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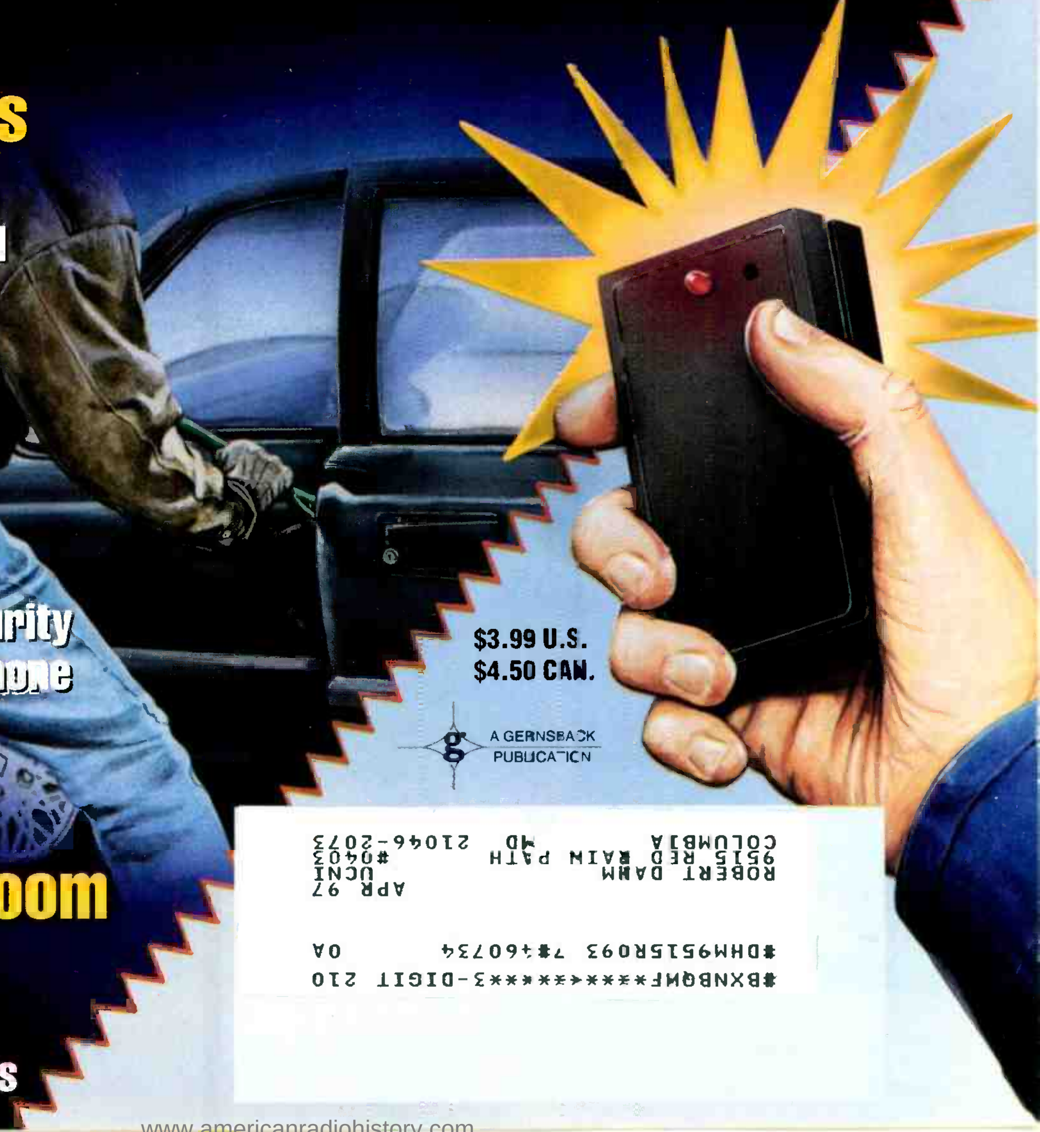

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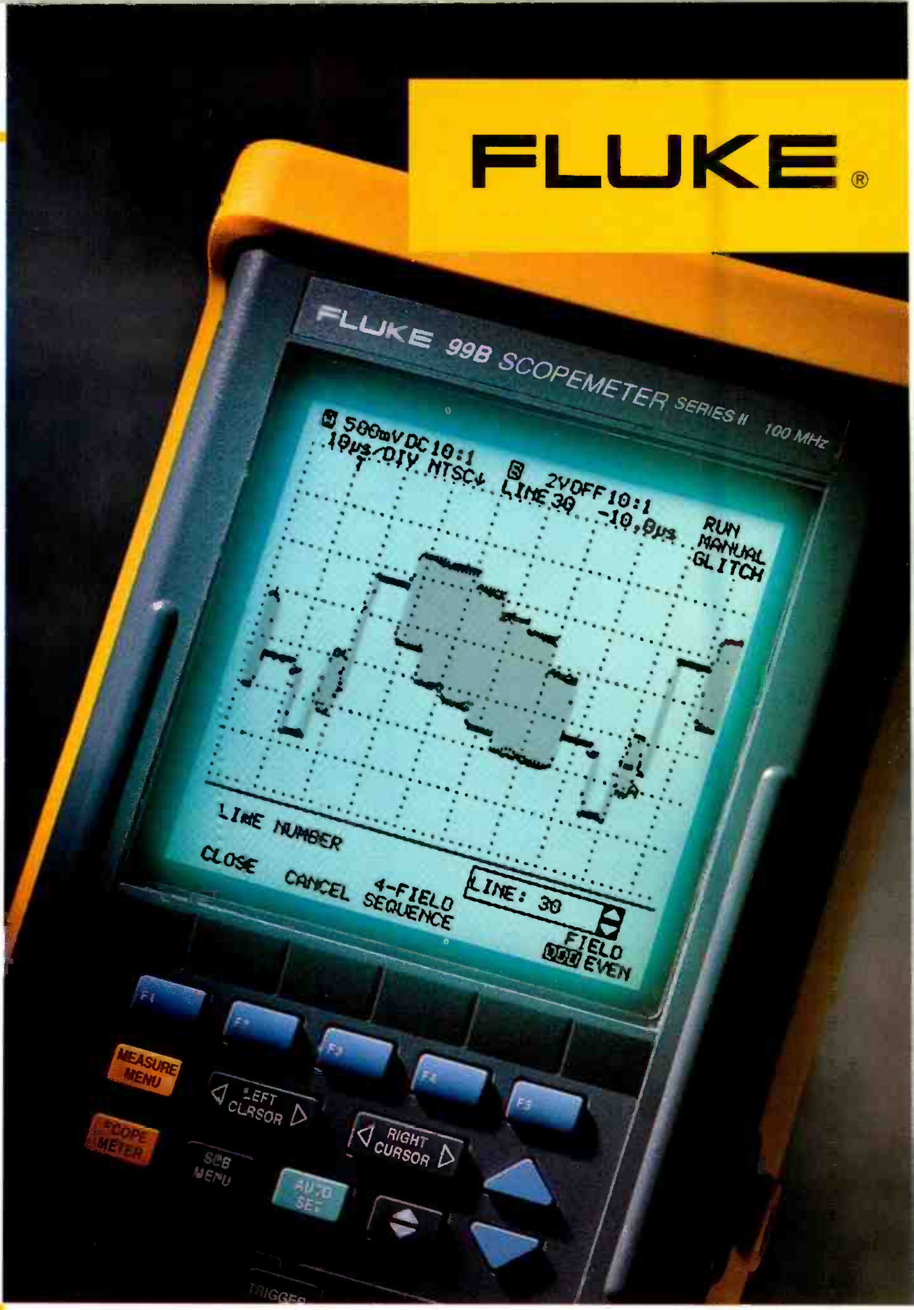

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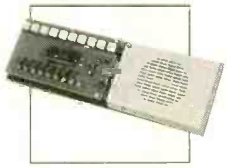

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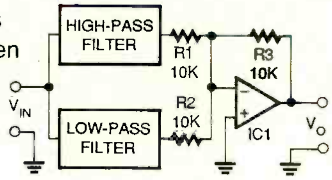

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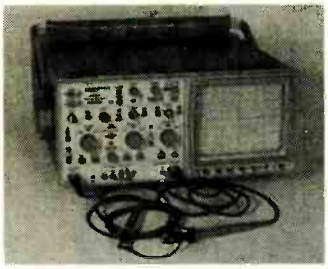

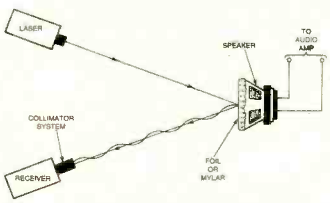

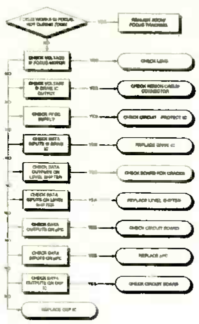

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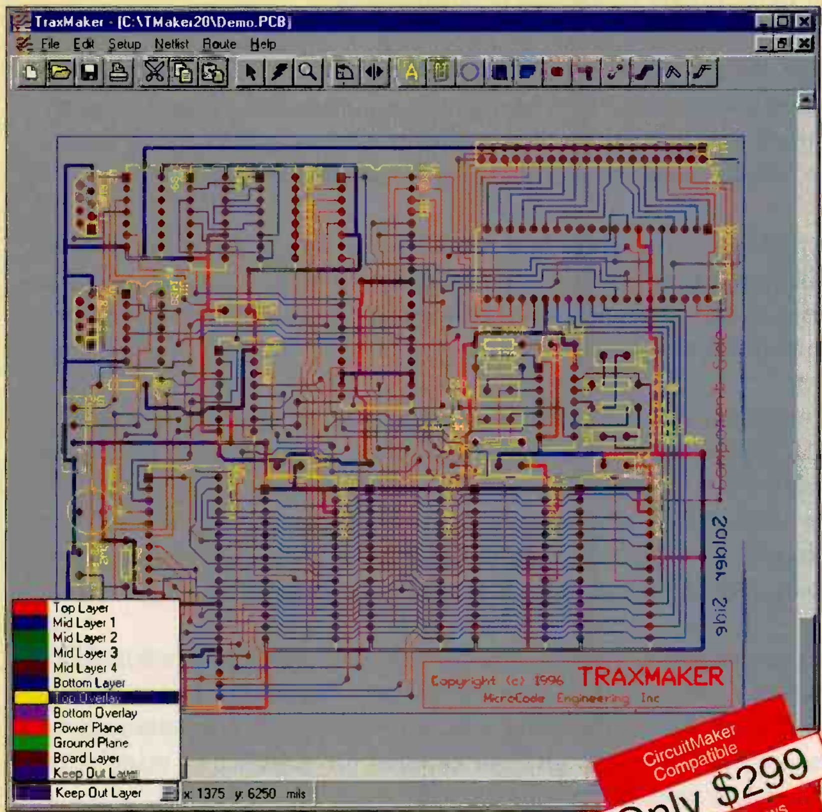

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EDITORIAL

A Question of Responsibility

As this is being written, there has been a lot of heat and noise being generated over the issues of TV-show ratings and the "V-chip." Notice that I said heat and noise, and not light.

That's unfortunate, because I believe that if a strong light were turned on the issues, more people might realize that the proposed answers don't address the real questions at all. In fact, they trivialize the issues to the point of being silly, or perhaps even dangerous.

On the surface, this seems to be an issue of how do we prevent impressionable young minds from seeing programming that is inappropriate, and that might cause them to form distorted views on topics such as violence, relationships, etc. But that greatly oversimplifies matters.

The problem is, no matter how many V-chips we install, no matter how detailed and exacting we make programming ratings, it's all a huge waste of time, money, and energy if the proper guidance does not come from the one place it should—parents.

TV watching, especially with children, should be an interactive experience. Programs should be watched together, and questions and issues raised by them should be answered and discussed . . . together. Using TV as an omnipresent baby sitter, and trusting to technology to keep our children from seeing the things we believe they shouldn't, is tantamount to abdicating our responsibilities as adults and parents.

Don't get me wrong. As long as its use remains optional, there is nothing intrinsically wrong with V-chip technology. The danger lies in relying upon it to be sure our children only see appropriate programming, or worse, relying upon it to give our children the guidance so many of us don't seem to have the time, or the will, to provide.

Carl Laron
Editor

WHAT'S NEWS

A REVIEW OF THE LATEST HAPPENINGS IN ELECTRONICS

New Copy-Protection Licensees

Set-top decoder manufacturers DX Antenna and Matsushita Electric Industrial Co., Ltd. have been licensed by Macrovision Corporation (Sunnyvale, CA) to incorporate its industry-standard copy-protection technology for pay-per-view (PPV) programming. DX Antenna will use the technology in its line of DSS Integrated Receiver Decoders (IRDs) for deployment within the PerfecTV system in Japan. Matsushita will use the copy-protection technology in its own digital set-top decoders, which it will deliver to subscribers of PerfecTV in Japan and DirecTv in the United States. The addition of DX Antenna and Matsushita brings the number of licensed set-top suppliers to 29.

Meanwhile, LG Electronics became the 21st semiconductor manufacturer to sign an agreement authorizing them to produce integrated circuits with the Macrovision copy-protection capability.

"We look forward to working with all of our licensees to ensure that all digital video networks throughout the world are equipped with copy-protection capability," said Mark Belinsky, vice president of Macrovision's Copy Protection Group. "We believe our wide range of partnerships will make it easier to deploy hardware in as many digital PPV, video-on-demand, and interactive multimedia networks as possible. This will allow system operators worldwide to incorporate copy-protection technology on a very cost-effective basis and offer it to major rights owners who wish to protect the downstream value of their theatrical releases."

Macrovision is best known for the videocassette version of its copy-protection technology, which is used by every major Hollywood studio, as well as more than 1500 corporate, educational, and special-interest rights holders in the U.S. alone. The company's videocassette technology degrades unauthorized copies made on more than 80% of consumer VCRs in the U.S. market.

Macrovision's pay-per-view technology degrades unauthorized copies made on over 95% of consumer VCRs. It contains an additional element called Colorstripe that can be used on transmitted programs but not prerecorded cassettes. PPV copy protection is gaining market acceptance among DBS, telephone, and cable operators.

