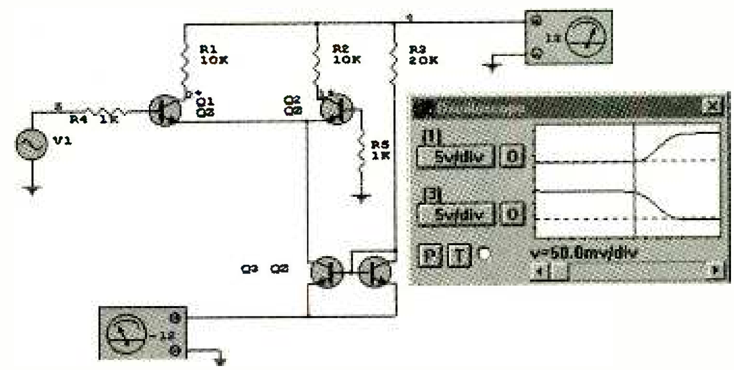


FIG. 4—UNLIKE MOST CIRCUIT SIMULATORS, SuperSPICE has to run from a separate companion schematic capture program, SuperCAD for Windows. SuperSPICE has an amazing assortment of test instruments, including a multiple-trace oscilloscope, Bode frequency analyzer, curve tracer, and an unlimited number of voltage and current meters.

ses supported are DC sweep, AC sweep, and transient. You can also select the DC operating point by changing the information in the setup menu and fiddling with the settings of the signal generators. Quitting SuperSPICE returns you to SuperCAD.

While SuperSPICE works best with analog circuits that fit on a single sheet, you can work with multiple sheets—but you'll probably have to switch from one sheet to another to view the simulation results. On the other hand, SuperSPICE, doesn't do mixed mode simulations. So by using different schematic sheets to split up analog and SPICE digital devices, it makes it easier to move information from one function to the other.

SuperSPICE is a venerable circuit design veteran that has been around for a decade. It interfaces flawlessly with its schematic capture program, the test instruments are second to none, and it's easy to use. Demos of both SuperCAD and SuperSPICE can be downloaded from the Electronics Now BBS.

SPICEing It Up

Developed at the University of California at Berkeley in the late 1960s, SPICE (Simulation Program with Integrated Circuit Emphasis) is the most popular tool for analog and gate-level digital simulation. In fact, more than three-fourths of the analog simulators in this review are SPICE based. Over the years, SPICE has gone through many iterations, and is sold under several different brand names by several software companies.

The secret to SPICE's success is in the simplicity of its models, which are very small ASCII files that can be linked to or embedded in the main netlist. The model contains information on how the device is supposed to react when subjected to changing voltages and currents. For example, the SPICE model for a 2N2222A transistor is

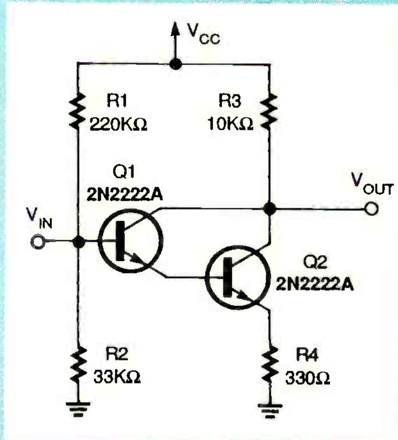
```
MODEL QN2222A NPN (IS=1.9E-14
BF=150 VAF=100 IKF= .175
ISE=5E-11 + NE=2.5 BR=7.5
VAR=6.38 IKR=.012 ISC=1.9E-13
NC=1.2 RC=.4 XTB=1.5 +
CJE=26PF TF=.5E-9 CJC=11PF
TR=30E-9 KF=3.2E-16 AF=1.0)
```

This model defines the gain of the transistor (BF) at 150 and the emitter capacitor (CJE) as 26pF. The more complex the device, the bigger the list grows.

To build a SPICE circuit, you simply enumerate the models used in your design in an ASCII file called a netlist. For example, if you have a simple audio amplifier circuit built around a pair of 2N2222A transistors (Fig. 10) the netlist might look something like this

AUDIO AMPLIFIER

VCC	2	0	DC	10V
R1	1	2	220K	
R2	1	0	33K	
R3	2	3	10K	
R4	5	0	330	
Q1	3	1	4	QN2222A
Q2	3	4	5	QN2222A



EACH CONNECTION on this simple amplifier represents a SPICE node, and potential simulation point. The 2N2222A transistor is a subcircuit model provided by Motorola.

The last two lines of this netlist tells SPICE to look for the model of the 2N2222A transistor under the filename QN2222A. Notice how compact this code is. Once a model has been defined, you can either import it into the netlist, or simply call it from the netlist.

Unfortunately, SPICE by itself doesn't do a good job of displaying information. It needs help. This is where the simulation software packages come into play. Typically, SPICE outputs the simulation results to an ASCII file as a list of numbers and an X-Y plot of dots that (when viewed from afar) form a very crude waveform. The software simulation program reads this file, processes the data, and converts it into oscilloscope-like images.

Product:	TurboSIM
Version:	1.1
Price:	$149
Platform:	Windows
Publisher:	Island LogiX

TurboSIM is new to the low-cost circuit CAE (computer-assisted engineering) fray. So new, in fact, that it almost escaped our attention. Despite its young age, this is a well-thought-out program that's loaded with a lot of really good features.

TurboSIM can be broken down into three components: a schematic-capture module, a SPICE simulator, and a digital simulator. Both simulators can link to the schematic-capture editor for simulation input, or read directly from a netlist file. However, the simulators are totally separate and independent of each other. Therefore, you can't mix analog and digital devices in the same circuit.

Actually, there are two versions of TurboSIM. There's the standard version which has all three modules. It supports DC operating point, DC sweep, AC sweep, and transient simulations (Fig. 5). For most users, this is all the simulation you'll ever need to find out if your design will fly or not. But heavy-duty designers will probably want the added benefits of noise, distortion, sensitivity, Fourier, and pole zero analysis that the Advanced version (also $149) serves up. Because of programming limitations, though, there isn't enough room for the schematic capture program or digital simulator. All you get is a fully-packed TurboSPICE simulator program with the monitoring instruments.

TurboScope is the oscilloscope display module that comes with all versions of TurboSIM. It works in real time, updating the display as the SPICE simulation progresses, and lets you easily jump from one wire or node to another without interrupting the simulation. Scale adjustment for the best display is automatic. If you really want to roll up your sleeves and get your hands dirty, TurboScope recognizes a long list of math functions that lets you display your waveform in just about any format you can think of—and some that you've probably forgotten.

TurboSIM is easy to use and perfect for electronics students and hobbyists — yet powerful enough to handle complex simulations demanded by engineers and technicians who handle hierarchal schematics and circuits containing multiple sub-circuits and pages.

Mixed-mode simulators

Sometimes it's necessary to mix analog and digital components in a single design. A good example is any circuit that uses an analog-to-digital (ADC) or digital-to-analog (DAC) converter. A short list of typical mixed mode applications include timers, PWM controllers, Class D audio amplifiers, switching power supplies, and ADC and DAC circuits Until recently, there was no easy way to handle analog and digital simulations simultaneously, and the process was generally broken down into two steps: an analog simulation followed by a digital simulation. Obviously, this makes it hard to get an overall view of circuit operations. Since then, many of the basic digital functions, like NAND and NOR, have been defined in analog terms using SPICE models. This allows you to do limited digital simulation as well as mixed mode simulation.

Although all the following mixed-mode simulation programs are SPICE based with a schematic capture front end, they are quite diverse in the way they work and ply their trade. The first, ICAP/4, does what you'd expect from a mixed mode simulation program—which is basically SPICE models put through their paces. This program is for the professional designer or hobbyist who knows what's happening and knows how to interpret the results. The next two programs, CircuitMaker and Electronics Workbench, have the added touch in that they teach you about electronics as you proceed through the tutorials. So you don't have to be a rocket scientist to use them.

Product:	ICAP/4Lite
Version:	7L.5
Price:	$40
Platform:	Windows
Publisher:	intusoft

ICAP/4Lite is an interesting analog-mostly simulator with as many twists as an Agatha Christie novel. To begin with, ICAP/4Lite is a 32-bit program that runs wonderfully well under Windows 95 and Windows NT. Unfortunately, it has some problems coping with Windows 3.1. Specifically, the included Windows 32S driver, which converts Windows 3.1 into a 32-bit operating environment, has a penchant to lock out the keyboard at the slightest whim.

The most interesting aspect, though, is its price — which is $599. Before you blast past this program as too expensive, you should know that you can buy a student version for a very low $40. Sure, the student version has limitations. For example,

WHERE TO BUY

Analyser III
BSoft Software, Inc.
444 Coltran Rd.
Columbus, OH 43207
(614) 491-0832
Ohio Automation
7840 Angel Ridge Rd.
Athens, OH 45701
(614) 592-1810

B²Spice
Beige Bag Software
2000 Hogback Rd., Ste. 2
Ann Arbor, MI 48105
(313) 971-4227

CircuitMaker
MicroCode Engineering
1943 North 205 West
Orem, UT 84057
(801) 226-4470

EE Works
Geoban Engineering
418 N Inyo St.
Ridgecrest, CA 93555
(800) 645-6806

Electronics Workbench
Interactive Image Technologies Ltd.
111 Peter St., Ste. 801
Toronto, Ontario, Canada
M5V 2H1
(800) 263-5552
E-mail: blegresley@interactiv.com
http://www.interactiv.com

ICAP/4Lite
intusoft
P.O. Box 710
San Pedro, CA 90733-0710
(310) 833-0710

SuperSPICE
Mental Automation
5415 136th Place S.E.
Bellevue, WA 98006
(206) 641-2141

TurboSIM
Island LogiX Inc.
P.O. Box 157
Waukegan, IL 60079
(708) 360-0458

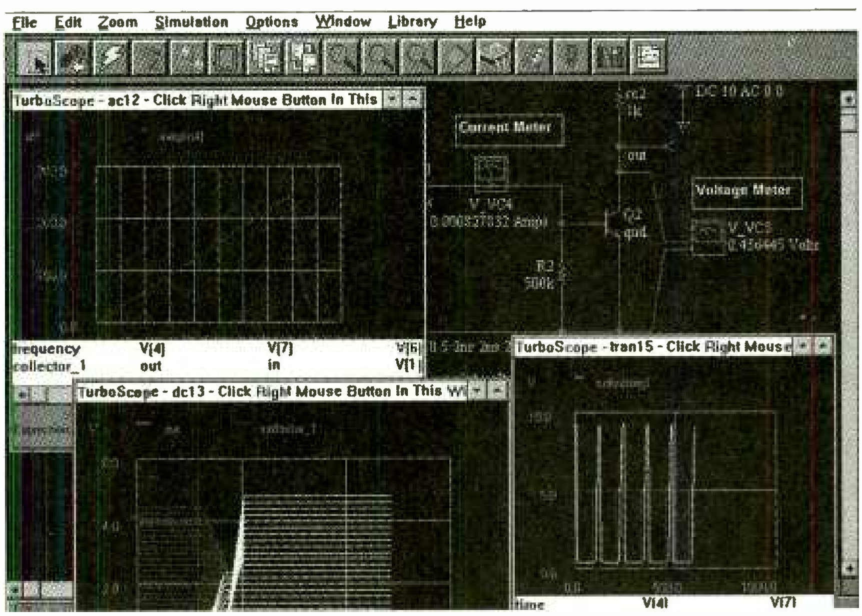


FIG. 5—TURBOSIM IS A POWERFUL WINDOWS SIMULATOR that comes in two versions. For most of your designs, the basic package will fill all your analog and digital simulation needs — plus it includes a schematic capture front end. If you need to do noise, distortion, or zero pole analysis, then you'll prefer the Advanced version, which costs the same but doesn't include schematic capture.

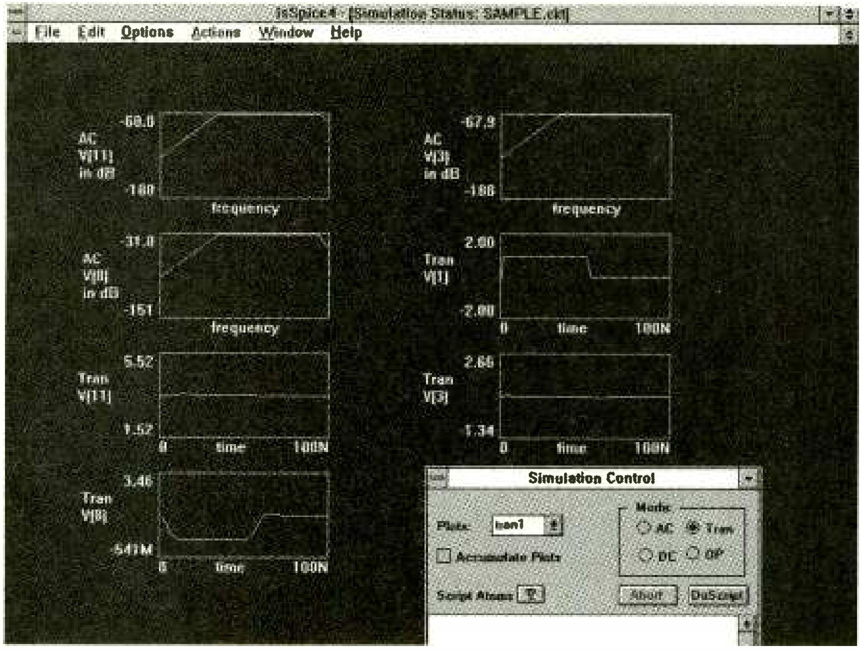


FIG. 6—ICAP/4LITE IS A MEDLEY OF FOUR interactive programs that includes a text editor, SPICE simulator, waveform analyzer, and a schematic capture program. In addition to simulating DC, AC, and transient analysis, ICAP/4Lite does temperature analysis, if-then-else analysis, and provides simulation breakpoints.

the component library is smaller, and you're limited to designs of 15 parts or less. But in this day of highly integrated circuits, 15 parts can go a long way.

ICAP/4Lite is actually a medley of four interactive programs. The first is a text editor that you use to compose SPICE netlists. IsSpice is the next program, and the SPICE engine that runs the simulation. The IntuScope program is the waveform analyzer and main display (Fig. 6). Finally, there's the schematic capture function.

There are three types of analysis performed by ICAP/4Lite: DC sweep and operating point, AC Bode plots, and transient analysis. ICAP/4Lite can also do temperature analysis and simulation breakpoints. Breakpoints are IsSpice4 commands that can be used to stop a simulation when certain conditions are met. For example, you could have the simulation stop when the voltage on pin 7 of IC3 exceeds 4.5 volts. ICAP/4Lite can pull this off because IsSpice4, intusoft's proprietary SPICE programming language, is a superset of Berkeley SPICE 3F.2.

While ICAP/4Lite isn't the easiest analog simulator to use, it certainly has more power than most. Best of all, though, it's the least expensive at just $40, if you can live with the limited parts count of the student version. A fully-functional ICAP/4Lite demo can be downloaded from the Electronics Now BBS or from intusoft's WEB site (http//www.intusoft.com).

Product:	CircuitMaker
Version:	3.5
Price:	$299
Platform:	Windows
Publisher:	MicroCode Engineering

CircuitMaker is a powerful yet easy-to-use schematic capture program and circuit simulation program. However, while CircuitMaker claims to be a mixed mode simulator, it's sharply divided between the analog and digital world. A single icon makes all the difference. Click on the AND gate and you're in the digital simulation mode. Click on the transistor and...well you get the message. Fortunately, CircuitMaker is SPICE based, so you can mix simulations if a SPICE model exists for the digital device you are considering inserting into your analog design.

All simulations begin with a schematic. However, the schematic-capture program has changed considerably since the last time we looked at it. It used to be that there were ten or so columns of parts, L1 through L10, each holding 24 devices. Now there are only two columns, with Browse at the beginning of the first column. Clicking on Browse opens up a whole new world of device options (Fig. 7) that weren't available in the CircuitMaker we looked at a year ago. The remaining forty listings let you bypass the browse menu and quickly place commonly-used components, like capacitors and resistors.

What makes CircuitMaker so powerful as a simulator is its Probe and Trace tools. As its name suggests, the Probe is a touching tool that taps into the inner workings of a circuit. In the digital mode, the Probe reacts like a logic probe, indicating whether your test point is logic high or low. In the analog mode, it becomes a voltmeter (Fig. 8). The Trace button is a digital-only tool that indicates the current state of the simulation by changing the colors of the wires. A wire at logic high is red, zero logic is blue, and three-stated (high-impedance) is green. While it's really cool to see these wires change colors, it's fairly slow — but that's for a good reason. Imagine trying to follow the changing colors at a rapid pace!

We were totally impressed with the signal generator. Not only does it do the necessary sine, pulse, and sawtooth functions of a mixed mode simulator, you'll also find an exponential generator, piece-wise generator, and an FM generator for spectrum analysis. Of all the circuit simulators, CircuitMaker has the most robust signal source.

We like the fact that CircuitMaker is a tutor as well as a schematic capture program and simulator, and that the test instruments are super. However, I'd certainly check out Electronics Workbench, which fol-

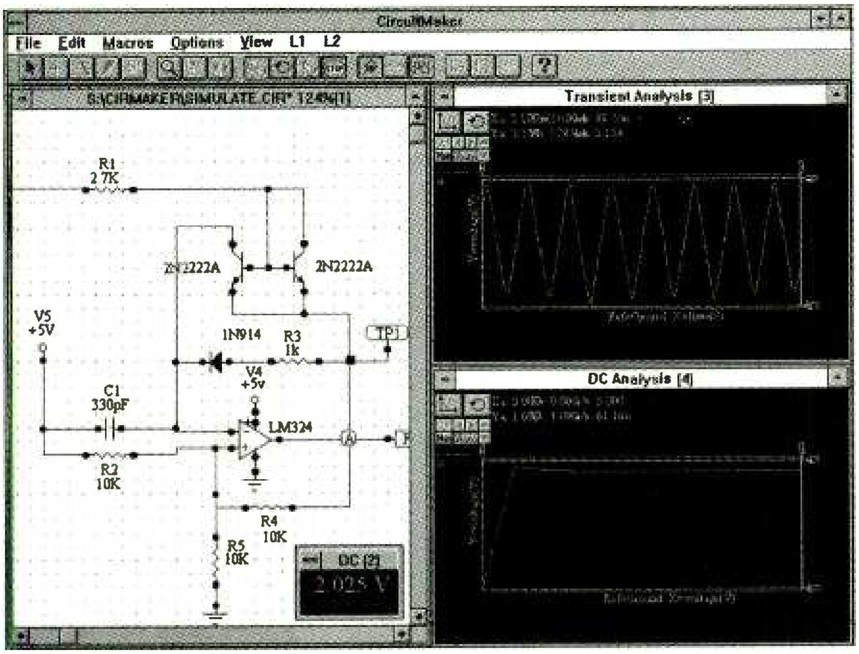


FIG. 7—CIRCUITMAKER IS A POWERFUL, yet easy to use, schematic capture and simulation program. It has a long list of test instruments, and the best looking display of any of the simulators.

lows, before making a decision. Both programs have a demo on the Electronics Now BBS, so check them out before you buy.

Product:	Electronic Workbench
Version:	4.0A
Price:	$299
Platform:	Windows
Publisher:	Interactive Image Technologies

Whether you're using Electronics Workbench to draw schematics or simulate your newest brainstorm, you'll find it extremely easy to use and a welcome design partner. The reason why Electronics Workbench is so easy to use is because it has the look and feel of a real test bench, like the kind you'd expect to find in a professional R&D laboratory environment.

Even the test instruments have the look and texture of the real thing. For example, to set up the oscilloscope you simply click on buttons to incrementally change the voltage and time base settings like you would on a real oscilloscope. This is in contrast to the imaginary instruments used by many simulators where you have to fill in a table of settings from the keyboard, and hope they are within the range of the instrument. The equipment inventory includes an oscilloscope, function generator, Bode plotter, multimeter, word generator, logic analyzer, and logic converter. In addition, there's an unlimited number of DVM current and voltage meters that can be inserted into the circuit at any point.

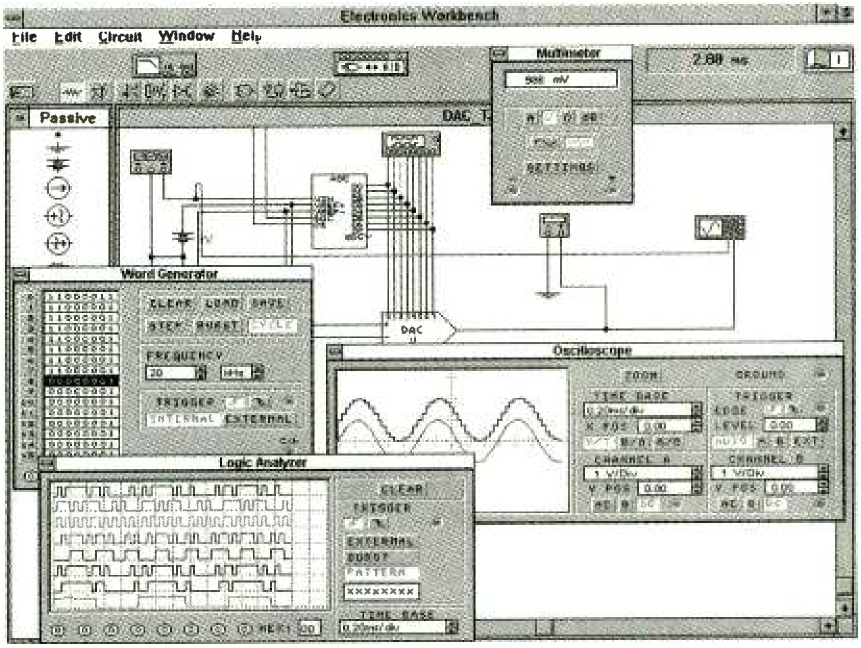


FIG. 8—ELECTRONICS WORKBENCH DOES THE BEST JOB of running mixed mode simulations. You're allowed to field both types of instruments, and you can change instrument settings as the simulation progresses. The test instruments are of laboratory quality, and even have the look and feel of their benchtop counterparts.

When it comes to mixed mode simulation, Electronic Workbench takes top honors. You're allowed to field both types of instruments, analog and digital, including a logic converter (Fig. 9). You can even change instrument settings as the simulation progresses. For example, if the oscilloscope's time base isn't showing what you want to see, simply click on the time base button and watch your display expand or collapse—as you simulate. Unfortunately, Electronics Workbench is not a fast simulator. Version 4.1, a 32-bit program, promises to speed along at about five times the speed of the sample we tested.

Like CircuitMaker, Electronics Workbench is a teaching tool as well a circuit simulator. The Help library goes into immaculate detail about the smallest components, like the battery. It is a great supplement for someone starting out in an electronics career.

Whether you're a novice or a nerd, you'll find Electronics Workbench a gem of a program and a great teacher. It's well worth the $299 asking price.

Next month, we'll look at the wide world of logic simulators.Ω

VIDEO PATTERN GENERATOR

continued from page 56

fied by gate IC6-b of IC6, a quad 2-input NAND IC and shaped by gates IC6-c and IC6-d to drive the counter consisting of the four 74HC161 synchronous binary counters.

Figure 3 is a schematic for a dual +12-volt and +5-volt power supply that can be built on a separate perforated board or be integrated with the rest of the circuit on the main circuit board. It contains two integrated circuit voltage regulators, IC9, an MC7805 positive 5-volt regulator and an MC7812, a positive 12-volt regulator

EPROM code listing

The EPROM codes can be conveniently generated by a personal computer. The program in Listing 1 is the C program for forming the sync, B/W checker and color bar codes. However, the listing does not include the code for the custom pattern. This program will generate a VIDEO.DAT file with 59,474 pixels. Any EPROM programmer can be used to program the 64 K × 8 74HC512 EPROM, IC5.

Building the generator

Refer to the video pattern generator schematic, Fig. 2, the dual power supply schematic, Fig. 3, and the parts placement diagram, Fig. 4. The author built the video pattern generator and the dual power supply on a rectangle of perforated board that measures 3⅜ × 4½ inches. The perforations are 0.10-inch apart on centers, and the board has foil pads and power buses.

Before beginning any assembly work, drill the four mounting holes in the four corners of the circuit board, and drill a hole large enough to admit the bushing of panel-mounted switch S1. Make a paper template of the circuit board hole spacing and bushing hole location for later transfer to the base of the plastic project case as a hole-drilling pattern.

Begin circuit construction by

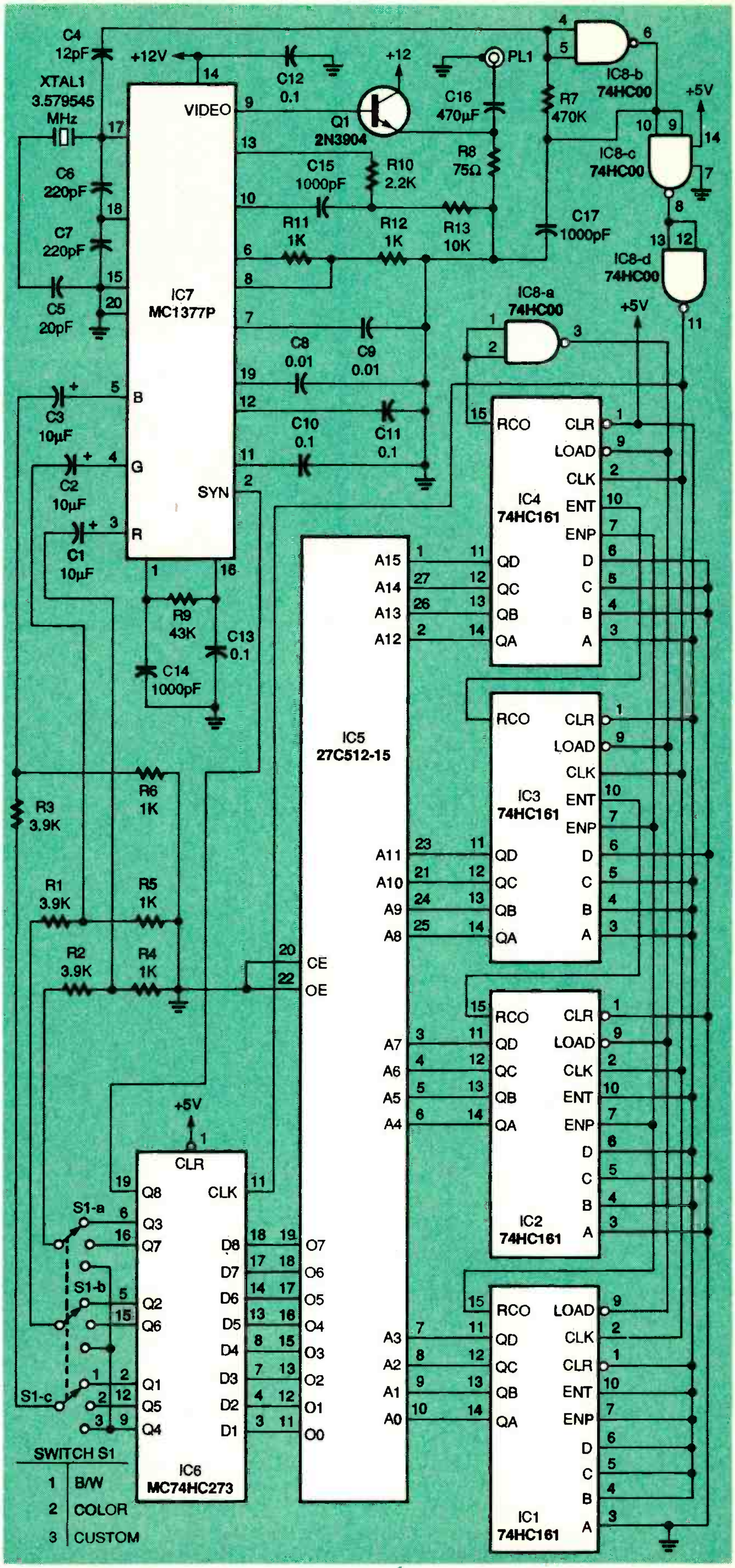


FIG. 2—SCHEMATIC DIAGRAM for the Video Pattern Generator.

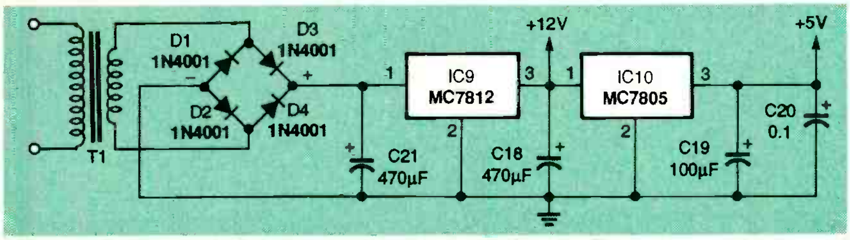


FIG. 3—SCHEMATIC DIAGRAM for the Dual Power Supply. This supply provides +12 and +5 volts. It can be built on a separate board.

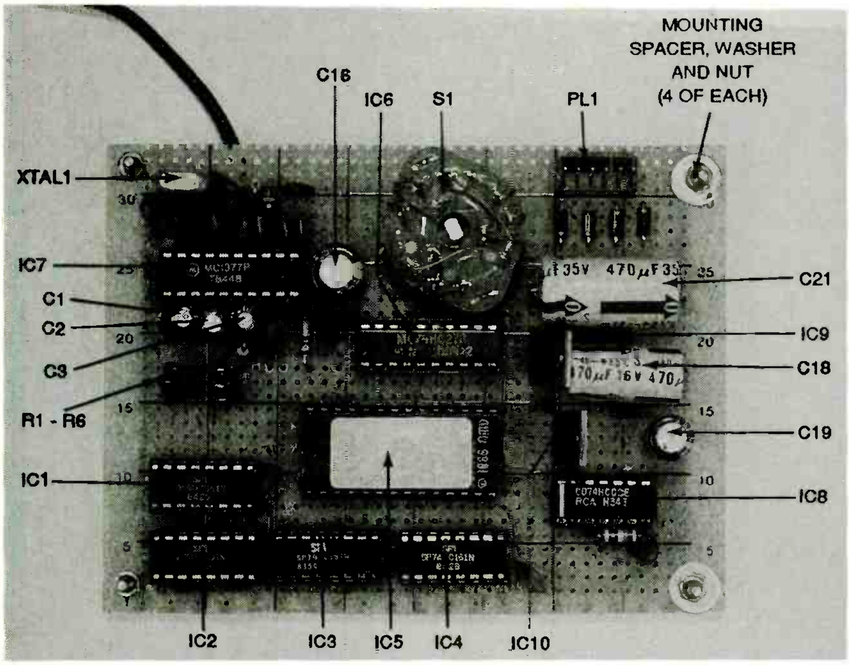


FIG. 4—SUGGESTED PARTS PLACEMENT DIAGRAM. The author integrated the video pattern generator and dual power supply (less transformer T1) on a single circuit board.

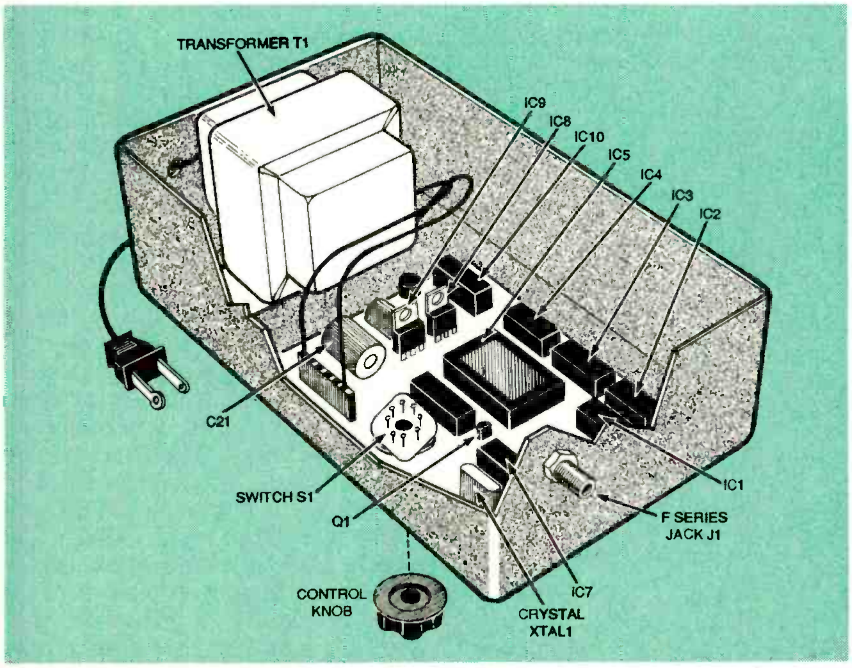


FIG. 5—ASSEMBLY DIAGRAM of the completed Video Pattern Generator. The power supply is located within the project case. The switch knob is attached to the PC board-mounted switch on the bottom of the case.

inserting and soldering the eight DIP sockets approximately in the positions shown on Fig. 4. Insert and solder the axial-leaded 470 µF aluminum electrolytic capacitors C16 and C18 so they lie horizontally on the circuit board. Insert and solder the TO-220-packaged 7805 and 7812 voltage regulators at approximately the locations shown. Insert panel-mounted, rotary switch S1 on the circuit board in the pre-drilled hole, and fasten it with the ring nut and washer provided.