Online Telecommunications-Industry Research

The Investext Group (Boston, MA), a leading provider of company and industry research has teamed with Internet Securities, Inc. (ISI), an Internet-based information distributor to offer one of the largest collections of in-depth, competitive research on the telecommunications industry on the World Wide Web. The service, called Telecom Strategies (http://telecom.securities.com), delivers more than 7000 full-text investment research reports on the telecommunications, cable, and broadcasting industries. The reports are authored by over 400 investment banks from around the world. In addition, the service offers daily news from more than 400 sources, including trade journals, business magazines, and newsletters.

"Our partnership with Investext brings top-quality telecommunications content together with top-notch Internet delivery," said Gary Mueller, president of ISI. "Now, customers can easily locate the specific, industry-related reports they need with immediate access and extensive searching and sorting capabilities."

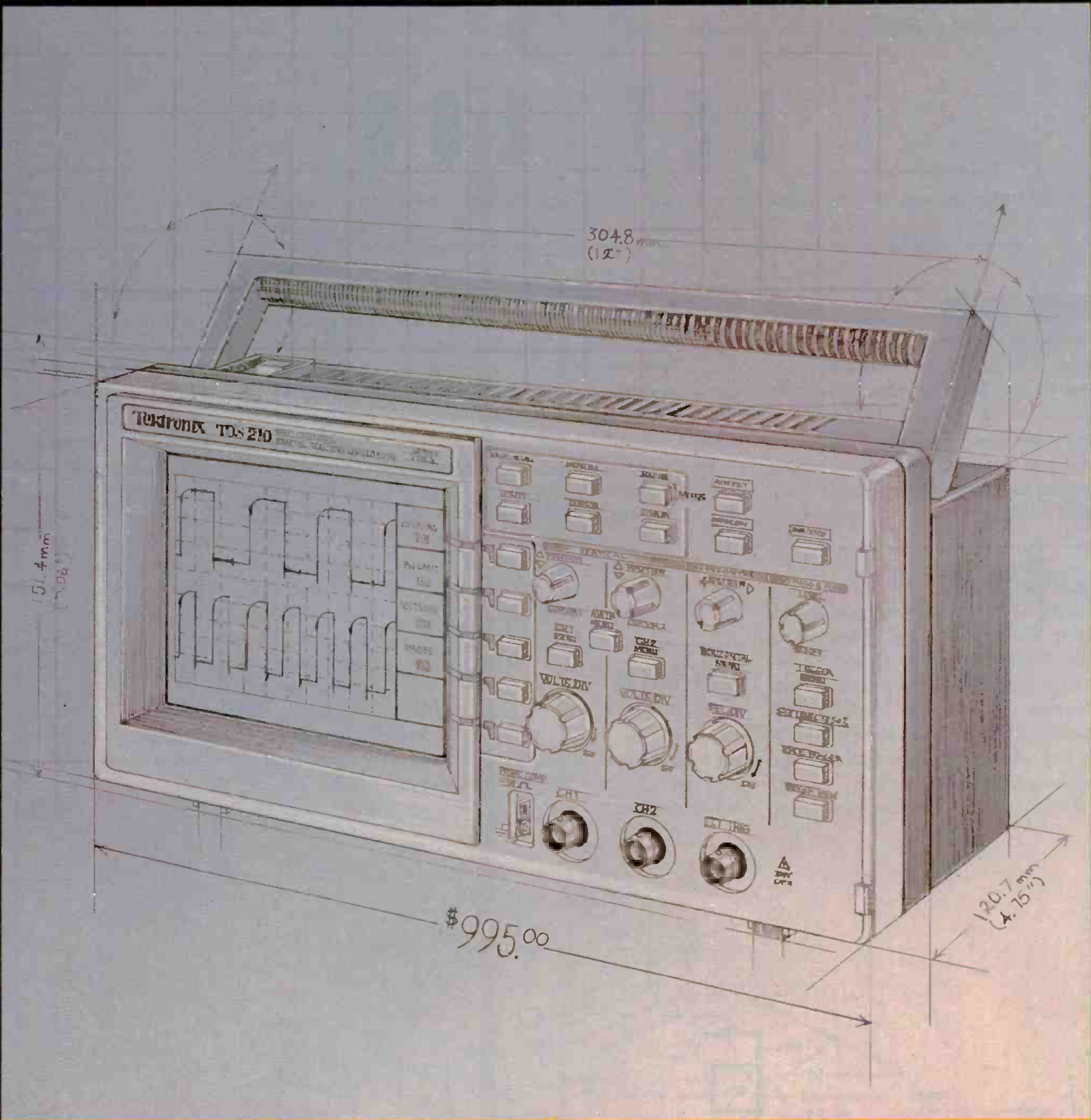
Telecom Strategies provides industry executives with important information needed to make decisions involving planning, competitive intelligence, global-marketing opportunities, and product development and forecasts. Subscribers to the service receive access to the entire collection of research reports and a continuous news feed of timely industry-related information. Users can log on and pinpoint the reports they need by searching by company name, geographic region, and other basic criteria such as product and business subject. A yearly subscription to Telecom Strategies costs $300. Subscribers can then purchase the investment research reports at a rate of $6 per page or $75 per report.

Temporary Home For Primestar Service

Satellite-TV provider Primestar (Bala Cynwyd, PA) has moved its service from its long-time home on GE Americom's K-1 satellite, which is nearing the end of its useful life, to a temporary home on K-2. The transition to K-2 was a planned step in the migration of the service to its permanent home on the more powerful GE-2 satellite a little later on this year.

"This transition was a success and, as expected, was transparent to our subscribers," said Joel Ginsparg, senior vice president of technology and operations for Primestar. "With this stage complete, we will now focus on the launch of the GE-2 satellite to begin the final stage of our significant service expansion."

GE-2's launch, scheduled for this past January, will pave the way for Primestar to introduce additional sports, movie, and basic programming networks this spring. The company intends to add more than 50 channels to its lineup, including CNNSI, BET, VH1, The History Channel, Court TV, the TV Food Network, and 16 more Digital Music Express channels. The move to the more powerful satellite will also allow Primestar to widely distribute a newly designed 27-inch dish. EN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LETTERS

SEND YOUR COMMENTS TO THE EDITORS OF ELECTRONICS NOW MAGAZINE

Jammed JamMix

It has come to our attention that there was an error in the Parts Placement diagram for the JamMix stereo mixer that appeared in the October, 1996 issue of **Electronics Now**. *The correct diagram is shown here in Fig. 1. We apologize for any inconvenience that this error might have caused.—Editor*

Required Reading

James E. Cicon's construction article, "Cable Reflection Tester" (**Electronics Now,** December 1996), should be required reading for technicians and hobbyists, or any one else involved with electronics. The article was well thought out and written in an easy-to-read and easy-to-understand manner.

Although the techniques it presented are familiar (or should be!) to amateur-radio enthusiasts, the average hobbyist might not realize all the implications shown here. Mr. Cicon did an excellent job in explaining propagation through cables without all of the "heavy" math—the oscilloscope tells all!

The article provides much food for thought: Somebody out there now should be able to design a set-up for fiber-optic cables—or how about a speed-of-light demonstrator?

SKIP CAMPISI
South Bound Brook, NJ

Keep Math In

Recently, I've spotted a disturbing trend. Reviews of electronics books and the sales blurbs on the backs of the books themselves have claimed that these books contain "a minimum of mathematics." Even so, one such book had an average of two equations or calculations per page!

What is not considered, however, is how clearly the necessary math is explained to the reader. I would rather have a "maximum" of mathematics, if it means that each step, substitution, and calculation is shown. Many authors are Ph.D.s, writing, it seems, for other Ph.D.s. For the mathematically challenged, showing variables, constants, and explaining specialized processes such as Fourier Transforms and calculus integrals and derivatives (even if that explanation is in an appendix or a side box) is essential.

Keeping mathematics to a minimum is not a virtue. Communicating clearly, to the skill level of the intended reader, is.

KURT FILLMORE
Petaluma, CA

EN

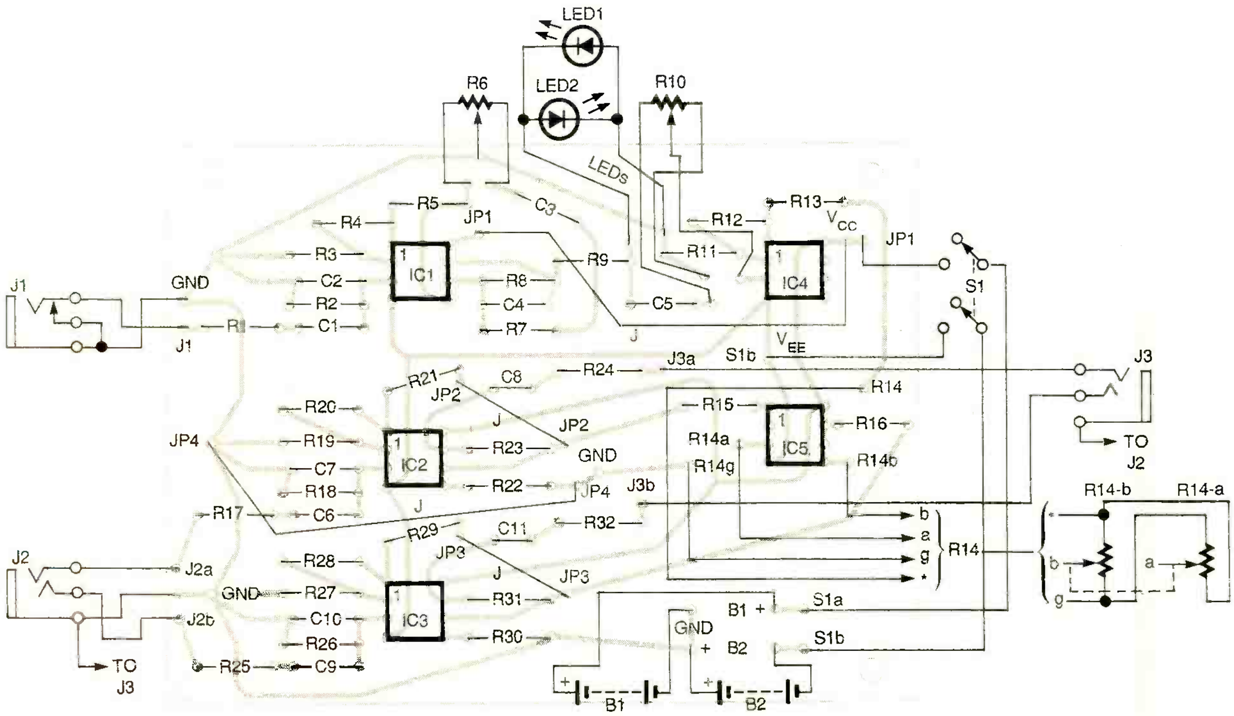

FIG. 1

Q & A

READERS' QUESTIONS, EDITORS' ANSWERS

Shortwave Converter

Q *Can you recommend an IC and a circuit that will divide an RF signal by 3, 10, 30, and 100, to feed shortwave signals into my car radio at broadcast-band frequencies?—E. L., Valhalla, NY*

A What you want to do is subtract, not divide. A frequency divider is a digital circuit that does not preserve AM or SSB modulation. Besides, if you divided the frequency by 10, signals that used to be 5 kHz apart would end up only 0.5 kHz apart and your radio wouldn't be able to separate them.

Frequencies can be added and subtracted by mixing the signals together in a nonlinear amplifier. That process is called heterodyning and is one of the basic principles of radio. Figure 1 shows how it works. If you mix a 9.5-MHz signal from the antenna with an 8.5-MHz signal from an oscillator, you'll get copies of the same signal at 1.0 and 18.0 MHz (9.5 – 8.5 and 9.5 + 8.5 MHz respectively). Your AM radio will tune in the 1.0-MHz signal (at 1000 kHz) and reject the 18-MHz one.

In fact, heterodyning is used within radios, too. Whenever you tune in an AM radio station, your radio heterodynes the signal down to 455 kHz before amplifying it. Only the input stage and the local oscillator are tunable; most of the amplifying stages work at 455 kHz regardless of what frequency the radio is tuned to. This system is called a superheterodyne receiver; all good radios since the 1930s have been built that way. Its advantage is that all those 455-kHz tuned circuits can be very accurate, since they never have to change frequency, and they can even use non-tunable components such as crystal filters.

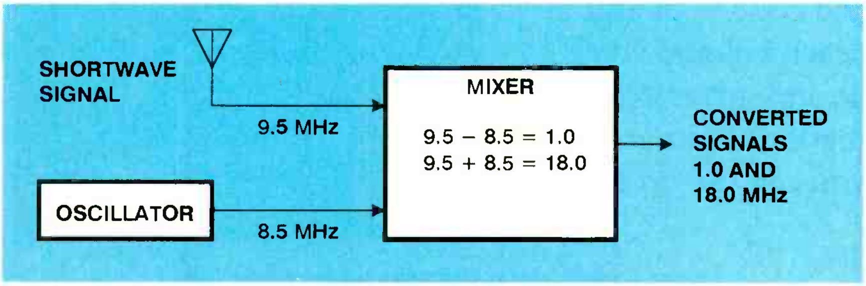

FIG. 1—A MIXER TAKES TWO signals and produces two more signals at the sum and difference of the original frequencies, preserving the modulation information.