Insert and solder all resistors, radial-leaded ceramic disc and aluminum electrolytic capacitors, silicon diodes, and crystal case at the locations approximately as shown on Fig. 4.

Mechanical work

A standard commercial two-piece plastic project case was selected for this project. It measures 7¹⁄₇ × 4³⁄₈ × 2¼ inches. This case is large and tall enough to accommodate the AC-line to 15-volt AC transformer T1. Locate transformer T1 at one end of the case as shown in the assembly drawing Fig. 5, and use the holes in its mounting bracket as a template for drilling the two mounting holes. Then drill those holes.

Position the paper template at the bottom of the case and tape it in position. Drill the four mounting holes and the hole for the switch shaft and bushing. Then drill a hole in the end wall of the case nearest the transformer location for the line cord, and drill another hole at the opposite end of the case for mounting the coaxial jack J1.

Final assembly

Refer to assembly diagram Fig. 5. Fasten ¼-inch standoffs to the underside of the circuit board at all four corners with screws or nuts. (The author selected standoffs with internal and external threads.) Solder a short length (approximately 6 inches) of RG174 or RG58 coaxial cable from capacitor C16 to the coaxial jack J1. Solder one end of the braided shield to the ground terminal of J1 and the other end to pin 3 of IC1.

LISTING 1—C PROGRAM TO FORM VIDEO.DAT

```
#include <stdio.h>
main()
{
int line, pixel, x, y, buffer;
int cross=0x08;
long data;
FILE *stream;
/* open EPROM code file "VIDEO.DAT" */
   if ((stream = fopen("VIDEO.DAT", "wb+")) == NULL)
   {
      fprintf(stderr, "Cannot open output file.\n");
      return 1;
   }
/* generate first four line codes */
   for (line=1; line<4; line++)
       {
         for (pixel=0; pixel<227; pixel++)
          {
                if (pixel<210)
                      data=00;
                      else data=0x80;
                fwrite(&data, 1, 1, stream);
       }
       }
/* generate 4-25th line codes */
   for (line=4; line<25; line++)
   {
         for (pixel=0; pixel<227; pixel++)
          {
                if (pixel<17)
                      data=00;
                      else data=0x80;
                fwrite(&data, 1, 1, stream);
       }
   }
/* generate 25-262th line codes */
   for (line=25; line<263; line++)
   {
   if (line-7==(line-7)/21*21)
      cross=cross^0x08;
         for (pixel=0; pixel<227; pixel++)
          {
                if (pixel <17)
                      data=00;
                else if (17<=pixel && pixel<38)
                 data=0x80;
                else if (38<=pixel && pixel<61)
                     data=0xf0;
                else if (61<=pixel && pixel<84)
                     data=0xe0;
                else if (84<=pixel && pixel<107)
data=0xb0;
                else if (107<=pixel && pixel<130)
                     data=0xa0;
                else if (130<=pixel && pixel<153)
                     data=0xd0;
                else if (153<=pixel && pixel<176)
                     data=0xc0;
                else if (176<=pixel && pixel<199)
                     data=0x90;
                else
                     data=0x80;
                if (pixel==pixel/13*13)
                     cross=cross^0x08;
                if (pixel>37 && pixel <223)
                     data=data+cross;
                fwrite(&data, 1, 1, stream);
       }
   }
   fclose(stream);
   return 0;
}
```

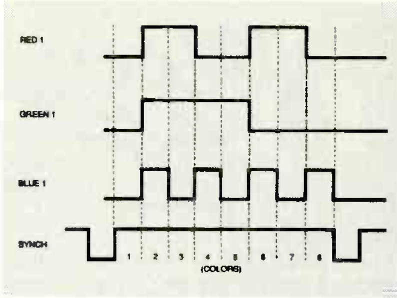


FIG. 6—TIMING DIAGRAMS for the color bar signals. The colors are: 1-white, 2-yellow, 3-cyan, 4-green, 5-magenta, 6-red, 7-blue and 8-black.

Insert the free end of the 120-volt line cord in the hole drilled for it in the case and solder the wires to the 120-volt input side of transformer T1. Then trim and solder the 15-volt secondary wires to the AC input terminals of the full-wave bridge formed by the four diodes D1 to D4. Fasten the transformer to the case with screws and nuts and fasten J1 to the case side wall. Be sure that the transformer and jack leads are long enough so that the circuit board can be removed from the case and inverted without having to break those connections.

When you are satisfied that all wiring is correct, install all the DIP-packaged integrated circuits in their designated sockets. *Caution:* ICs 1 through 6 are CMOS devices subject to damage or destruction by electrostatic discharge (ESD). Mount the circuit board in the case, and fasten it to the four standoffs with screws. Fasten the control knob to switch S1.

Calibrating the generator

This video pattern generator was designed to eliminate the need for periodic adjustments. The only component that calls for special attention is capacitor C17, which is used to calibrate the subcarrier frequency. If the subcarrier frequency of your video pattern generator deviates significantly from 3.579545 MHz, the pattern will lose color. If that happens, substitute slight variations of the specified value for C17 until the video patterns gain color. The order of the waveforms of the color bar pattern are shown in Fig. 6. Ω

CORNER REFLECTOR

continued from page 58

Cut two slots lengthwise along one end of the ⅝ tubing, on opposite sides of tubing. Use a hacksaw or small saw and cut both slots at the same time with the saw passing through the center axis of the tube. The slot lengths should be ¼ wavelength at the operating frequency. For 923 MHz operation this cut should be approximately 3.2 inches. The slot width is not very critical.

Next, drill holes for the dipole elements as shown in Fig. 5. Leave about 1/16-inch space between the edge of the hole and the end of the tube. The dipole elements can be either 1/16 or ⅛-inch diameter brass rods or 3/32-inch diameter brass welding rod. Use a drill that is the same diameter as the dipole elements for a snug fit. Cut a length of brass rod that is to be used for the dipole elements to 1.05 wavelengths long at the desired center frequency. See Table 2 for data on the dipole length.

Carefully clean up and deburr the cut edges on the ⅝-inch and ¼-inch tubes. File the ends of the dipole element rods to remove burrs and sharp projections. Solder one end of the ¼-inch tubing to the center pin of a type N connector so that the center line of the tube is aligned with the centerline of the center pin on the type N connector. Allow ⅛-inch of space between the tube and the type N connectors flange as shown in Fig. 5. If necessary, build up the diameter of the center pin with some bare copper wire for a snug fit to ensure concentricity. Place the ⅝-inch tube over the ¼-inch tube, and check to see that the end of the center tube is flush with or is slightly shorter than the outer tube by approximately 1/16 inch, or less. Trim the center tube as needed. Clean the square flange on the connector with fine steel wool for soldering later.

Slip a ½-inch copper pipe coupling (use the kind that has no internal pipe stop) over the outer ⅝-inch tube. The commonly used ½-inch copper water pipe has a ⅝-inch outside diameter so a smooth slip fit should result. If OK, remove and drill a hole at one end to pass a #4 machine screw. See Figs. 6 and 7. A #33 drill is large enough, but a #28 drill was used to allow extra clearance. Polish the copper pipe coupling with fine steel wool to a bright finish. Using rosin core solder, solder a #4 brass nut to the coupling centered over the hole. Use a stainless steel #4 screw about 1-inch long to hold the brass nut in place while soldering. Solder will not stick to stainless steel.

Remove the screw after the solder joint cools.

TABLE 2
COAXIAL LINE IMPEDANCE WITH AIR DIELECTRIC

I.D./O.D.	Antenna Impedance (Ω)
2.0	41.5
2.1	44.5
2.2	47.25
2.25	48.6
2.3	49.9
23.33	50.7
2.5	54.9
2.67	58.8
2.75	60.6
3.0	65.8
3.5	75.1
4.0	83.1

Note: Shaded area indicates coaxial line impedances are within 10% of 50 ohms.

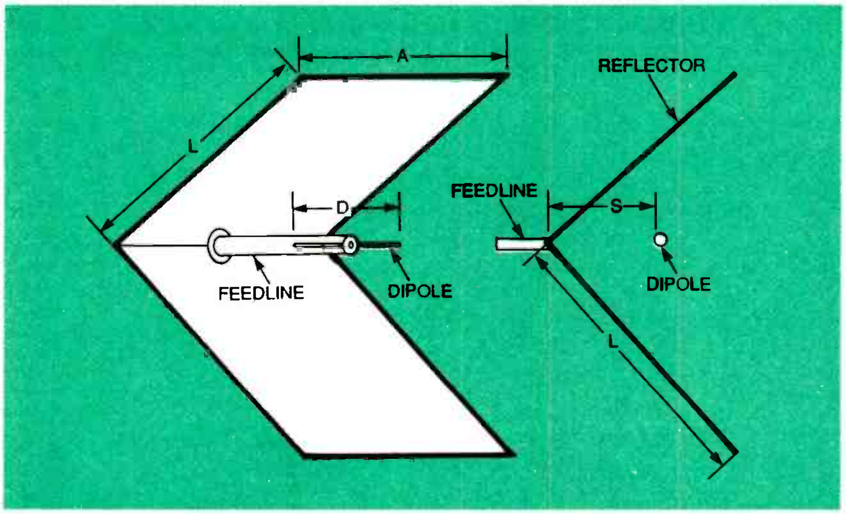


FIG 4—CORNER-REFLECTOR ANTENNA dimensions are determined by the frequencies used. Refer to Table 1 values.

TABLE 1—SUGGESTED CORNER-REFLECTOR DIMENSIONS FOR ELEMENTS IDENTIFIED IN FIG. AAA

CENTER FREQ. (MHz)	Dipole Spacing S (Inches)	SIDE LENGTH L (Inches)	CORNER LENGTH A (Inches)	DIPOLE LENGTH D (Inches)
420-450 (70 cm Amateur)	8.5	≥24	≥15	13.6
450-470 (2-way Commercial)	8	≥22	≥14	12.7
850-870 (2-way Commercial)	4.25	12	10	6.8
902-928 (33 cm Amateur)	4	12	10	6.4
928-960 (Commercial)	3.9	12	10	6.2
1240-1300 (23 cm Amateur)	2.9	12	10	4.6

Note: Dimensions are suggested starting points for minimum 8-dB antenna gain and are not exact value. The values are for practical sizes and are a compromise value given where necessary for mechanical construction reasons.

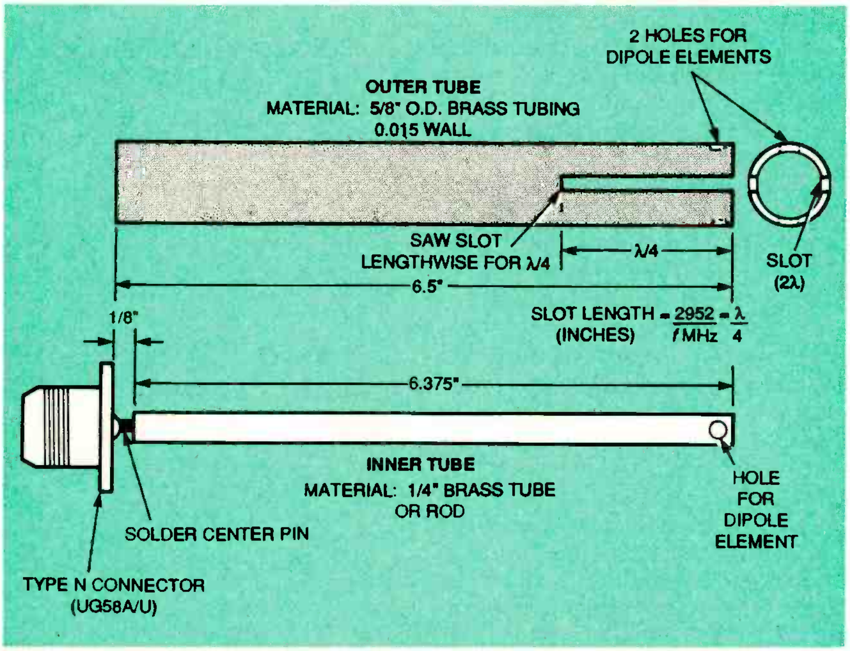


FIG. 5—PRE-ASSEMBLY DETAILS of the feedline/balun tubes. For 400 to 470-MHz operation of the corner-reflector antenna the outer tube length should be increased to 14 inches; the inner tube, 13.785 inches.

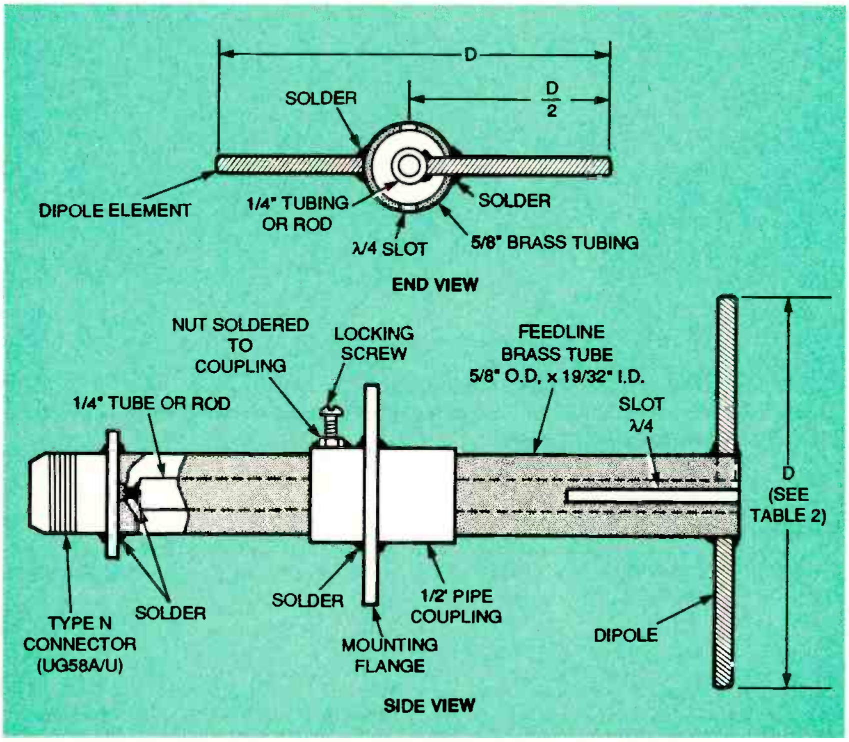


FIG. 6—TWO VIEWS OF THE DIPOLE AND FEEDLINE construction details. In the end view drawing note that the right dipole element connects to the inner and outer tubes and shorts them together. The left dipole element connects just to the outside tube. The ends of both dipole elements are equi-distant from the center of the inner tube.

Prepare a mounting flange from a 2 × 2-inch square plate made of copper, brass, or surplus PC board G-10 material. See Fig. 7. At its center, punch a hole in the flange to the outside diameter of the pipe coupling. Solder the coupling in place about the entire circumference. Make sure coupling is perpendicular to the plate. Slip the flange assembly over the ⅝-inch tube, the slit end opposite the nut as shown. Clean both ends

LIST OF MATERIALS

Parts specified for 800-1300-Mhz range. Lengths given in brackets are for 400-470-MHz range.