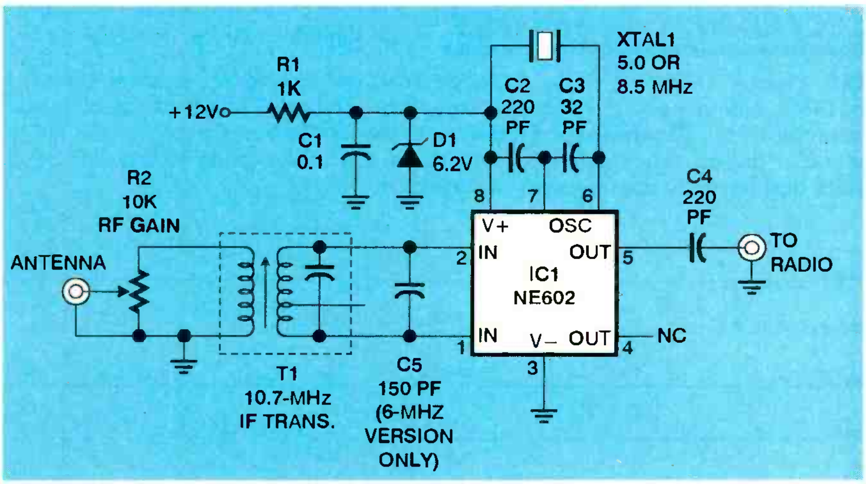

FIG. 2—THIS SIMPLE CIRCUIT, built around a NE602, allows you to receive either the 6- or 9.5-MHz shortwave band on your car radio.

Now back to your question. Fig. 2 shows a complete, working circuit for listening to the 6.0- or 9.5-MHz shortwave band on an AM car radio. The Philips NE602 IC contains an oscillator and mixer on one chip; all you add is an input transformer, a crystal for the oscillator, and a few coupling capacitors and power supply parts. The input transformer is a 10.7-MHz IF transformer of the type used in FM radios; it will tune down to 9.5 MHz without modification, or 6.0 MHz with a 150-pF capacitor added. Adjust it for best reception after assembling the circuit.

This construction project was published in our sister magazine, **Popular Electronics**, in October 1989, pages 42–44 and 99. A more sophisticated shortwave converter appeared in **Popular Electronics**, September 1995, pp. 41–46. We covered the NE602 mixer-oscillator in **Radio-Electronics**, April 1990, pp. 49–52.

Hewlett-Packard's First Product

Q *I have a Hewlett-Packard audio oscillator, model 201B. I know nothing about it or how it works or what it was used for. A manual would be helpful. If any of your readers can help, that would be very much appreciated also.—D. W., Manistee, MI*

A Your audio oscillator is a piece of electronic history—it is a slightly updated version of Hewlett-Packard's very first product. You may be able to get a manual from Hi Manuals, PO Box 802, Council Bluffs, IA 51502.

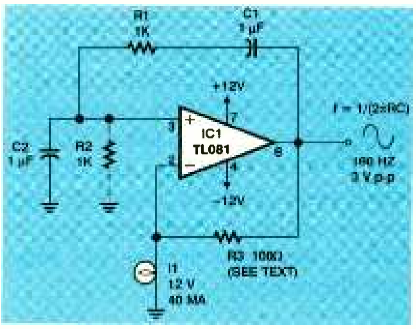

FIG. 3—HERE'S A MODERN VERSION of the classic Hewlett oscillator. It uses a light bulb as a stabilizing element. The original version used vacuum tubes.

The HP 201B is a source of low-distortion sinewaves for testing audio equipment. The design goes back to William R. Hewlett's master's thesis project at Stanford University in 1939. Hewlett discovered that he could use a light bulb as an intelligent variable resistor to control the level of feedback in an oscillator. That enabled him to get pure sinewaves over a wide range of frequencies, including frequencies too low to generate with LC tuned circuits.

Hewlett teamed up with David Packard to build their Model 200 audio oscillator in a garage; it was a popular test instrument and one of their first customers was a motion-picture experimenter named Walt Disney. From there, Hewlett-Packard branched out to build all sorts of test equipment, and variations of the 200 oscillator remained in their catalog until the 1980s.

Figure 3 shows a modern version of the Hewlett oscillator that you can experiment with. (The original, of course, used vacuum tubes.) The frequency of the oscillator is controlled by a Wien bridge (pronounced veen bridge) consisting of two resistors and two capacitors. If the resistors are a two-gang potentiometer, the frequency can be varied over a wide range. The 100-ohm feedback resistor is somewhat critical and you may have to change it slightly.

The light bulb regulates feedback because its resistance rises as it heats up. At first, the bulb is cold, its resistance is low, and the op-amp gets little negative feedback, resulting in high gain. As oscillation starts, the output signal level rises and the bulb heats up. Its resistance rises, negative feedback increases, and the gain is reduced to just the right level to sustain oscillation. In use, the bulb glows dimly or not at all. Because it can't change temperature significantly within a single cycle of the oscillation, the bulb does not disturb the waveform. Total harmonic distortion in this type of oscillator is well under 0.1%.

For more information on Wien bridge, see Ray Marston's article on oscillators, **Electronics Now**, December 1995, pp. 35-36 and 82-87.

Amp-Hour Clarification

Q *Your description of an "amp-hour" in the November 1996 installment of* "Q & A" *is somewhat misleading. Rather than simply multiplying the amps by the hours, the true amp-hour rating would be derived by attaching a resistive load to a battery for one hour. Manufacturers generally publish discharge curves for several different load currents.*

The "D" cell that you quoted may have been rated for 10 Ah, but you should have stated at what discharge rate that capacity was obtained. If it could actually deliver 10 amps for one hour, we would all be in electric cars by now!—R.A.K, Huntsville, AL

A We obviously left something out, and our ever sharp readers have been quick to set us straight (we received several other letters on this topic). In itself, the term "amp-hour" does not imply a one-hour discharge period. Amp-hours are a unit for current multiplied by time. But in our zeal to define "amp-hours," we forgot to explain that the amp-hour rating of a battery isn't really a fixed quantity. Batteries are not perfectly efficient reservoirs of energy. Generally, you get more energy out of a battery if you discharge it slowly.

For example, the 10-Ah rating for the D-cell that we quoted was based on a Panasonic spec sheet for a 100-ohm load (initial current 15 mA, dropping to less than 10 mA as the battery discharges). That battery certainly wouldn't deliver 10 amps for one hour; in fact, it might never deliver 10 amps at all due to internal resistance, and if it did, it would overheat. Delivering one amp, it wouldn't last 10 hours. Its capacity is 10 Ah only for sufficiently light loads; under heavier loads, the capacity is less.

PC Power Supply On Workbench

Q *I have some extra PC/XT power supplies that I would like to use for experiments. Is it safe to turn them on with no load? If not, what kind of external circuitry would I need to make it safe? —R. C., Elk Grove, CA*

A Many PC power supplies will refuse to operate with no load, but they run fine if you connect a 12-volt, 1-amp automotive bulb across the 5-volt output (the red and black wires at a disk-drive connector). The bulb will burn at half brightness and will give you an immediate visual indication if the voltage fluctuates. A few power supplies require more of a load than that; try two or three bulbs in parallel.

Old PC power supplies are excellent for powering experimental digital circuits. (They're a bit too noisy for audio or radio work.) The 65-watt supply of the original PC can supply +5V at 7 amps, –5V at 300 mA, +12V at 2 amps, and –12V at 250 mA. Newer PC power supplies can deliver three or four times as many amps. In fact, it's a good idea to put a fuse between the power supply and your circuit so that if something shorts, the power supply won't drive 20 amps through it!

Adding Frequency Display

Q *I would like to build, buy, or receive information on a frequency meter suitable for use on receivers such as the Eddystone 810 (shortwave) and the H. H. Scott 340 (FM). I've looked at modern Sony, Grundig, and Drake receivers, but the digits are too small and not bright enough for a 72-year-old with bad eyesight who scans the bands in the dark when he can't sleep.—P. W., Sterling, VA*

A As you note in your letter, simply connecting a frequency counter to the receiver's local oscillator won't do the job because it would read out the oscillator frequency rather than the frequency the radio is tuned to. For example, if the radio is tuned to 10.000 MHz and has a 455-kHz IF, the counter would read 10.445 MHz. For shortwave listening that may be acceptable, though awkward. Without a schematic of the receiver, we can't tell you where to connect the counter or whether alignment would be required afterward. If you want to pursue this, you can try connecting to a low-impedance point, such as the emitter of a transistor.

What you need is a frequency counter that automatically subtracts out the IF.

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On the Internet: See our Web site at http://www.gernsback.com for information and files relating to our magazines (Electronics Now and Popular Electronics) and links to other useful sites.

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

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

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

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

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

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

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

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

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

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

There used to be a one-chip solution to this problem (the General Instruments AY3-8112) but as far as we know, it's no longer available. We published a project built around this chip in our January 1978 issue, pp. 21-24 and 74.

The alternative is to build your own counter using a separate decade counter for each digit. To accomplish the subtraction, the counters don't start counting at 0; instead, they're preset to values that will make the count roll over to 0 after the appropriate number of cycles. All told, you're looking at a project with perhaps 20 ICs and a complicated circuit board. For plans see *QST*, January 1980, pp. 11-15.

Even then, your receiver wouldn't have digital stability, and that's why people are no longer building digital frequency displays for older receivers. Modern receivers use digital circuits to generate the local oscillator signal, not just to measure it, and as a result, the receiver is practically immune to drift.

Your money and effort would probably be better spent on a newer receiver; even $150 will nowadays buy a good one. If the digits are too small to read, you can mount a magnifying lens in front of them and perhaps add some extra illumination.

6 Volts, 1 Amp

Q *Where can I get a 6-volt, 1-amp power supply for less than $60. I want it for powering some miniature fluorescent lamps?—S. W., Wichita, KS*

A Check the catalogs of MCM Electronics (650 Congress Park Drive, Centerville, OH 45459) and Parts Express (340 East First St., Dayton, OH 45402). Or order a Stancor STA-4860 wall transformer from Newark Electronics (1-800-298-3133) or any Stancor distributor. The power supply will cost about $20, but those firms' usual minimum order is $25, so look at the catalogs first and see if there's anything else you need.

Amplify It All?

Q *The op-amp antenna amplifier in the September, 1995, "Q&A" jump started my brain into action. I am interested in making a similar distribution amplifier, but with a wider bandwidth (0.5 to 2000 MHz) for use with scanners. Would a monolithic amplifier such as the Mini-Circuits MAR-6 work for my application?—H. A., Colonial Beach, VA*

A Well . . . 0.5 to 2000 MHz is an enormous bandwidth. The problem you'll run into is that somewhere in that range of frequencies, there will be a very strong signal near your location, probably a radio or TV broadcaster, which will overload the amplifier. A nearby broadcast station can put 1 volt of RF into your antenna; the weakest signals you want to hear are probably about 1 microvolt. Even the best amplifier isn't going to handle a million-to-one voltage range.

A much better plan is to use antennas that are tuned to specific bands to avoid overloading from strong out-of-band signals. You can use scanner antennas with a standard TV distribution amplifier, which probably has a MAR-6 or a similar device as its heart.

Our op-amp antenna amplifier worked well because its needed bandwidth was relatively modest (0.5 to 2 MHz) and the signals we wanted to hear were the strongest signals in the band (AM broadcast signals).

Kits With Tubes

Q *I am writing to you to request information on kits that use vacuum tubes or books that contain projects using tubes. When I was in senior high (1973) we assembled and tuned 5-tube AC/DC radio kits. Does anyone still make these kits? Are there any catalogs that specialize in tube kits and supplies?—W. D. B., Minneapolis, MN*

A Today, tubes are used only for a few special purposes, and most tube circuitry is only of historical interest. One company you should certainly get in touch with is Antique Radio Supply, 6221 S. Maple Ave., Tempe, AZ 85283 (phone 602 820-5411). They sell tubes at reasonable prices, along with tube-circuit components, books, and kits (including a 7-tube superhet radio kit). Also, look for older electronics books in libraries and used book stores in your area. An especially useful book on tube theory is Malmstadt, Enke, and Toren's *Electronics for Scientists*; it includes detailed instructions for experimenting with tube circuitry.

Writing to Q&A

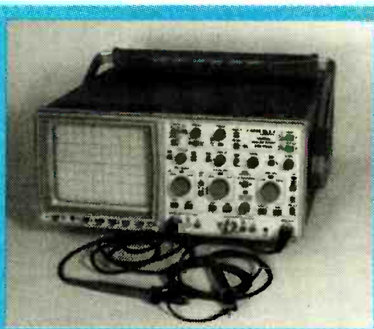
As always, we welcome your questions. The most interesting ones are answered in print, usually within nine months. Please be sure to include plenty of background information (we'll shorten your letter for publication). If you are asking about a circuit, please include a complete diagram. Address your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

EQUIPMENT REPORTS

Hameg Instruments HM1505 150-MHz Oscilloscope

Here's a multi-featured analog oscilloscope that can either stand alone or be controlled and programmed by a PC.

CIRCLE 15 ON FREE INFORMATION CARD



A basic analog oscilloscope is a must for any test bench. But if your needs are more than modest, a new oscilloscope from Hameg (Hameg Instruments, 1939 Avenida Plaza Real, Oceanside, CA 92056) should get serious consideration. What sets that scope, the microprocessor-controlled Hameg HM1505, apart from the run-of-the-mill units is that it can be used in conjunction with, and controlled by, your personal computer.

Features

The HM1505 features are so numerous that space prevents us from touching on more than a few of the more significant ones. For example, for ease of operation an "auto set" feature allows for signal-related automatic setup of measuring parameters. On-screen alphanumeric readout and cursor functions for voltage, time, and frequency measurement provide extraordinary operational convenience. Nine different user-defined instrument settings can be saved and recalled without restriction.

The HM1505 offers two vertical input channels and a second time base with the ability to magnify extremely small portions of the input signal over 1000 times. The second time base has its own triggering controls, including level and slope selection, to allow a stable and precisely referenced display of asynchronous or jittery signal segments. The trigger circuit is designed to provide reliable triggering to over 250 MHz at signal levels as low as 0.5 graticule divisions. An active TV-sync separator for TV-signal tracing ensures accurate triggering with noisy signals. Signals are solid and distortion-free even at the upper frequency limit. The built-in Y delay-line allows for leading-edge display of even low repetition-rate signals.

Because it is so important to be able to trust the accuracy of the CRT display when viewing pulse or squarewave signals, the HM1505 has a built-in switchable calibrator, which checks the instrument's transient response characteristics from probe tip to CRT screen. The essential high-frequency compensation of wide-band probes can be performed with that calibrator, which features a rise time of less than four nanoseconds. A front-panel-accessible trace-rotation control helps make sure that the trace is perfectly aligned.