1—⅝-in. O.D. × 19/32-in. I.D. brass tubing, 0.015 nominal wall thickness, 6.5-in. long (14-in. long)
1—¼-in. O.D. brass tubing or rod, I.D. not critical, 6- ⅜-in. long (13⅞-in. long)
1—1/16-in. to ⅛-in. O.D. brass rod, or 3/32-in. brass welding rod, 15-in. long
1—Type N UG58A/U UHF connector, flange mount, or BNC UG290A/U RF connector, flange mount (either item preferably silver plated)
1—3-in. sq. ft material for reflector, 0.019-inch thick, perforated or grille aluminum recommended (see text)
1—4-40 brass hex nut
1—4-40 × ½-in. brass screw
1—4-40 × 1-in. stainless-steel screw
1—0.032 brass or copper plate, 2 × 2-in. square, or double sided G-10 material, 2 × 2in. × 0.062-in. thick
1—½-in. stop-less copper pipe coupling, sweat type
1—Wood, 1- × 2- × 12-in.
8—#6 × ½-in. sheet metal or wood screws
Also: Solder (both resin core and solid), fine steel wool, hardware as needed, miscellaneous wood blocks, ½ × ½-in. wood lengths for bracing as required, suitable plastic container for optional cover.
A catalog describing kits for ATV transmitters, ATV receiving converters and other projects useable with the antennas described in this article is available from North Country Radio, PO Box 53, Wykagyl Station, New Rochelle, NY 10804. Please include a #10 SASE and $1.00 to cover handling and postage.

E-mail: Ncradio200@aol.com
Compuserve 102033,1572

Note: Materials illustrated and listed are for a corner-reflector antenna operating at about 900 MHz. Antennas for lower frequencies are larger and will require correspondingly larger or more materials. Brass tubing for inner and outer conductors can also be any other reasonable dimensions as long as they have approximately a 2.3 to 1 ratio of ID (outer) to OD (center). See Table 2 for other suitable sizes and corresponding impedances.

of the outer tube with fine steel wool to facilitate soldering in the following steps.

Insert the ¼-inch tube and type N connector assembly into the outer ⅝-inch tube placing type N connectors flange flush against outer tube (see Fig. 6). Check to see that pre-drilled holes for dipoles are aligned. You can insert the dipole elements and fasten them in place with tape to check for correct alignment. When the tubes are concentric, solder connector flange to ⅝-inch tube all around the edge. Use as little solder as you can for a neat job, and if possible use a hot 100-watt iron with a ¼-inch tip. A few wooden blocks drilled with ⅝ diameter holes will be useful for holding parts during assembly and soldering operations.

Clean all solder residues deposited in the previous step with isopropyl alcohol, flush with water and blow dry. Do this outdoors away from flame or sparks. Remove the dipole elements and make sure no electrical contact (short) between the outer and inner tubes exist.

Solder the dipole elements in place. The outer and inner conductor are shorted together by one dipole element. This is normal. Make sure they are aligned as shown in Fig. 6. Measuring from center of center tube, the dimensions of each side of the dipole should be equal in length and symmetrical.

You now have a half-wave, slot-fed dipole. Connect it to a receiver and check to see if it works as a receiving antenna. It should work as well as your whip antenna or better. Try orienting vertically and horizontally for best signal reception.

If you have the test equipment, use an RF source and a SWR or power meter to check the VSWR. It should be 2.0 or better. The dipole elements can be trimmed for lowest VSWR later. This will be affected by reflector spacing, slot length, and also presence of nearby reflecting objects. If the antenna pulls in no signals, check for shorts from burrs, solder drops, steel wool fragments, or other foreign material.

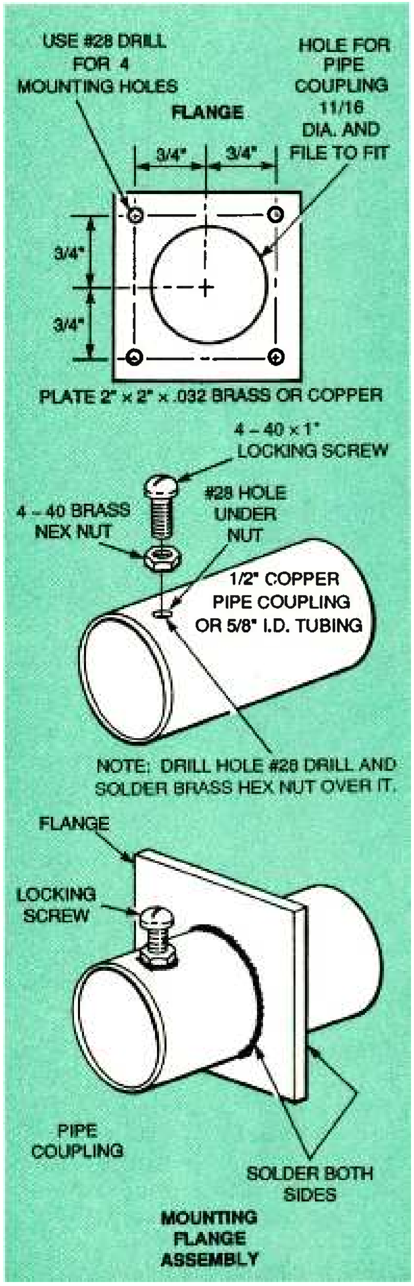


FIG. 7—DETAILS AND DIMENSIONS for the mounting flange assembly.

The reflector

Almost any perforated, stiff aluminum material can be used to make the reflector. A 0.019-inch thick perforated aluminum sheet was used. It is available in hardware stores for making grilles and covers for radiators, etc. The holes reduce the overall weight and wind resistance. Solid sheet aluminum, copper, wire mesh, or screening can be used since all you need is a conducting surface. Plywood or heavy cardboard covered with aluminum foil can also be used, if weatherproofing is not needed, for experimental or temporary use. Hardware cloth (aluminum or copper screening material) is also useful but hard to handle.

Referring to Fig. 3, you see that the reflector is made by bending a 1 × 2-foot sheet of perforated aluminum sheet. The exact reflector dimensions are not critical, larger being better. Instead of one 90-degree bend, two 45-degree bends were used leaving a 1⅝-inch valley that provides a surface for a good mechanical support. A piece of 1⅞ × ¾ × 12-inch wood is used to support the reflector and to mount the dipole in the center of the reflector. This piece of wood can also be used for mounting a bracket to hold the completed antenna to a mast or other support.

Bracing can be added to the reflector if desired as shown in the photo. Use wood, plastic, fiberglass, or other non- conducting material. Conductive materials in front of dipole will cause detuning and pattern distortion. If thin sheet metal is used alone for the reflector it is wise to cut the metal 1-inch larger in width and length and use this extra material to form a folded edge around the perimeter to stiffen the reflector surface. A block of wood can be used to form the bends, as the material is easily worked by hand. Make bends along perforated lines in the aluminum for sharp and true bends.

After the reflector is formed, cut a hole in the center of the valley fold as shown in Fig. 3 and fasten the flange on the dipole assembly to the reflector. The dipole should be parallel to the bend in the reflector. Initially set the dipole about 0.3 wavelengths from the reflector. Install a 4-40 screw in the nut previously soldered to the flange assembly to lock the dipole in place. Final adjustment can be made later by setting the dipole position for lowest VSWR, with an RF source and reflected power meter or SWR bridge. For receive only applications, no further adjustments are needed. You could try peaking the adjustments on a weak signal if you are fussy, but you will find that they are very broad and have little noticeable effect.

Next, mount the antenna in its final location. Make sure to mount the antenna for correct polarization. Polarization is same as dipole (e.g. vertical for vertical polarization). Vertical polarization is generally used for amateur and commercial two way FM, but horizontal is used for SSB amateur work and some amateur TV. UHF TV is generally horizontal or circular. As a compromise, the antenna could be mounted at 45 degrees to vertical.

You will find that the antenna has pronounced directivity, maximum pickup occurring along a line bisecting the reflector angle, in the direction the dipole faces. The pattern is clean and well defined. Pickup towards the sides or rear is much less. Therefore, face the antenna in the direction of desired reception. Two or more of these antennas can be used if multi-directional reception is desired, or a rotator can be used. Bandwidth depends on the VSWR desired, but this antenna should work well over a range of 10 percent or so. An antenna made for 900 MHz will easily work well from 800 to 1000 MHz, and reception at 450 MHz and 1280 MHz will be adequate, but not optimum. You should find this antenna easy to make and quite effective and may even wish to build several for different frequency ranges. Simply scale the dipole element length and reflector size as needed.

For outdoor use, it would be a good idea to cover the dipole and slotted feedline assembly with a plastic cover to keep out water and insects. Use a clear, plastic-food container that is microwave safe. If it does not heat up in a microwave oven, it probably has low RF losses and will not affect the antenna. The container can be slit and placed over the dipole with the slit facing down. The lid can be used to cover the open end of the tubing. Clear silicone seal can be used to seal edges and joints

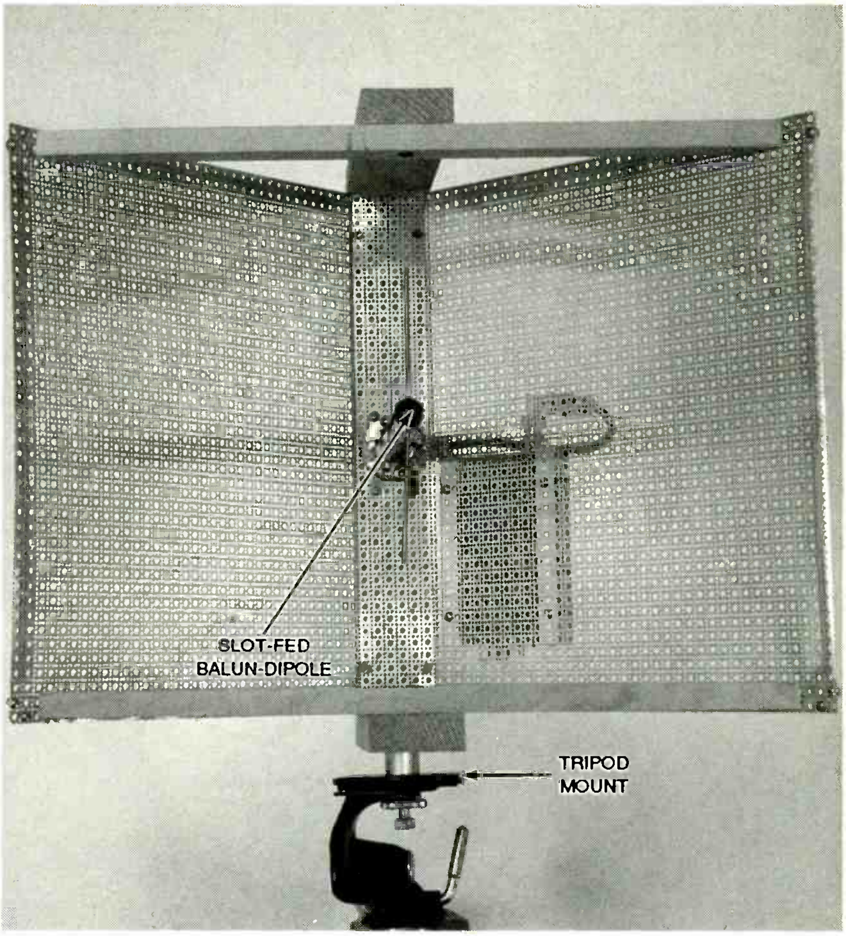


FIG. 8—THE CORNER-REFLECTOR ANTENNA fully assembled and mounted on a photographer's tripod for evaluation.

against leakage. Clear materials are preferred since pigments such as metal dust or carbon can be lossy for RF. Make sure to leave a small hole in the bottom of the container to allow escape of condensation.

How it performs

The corner-reflector antenna provides noticeable improvement over an omni-directional or ground-plane antenna. It can be used indoors as well. Fig. 8 shows the antenna mounted on a photographer's tripod for initial testing. The transmiter (or antenna) is mounted on the rear surface of the aluminum grille. This corner-reflector antenna is not intended for moonbounce, weak-signal SSB, DX contests or other such exotic amateur radio uses but it will be a darn good antenna for much scanner listening and routine ham use, or as a temporary, cheap antenna to use before investing in a larger Yagi or other expensive setup. With a low-loss feedline, an 8 to 10 dB antenna will give very good results both in transmission and reception.

The author has used two of these antennas for amateur TV transmission at 923 MHz, one antenna at the home station about 30 feet above ground, the other in a vehicle with a portable TV set and a receiving downconverter to allow reception of the 923 MHz amateur TV signals on VHF channel 3. A 1-watt transmitter was used at the house. Excellent pictures were received 8 miles away and, although snowy, a picture was seen at 17 miles. The tests were repeated at 1289 MHz with a pair of corner-reflectors designed for this frequency and similar results were obtained. The transmitters and receiving downconverters were described in articles published in the April and May, 1996. Ω

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3.5 Digit, 0.6% accuracy
Auto/Manual ranging
Energy saver
Student & hobbyist's favor

DMM 20 $74.95

Inductance: 1μH-40H
Capacitance: 1pF-200μF
Frequency: 1Hz-20MHz
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Fluke 73 II	$97.50
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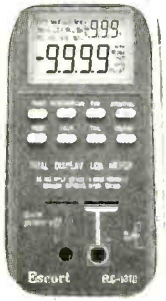
Fluke 79 II	$175
Fluke 29 II	$175
Fluke 76	$175
Fluke 87	$287
Fluke 867	$1199
Fluke 97 Scope Meter	$1785
Fluke 105 Scope Meter	$2799



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Most Advanced LCR
Dual display:L/Q or C/D
Inductance: 0.1μH-1000H
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Impedance:1mΩ-10MΩ
0.7% basic accuracy
Auto/manual range
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Capacitance: 0.1pF-20,000μF
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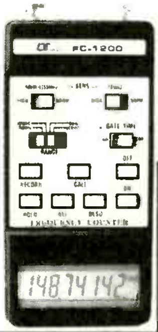

Frequency Counter FC-1200 $129.95

Frequency:0.1Hz-1.25GHz
Display: 8 digit LCD
Period: 0.1μs-0.1s
Records Max/Min/Average
Data hold, relative mode
Telescoping antenna $8.00
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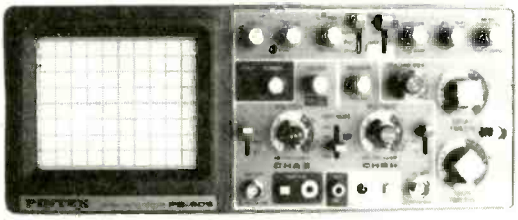


20 MHz Oscilloscope with Delay Sweep PS-205 $429.95

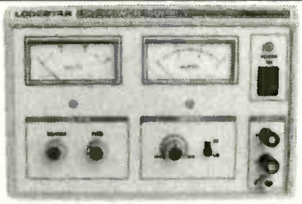
Dual Trace, Component test, 6" CRT, X-Y Operation, TV Sync, Z-Modulation, CH2 Output, Graticule Illum, 2 probes each has x1,x10 switch. Best price with delay sweep.

PS-200	20 MHz DUAL TRACE	$339.95
PS-400	40 MHz DUAL TRACE	$494.95
PS-405	40 MHz DELAY SWEEP	$569.95
PS-605	60 MHz DELAY SWEEP	$769.95
PS-1000	100 MHz DUAL TRACE	$999.95

Scope Probe: 60MHz x1, x10 $15, 100MHz x1, x10 $22
250MHz x1, x10 $29, 250MHz x100 $39

Digital Storage Scope

DS-303 30MHz, 20M Sample/sec $849.95
DS-303P with RS-232 interface $1,049.95
Switchable between digital and analog modes
2 K word per channel storage
8 bit vertical resolution (25 Lerel/div)
Expanded Timebase 10ms/div - 0.5 s/div
Refresh, Roll, Save all , Save CH2, Pre-Trig
Plotter control



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0-30 VDC , 0-3A output
Constant voltage & constant current mode
0.02% + 2mV line regulation
0.02% + 3mV load regulation
1 mVrms noise and ripple
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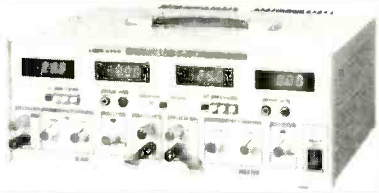
Also available: 30V/5A, 60V/3A, 60V/5A
16V/10A, 30V/10A



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One fixed 5VDC, 3A output
Capable of independent or tracking operation
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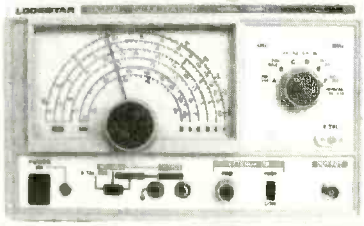

RF SIGNAL GENERATOR SG-4160B $124.95

100 kHz-150MHz sinewave in 6 ranges
RF Output 100mVrms to 35 MHz
Internal 1kHz, External 50Hz-20kHz AM modulation
Audio output 1 kHz, 1 Vrms

RF SIGNAL GEN./COUNTER SG-4162 AD $229.95

Generates RF signal same as SG-4160B
6 digit frequency counter 1Hz - 150 MHz for internal and external source Sensitivity <50mV

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10Hz - 1MHz in 5 ranges
Output: 0-8Vrms sinewave
0-10Vp-p squarewave
Synchronization: ±3% of oscillation frequency per Vrms
Output distortion:
0.05% 500Hz - 50kHz
0.5 % 50Hz - 500kHz
Output impedance: 600 ohm

AUDIO GEN./COUNTER AG-2603AD $229.95

Generates audio signal same as AG-2601A
6 digit frequency counter 1Hz-150MHz for internal and external sources Sensitivity <50mV

FUNCTION GENERATOR FG-2100A $169.95

0.2 Hz -2 MHz in 7 ranges
Sine, square, triangle, pulse and ramp
Output: 5mV-20Vp-p
1% distortion, DC offset ± 10V
VCF: 0-10V control frequency to 1000:1

FUNCTION GEN/COUNTER FG-2102AD $229.95

Generates signal same as FG-2100A
Frequency counter 4 digits
Feature TTL and CMOS output

SWEEP FUNCTION GEN./COUNTER $329.95

0.5Hz to 5 MHz in 7 ranges
Sweep: Linear 10:1/Log 10:1 20ms to 2s
AM Modulation
Gated Burst, Voltage Control Generator
Generator Control Voltage & 6 digit counter
1Hz-10MHz for internal & external sources

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160 x 128 dot LCD with built-in controller (T6963C)
20 character x 16 line **$79.00 or 2 for $149.00**
Mfr.: Toshiba TLX-1013-EO.
Unit is EL back-lit. Dim: 5 1/16"L x 4 1/16"H.
The built-in controller allows you to do text and graphics.

240x64 dot LCD with built-in controller. $79.00
Mfr: AND 4021ST-EO. *Unit is EL back-lit.* or 2 for $149.00

Alphanumeric—parallel interface

16x1 ....3 for $25.00	20x2 ....$12.00	40x1 ....$8.00
16x1 (lg. char.)....$12.00	20x4 ....$25.00	40x2 ....2 for $25.00
16x2 ....$8.00	20x4 (lg. char.)....$25.00	40x4 ....$25.00
16x2 (lg. char.)....$12.00	24x2 ....$12.00	4x2 ....$5.00
16x4 ....$15.00	32x4 ....$10.00	

5V power required • Built-in C-MOS LCD driver & controller • Easy "microprocessor" interface • 98 ASCII character generator • *Certain models are backlit, call for more info.*

Graphics and alphanumeric—serial interface

size	Mfr.	price	size	Mfr.	price
640x480 (backlit)	Epson	$35.00	480x128	Hitachi	$15.00
640x400 (backlit)	Panasonic	$25.00	256x128	Epson	$20.00
640x200	Toshiba	$15.00	240x128 (backlit)	Optrex	$20.00
480x128 (backlit)	ALPS	$15.00	240x64	Epson	$20.00
			160x128	Optrex	$15.00

LASER PRODUCTS

HeNe Laser Head (10Mw max. output) TEMOO. 15.5" long MFG: NEC **$99.00**
Laser Power Supply (for HeNe tube) **$89.00**

LASER SCANNER ASSEMBLY $29.00
Assembly intended for a laser printer. Includes laser diode, polygon motor (6 sided) and misc. optics and lenses.

LASER DIODE (5mW) with collimator **$20.00**

VISIBLE LASER DIODE: 5mw at 670nm **$15.00**
index guided. Threshold current 40 ma typical.

POLYGON MOTOR UNIT & DRIVER **$79.00**

Ten-sided first surface mirror mounted on an armature that spins at 125 revolutions per second yielding a beam sweep rate of 1250 sweeps per second. The driver for the polygon unit requires 24 volts and plus and minus 12 volts to operate. There is also an f-theta lens in front of the polygon scanning mechanism with a three inch diameter. Great for optical experiments, etc. Very high quality units. (MFR: JAPAN ELECTRONICS)

NETWORK

Proteon ProNet-4 Model p1347 Token Ring Board $79.00
16 bit • 4 Mbps • IEEE 802.2 and 802.5 compatible • twisted pair • Interoperable with IBM Token Ring network

POS & BAR CODE

MAGNETIC CARD READER $25.00
Includes: • 20 character dot matrix display with full alpha-numeric capability • keypanel with full alpha-numeric entry • separate 7.5 VDC/0.5 Amp power supply • standard telephone interface extension cord • lithium battery and flat-cone speaker.
HP bar code wand (HBCS 2300).....................$35.00

POWER SUPPLYS

73 WATT SWITCHING $15.00 or 2 @ $25.00, (2) 4 pin power connectors attached • 115/230 Volt, Dim: 8.5" L x 4.5" W x 2" H • Output: +5V @ 2-9.75 A, +12V @ 0-1.5 A, -5V @ 0-0.4 A, -12V @ 0-0.5 A
68 WATT SWITCHING $12.00 or 2 for $20.00, 115/230 Volt, Dim: 5.5" L x 3.2" W x 1.7" H • Output: 5V @ 4 A, 12V @ 4A

MISCELLANEOUS

ADAPTEC 4070A (RLL) OR 4000A (MFM) SCSI Controller, your choice $25.00

IBM 370 option XT and AT emulation boards $35.00

MONITORS

Non-Enclosed TTL

Comes with pinout. 12V at 1.4 Amp input • Horizontal frequency 15Khz. • Ability to do 40 and 80 column.

5 inch Amber	**$35.00**
7 inch Amber	**$39.00**
9 inch Amber or Green	**$29.95**

5" COLOR MONITOR $49.00
• Flat Faceplate • 320 x 200 Dot Resolution • CGA & Hercules Compatible • 12 VDC Operation • 15.75 KHz Horiz. Freq. • 60 Hz Vert. Sync. Freq. • Open Frame Construction • Standard Interface Connector • Degaussing Coil included • Mfr. Samtron

9" VGA MONITOR $59.00
Original IBM units. Monochrome - page white. Tilt & swivel.

CHARGE COUPLED DEVICES

"The Spy In The Sky" $29.00 — MATRIX TYPE

Sony CCD Imager - designed for black and white composite video cameras. Picture elements: 384 (H) x 491 (V)
Chip size 10.7 (H) x 9.3 (V) mm² • Unit cell size 23.0 (H) x 13.4 (V) um². Ceramic 24 pin DIP package • Mfr: Sony, Part# 016AL

LINEAR TYPE
4096 element CCD $29.00
1024 element CCD $15.00
2048 element CCD $15.00 • 1728 element CCD $15.00

HACKER CORNER

CELL SITE TRANSCEIVER $99.00

These transceivers were designed for operation in an AMPS (Advanced Mobile Phone Service) cell site. The 20 MHz bandwidth of the transceiver allows it to operate on all 666 channels allocated. The transmit channels are 870.030-889.980 MHz with the receive channels 45 HMz below those frequencies. A digital synthesizer is utilized to generate the selected frequency. Each unit contains two independent receivers to demodulate voice and data with a Receive Signal Strength Indicator (RSSI) circuit to select the one with the best signal strength. The transmitter provides a 1.5 watt modulated signal to drive an external power amplifier. channel selection is accomplished with a 10 bit binary input via a connector on the back panel. Other interface requirements for operation are 26 VDC (unregulated) and an 18.990 MHz reference frequency for the digital synthesizer. The units contain independent boards for receivers, exciter, synthesizer, tunable front end, and interface assembly (which includes power supplies and voltage-controlled oscillator). Service manual, schematics and circuit descriptions included.

Encased Black & White Composite CCD Camera with Adapter
IR viewing to 1000 nm 7 ½ L x 2 ¾ W x 1 ¾ H
Comes complete with CCD camera, mounting nut on bottom of casing, 12VDC power supply. Excellent low light capability, standard RCA NTSC video out. **$89.00**
Great for: entryway security/remote monitoring, video conferencing/desktop video conferencing **2 for $159.00**
This miniature camera is perfect for multimedia computer applications as well as security and surveillance. NTSC output allows use with all popular video digitizing boards for Apple Macintosh and Microsoft video for Windows. Connects directly to any composite monitor or VCR with "video" input. Its razor-sharp wide-angle lens focuses from two inches to infinity and its state-of-the-art CCD technology accurately captures 16 level grayscale images for Quick Time movies and still pictures. Records at 30 frames per second and 260 lines resolution with excellent low light capability. Uses 12VDC (adapter supplied) and standard RCA cable.

Portable **Micro Terminal $99.00** or 2 for $149.00
Flip up LCD display (9-16 VDC) • Can communicate with a[illegible]puter having RS 232 port • Can communicate with another Mi[illegible]inal [illegible]se [illegible]sel[illegible]s e[illegible]tronic notebook • Onboard mic[illegible]co[illegible]or, [illegible]RAM [illegible]32[illegible] and [illegible]ide[illegible]RA[illegible]4K) • Complex built in diagnostics a[illegible]cap[illegible]ginal intention for POS applications. • display size 40x16 (256 x [illegible] pixels.) Dimensions: 6.3" W, 11"L, 2"H. (With LCD up height is 7.1")

SOLD OUT

BAREBONES 286-12 COMPUTER $49.00 (2 FOR $79.00)
Slimline desktop case, 100 watt supply, math co-processor support. On board IDE, & Floppy controllers. 2 COM ports and 1 parallel port with software setup. Supports up to 8 Megs using standard 30 PIN SIMMs. Internal room for (1) 3 1/2 inch IDE hard drive and (2) 3 1/2 inch floppies. Four 16 BIT ISA slots, accepts full length AT size cards. Keyboard can be set to no test at boot. Case size is 15.5"W x 16"D x 4"H.
(Motherboard can be purchased separately: $29.00 or 2 for $49.00)

.6" COMPOSITE MINIATURE COLOR DISPLAY $149.00
Fully encased. Dim: 1.3" x 1.3" x 4". 12 Volts DC power. NTSC signal. 250 H x 300 V resolution. Focus adjustable eyepiece. Applications include camcorder viewfinder, helmet mounted display, etc... Original cost over $600.00

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CIRCLE 275 ON FREE INFORMATION CARD

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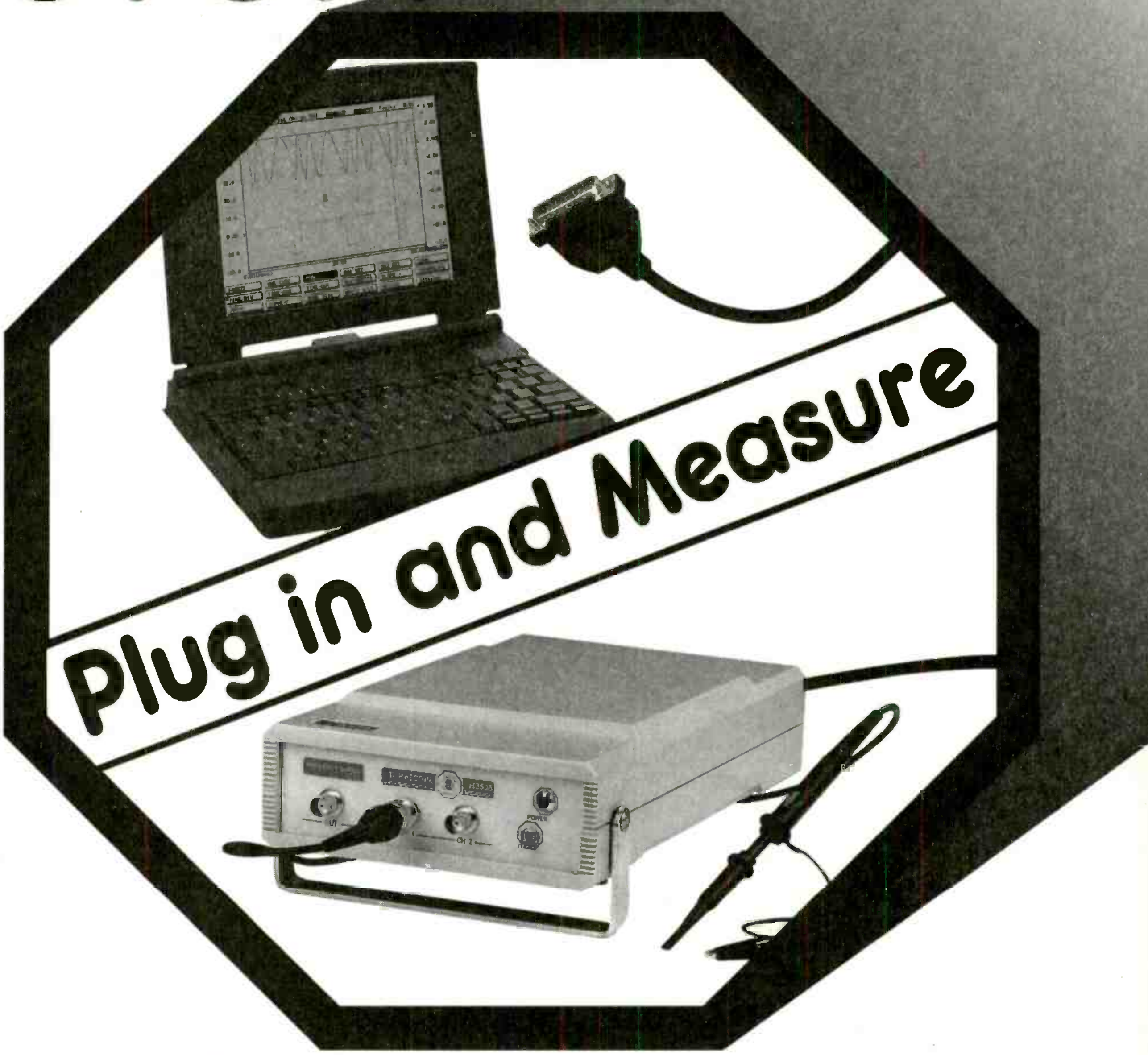

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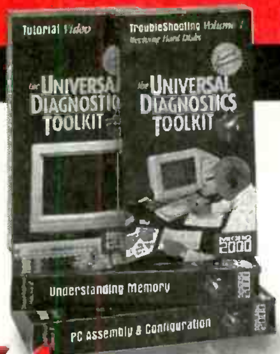

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MICRO-SCOPE Universal Computer Diagnostics was developed to satisfy the expanding need for accurate system diagnosis in the rapidly growing desktop computer market. Patterned after super-mini and mainframe diagnostic routines, **MICRO-SCOPE** runs independently of any standard operating system, and is therefore at home on any machine in the Intel world. Speed, ease-of-use, and razor sharp **ACCURACY** are a few of the advantages that arise from this system independence. **Jerry Pournelle** awarded MICRO-SCOPE & POST-PROBE the User's Choice Award in the May 1994 issue of Byte Magazine, saying: **"You name it, this tests it. If you maintain PCs you'll love it."**

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First Ever Universal P.O.S.T. Card for All PCs!

Use this Power-On Self-Test card to debug any "dead" PC that won't boot...

"This is the only card that will function in every system on the market. The documentation is extensive, and not only covers the expected POST Codes for different BIOS versions, but also includes a detailed reference to the bus signals monitored by the card." —**Scott Mueller** from his globally recognized book, ***'Upgrading & Repairing PCs, Second Edition'***

♦ Includes pads for voltmeter to attach for actual voltage testing under load. ♦ 4 LEDs monitor +5vdc -5vdc +12vdc -12vdc. ♦ Monitors Hi & Lo clock and OSC cycles to distinguish between clock chip or crystal failure. ♦ Monitors I/O Write and I/O Read to distinguish between write and read errors. ♦ Accurately monitors progress of POST for computers *without* POST codes. ♦ Reads POST codes from any IBM or compatible that emits POST codes. ISA/EISA/MCA. ♦ Compatible with Micro Channel computers. ♦ Dip switch allows easy selection of I/O ports to read. ♦ Includes tri-state **LOGIC PROBE** to determine actual chip failures. ♦ Manual includes chip layouts and detailed POST procedures for all major BIOS's. ♦ **AND MUCH MORE...**call for more details.