Serial Interface

The HM1505 is supplied with a RS232 serial interface to allow it to be used in conjunction with a personal computer. The RS232 parameters are: N-8-2 (no parity bit, 8 data bits, 2 stop bits, (XON/XOFF protocol). After powering up of the oscilloscope and the first command "SPACE" is sent from the PC, the baud rate is recognized and set automatically between 110 baud and 19,200 baud. The oscilloscope is then switched over to the remote-control mode and the HM1505 transmits the "return code" to the PC. In that remote-control mode, almost all oscilloscope settings can be controlled via the PC interface.

Commands typed into the PC are numerous, but all of them are listed and described in the manual. Programming itself is left to the user, but a supplied diskette contains example programs to get you started.

Ergonomics

In addition to its outstanding electronics features, the HM1505 has been designed for ease-of-use and operator safety. The controls are laid out in a practical arrangement, making it easy to become quickly familiar with their locations and operation. The adjustable, locking tilt handle allows three convenient viewing angles—0, 10, and 20 degrees. The instrument fully complies with IEC publication 1010-1, Safety Requirements for Electrical Equipment for Measurement, Control, and Laboratory Use. The unit's switching-mode power supply offers both over-voltage and overload protection, and is designed to keep power usage to a minimum. All fuses are externally accessible. The unit carries a two-year warranty.

The Manual

The manual that comes with the HM1505 is a notch above manuals for other similar oscilloscopes. The instructions are complete with accompanying drawings. To get your oscilloscope up and running in as little time as possible, the provided "short instructions" section would be hard to beat. It starts with power-up direction and then walks you through the "bells and whistles" as you work the controls on the front panel of the scope.

Made in Germany, the HM1505 sells for $1480.00. A less expensive model, the HM1004, which operates up to 100 MHz, is also available. For more information on either scope, contact Hameg directly at the address given earlier in this article or circle 15 on the Free Information Card. EN

Budget Project and Computer Books

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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Handheld Digital Multimeters

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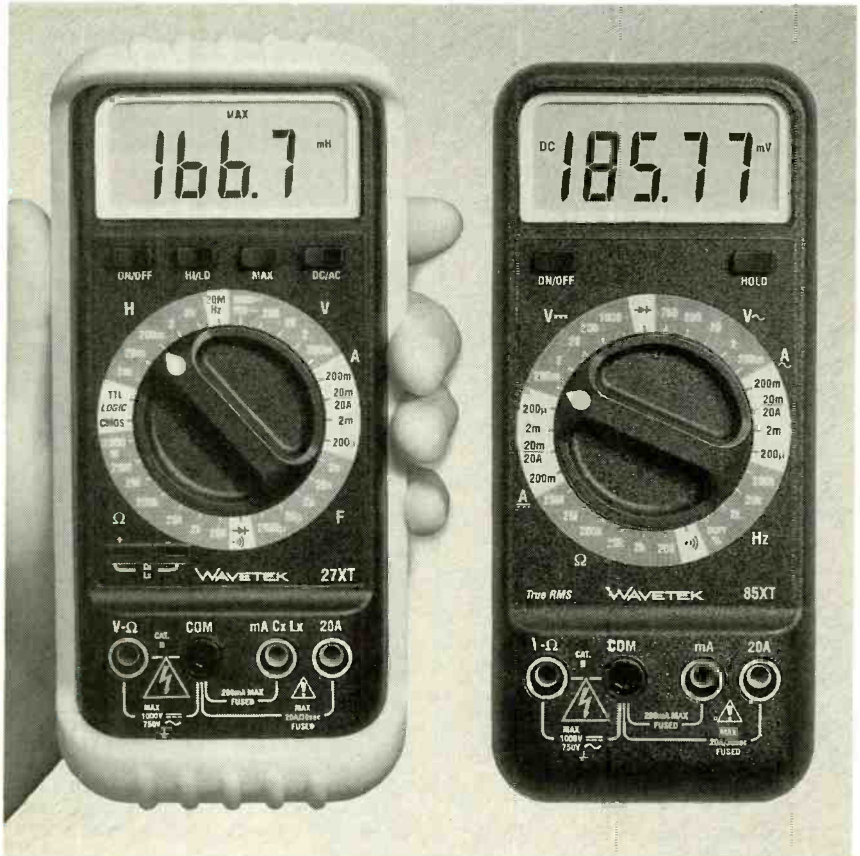

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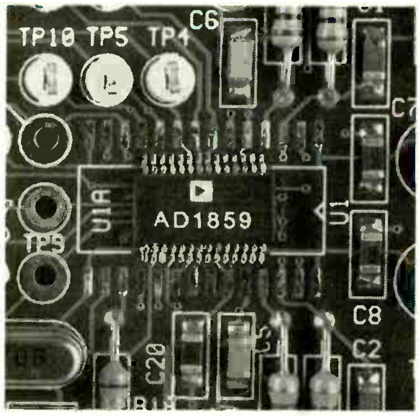
multimeters and one LCR component tester. Each XT model is optimized with a unique combination of measuring features. Component-checking functions such as capacitance, inductance, frequency, and temperature are combined with standard DMM measurements. Additional features include easy-to-read oversized characters, auto-off, wide measuring ranges, fully-fused current inputs, and input warning beepers. The meters are intended for applications in electronic testing, electrical troubleshooting, and HVAC/R.

Prices for the XT Series range from $89.95 to $179.95.

WAVETEK CORPORATION
9045 Balboa Avenue
San Diego, CA 92123
Tel: 619-279-2200
Fax: 619-565-9558

Single-Chip Digital Stereo Subsystem

According to Analog Devices, its AD1859 is the industry's most functionally complete 16/18-bit stereo digital audio playback subsystem on a single



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chip. It comprises a variable-rate digital interpolation filter, an innovative multi-bit sigma-delta modulator with dither, a jitter-tolerant digital-to-analog converter (DAC), switched-capacitor and continuous-time analog filters, and analog output drive circuitry—all in a 28-lead surface-mount package. Other on-chip features include a stereo attenuator and mute, programmed entirely through an SPI-compatible serial control port.

A flexible serial data input port allows for glueless interconnection to a variety of ADCs, DSPs, AES/EBU receivers, and sample rate converters. The port can be configured for left-justified, right-justified, and DSP serial port compatible modes. The AD1859 accepts 16- or 18-bit audio data in MSB-first, twos-complement format. A power-down mode minimizes power consumption when the device is inactive. The entire stereo digital audio playback system operates from a single +5-volt power supply over the temperature range 0° to +70°C and is packaged in a 28-pin SOIC and SSOP.

Prices for the AD1859 start at $4.90 each in quantities of 1000.

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

Audio-Level Controller Speaker

C & S Electronics' ALC247 extension speaker/amplifier is design-ed for amateur radio, commercial radio, SWL, scanner, CB, PA, and TV applications when a constant audio level is desirable for comfort and safety. Its built-in audio-level controller provides a nearly constant output level whether the input level is a volume or a scream. A three-band equalizer is provided to further reduce unwanted noise and tailor the audio to meet individual requirements. The large signals

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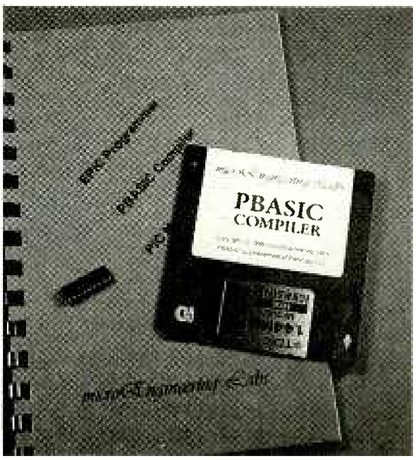
are attenuated and the low levels are amplified, while the ambient and noise are reduced.

The ALC247 costs $49.95.

C & S ELECTRONICS
P. O. Box 2142
Norwalk, CT 06852-2142
Phone: 203-866-3208
Fax: 203-854-5036

PBASIC Compiler

The PBASIC Compiler from micro-Engineering Labs takes programs written for the BASIC Stamp and converts them into PIC-compatible hex or binary files. Those files can be programmed directly into a PIC microcontroller, eliminating the need for a BASIC Stamp module. The easy-to-use BASIC language, with its English-like instruction set, makes PIC programming available to all levels of users. Along with hex or binary file output, the PBASIC Compiler generates an intermediate assembler file, which can be edited and reassembled to allow additional operations or access to other PIC registers.



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When compared to BASIC interpreters, the PBASIC Compiler offers faster program execution and the potential for longer programs. It offers substantial price savings over a BASIC Stamp. Intended primarily for use with the electrically erasable PIC16C84, other PICs with more memory or larger pin counts can be substituted. Using other PICs allows for lower cost, longer programs, and access to more I/O or RAM through the use of additional assembler programming.

The PBASIC Compiler, which accepts the BASIC Stamp I instruction set and works with most PIC programmers, is available for a special introductory price of $99.95.

microENGINEERING LABS
Box 7532
Colorado Springs, CO 80933
Phone: 719-520-5323
Fax: 719-520-1867

Automatic Scanner Recorder

The Nightlogger II from Benjamin Michael Industries (BMI) provides an interface between a scanner radio (or

CIRCLE 24 ON FREE INFORMATION CARD

other 8-ohm source) and a tape recorder for automatic recording. When audio is present at its input, the Nightlogger II will start the recorder. When audio is no longer detected, the unit will deactivate the recorder and wait until the channel is active once again. Proper audio matching is provided to ensure clean, crisp recordings.

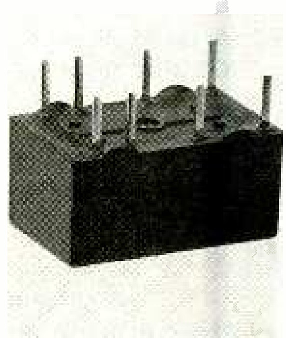
The Nightlogger II features a speaker so that you can hear what is happening on the channel as it is being recorded. A volume control is also included. The volume can be muted for silent recording, if desired. Other features include "audio present" and "record" indicators, a control to adjust the drop-out delay time, and a bypass switch that returns the control of the recorder to you without disconnecting any cables.

The Nightlogger II, complete with all necessary cables and a wall-charger-type power supply, has a suggested retail price of $69.95.

BENJAMIN MICHAEL INDUSTRIES, INC.
P. O. Box 91
Caledonia, WI 53108
Phone: 414-835-4299
Fax: 414-835-4298

Test And Measurement Relays

NTE Electronics' R72 Series of subminiature 1-amp relays is specifically designed for use as replacement parts in office-automation and test and measurement instruments. The series features high sensitivity, low power consumption, and fully sealed construction. With a DPDT contact arrangement, the series is also available in a dual-coil latching type. R72 relays offer coil voltages of 5, 6, 12, and 24 volts DC.



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The R72 Series is DC operational at a temperature range of 40C to +70C. The dielectric strength is 1000 VAC

continued on page 22

NEW PRODUCTS

continued from page 20

between coil and contacts, 250 VAC (latching) between set and reset coils, 750-volts AC between contacts of the same polarity, and 1000-volts AC between contacts of different polarity. Maximum resistance is 50 megohms.

The R72 Series relays are priced under $3 each in 1000-piece quantities.

NTE ELECTRONICS, INC.
44 Farrand Street
Bloomfield, NJ 07003
Tel: 1-800-631-1250
Fax: 201-748-6224

DSS Surge Protector

Thomson's Model D918 Surge Protector Plus is specifically designed to protect equipment that is connected simultaneously to phone lines, coaxial cable, and electrical cords—for instance, Thomson's Digital Satellite System (DSS)—from potentially damaging power surges. The device is backed by a $10,000 limited lifetime equipment guarantee. If it fails to protect any equipment that is properly connected to the Surge Protector Plus, the damaged equipment (up to $10,000 worth) will be repaired or replaced.

The surge protector accommodates up to eight products, including satellite receivers, TVs, VCRs, stereos, fax machines, and modems. Its master power control powers up all eight outlets at once. When dangerous heat levels caused by surges and/or sustained overvoltages are detected, a heat-sensitive fuse takes the surge suppressor and all connected equipment off-line.

The device also features 24-karat gold-plated connectors, extra shielding to block electronic interference, a six-foot power cord, a six-foot phone cord, and two six-foot coaxial RG6 cables. "Safe operation" indicators let users know if the surge protector is working properly and if the outlet is wired and grounded correctly.

The Surge Protector Plus has a suggested retail price of $69.95.

THOMSON CONSUMER ELECTRONICS
2000 Clements Bridge Road
Deptford, NJ 08096

CIRCLE 26 ON FREE INFORMATION CARD

Tape Motion Meter

Accurate Sound Corporation's Model TMM-100 is a test instrument that measures the speed and length of moving tape, film, or other material. The microprocessor-based tape-motion meter accurately displays speeds from 15/32 to 400 inches-per-second, and simultaneously displays lengths up to 100,000 feet on its digital readout. Media widths from 0.150- up to 1.0-inch can be measured.

Speed resolution is four digits, and length resolution is in tenths of feet. Power is supplied by an internal 9-volt battery with a power-saving circuit that shuts down if no motion is detected for three minutes. An optional AC adapter is available.

The Model TMM-100 tape motion meter has a suggested list price of $995.

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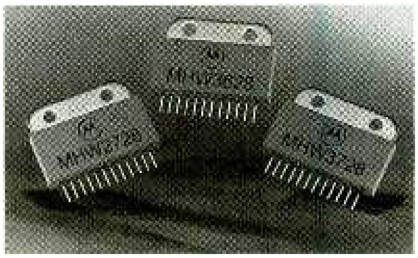
ACCURATE SOUND CORPORATION
3475A Edison Way
Menlo Park, CA 94025
Tel: 415-365-2843
Fax: 415-365-3057

RF Amplifiers

Motorola has added three triple video drivers to its CRT hybrid amplifier line. The MHW2728, MHW3628, and MHW3728 triple video drivers were designed for CRT driver applications requiring high-frequency response and high voltage, and specifically for use as the video channel final stage in high-resolution color monitors.