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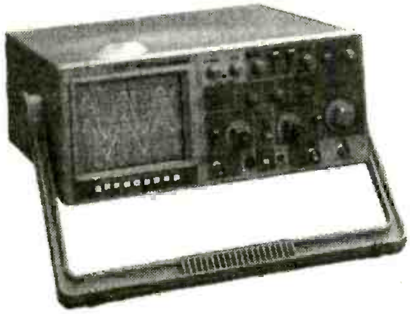
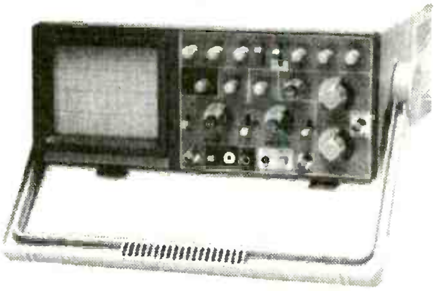
V-555 - w/ Cursors $1095
V-552 . . . . $949
V-509 - Battery Operated . $1795

20MHz

VC-5025A - 20MS/s DSO w/ DMM $1160
VC-5025 - 20MS/s DSO w/ DMM $935
VC-6523 - Storage 20MS/s $1995
V-252 . . . . $449
V-209 - Battery Operated . $1425

Quality Scopes by Elenco





60MHz

DS-603 $1350
• Analog / Digital Storage
• 20MS/s Sampling Rate

S-1365 $795
• Analog w/ Cursors

S-1360 $759
• Analog with Delayed Sweep

40MHz

S-1345 $569
• Analog with Delayed Sweep

S-1340 $489
• Analog

2 Year Warranty

25/30MHz

DS-303 $1095
• Analog / Digital Storage

S-1330 $439
• 25MHz Analog
• Delayed Sweep

S-1325 $335
• 25MHz Analog

OSCILLOSCOPE SELECTION CHART

ANALOG

Model	Bandwidth MHz	Sensitivity (max)	No. of Channels	Sweep Rate Max ns/div	Delayed Sweep	Video Sync	Component Tester	Beam Find	Time Base
S-1365	60	1mV/div	2	10ns/div	Yes	Yes	Yes	Yes	2
S-1360	60	1mV/div	2	10ns/div	Yes	Yes	Yes	Yes	2
S-1345	40	1mV/div	2	10ns/div	Yes	Yes	Yes	Yes	2
S-1340	40	1mV/div	2	10ns/div	No	Yes	No	No	1
S-1330	25	1mV/div	2	10ns/div	Yes	Yes	Yes	Yes	2
S-1325	25	1mV/div	2	10ns/div	No	Yes	No	No	1

DIGITAL STORAGE

Model	Bandwidth MHz	Analog Sen (max)	No. of Channels	Sampling Rate	Memory Channel	Internally Backed Up	Pretrigger %	Output
DS-303	30	1mV/div	2	20MS/S	2K	Yes	0, 25, 50, 75	RS232
DS-603	60	1mV/div	2	20MS/S	2K	Yes	0, 25, 50, 75	RS232

B&K Precision at Discount Prices

20MHz Analog
2120 - $389.95
2125 - $539.95
Delayed Sweep

Model 1541C
40MHz
$695
Dual Trace

60MHz with Cursors readouts and Dual Time Base
Model 2260
$1225

Model 2160
60MHz Dual Trace
$949
Dual Time Base • Delayed Sweep

Model 2190A
100MHz 3 Channel
$1379
Dual Time Base • Delayed Sweep

Fluke Scopemeters

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92 . . . . . . $1525
96 . . . . . . $1795
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97A $2945
99 . . . . . . $2095

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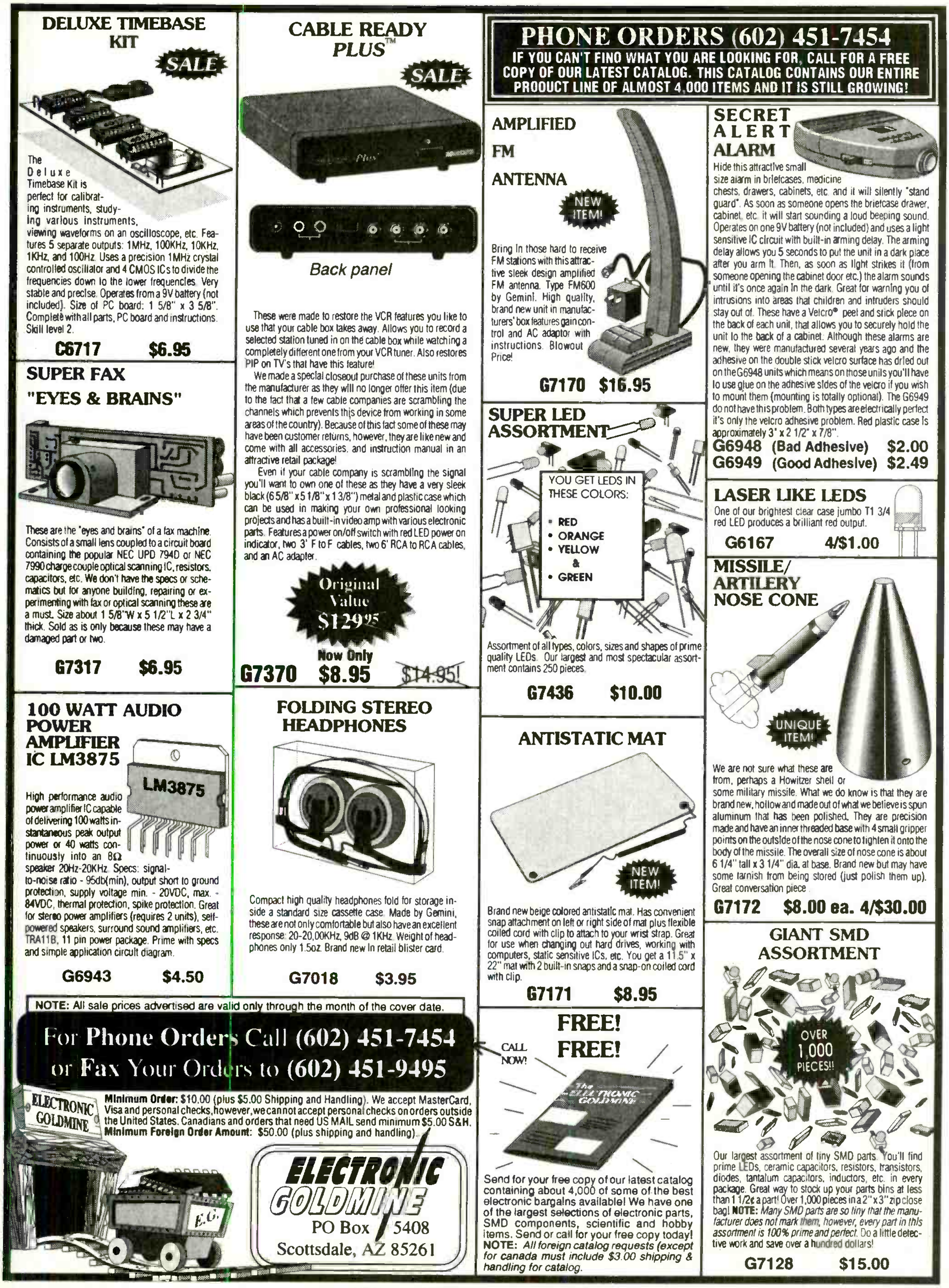
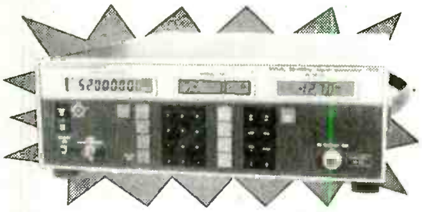
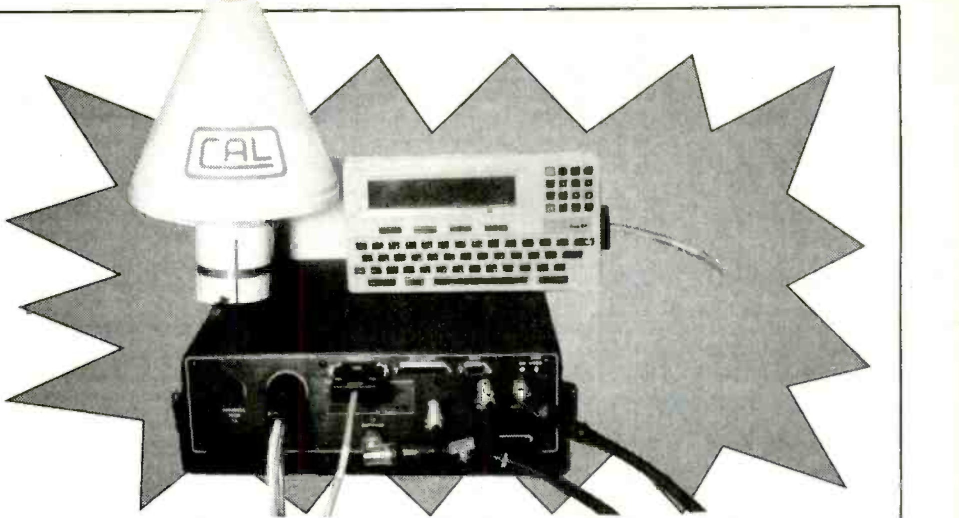


CIRCLE 241 ON FREE INFORMATION CARD



MARCONI SYNTHESIZED SIGNAL GENERATOR Model 2018

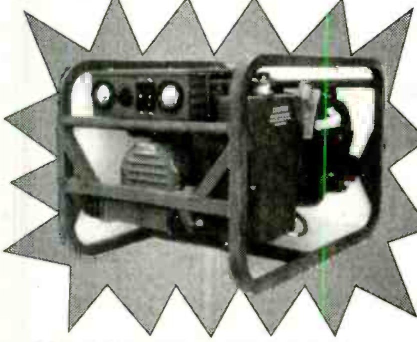
Freq range 80Khz-520Mhz with calibrated output levels from -127 dBm to +13dBm. Resolution 10Hz. It can be freq, phase or amplitude modulated from ext or int modulation sources. RF output resolution is 0.1dB, reversepower protection of up to 50W is possible without damage to the instrument. This instrument is microprocessor controlled and very easy to use, a must for any serious repair or development lab.**Price : $1750.00 Checked**



"CAL" ASTRONAUTICS MOBILE SATELITE COMMUNICATIONS STATION

This is a box chock full of "***current***" high-end communications technology. These units were designed so that mobile land based vehicles could keep in touch (via Geostationary Inmarsat satellite network) with home base using an intellegent data terminal. The terminal features a back-lit 4 line LCD display and illuminated keys; one of the transciever's most impressive features is an "L" Band 1.2-1.55GHz 60 watt amplifier. The fabulous helix antenna (with LNA built-in) is an amazing design with all kinds of active and passive devices surface-mounted on to the antenna reflector. We consider this the "ultimate gadgeteers goodie pack" with all kinds of up-to-date RF satellite ground technology. These systems come complete in their original shipping container with all cables and mounting bracket. Best of all they operate on 12 VDC. Operators manual supplied (but, there isn't any subscriber data).

(NOT TESTED) IN GOOD CONDITION............$345.00

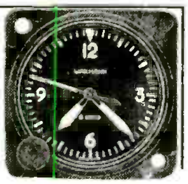


MILITARY STANDARD D.C. GENERATOR

Superior QUALITY plus rugged design are features of this deluxe 2 cylinder 4 stroke gasoline generator. The control panel contains meters for voltage & current indication, main circuit breaker and voltage adjustment. Shielded wires and plugs comprise the RFI suppression ignition system eliminating most radio noise. These units are "**new**" in the original carton complete with operators manual and only require fuel and oil for operation; output voltage is adjustable approx. 10-32v (28v nom) @ 53.3A (1.5Kw) continuous duty load.

Price: $379.00 New in Orig. Carton.
You will be impressed!!!

COLLECTOR ALERT - $39.00
8-DAY AIRCRAFT
CLOCK
1-7/8" dial
Great collectors item for the ham shack, fifties vintage funct/chkd.



ESI MODEL 250 DA IMPEDANCE BRIDGE

Resistance range- 0.1 milliohms - 11megohms, capacitance 0.1pf-1100mf, inductance 0.1 µH to 1100 Hy. Dissipation factor (R/X or D) 0.001 to 1000. Internal oscillator 1 KHz.

Used, not functionally checked.............$95.00
Functionally checked..........................$165.00

PDR-63 PORTABLE RADIAC METER

This portable radiac set is loaded with all kinds of extras featuring six ranges of sensitivity for both Gamma or Beta radiation measurements. The 1st scale 0-1 rad/hr up to 0-5000 rad/hr. The unit comes supplied with headset & bat/charger. Req's only 4 AA Batteries. **Price: $149.95**

-HP 3551A TRANSMISSION TEST SET .... $ 950.00
-HP 3581A WAVE ANALYZER $1,295.00
-HP 4260A LCR BRIDGE .... $ 385.00
-HP 4948A IN-SERVICE TIMS (brand new) $2,995.00
-HP 5006A SIGNATURE ANALYZER .... $ 350.00
-HP 5315AUNIVERSAL COUNTER (1 GHz) .... $ 675.00
-HP 54111D COLOR DIGITAL STORAGE SCOPE $5,500.00
-HP 6472C POWER SUPPLY 0-64V @ 0-150A $1,800.00
-HP 8160A OPT-20 PROG PULSE GEN $2,995.00
-HP 8505 NETWORK ANALYZER SYSTEM $4,980.00
-HP 8558B SPECTRUM ANALYZER .01-1.5GHz $2,350.00
-HP 8559A SPEC-ANALYZER .01-22GHz $4,995.00
-TEK FG504 FUNCTION GENERATOR (40MHz) .... $ 875.00
-TEK 1502 TDR w/CHART REC $2,200.00
-TEK 485 350 MHz OSCILLOSCOPE .... $ 1195.00

-CROWN MODEL 7560 1KW PWR AMP. DC - 40KHz . $1,800.00
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-ENI MOD 406L 150 KHz-250MHz @ 40db GAIN .... $ 650.00
-GOULD 220 CHART RECORDER .... $ 750.00
-GOULD RS 3800 PROGRAMABLE CHART RECORDER/w MOD 5900 SIG CONDITIONER &DC AMPS (NEW) $6,500.00
-HI- ENERGY CORP. DISCHARGE CAP. 1µF@ 20KV $ 300.00
140µF@ 6KV $1,000.00
-MARCONI 2018 SYNTHESIZED SIGNAL GENERATOR 80KHz - 520MHz $1,750.00
-ROHDE & SCHWARZ SIG GENERATOR .4-484MHz . $ 750.00
-WATKINS JOHNSON 8626A-4 with WJ8626-1 & SPN 108 5KHz-30 MHz MIL-SPEC communications reciever $3,950.00

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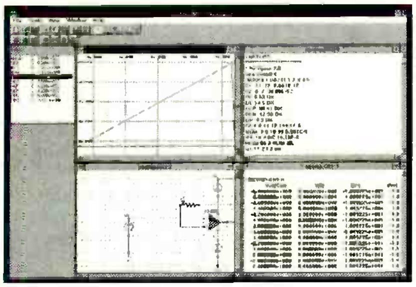
- BOONTON 82AD AM/FM MOD-METER $1,275.00
- COLLINS HF 8054A 4-chan receiver (new in box) $3,695.00
- COLLINS 651S-1 RECEIVER $1.250.00
- GRT-22 UHF POWER AMPLIFER .... $ 200.00
- HARRIS RF280 HF/TACTICAL TRANSCEIVER $1,500.00
- R392 RECEIVER .5-30MHz .... $ 165.00
- T195 100w COMPANION XMTR TO 392 .... $ 85.00
- WAVETEK 3002 RF SIG. GENERATOR .... $ 795.00
*****ATTENTION DIVERS-GAS DRIVEN COMPRESSORS*****
- BAUER 11CFM 3500 PSI COMPRESSOR SYSTEM $3,500.00
- BAUER K14 3500 PSI COMPRESSOR SYSTEM $2,750.00

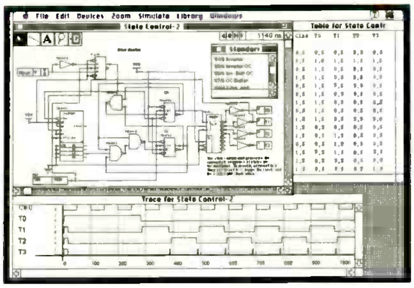
July 96

CIRCLE 323 ON FREE INFORMATION CARD

B² Spice v 2.0   B² Logic v 3.0

for windows™ and macintosh™





B² Spice v 2.0 — $199

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- Full SPICE 3f5 implementation
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- Flexible Visualization of Results: customized graphs and tables
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- Version 1.1 for Mac & Power Mac

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- Subcircuit Probing
- Over 100 components available

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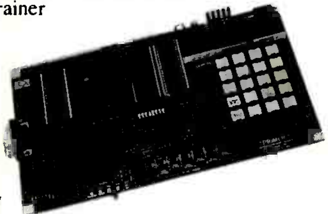
uPROCESSOR TRAINER

The PRIMER 8085 Based Microprocessor Training and Control System takes you from writing simple programs to controlling motors. This trainer can be used stand alone via the keypad and display or connected to a PC with the optional upgrade ($49.95). The Upgrade includes: an RS232 serial port, a serial cable, 32K of battery backed RAM and Assembler/Terminal software.



EXPERIMENTS USING THE PRIMER INCLUDE

- Measuring Temperature
- Using a Photocell to Detect Light Levels
- Making a Waveform Generator
- Constructing a Capacitance Meter
- Motor Speed Control Using Back EMF
- Interfacing and Controlling Stepper Motors
- Scanning Keypads and Writing to LCD/LED Displays
- Using the Primer as an EPROM Programmer

The PRIMER is only $119.95 in kit form. The PRIMER Assembled & Tested is $169.95. Please add $5.00 for shipping within the U.S. Picture shown with upgrade option and optional heavy-duty keypad ($29.95) installed.

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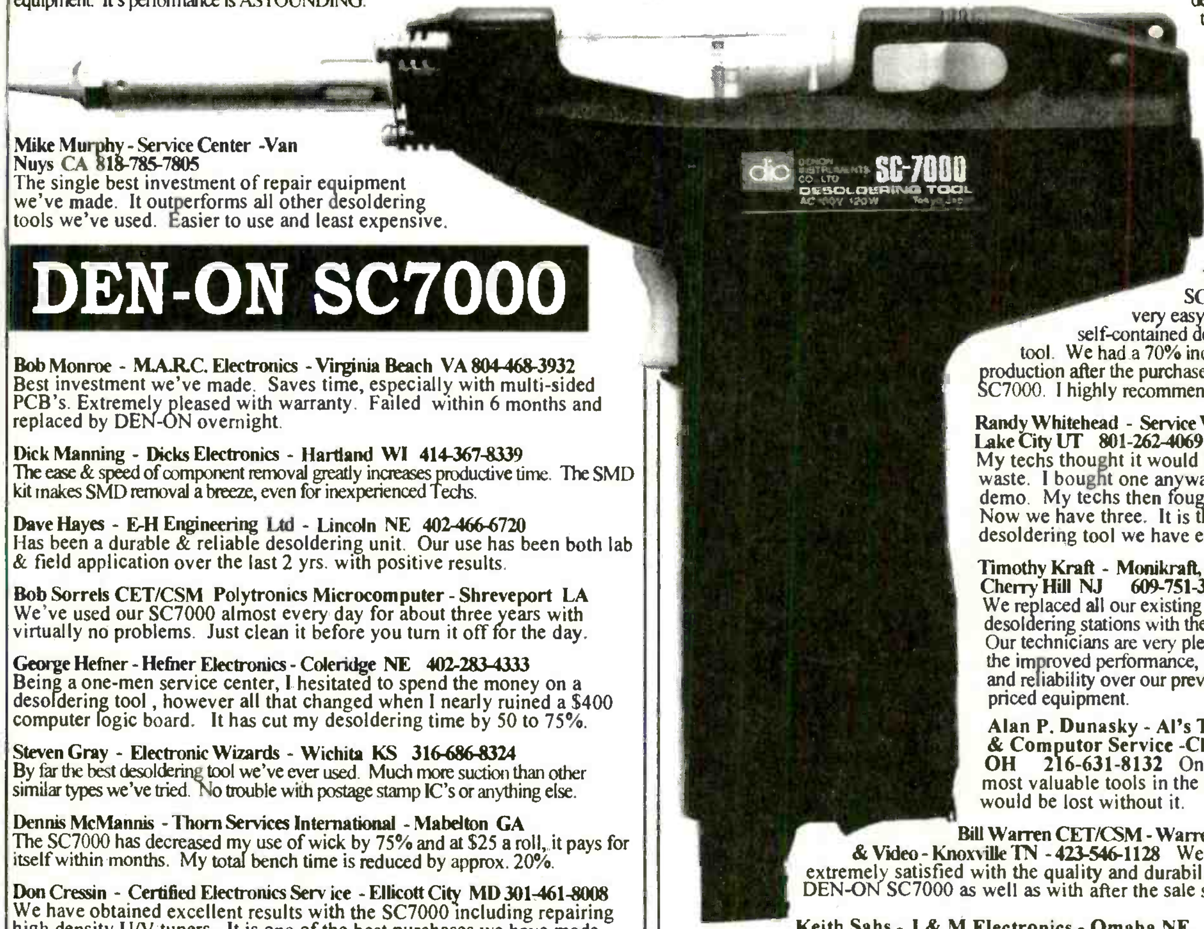
Lane Norman - Normans Electronics Inc. Atlanta GA 404-451-5057
A cost effective solution to desoldering equipment at less than half the price of most equipment. It's performance is ASTOUNDING.

Harold Smedberg - Smedberg Electronics - Custer MI
The SC7000 has reduced my damage to PC boards by 90%. It has also decreased my desoldering time by 50%. The best priced tool on the market.



Mike Murphy - Service Center -Van Nuys CA 818-785-7805
The single best investment of repair equipment we've made. It outperforms all other desoldering tools we've used. Easier to use and least expensive.

Tom Mullett - JC Penny TD&S - Wausatose WI 414-259-2486
The SC7000 is a very easy to use, self-contained desoldering tool. We had a 70% increase in production after the purchase of the SC7000. I highly recommend it.

DEN-ON SC7000

Bob Monroe - M.A.R.C. Electronics - Virginia Beach VA 804-468-3932
Best investment we've made. Saves time, especially with multi-sided PCB's. Extremely pleased with warranty. Failed within 6 months and replaced by DEN-ON overnight.

Dick Manning - Dicks Electronics - Hartland WI 414-367-8339
The ease & speed of component removal greatly increases productive time. The SMD kit makes SMD removal a breeze, even for inexperienced Techs.

Dave Hayes - E-H Engineering Ltd - Lincoln NE 402-466-6720
Has been a durable & reliable desoldering unit. Our use has been both lab & field application over the last 2 yrs. with positive results.

Bob Sorrels CET/CSM Polytronics Microcomputer - Shreveport LA
We've used our SC7000 almost every day for about three years with virtually no problems. Just clean it before you turn it off for the day.

George Hefner - Hefner Electronics - Coleridge NE 402-283-4333
Being a one-men service center, I hesitated to spend the money on a desoldering tool, however all that changed when I nearly ruined a $400 computer logic board. It has cut my desoldering time by 50 to 75%.

Steven Gray - Electronic Wizards - Wichita KS 316-686-8324
By far the best desoldering tool we've ever used. Much more suction than other similar types we've tried. No trouble with postage stamp IC's or anything else.

Dennis McMannis - Thorn Services International - Mabelton GA
The SC7000 has decreased my use of wick by 75% and at $25 a roll, it pays for itself within months. My total bench time is reduced by approx. 20%.

Don Cressin - Certified Electronics Serv ice - Ellicott City MD 301-461-8008
We have obtained excellent results with the SC7000 including repairing high density U/V tuners. It is one of the best purchases we have made.

Doug Pettit - LuRay Electronics - LuRay VA 703-743-5400
We found that the SC7000 not only saves money vs. wick, but saves valuable time in troubleshooting. It allows you to be more accurate in removing SMD's.

Paul Horvat - Service Excellence Inc. - Bergenfield NJ 201-387-7776 It has made a almost impossible job (desoldering a 64 pin CPU) a piece of cake.

Randy Whitehead - Service West - Salt Lake City UT 801-262-4069
My techs thought it would be a waste. I bought one anyway after a demo. My techs then fought over it. Now we have three. It is the Best desoldering tool we have ever used.

Timothy Kraft - Monikraft, Inc. - Cherry Hill NJ 609-751-3252
We replaced all our existing desoldering stations with the SC7000. Our technicians are very pleased with the improved performance, portability, and reliability over our previous higher priced equipment.

Alan P. Dunasky - Al's TV, VCR, & Computor Service -Cleaveland, OH 216-631-8132 One of my most valuable tools in the shop. I would be lost without it.

Bill Warren CET/CSM - Warrens Audio & Video - Knoxville TN - 423-546-1128 We have been extremely satisfied with the quality and durability of the DEN-ON SC7000 as well as with after the sale support.

Keith Sahs - J & M Electronics - Omaha NE 402-291-7100 It's a must tool for my bench. I can desolder multiple pin IC's quickly and clean. It will even take up large solder amounts on tuner and case grounds.

Ray Wurmnest - Ray's Electronics, Inc.-Bloomington IL 309-829-3238
The SC7000 saves time when changing out parts in the home or in the Service Center — Worth every penny we spent.

Specifications

- Totally Self Contained diaphragm vacuum pump and AC motor for high vacuum suction or reversible hot air blow for SMD removal.
- 100Watt Ceramic heater with zero-crossover switching heater control circuit which prevents spikes and leakage currents.
- Unique patented long lasting filter cartridge design. Solder builds up on easily cleaned baffle, while air flows around the outside of baffle.
- Totally ESD Safe. The housing contains carbon and the tip is at ground potential for complete ESD Protection.
- Maximum vacuum of 600mmHg is attained in 0.2 seconds.
- Temperature adjustable from 300°C - 450°C or 572°F - 842°F

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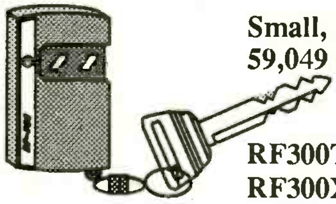
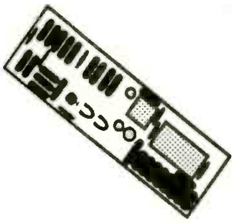
CIRCLE 329 ON FREE INFORMATION CARD

Miniature Transmitters and Receivers



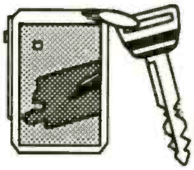
Small, Attractive, High End Quality, 2 Channel 318 MHz Transmitter
59,049 Settable Codes, 120'–300' Range, 1–1/4" x 2" x 9/16", Assembled

	Qty	1	5	10
RF300T	150' Range Transmitter	24.95	19.95	15.95
RF300XT	300' Range Transmitter	29.95	24.95	19.95



Small, High End Quality, 2 Channel Receiver for the RF300 Transmitters
1–1/4" x 3–3/4" x 9/16" PCB w/ .1" spaced pads for standard connectors
Input: 8–24 vdc Output: Gated CMOS Momentary and Latching Lines

	Qty	1	5	10
RF300R	Receiver, Fully Assembled	24.95	20.95	16.95
RF300RK	Receiver, Complete Parts Kit	19.95	15.95	12.95
RF300PA	Pre–Amplifier. Doubles Range	14.95	11.95	9.95



Small, Economical, Single Channel Transmitter and Receiver Set
Set Code, 60' Range, 1–7/8"x2–3/8"x7/16" (T), 2"x2–3/4"x9/16" (R)
Receiver Input: 5 vdc Output: Gated TTL Momentary Line

	Qty	1	5	10
RF60	Transmitter and Receiver Set	24.95	19.95	14.95

Add $ 4 shipping for first item + $ 1 for each additional item. Ca. residents add 8.25% tax
Visa, Mastercard, Money Orders Personal Checks and Cash C.O.D.s

Visitect Inc. P.O. Box 14156 Fremont, CA. 94539 (510) 651–1425 Fax (510) 651–8454

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Monthly Special! Free window clip antenna with these radios!

TRIDENT Bearcat

Trident Spectrum Analyzer
1-1300MHz in two bands with a Span that's variable from 500 MHz to 10 MHz. 80db on Screen Range, marker generator, 200K/10K selectable bandwidth, -117dBm Sensitivity, outputs to any x/y o'scope.
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CIRCLE 212 ON FREE INFORMATION CARD

ARE YOU BEING "BUGGED?"

EVEN AS YOU READ THIS, countless individuals and firms are being enormously damaged by having their private conversations overheard, monitored, and\or recorded.
Almost without exception and AFTER the fact, the victims make a statement something along the lines of "But, I never thought it could happen to ME!

OUR FINEST

Counter-Surveillance Device

THE ULTIMATE IN "BUG" DETECTION EQUIPMENT "DEBUGS" ROOMS AND TELEPHONES!

If you require GUARANTEED PROTECTION against electronic telephone monitoring devices and COMPLETE CONFIDENTIAL PRIVACY in certain rooms and areas, we highly recommend the COUNTER-SURVEILLANCE DETECTOR CSD-18.

EXTREME SENSITIVITY!

This is our finest piece of detection equipment! The CSD-18 quickly locates electronic eavesdropping devices in telephones, homes, offices, vehicles, boats, or concealed on the body. It will actually pick up many eavesdropping transmitters at ranges up to 25 ft! Extreme sensitivity is obtained via ultra-efficient amplification circuitry directly following the RF detection stages. Excellent quality dynamic headphones exclude all external sounds to further enhance detector output.

Encompassing an extremely wide-band frequency coverage of under 1 Mhz to over 3 Ghz, the CSD-18 quickly "homes-in" on any eavesdropping transmitter and immediately pinpoints its location. The closer you get to the "bug", the further the needle moves to the right. It's as simple as that.

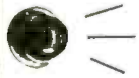
FULL RANGE DYNAMIC HEADPHONES

CONDUCT A PROFESSIONAL SEARCH...ANYTIME...ANYWHERE!

Every newspaper and magazine article and every radio and TV story discussing some new episode involving "Bugging" devices, continues to increase the ever growing demand for electronic Counter-Surveillance "sweeps" and equipment. The very limited supply of competently trained and equipped Counter-Surveillance specialists has created a situation where "sweep" rates exceeding $250 per hour are now considered reasonable and appropriate.

This is an exciting, immensely interesting and profitable field that you can enter with a minimum investment. Two hours actual practice with the CSD-18 will have you "reading" and "clearing" telephones and rooms with professional ease and competence. The average fee for "debugging" a single telephone is over $200.00 It requires about 45 minutes to complete the job and once it gets around that YOU can provide this service, you'll quickly have more clients than you can handle.
Even if you choose to provide "sweeps" for only a small number of friends and associates, your initial investment will quickly be returned many times over.

"FLASHING" LED WARNS YOU INSTANTLY!



And, for maximum telephone security, the CSD-18 automatically analyzes a pre-programmed series of electronic measurements along the telephone line and converts the analysis into an easy to follow, step by step, test procedure. No technical knowledge is required or necessary. A visual indication (via a flashing LED) immediately reveals the presence of the various types of telephone "taps" and the flashing sequence identifies the actual type of eavesdropping device.

DETECTS THE LATEST "SUPER-BUGS"

Exclusive GSS proprietary circuitry assures the utmost privacy protection possible today. The CSD-18 detects even the very latest ultra-sophisticated eavesdropping devices specifically designed to defeat detection, including sophisticated "Frequency Hoppers" and "Burst Bugs". Also includes multi-line option for testing business phones.

FREE WITH ORDER!

SUBMINIATURE "BODY WIRE" DETECTOR!

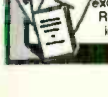
If you fear the possibility of being overheard and/or recorded during private conversations and require "silent" notification, we've also included our SBD-5 (regularly $225) as a FREE GIFT! Only 3" x 2" x 1", this exciting new development in micro-miniaturization will instantly detect hidden body wires at ranges up to 10 ft and alert you via a silent vibration.

BIG MONEY OPPORTUNITIES!