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The new devices have an output swing capability of up to 70 volts peak-to-peak and a typical rise and fall time of 3.0 nanoseconds or less. The hybrid amplifiers will support video clock rates up to 220 MHz. Other features include unconditional stability, excellent gray-scale linearity, and low power consumption. Pixel frequencies are 190 MHz for the MHW2728, and 220 MHz for both of the other amplifiers. Typical 10% to 90% transition times vary with the device, ranging from 2.7 to 3.0 nS.

The MHW2728, MHW3728, and MHW3628 amplifiers are all priced at $14.50 each in low-volume quantities.

MOTOROLA INC., E 114
5005 East McDowell Road
Phoenix, AZ 85008
Tel: 602-244-3910
Fax: 602-244-5898

EN

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In less time than you think, you'll learn this all-purpose easy to use computer language — and create a variety of practical programs! You get a complete training package along with the know-how to handle personal and business needs. You'll also grasp the essentials of computer operations and applications as you prepare for advanced training.

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Here's how to get the object-oriented skills you need, quickly, easily, without wasting time on elemental PC operations or theory. You launch right in, so you can add Visual Basic programming expertise to your resume in as little as 3 months!

Included with this ICS home-study training program is the latest professional edition of Visual Basic™, version 4.0 — yours to keep! This state-of-the-art Microsoft® development software lets you create applications for Windows® 95, Windows® NT and Windows® 3.1. You'll program client/server solutions with 16-bit and advanced 32-bit support...even design reusable OLE and OLE-based DLL components.

Seeking advanced preparation? Learn Microsoft® Visual C++™

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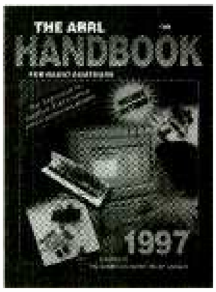

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It's here—the 74th edition of the book for radio enthusiasts! Starting with DC and heading into the microwave, the book's 1200 pages are filled with clear explanations and practical projects to build. Several generations of hams have kept their copies of this book readily available for quick reference. Whether you're a new ham, an experienced engineer or technician, or a student, you'll want to do the same with your copy.

The 1997 edition features several new projects, with an emphasis on those that can be built in an evening or two. Some of the highlights are a modern switched-capacitor filter that uses one of the newest inexpensive chips; a new digital frequency-counter; and, for those using vacuum-tube gear, a T/R switch built around a keyer chip. The one-evening projects—an inductance-measuring front end for your digital voltmeter and a companion capacitance-measuring front end—will increase your test capability. In addition, the reference chapter has been updated to include the latest contact information for ham-radio suppliers.

The companion disk includes a new standard-value-capacitor filter design program and an update of the popular Transmission Line (TL) program. For VHF/UHF operators, a grid-square program has been added. The disk also contains a database of *QST* Product Reviews.

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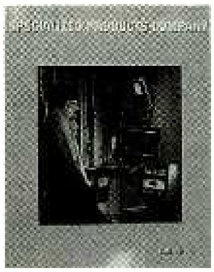
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This 369-page catalog is chock-full of useful gear for electronics professionals and hobbyists alike. It offers a wide selection of tool kits and cases, instrument and shipping cases, tool chests, vacuums, two-way radios, PC diagnostic tools, breakout boxes, power tools, test accessories, connector tools and equipment, soldering and desoldering gear, precision hand tools, specialty chemicals, static-control products, breadboards, workbenches, technical books, and training videos. Test equipment from popular manufacturers includes digital multimeters, data communications and telecommunications testers, temperature-measuring equipment, oscilloscopes, photometers, power-analysis equipment, function generators, memory testers, and logic test equipment. Product descriptions are accompanied by full-color photographs, specifications, and prices.

Learn 3D Design on the Macintosh

by Michelle Szabo
John Wiley & Sons, Inc.
605 Third Avenue
New York, NY 10158-0012
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Web site: http://www.wiley.com
$34.95, including CD-ROM


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Armed with today's 3D technology—and the know-how to use it—designers can create an astonishing variety of alternate realities. This book provides that know-how for designers who are already familiar with the Macintosh and with programs such as Adobe Illustrator and Photoshop. The accompanying CD-ROM features the Infini-D 3D graphics package.

The book covers everything about 3D design on the Macintosh, beginning with basic theory and progressing to advanced design techniques. It combines step-by-step instruction with all the software tools needed to create 3D illustrations and animations. The book also presents methods for managing the entire 3D design process.

The CD-ROM contains a sample version of the Infini-D software, and additional demo software from Spectacular International and Meta Tools. Also featured are examples of 3D illustrations and animations and an extensive library of sample 3D textures and models.

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3M's 30-page product selection guide for 0.001-inch connectors presents the four primary types of board stacking systems: between board, out board, thru board socket, and mix stacking systems. The systems are intended to help electronic hardware designers to manage increased demand for add-on boards by reducing customization time, as well as the number of interconnects and cable connections required for smaller board footprints.

The brochure includes photographs, specifications, and ordering information on 3M's complete line of Board Stacking Solutions. Easy-to-read tables allow engineers to match the appropriate header and socket based on board spacing requirements.

Instrumentation Reference and Catalog 1997

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This 696-page catalog describes National Instruments' more than 500 software and hardware products, which are intended for use by engineers and scientists in the development of integrated, PC-based instrumentation systems for test and measurement and industrial automation. New product highlights include object-oriented Lookout MMI/SCADA software, BridgeVIEW industrial-automation software, a new line of VXI-DAQ instrument modules, new IMAQ Vision (machine vision) software, and the company's first image-acquisition board.

The catalog is divided into six sections—Software, Data Acquisition, GPIB, VXI/MXI, Industrial Communications, and Customer Education. The first section introduces the concept of virtual instrumentation and helps users choose the components best suited to their individual applications. The five product sections feature comprehensive tutorials, complete with application examples, to help readers learn more about using plug-in data-acquisition (DAQ) systems, signal conditioning, IEEE 488.2, VXI and MXI instrumentation, serial instrumentation, and more.

The Unix Companion

by Harley Hahn
Osborne/McGraw-Hill
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Fax: 614-759-3644
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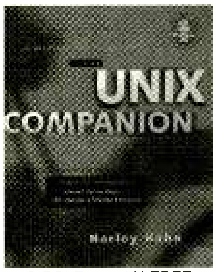

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Whether you need to use Unix for your work or school, to send e-mail, to use the Internet, or just to have fun, this book will help you become proficient. The book takes you from the fundamentals to a fuller, more enjoyable understanding of one of the most powerful and widely used operating systems in the world.

Written in a clear, concise style, the book reveals everything you need to know to feel comfortable using Unix in your day-to-day work. It helps you get started quickly, and includes special considerations for the X Window user. The book explains how to access the online Unix manual, use built-in Unix programs such as the calculator and games, use the C-shell and the Korn shell; and use the Unix toolboxfilters and redirection. It covers talking with other people online, sending and receiving mail with pine and elm, displaying and printing files, and editing with vi and emacs. The book also discusses the Unix file system and job control.

Digital Money: The New Era of Internet Commerce

by Daniel C. Lynch and Leslie Lundquist
John Wiley & Sons, Inc.
605 Third Avenue
New York, NY 10158-0012
Tel: 1-800-225-5945
Web site: http://www/wiley.com
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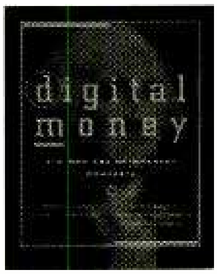
This is the book to read before you invest your money in commerce on the Internet. It provides an inside look at the emerging world of Internet commerce that will help you make informed decisions.

The book explains the processes, issues, and strategic considerations of options that are available now, or soon will be. It discusses the various ways in



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which your business can profit from developing Internet transaction capabilities. It also answers an array of practical questions, such as how much it will cost to set up and maintain a digital exchange system, what types of technologies and resources will be needed to support it, and which methods are most appropriate for your type of business.

The book covers the essential principles of exchanging digital money and goods. It examines the technical basics of a secure digital transaction, including encryption and digital signatures, and describes current and emerging forms of digital financial transactions, including direct sales, online investing and banking, and the exchange of commodities. It offers critical reviews of proposed protocols and standards now vying for predominance, including Netscape, DigiCash, First Virtual Holdings, and CyberCash. (Co-author Daniel Lynch is a founder and the chairman of CyberCash.) Finally, the book describes creative ways for using digital money to open new markets and sales opportunities.

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MCM stocks more than 30,000 items used in the maintenance and repair of consumer-electronic goods. In this 179-page catalog, the emphasis is on new products, with over 6000 new items represented.

The new additions include project accessories, semiconductors, connectors, test equipment, computer products, audio gear, and hundreds of original OEM and generic TV/VCR repair parts. Also introduced in Catalog Number 38 are several new sections: Computer Software, Data Communications, Gaming and Amusement, Office Supplies, Printer Parts, and Safety. Franchised lines appearing for the first time in this catalog include Lexmark, ECG/Philips, Sovtek, and Panduit.

Signal and Power Integrity in Digital Systems: TTL, CMOS & BiCMOS

by James E. Buchanan
McGraw-Hill, Inc.
11 West 19th Street
New York, NY 10011
Tel: 1-800-822-8158
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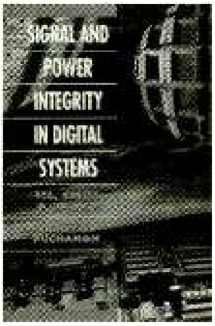

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This practical guide shows designers how to ensure signal integrity and control noise in high-speed digital systems—particularly important in a Pentium-based environment where functional logic design can no longer be separated from electrical and mechanical design. It is aimed at engineers involved in the design of computers, peripherals, signal processors, and control and communications equipment, as well as young engineers facing their first designs using high-speed logic devices.

With an emphasis on TTL, CMOS, and BiCMOS logic applications in a single source, the book provides a solutions-oriented approach to a wide variety of relevant interconnection and timing issues. It offers in-depth discussions of noise-tolerant logic architecture; power distribution techniques that reduce noise; clock distribution techniques that ensure clock-signal quality; and signal interconnection techniques that reduce crosstalk, signal loading, and transmission-line effects. It also explains how to get optimum performance from high-speed memory devices, and delivers system application tips for high-speed PALs, PLAs, FIFOs, and ASICs. Designers will appreciate the practical engineering approximations provided for the calculation of design parameters, as well as the numerous illustrations and tables that can be used for quick reference and to compare characteristics.

Core Java

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This book helps experienced programmers get quickly and easily to the heart of Java. It opens with a brief look at the fundamentals and then moves right on to the most advanced topics. The book provides comprehensive coverage of all Java features and offers a wealth of tips and tricks. It offers Visual Basic and C/C++ notes that compare and contrast features of Java to those languages. Among the many topics covered in depth are classes, inheritance, graphics programming and interface design with AWT, exception handling, debugging, data structures, and networking.

The book introduces the new Java development environments for both Solaris and Windows 95. It presents detailed coverage of Java's AWT system for graphics programming and interface design. Then it walks the reader through the construction and debugging of several real-world Java programs.

Web Publishing with Adobe Acrobat and PDF

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John Wiley & Sons, Inc.
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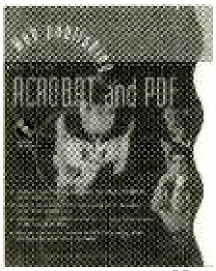
The World Wide Web has made it possible for individuals and businesses of all sizes to establish their own places in cyberspace. Adobe's Acrobat software and PDF (portable document format) electronic-publishing format gives them the tools needed to create high-quality electronic documents—and this book provides the know-how.



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The book covers topics ranging from why publishers would want to get on the Web to securing commercial PDF files from unauthorized access. It teaches readers how to prepare information for multimedia publishing using PDF and the Web, and how to create PDF documents with both Acrobat and traditional desktop-publishing tools. It explains how to configure a Web server to manage interwoven PDF and HTML documents and indexed sets of PDF files. Readers learn how to publish PDF documents on CD-ROMs and on networks, as well as on the Web.

Designing Large-Scale Web Sites: A Visual Design Methodology

by Darrell Sano
John Wiley & Sons, Inc.
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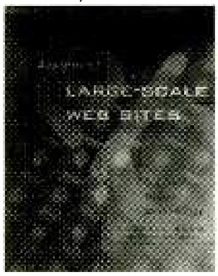

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Designing a large-scale Web site—which must handle complex human interactions, yet remain attractive, appealing, and usable—is no easy task. This book, written by Netscape's own Web-site designer, explores all the unique difficulties faced by professional Web-site developers when planning and building a large-scale site. Readers are guided through the author's proven methods for creating sophisticated Web sites for business, education, and entertainment interests.

The book explains how to apply user-interface design, graphic design, and engineering strategies when designing large-scale Web sites. It explores critical site-development issues, such as organizing content, supporting multiple user tasks, and advanced layout design—

including Netscape 2.0 Frameset documents. Dozens of examples of effective Web-site design, along with eight pages of full-color screen shots, illustrate the concepts presented in the book..

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This 104-page catalog provides electronics professionals with a one-stop shopping source for original-equipment replacement parts, test equipment, wire, chemicals, and tools. Aimed at broadcast, industrial, and consumer service dealers, the catalog presents wide selections of semiconductors, capacitors, and resistors; replacement idlers, pinch rollers, and belts; video heads and an extensive TCE video-head cross reference; video service aids; technician aids; rebuilt picture tubes; flyback transformers and triplers; connectors; indoor and outdoor antennas; DSS replacement parts and accessories; batteries; computer accessories; and microwave replacement parts.

Silver-Zinc Battery: Best Practices, Facts and Reflections

by Albert Himy
Vantage Press
516 West 34th Street
New York, NY 10001
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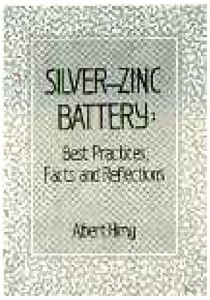
The silver-zinc battery has the highest gravimetric energy density and the highest volumetric energy density of all rechargeable batteries in widespread use today. Primarily used in military applications, the silver-zinc system currently lacks adequate research funding.



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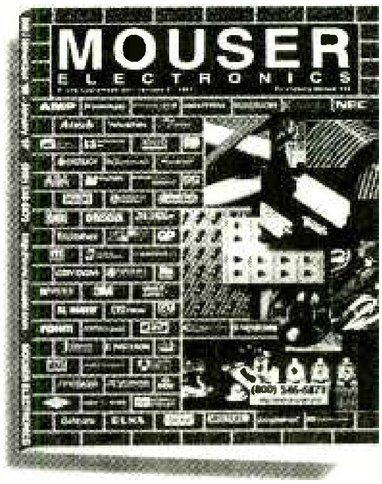
This detailed technical study is aimed at engineers and scientists working in this area. It offers a definitive review of various battery designs, components, and manufacturing processes, and an evaluation both in terms of functioning and quality control. The author, a recognized battery expert with 30 years in the field, also offers his own independent theories to explain the data. EN



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BUILD The GUARDIAN

Worried that your car might not be there when you return? Let the Guardian alert you to a break-in without alerting the thief.

ANTHONY J. CARISTI

You have invested a lot of your hard-earned money into your auto, van, or truck. Understandably, you'd like to protect it as much as you can while it is parked out of sight near your home or where you work. Some type of alarm system would certainly help in that respect. Most alarms with a siren don't bother thieves—they are so prevalent nowadays that a screeching alarm is ignored by almost everyone.

But if a vehicle is equipped with a silent alarm, thieves will take their time, giving the owner time to contact the local police. The Guardian alarm project presented here is just such a system, using state-of-the-art wireless technology. It is especially valuable to those who have recently purchased a new vehicle.

The Guardian consists of two parts: a transmitter and a receiver. The transmitter is a digitally-encoded UHF unit that is completely automatic in operation and permanently installed in the vehicle. Connected only to the 12-volt battery line, its current draw is just 2 milliamps, so it can never run down the battery. The receiver, battery-operated for portability, might be carried around wherever you go like a small pager, or placed at a convenient location and powered by a common wall-mounted transformer. The RF section of the receiver consists of a highly-sensitive, one-chip superheterodyne circuit that has been designed for easy construction using a small printed-circuit board. A second board contains the decoder and audio section, and the entire assembly fits neatly into a small enclosure.

Once installed in a vehicle, the Guardian is on duty at all times with no attention to it ever required. When a door on the vehicle is opened, the Guardian senses the current flow to the vehicle's interior light, and automatically transmits a digitally-encoded UHF pulse train. That causes the receiver to respond with an attention-getting audible signal, so that corrective action may be taken before a would-be thief can steal the vehicle or its contents.

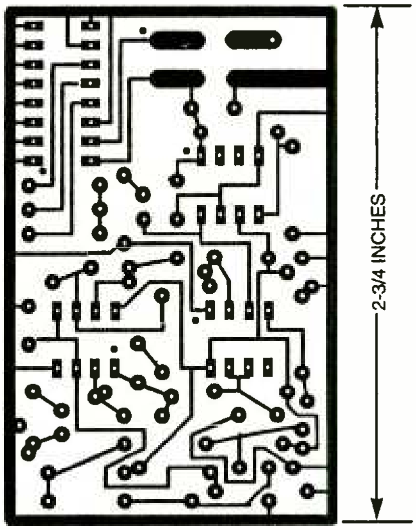
Although the Guardian operates at 433.92 MHz, it is easily built and no complicated RF-alignment procedures are required. The entire RF circuitry of the transmitter is contained on a hybrid module that is smaller than a postage stamp. That module has been designed to meet all requirements of Part 15 of the FCC Rules and Regulations that govern the use of unlicensed transmitters.

Digital Encoding And Decoding System. A wireless-security system is useful only when the radio-frequency carrier is modulated by an encoded signal that is decoded at the receiver. That avoids spurious operation or false alarms due to interference or an unauthorized RF signal. The Guardian uses a sophisticated digital encoding/decoding scheme by using a pair of chips developed by Motorola. The transmitter contains the encoder, and the receiver contains the decoder. The two chips are specifically designed for wireless-signaling applications.

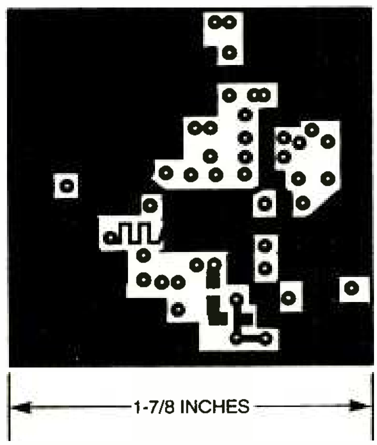
The encoder chip, an MC145026P, encodes nine digital bits of information that are programmed by means of hard-wiring to the input terminals of the chip. Each bit can be individually set to one of three states—logic 0, logic 1, or open. That permits up to 19,683 discrete codes. Both transmitter and receiver PC boards for the Guardian are hard wired for address zero, but any other address may be selected by re-connecting the addressing pins to any combination you choose. When the transmitter is enabled, the encoder chip generates a positive going pulse train at pin 15 that contains the encoded address. That pulse train is used to modulate the UHF oscillator.

Serial data is detected by the receiver and presented to the decoder at its data input terminal, pin 9. When that occurs, the address is checked. If two successive transmitted pulse trains contain the correct address, the valid output terminal of the decoder, pin 11, goes to logic 1 condition and remains so as long as the transmitter is operating. At all other times, the decoder output remains at a logic-zero level. The nine address bits of the decoder chip are wired the same as the encoder, allowing the receiver to respond only to its companion transmitter. If two or more independent systems are desired, each system should be wired for different address codes.

About The Transmitter. Figure 1 shows the schematic diagram of the transmitter assembly. The circuit is powered by the vehicle's 12-volt battery. Diode D1 protects the circuit from reverse voltage transients that may appear on the electrical system of the



Here is the foil pattern for the Guardian's transmitter. Cleaver layout allows for a single-sided board to contain both through-hole and surface-mount components.



The component side of the receiver board is mostly ground plane. The squarewave-like trace in the middle of the board is actually L6—necessary for proper operation.

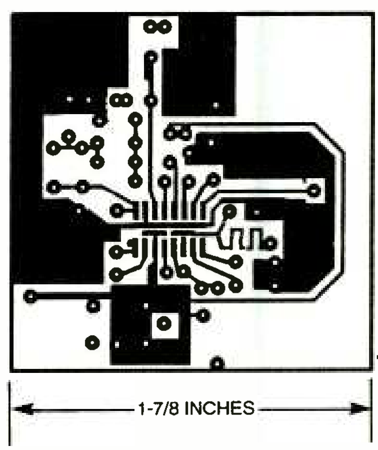
vehicle. A pair of Zener diodes, D2 and D3, create two regulated voltage sources of 10.9 and 6.2 volts.

Integrated circuit IC2 contains a pair of identical op-amps, which are cascaded. The negative input of IC2-a is AC-coupled to the 12-volt bus so that it can detect a sudden sag in voltage caused by current draw of the vehicle's dome lamps when a door is opened. A change in battery voltage of 3 millivolts will cause a −6-volt swing at the output of IC2-b, which is great enough to trigger IC3, a CMOS 555 timer chip. That IC is wired to operate as a one-shot pulse generator. An output pulse about 2-½ seconds long appears on pin 3 of IC3 when triggered by IC2-b.

The output of IC3 is connected to the enable input of IC1, a switching-type voltage regulator. When IC1 is enabled, it outputs a regulated 3.3-volt DC power source for the transmitter portion of the circuit. That portion consists of encoder IC4 and transmitter module MOD1. When power is applied to the encoder, a series of pulse trains is generated that contain the address of the encoder. That pulse train is applied to pin 1 of the hybrid module to produce an RF signal with an on-off pulse modulation, sometimes called *amplitude-shift keying*. When the 2-½ second pulse time of IC3 is completed, the transmitter shuts down, returning to its dormant state.

In order to prevent RF transmission while the vehicle is running, voltage detector IC5 uses R11 and R12 as a voltage divider to sense when the supply voltage rises above 12 volts due to alternator charging when the engine is running. Under that condition, the output of IC5 is open, turning off Q1. That holds the reset input of IC3 low, preventing the timer chip from responding to any trigger pulses from the amplifier. As a result, no transmission takes place.

The HX1000 hybrid-transmitter module, MOD1, is a four-terminal device that contains a surface-acoustic-wave-stabilized UHF oscillator. The oscillation frequency, 433.92 MHz, is stabilized and controlled by the resonant frequency of the internal surface-acoustic-wave filters, which also filter out undesirable harmonics. An ad-



Here's the foil pattern for the solder side of the receiver board. Don't forget to solder connections on both sides of the board where necessary.

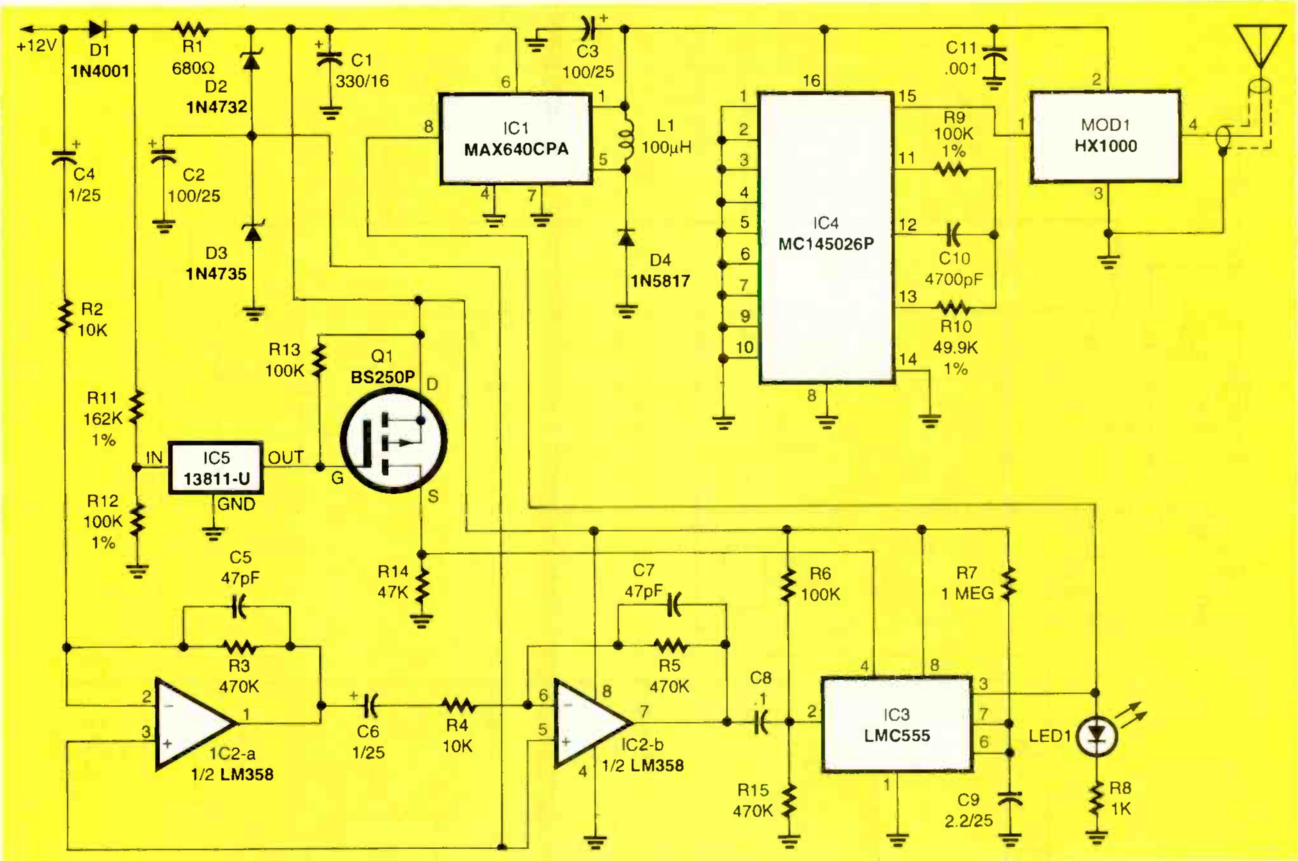


Fig. 1. Here is the schematic for the Guardian's transmitter. When a sag in the battery voltage is detected, an encoded address is broadcast to the receiver. Precision components and special ICs make the circuit adjustment-free and reliable.

PARTS LIST FOR THE GUARDIAN TRANSMITTER

SEMICONDUCTORS

D1—1N4004, silicon diode
D2—1N4732A, Zener diode, 4.7 volts
D3—1N4735A, Zener diode, 6.2 volts
D4—1N5817, Schottky diode
IC1—MAX640CPA, switching regulator, integrated circuit (Maxim)
IC2—LM358N, dual op-amp, integrated circuit
IC3—LMC555CN, CMOS timer, integrated circuit
IC4—MC145026P, digital encoder, integrated circuit (Motorola)
IC5—MN13811-U, voltage detector, integrated circuit (Panasonic)
LED1—Light-emitting diode, red
MOD1—HX1000, hybrid transmitter, 433.92-MHz (RF Monolithics)
Q1—BS250PJ, P-channel, MOSFET transistor

RESISTORS

(All resistors are ¼-watt, 5%, carbon units, unless otherwise noted.)
R1—680-ohm
R2, R4—10,000-ohm
R3, R5, R15—470,000-ohm
R6, R13—100,000-ohm
R7—1-megohm
R8—1,000-ohm
R9, R12—100,000-ohm, 1%, metal-film
R10—49,900-ohm, 1%, metal-film
R11—162,000, 1%, metal-film
R14—47,000-ohm

CAPACITORS

C1—330-µF, 16-WVDC, radial, aluminum electrolytic
C2, C3—100-µF, 25-WVDC, radial, aluminum electrolytic
C4, C6—1-µF, 25-WVDC, radial, aluminum electrolytic
C5, C7—47-pF, ceramic-disc
C8—0.1-µF, ceramic-disc
C9—2.2-µF, 25-WVDC, radial, aluminum electrolytic
C10—4700-pF, Mylar
C11—0.001-µF, ceramic-disc

ADDITIONAL PARTS AND MATERIALS

L1—100-µH, inductor (Mouser 542-78F101 or similar)
Hookup wire, 50-ohm coaxial cable (RG174 or similar), enclosure, PC board, etc.

vantage to using that module is that frequency tuning has already been done when the module was fabricated, so no further tuning is necessary. The hybrid module is capable of delivering about 1 milliwatt of power (0 dBm) into a 50-ohm load. It is connected to the transmitting antenna through a 50-ohm coaxial cable.