Also, complete information describing the fantastic opportunities now open to trained Counter-Surveillance technicians and how a number of individuals are reaping a Bonanza in this booming business! You'll learn exactly how the ever increasing use of Electronic Listening Devices by investigative agencies, government agencies, jealous suitors and unscrupulous business competitors, etc. has created huge demand for this service.

FASCINATING HI-TECH INFORMATION PACKAGE!

A detailed analysis of a variety of extremely fascinating hi-tech devices and procedures used for ultra-sophisticated audio and video eavesdropping including micro-wave and laser device monitoring; new methods for listening thru walls; all about scramblers, voice changers and exactly how neighbors eavesdrop. How missing persons are found, confidential data banks are broken into, lie detectors deceived and much more!



A comprehensive information package JAM-PACKED FULL of some of the most exciting and fascinating reading imaginable. Reads like a James Bond novel, with one important exception...IT'S NOT FICTION!

THE ONE "BUG" TO FEAR MOST!

While most individuals are now somewhat guarded in their telephone conversations, they still rather naively feel secure in the "privacy" of their own home or office. However, the most common type of "tap" presently used by eavesdroppers now picks up ALL SOUNDS AND CONVERSATION WITHIN A ROOM ... WITH THE TELEPHONE STILL ON THE HOOK!

Due to this devastating capability, this "Infinity" tap (variously referred to as Infinity Transmitter, Hookswitch Bypass, 3rd Wire, Harmonica Bug, etc.) has become the "bug of choice".

In flagrant violation of federal law prohibiting their use and sale, these devices in various forms are openly advertised in many technical publications for as little as $30. Literally thousands of these devices are now in the hands of unscrupulous individuals all over the country!

In response to this ever-growing threat, a uniquely engineered feature of the CSD-18 now also detects Infinity type devices anywhere "down the line".

In other words, if ANYONE ... ANYWHERE ... is utilizing the telephone tip and/or ring wires to monitor your private room conversations while your telephone is on the hook, you'll immediately be made aware of it via a flashing LED!

100% POSITIVE INDICATION

The CSD-18 also flawlessly detects "Series" and "Parallel" telephone transmitters and "Telephone Recording Devices". And, a separate feature silently indicates when extension phones are picked up or being used. The CSD-18 completely eliminates all doubt and guesswork.

EXCLUSIVE "LISTEN-IN" FEATURE!

The CSD-18 will even allow you to "listen-in" to exactly what the eavesdropper is surreptitiously monitoring. And, without the eavesdropper ever becoming aware that he has been detected! We are unaware of ANY other detection equipment having this combined capability AT ANY PRICE!

MAXIMUM PROTECTION

The CSD-18 detects and locates ALL major categories of surveillance equipment including:
BUMPER BEEPERS,
"BODY" TRANSMITTERS
TELEPHONE RECORDING DEVICES
SERIES & PARALLEL PHONE TRANSMITTERS
"INFINITY", MICRO-WAVE AND "LASER" BUGS
& ALL TYPES OF CONCEALED TRANSMITTERS
including Video, Computer and Fax Transmitters

CSD-18 **$495** Complete

Includes headphones, antenna/probe, all plugs and adapters, batteries, the Free SBD-5 & Info Packages.

HOW TO ORDER

Order NOW by Mail or Telephone. 10 DAY MONEY BACK GUARANTEE if you're not 100% pleased and completely satisfied. We pay shipping charges on all prepaid & credit card orders. Add $15 for CODs.

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Fantastic DMM Offer!!!

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

Rubber Boot Included

Our Best Offer Ever on a High Quality Full Sized DMM

General

Display: 3-1/2 Digit LCD, 21mm Figure Height with Automatic Polarity
Overrange Indication: 3 Least Significant Digits Blank
Temperature for Guaranteed Accuracy: 23°C±5°C RH<75%
Temperature Ranges:
Operating: 0°C to 40°C (32°F to 104°F)
Storage: -10°C to 50°C (14°F to 122°F)
Power: 9V Alkaline or Carbon-Zinc Battery(NEDA1604)
Low Battery Indication: BAT on Left of LCD Display
Dimensions: 188mm long x 87mm wide x 33mm thick
Net Weight: 400g

$19.00 any qty

DC Voltage (DCV)

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

Maximum Allowable Input: 1000V DC or Peak AC.

DC Current (DCA)

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

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

AC Voltage (ACV)

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

Frequency Range: 45Hz-450Hz
Maximum Allowable Input: 750V rms
Response: Average Responding, Calibrated in rms of a Sine Wave.

Resistance (Ω)

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

Maximum Open Circuit Voltage: 2.8V

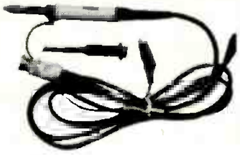
Diode Test
Measures forward voltage drop of a semiconductor junction in mV test current of 1.5mA Max.

Continuity
The beeper will sound when the resistance of circuit under measurement is less than 30Ω.

hFE Test
Measures transistor hFE.

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

Switchable Scope Probe Sets



(Selectable X1/Ref/X10) These high quality scope probe sets are for oscilloscopes up to 60MHz (model HP9060) or 150MHz (model HP9150). Both sets include a handy storage pouch and include an IC test-hook adapter for the probe. The BNC connector rotates to avoid cable tangle or kink. Cable length is 1.4 meters.

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

Positive Photo Resist Pre-Sensitized Printed Circuit Boards

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

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

CAT NO	DESCRIPTION	PRICE EACH 1	10	50
PP101	100mm x 150mm/3.91" x 5.91"	$2.55	$1.90	$1.70
PP114	114mm x 185mm/4.6" x 6.6"	2.98	2.45	1.98
PP152	150mm x 250mm/5.91" x 9.84"	5.40	3.98	3.60
PP153	150mm x 300mm/5.91" x 11.81"	6.15	4.48	4.10

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

CAT NO	DESCRIPTION	PRICE EACH 1	10	50
GS101	100mm x 150mm/3.91" x 5.91"	$ 3.90	$2.98	$2.60
GS114	114mm x 185mm/4.6" x 6.6"	4.80	3.49	3.20
GS152	150mm x 250mm/5.91" x 9.84"	8.69	5.98	5.78
GS153	150mm x 300mm/5.91" x 11.81"	10.20	7.20	6.80

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

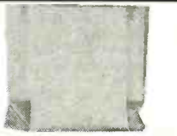
CAT NO	DESCRIPTION	PRICE EACH 1	10	50
GD101	100mm x 150mm/3.91" x 5.91"	$ 5.07	$3.68	$3.38
GD114	114mm x 185mm/4.6" x 6.6"	5.95	4.29	3.99
GD152	150mm x 250mm/5.91" x 9.84"	10.47	7.39	6.98
GD153	150mm x 300mm/5.91" x 11.81"	11.95	8.69	8.30

Etching Chemicals/Ferric Chloride

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

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

Developer



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

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

Etching Tank

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

REDUCES ETCHING TIME!

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

Desoldering Pumps

These powerful plastic body desoldering pumps are designed for easy one hand operation for fast, efficient desoldering. Double O-ring piston seals for maximum suction.

CAT NO	DESCRIPTION	PRICE EACH 1	5	10
08-366S	Large Desoldering Pump	$15.89	$13.49	$11.95
08-366E	Regular Desoldering Pump	10.89	8.59	7.39
08-366TIP	Replacement Tip	1.95	1.95	1.95

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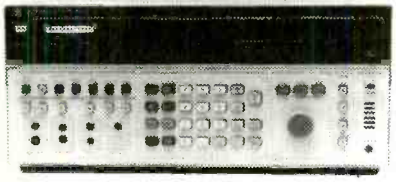

Hewlett-Packard 3586B Selective Level Meter

Makes carrier measurements to 32.5 MHz, voice channel measurements from 50 Hz to 100 kHz, can use the 3336B Level Generator as an automatic tracking generator. Opt 004. Like new condition.

$850.00

Hewlett-Packard 3336B

Synthesizer/ Level Generator covers the frequency range from 10 Hz to 21 MHz, making the 3336B useful for telephone circuit loop testing on most FDM systems. Includes opt 005. Like new.

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Synthesizer/ Function Generator, 1 µHz to 21 MHz, wideband sweeper, programmable, 11 digit resolution.

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Function Generator, .001 Hz to 19.99 MHz with an amplitude range of .01 mV to 10 V p-p, sine, square and triangle waves, arbitrary signals, AM/ FM/ VCO, gate and counted burst.

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Hewlett-Packard 8901A

Modulation Analyzer, 150 kHz to 1300 MHz, measures AM and FM to 1% accuracy, measures RF frequency and power, completely automatic, options available.

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Hewlett-Packard 8903A

Audio Analyzer, measures distortion, SINAD, signal-noise, frequency (20 Hz to 150 kHz), ac and dc level, options available.

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WANTED USED TEST EQUIPMENT

Tektronix 475A DM44 Oscilloscope

250 MHz bw, dual channel, 5 mV/ div sensitivity, 1nS/ div sweep rate. With differential-time/ DMM option. Includes 2 probes.

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Tektronix 465 Oscilloscope

100 MHz bw, dual trace, 5 mV/div sensitivity, 5 ns/ div sweep rate, 8 x 10 cm CRT. Includes 2 probes.

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Tektronix 485 Oscilloscope

350 MHz bw, dual trace, 5 mV/ div sensitivity, 1 ns/ div sweep rate, 3.0 div/ ns writing speed, selectable input impedance.

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Tektronix 7834 Package

Dc to 400 MHz Storage Oscilloscope Mainframe with the following plug-ins: (1) 7A19 amplifier, (1) 7A26 dual trace amplifier, (1) 7B85 delaying time base, and (1) 7B80 time base.

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Tektronix 7904 Package

Dc to 500 MHz Oscilloscope Mainframe with the following plug-ins: (1) 7A24 dual trace amplifier, (1) 7A26 dual trace amplifier, (1) 7B80 time base, and (1) 7B85 delaying time base.

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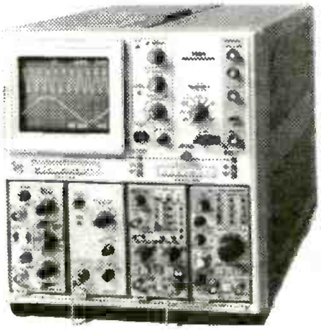

Fluke 1900A

Multifunction Counter, 5 Hz to 80 MHz, provides frequency, period, period averaging and totalize measurements, 6 digit display, 1 MHz low-pass filter.

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Hewlett-Packard 8569B

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Tektronix 492 Spectrum Analyzer

50 kHz to 21 GHz, 80 dB dynamic range, amplitude comparison in 0.25 dB steps. Options 01, 02.

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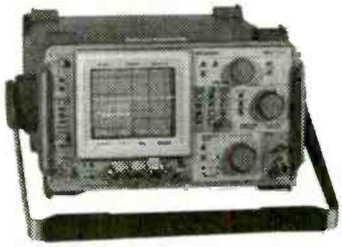

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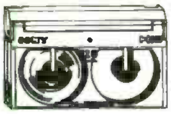

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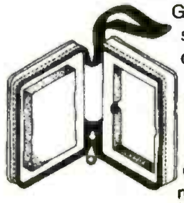

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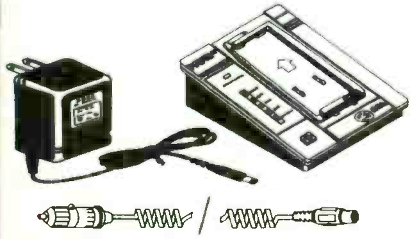

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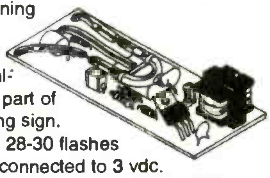

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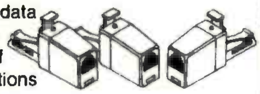

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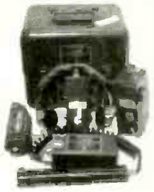

AN/PDR-63 RADIAC SET, military modular unit uses IM-226 module for 0-10-100-1000 rad/hour gamma detection, DT-507 low-range detector indicates 0-1-10-100-1000 mrad/hr and DT-508 0-500-5000 rad/hr plus simulates radiation absorption by human skin. Requires four AA batteries (not supplied). Set also includes ni-cad battery charger, headset, case, and manual; 15 lbs sh. **Used** **$185.00**

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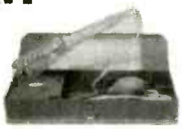

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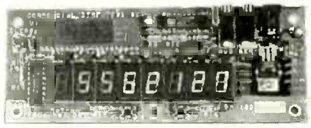

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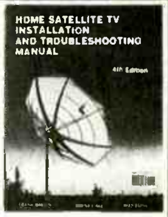

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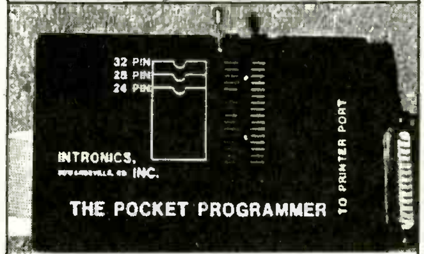

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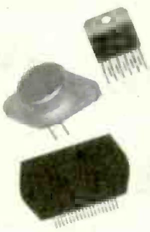

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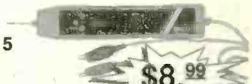

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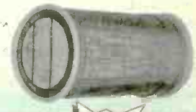

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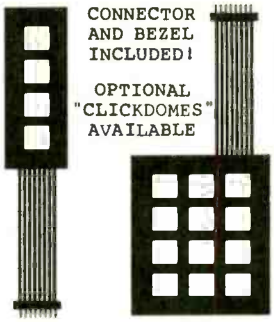

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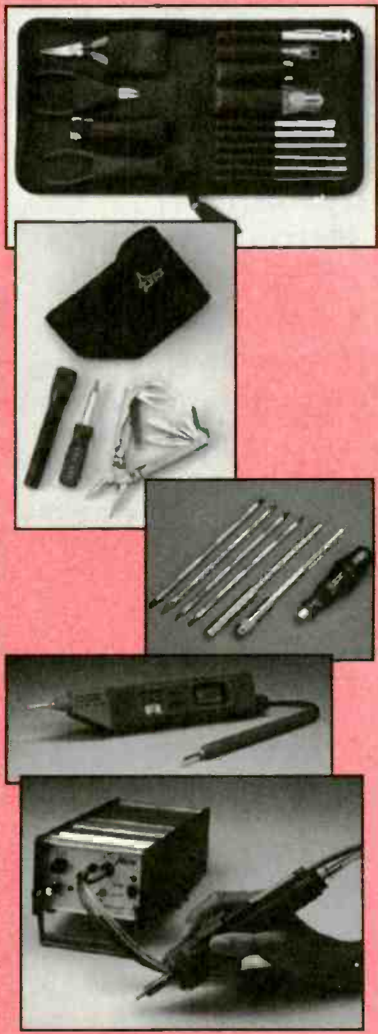

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	33	62	91	120	149	178	207	237	266	295	325	354
	34	63	92	121	150	179	208	238	267	296	326	355
	35	64	93	122	151	180	209	239	268	297	327	356
	36	65	94	123	152	181	210	240	269	298	328	357
	37	66	95	124	153	182	211	241	270	299	329	358
	38	67	96	125	154	183	212	242	271	300	330	359
	39	68	97	126	155	184	213	243	272	301	331	360
	40	69	98	127	156	185	214	244	273	302	332	361
	41	70	99	128	157	186	215	245	274	303	333	362
	42	71	100	129	158	187	216	246	275	304	334	363
14	43	72	101	130	159	188	217	247	276	305	335	364
15	44	73	102	131	160	189	218	248	277	306	336	365
16	45	74	103	132	161	190	219	249	278	307	337	366
17	46	75	104	133	162	191	220	250	279	308	338	367
18	47	76	105	134	163	192	221	251	280	309	339	368
19	48	77	106	135	164	193	222	252	281	310	340	369
20	49	78	107	136	165	194	223	253	282	311	341	370
21	50	79	108	137	166	195	224	254	283	312	342	371
22	51	80	109	138	167	196	225	255	284	314	343	372
23	52	81	110	139	168	197	226	256	285	315	344	373
24	53	82	111	140	169	198	227	257	286	316	345	374
25	54	83	112	141	170	199	228	258	287	317	346	375
26	55	84	113	142	171	200	229	259	288	318	347	376
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