About The Receiver. The schematic diagram for the receiver is detailed in Fig. 2. Signals from the antenna are coupled through C12 to pin 14 of IC6, a complete superheterodyne-receiver chip that contains a local oscillator, mixer, limiter, and detector. A parallel-tuned circuit (L2 and C13) is adjusted to the carrier frequency of 433.92 MHz. The local oscillator is set to 433.42 MHz, and its frequency is stabilized by FL1, a surface-acoustic-wave resonator. The intermediate frequency (IF), which is the difference between the received frequency and the local oscillator frequency, is 500 kHz. The IF filter is composed of L3, L4, and C16 through C20. After IC6 processes the received RF signal, the

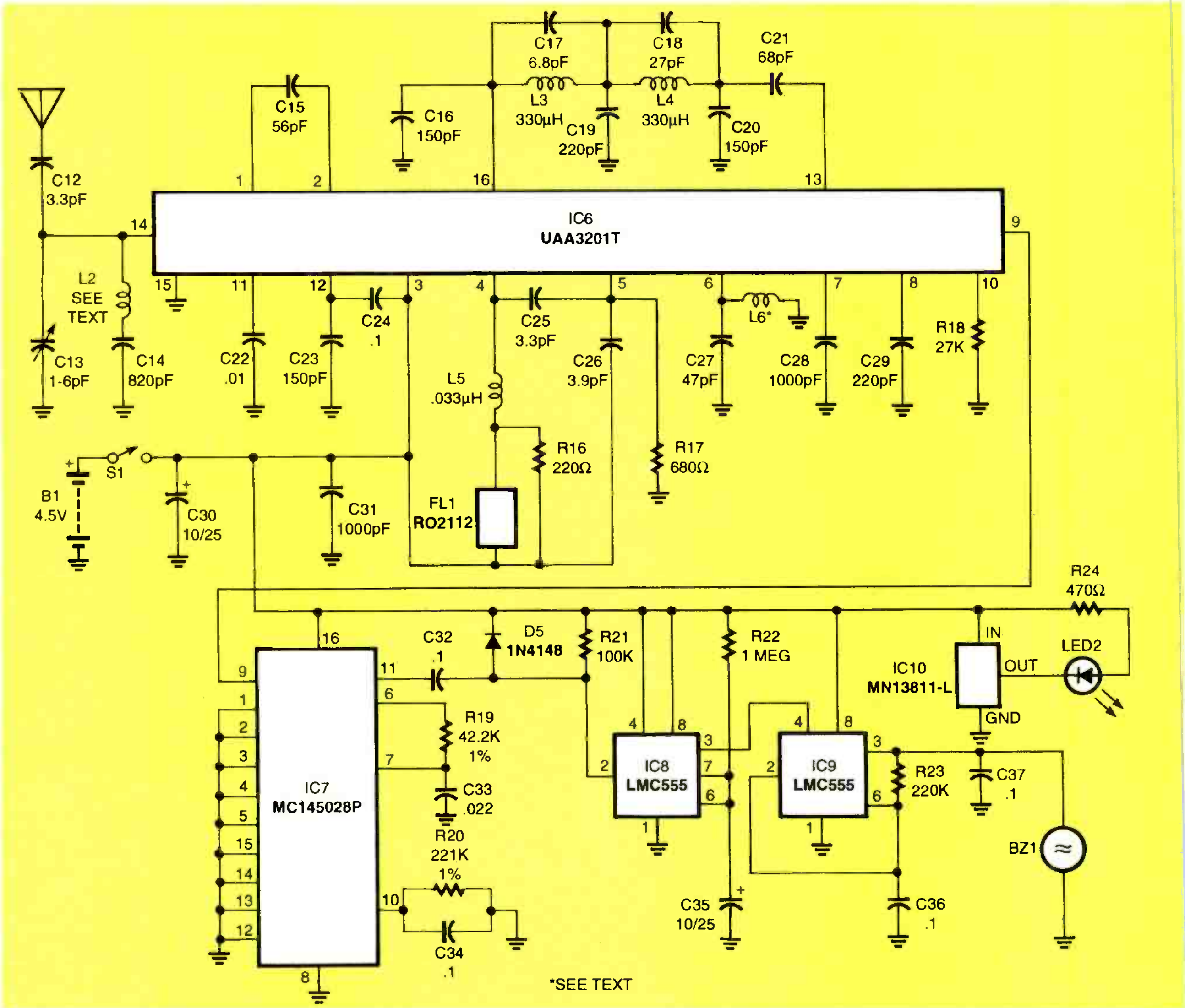


Fig. 2. The companion receiver for the Guardian takes advantage of the same reliable design as the transmitter. Only one simple adjustment is needed to tune the antenna to the Guardian's RF frequency.

transmitted pulses appear at pin 9. An unusual aspect of the design is L6, an inductor that is created by an etched pattern on the PC board. Because of that, use of the supplied PC pattern is an absolute must.

The companion decoder, IC7, checks the incoming pulse train for the correct address. If present, its valid output terminal, pin 11, goes high for the 2-½ second duration of the transmitted pulse trains. When the valid output signal returns to a low state, timer IC8 is triggered into operation. The output terminal of IC8, pin 3, goes high for a time period of about 11 seconds as determined by R22 and C35. That output, in turn, enables IC9, a timer configured as a 50%-duty-cycle oscillator with a period of about ¼ second. The output of IC9 drives a piezo buzzer, which produces an attention-getting audio signal that alerts the user that a door of the vehicle has been opened.

Power to operate the receiver is obtained by a set of three "AAA" alkaline cells connected in series to produce 4.5 volts. Current draw is only 3 milliamperes during standby, so battery life will be in the hundreds of hours. IC10 is a voltage-detector IC that allows current to flow though LED2 when the battery voltage falls below 3 volts. That alerts the user that battery replacement is necessary.

Transmitter Construction. The transmitter is built on a small, single-sided PC board measuring about 1¾ by 2¾ inch. It may be placed into a small enclosure, and it is powered by the vehicle's 12-volt DC electrical system. A suitable length of 50-ohm coaxial cable is used to make the connection between the transmitter board and the Guardian's antenna.

Figure 3 illustrates the parts placement for the transmitter. For all components other than the RF module MOD1, the transmitter is assembled using standard through-hole wiring techniques. A printed circuit board is available from the source given in the parts list if you do not wish to etch and drill your own. Regardless of which source you use for the PC board, always clean the soldering surface with steel wool and detergent before assembly to remove any possible oxidation or dirt. That procedure will provide a clean metal surface and allow good solder joints to be made. Rinse the board in cold water and dry

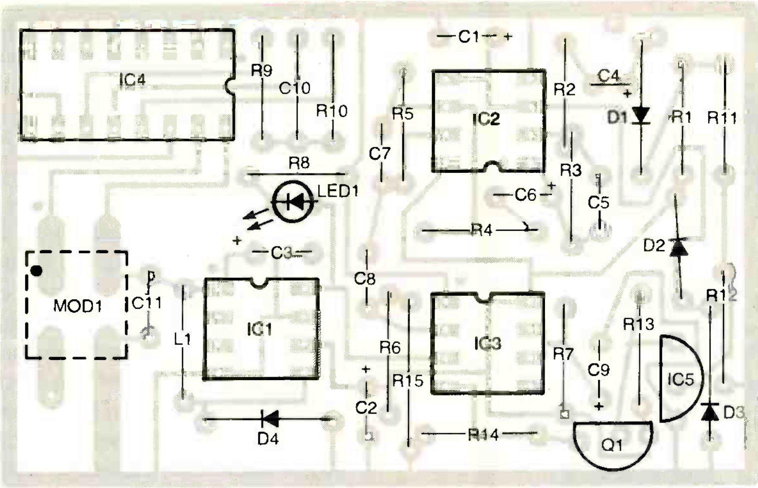


Fig. 3. Here is the parts-placement diagram for the Guardian's transmitter. A single-sided PC board makes the Guardian a suprisingly easy project to build. Only MOD1 is surface-mounted to the solder side of the board.

thoroughly before proceeding.

Insert all through-hole components in their respective locations as shown and solder them in place. It is important to use 1% tolerance metal-film resistors as specified for R9–R12. Pay strict attention to the orientation of all solid-state devices and electrolytic capacitors. The ICs should be soldered directly into the circuit board for utmost circuit reliability since the Guardian is a security device. Once again, double-check the orientation before soldering—any polarized component placed backwards in the circuit will cause an inoperative transmitter and possible damage to one or more of the parts.

The RF module, MOD1, should not be installed at this time. It will be done later during transmitter test. That will ensure that the module is not subject to any voltage higher than 3.3 volts in the event there is an error in the board assembly. In the meantime, set the transmitter aside while the receiver is assembled.

PARTS LIST FOR THE GUARDIAN RECEIVER

SEMICONDUCTORS

D5—1N4148, silicon diode
FL1—RO-2112, surface-acoustic-wave resonator, integrated circuit (RF Monolithics)
IC6—UAA3201T, UHF receiver, integrated circuit (Philips)
IC7—MC145028P, digital decoder, integrated circuit (Motorola)
IC8, IC9—LMC555CN, CMOS timer, integrated circuit
IC10—MN13811-L, voltage detector, integrated circuit (Panasonic)
LED2—Light-emitting diode, red

RESISTORS

(All resistors art ¼-watt, 5%, carbon units, unless otherwise noted.)
R16—220-ohm, ⅛-watt, surface-mount
R17—680-ohm
R18—27,000-ohm
R19—42,200-ohm, 1%, metal-film
R20—221,000-ohm, 1%, metal-film
R21—100,000-ohm
R22—1-megohm
R23—220,000-ohm
R24—470-ohm

CAPACITORS

C12, C25—3.3-pF, ceramic-disc
C13—1.8–6.0-pF, trimmer (Mouser 24AA070)
C14—820-pF, ceramic-disc
C15—56-pF, ceramic-disc
C16, C20, C23—150-pF, ceramic-disc
C17—6.8-pF, ceramic-disc
C18—27-pF, ceramic-disc
C19, C29—220-pF, ceramic-disc
C21—68-pF, ceramic-disc
C22—0.01-µF, ceramic-disc
C24, C32, C34, C36, C37—0.1-µF, ceramic-disc
C26—3.9-pF, ceramic-disc
C27—47-pF, ceramic-disc
C28, C31—1000-pF, ceramic-disc
C30, C35—10-µF, 25-WVDC, radial, aluminum electrolytic
C33—0.022-µF, Mylar

INDUCTORS

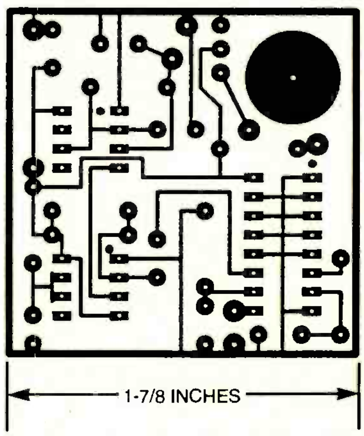
L2—Antenna coil (see text)
L3, L4—330-µH (Mouser 43LS334 or similar)
L5—0.033-µH, surface-mount (Mouser 434-07-033K or similar)
L6—See text

ADDITIONAL PARTS AND MATERIALS

B1—4.5 volts, 3 alkaline cells, size "AAA"
BZ1—Piezo buzzer, 3–5-volt DC (see text)
S1—Slide switch, SPST, miniature (Mouser 102-1211 or similar)
Hookup wire, enclosure (Pac Tec K-HM-9VB or similar), PC boards, optional 5-volt DC wall-adapter transformer supply (Digi-Key T309 or similar), etc.

Receiver Construction. The receiver consists of two printed-circuit boards that are stacked on top of each other and housed in a small plastic enclosure that contains a battery compartment. The receiver PC board is double-sided, and the decoder board is single-sided. Etched and drilled boards are available from the source specified in the Parts List if you do not wish to make you own boards.

Assemble the decoder board first, following the same precautions mentioned for the transmitter. Carefully orient all solid state devices and integrated circuits properly, following the parts-placement diagram in Fig. 4. Be sure to use 1% tolerance metal-film resistors for R19 and R20.



The decoder board is also single-sided. If you need to change the Guardian's address code, you can modify the traces by cutting them and attaching jumpers, or by changing the traces when etching the board. Don't forget to modify the transmitter board to send the same address!

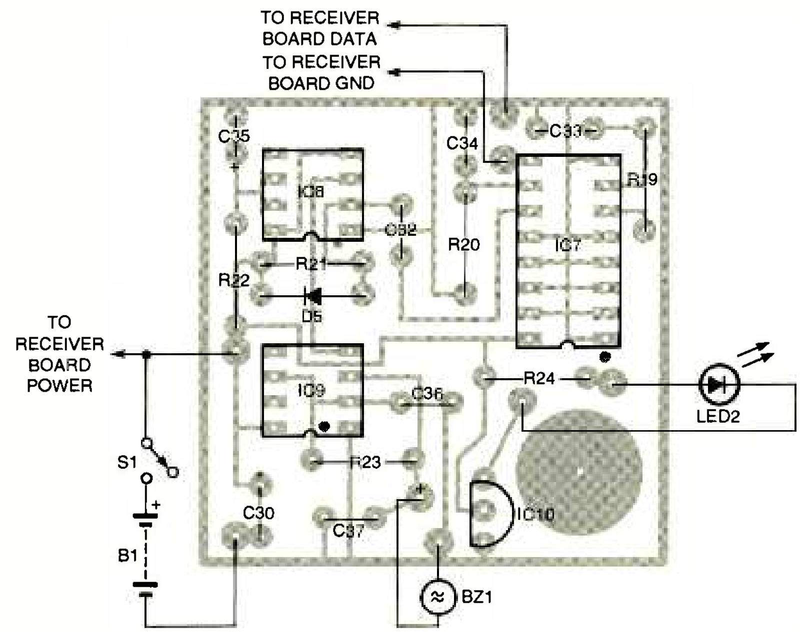


Fig. 4. The decoder section of the Guardian's receiver has an area reserved for mounting the buzzer directly to the board.

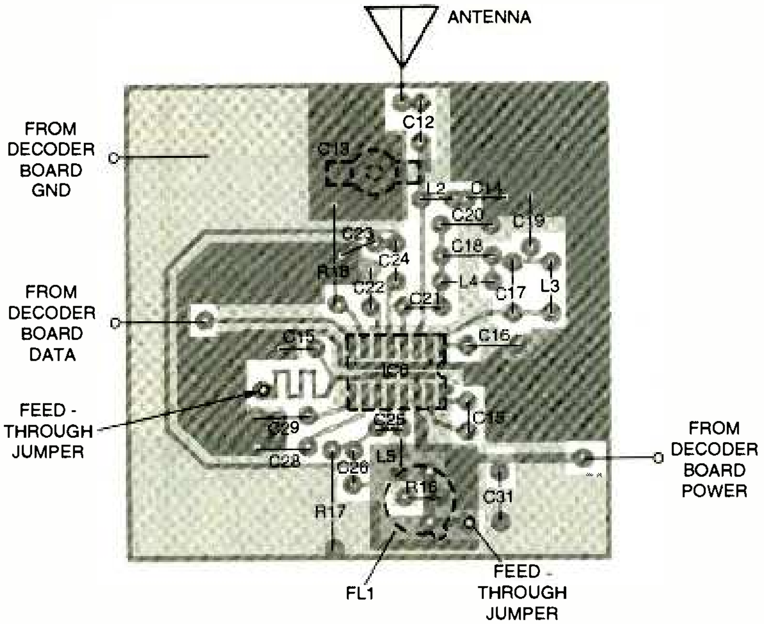


Fig. 5. The RF section of the Guardian's receiver uses a combination of through-hole and surface-mount components. Note the squiggly trace—it is actually an inductor necessary for the circuit's proper operation! The bottom side of the receiver board has three components mounted to it. Be careful of the orientation of IC6.

The body of BZ1 must be mounted in such a way that when both boards are stacked together, the entire assembly will fit into the enclosure selected for the receiver. If you are using the items recommended in the Parts List, drill a ½-inch diameter hole in the decoder board where BZ1 is to be located. If not, then drill a suitably-sized hole for the body of the buzzer you will be using. Cement the buzzer in place using silicon rubber or epoxy. Be sure to observe proper polarity when wiring the buzzer to the circuit. For maximum sound level, drill a small hole or a series of holes in the enclosure where BZ1 is located.

The double-sided receiver board must be assembled using good RF construction techniques, and with the proper through-hole components as specified in the parts list. Use the parts-placement diagram of Fig. 5 to locate the components that mount on the top side of the board. All capacitors and inductors must be inserted with a minimum amount of lead length. Maximum component height above the top of the assembled board should not be over 11⁄32-inch so that the two PC boards will fit into the suggested enclosure mentioned in the Parts List. Where a component wire passes through both top and bottom ground planes of the board, it should be soldered on both sides.

Inductor L2 is a hairpin-type design that is made from a piece of scrap ¼-watt resistor lead. Use the dimensions in Fig. 6 to make the inductor. Solder surface-mount components L5 and R16 to the top side of the board. Note that one lead of C25 must be soldered on both sides of the board to make a connection for L5.

On the bottom side of the board, IC6, C13, and FL1 are placed as shown in Fig 5. Because of its unusual package design, the method used to mark pin 1 of IC6 is depicted in Fig. 7. When soldering IC6 to the board, center it within the foil pattern on the board. Carefully solder just one corner pin, and check the position of the chip to be sure all terminals are lined up with the pattern. If it is necessary to readjust IC6, it is easier to do so if only one pin is soldered. Once IC6 is properly oriented, solder the remaining terminals, being very careful not to use excessive heat or short one terminal to the next with solder. If inadvertent solder bridges occur during placement of IC6, use desoldering braid to remove the excess solder. Capacitor C13 is also surface-mounted to the board. Be sure to position C13 so that the screwdriver adjustment terminal is at ground potential. Filter FL1 mounts through holes in the board and is soldered from the top side.

Finally, two through-hole wires connecting the traces from the top of the board to the bottom are required. One is placed near FL1, and the other at L6 (the inductor created by the etched pattern on the PC board). Solder carefully on both sides.

Receiver Power Supply. For non-portable applications, the receiver may be operated by a wall-mounted power supply. Use a 4.5- to 5-volt, well-filtered DC supply with a load-current

PARTS LIST FOR THE DETECTOR PROBE

D6—1N90, diode
C38—4.7-pF, ceramic-disc capacitor
R25—10,000-ohm, ¼-watt, 5%, carbon resistor

Note: The following items are available from A. Caristi, 69 White Pond Road, Waldwick, NJ 07463: Set of three etched and drilled PC boards, $29.75; IC1, $6.75; IC4, $6.75; IC6, $11.75; IC7, $6.75. Add $5.00 for shipping and handling. NJ residents add appropriate sales tax. MOD1 and FL1 are available from RF Monolithics, 4347 Sigma Rd., Dallas, TX 75244, Tel: 214-233-2903. Receiver enclosure is available from Pac Tec, 8425 Executive Ave., Philadelphia, PA 19153, Tel: 215-365-8400.

rating of 25 milliamps. It is important that the voltage applied to the receiver must never exceed 5 volts, or IC6 might be damaged. The Parts List specifies one suitable 5-volt DC wall-transformer supply. If you want to use a power supply that has a rating greater than 5 volts, you can add a 5-volt regulator circuit as shown in Fig. 8 to reduce the output voltage to a safe level.

Transmitter Test. The transmitter must be checked first so that it can act as a signal source to test the receiver. The test consists of two parts: First the analog circuits are checked for proper operation, then the transmitter module is installed and its RF output verified.

The transmitter will require a 12.6-volt power source that contains extremely low or no ripple in the output. A battery, not exceeding 12.6 volts, is recommended. If you use a DC supply that has a millivolt or more of AC ripple in its DC output, the detection circuit will trigger, making it difficult to test the transmitter properly. A voltmeter, either digital or analog, is needed to check voltages, and a triggered oscilloscope will be handy to observe transmitted waveforms. Additionally, a simple diode detector assembly may be constructed to verify transmitter operation. More about that later.

Apply the 12.6-volt power supply to the transmitter board, observing proper polarity. The absolute maximum voltage allowed during the test is 12.8 volts. The measured voltage between the cathode of D2 and ground should be about 10.9 volts, and about 6.2 volts from the cathode of D3 to ground. If you do not obtain the correct readings, do not proceed until the fault is located and corrected. Components that should be examined carefully for proper value and orientation include D1–D3, C1, and C2. Examine the board carefully for shorts, opens, or cold solder joints, which may appear as dull blobs of solder.

Create a sag in the 12-volt power source by momentarily connecting a low value resistor across the battery terminals. You could use a 100-ohm 1-watt resistor or a 12-volt lamp for that. If you are using a regulated power supply, you could rapidly disconnect and reconnect the 12-volt lead to the transmitter. The sag in voltage should trigger IC3, and LED1 should light up for about 2-½ seconds. If LED1 does not light, check its orientation. You can test the operation of IC3 by momentarily shorting pin 2 to ground. That should cause pin 3 to rise to about 10 volts for about 2-½ seconds, lighting up LED1. Also check that pin 4 of IC3 is at the same voltage as pin 8. If pin 4 is at a lower voltage, IC3 will think the car engine is running, and will not trigger. If that seems to be the case, check voltage detector IC5 and Q1.

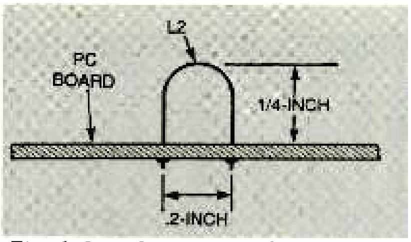


Fig. 6. In order to make L2, bend a scrap resistor lead to this size.

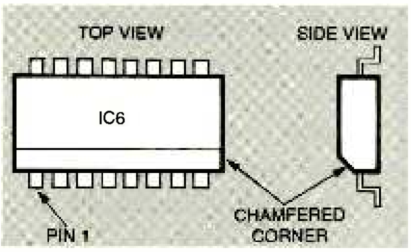


Fig. 7. The component used for IC6 has an unusual method of marking the location of pin 1.

If LED1 can be triggered manually, but does not sense a voltage sag, the trigger-output level at pin 7 of IC2B can be checked with an oscilloscope. A sag of about 3 millivolts on the input voltage is necessary to cause a negative going trigger pulse that goes to zero volts. If the amplifier is not working, check all components associated with IC2. A new chip might be necessary.

With LED1 reliably illuminating each time the battery voltage sags, measure the voltage at pin 1 of IC1. Normal indication is 3.3 volts, which lasts only as long as LED1 lights. If IC1 does not put out the proper voltage, check the orientation of C3, D4, and IC1. Check L1 for any assembly damage, as well as any opens or shorts in the PC board. You might have to replace IC1.

Temporarily connect the transmitter board to the vehicle's electrical system, and verify that LED1 lights each time a door is opened. The engine must be off when making that test.

With the analog circuits working, MOD1 may now be installed on the transmitter board. That component is surface-mounted on the foil side of the board. Before installing MOD1, all power from the tests should be removed. The four pins of MOD1 should be lightly tinned, using a minimum of heat from the soldering-iron tip. Additionally, the four pads on the PC board should similarly be coated with a very thin layer of solder. Doing so will greatly simplify achieving a solid solder connection between MOD1 and the foil pattern of the board.

Carefully note the location of pin 1 of MOD1 and pin 1 of the PC layout, both of which are identified by small dots. Using Fig. 3 as a guide, position MOD1 over the four copper pads so

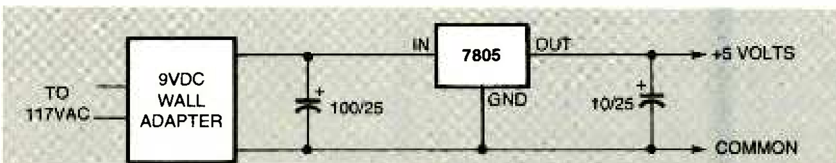


Fig. 8. If you want to mount the receiver at a permanent location, you can use this circuit to power the receiver from a wall outlet in place of the batteries

that pin 1 matches the corresponding PC pad, and the remaining three connections lie directly over their respective pads. Be careful with the soldering procedure to be sure the hybrid module is properly oriented and soldered in place. Use only enough heat and solder to attain good solder connections.

Detector Assembly And Final Checkout. To test the RF output of the Guardian, a parallel-tuned detector probe is used to view the signal on an oscilloscope. Construction details for the detector are shown in Fig. 9. The tuned circuit of the detector probe is composed of C38 and an inductance that is composed of the capacitor leads formed into a ½-inch diameter circle and butt-soldered together. A germanium diode and resistor complete the circuit. To view the transmitted RF pulses, an oscilloscope probe set to a 1:1 attenuation is connected across the resistor as shown.

Cut a piece of insulated solid wire about 6-½ inches long and connect it to the antenna pad (pin 4 of MOD1) to act as a temporary antenna. Apply 12.6-volt DC power to the transmitter (as before, do not exceed 12.8 volts) and trigger IC3 either manually or by sagging the power supply. Note that LED1 lights for a couple of seconds.

Adjust the scope for maximum DC gain and place the pickup loop of the detector probe near the antenna. Set the sweep speed of the scope to 10 milliseconds per centimeter. When LED1 is lit, you should be able to see a display of 18 positive-going pulses, indicating that the transmitter is sending out a modulated RF signal.

If you do not see the pulse display, check the detector probe to be sure it is properly assembled. Check pin 15 of IC4 with the oscilloscope probe (set to 10:1 attenuation) to verify the presence of the 3.3-volt peak-to-peak pulse train. If IC4 is not generating a pulse train, check the orientation of IC4 and Q1, along with R9, R10, R11, R12, and C10. The encoder chip may have to be replaced. If the pulse train is normal, check the orientation and solder connections of MOD1.

Once all tests on the transmitter board are done, it may be installed in a small enclosure that has been drilled to accommodate two power leads and a coaxial cable. Use two different colors for the power leads. Red for plus and black for ground makes the best choice, as those colors are almost universal for automotive electrical systems.

Receiver Checkout. Once the transmitter is working properly, it is used to test the receiver. The assistance of another person will be handy in testing the receiver at a dis-

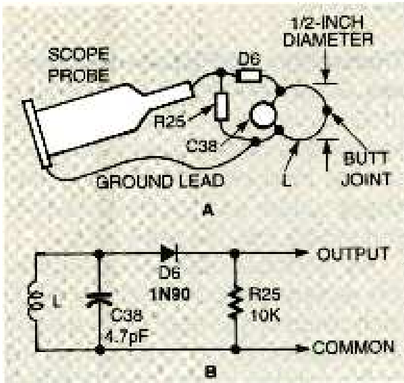


Fig. 9. This simple detector probe will allow you to view the Guardian's RF signal on an oscilloscope. Follow the dimensions and shape of the leads for C38 exactly as shown in A; the probe's schematic is shown in B.

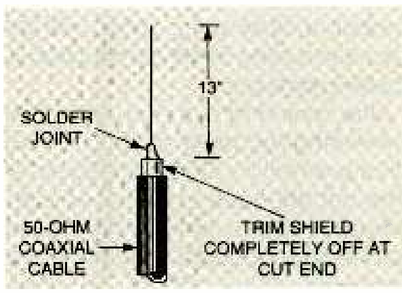


Fig. 10. A simple length of wire forms a ½-wavelength antenna for the transmitter.

tance from the transmitter. If you need to, the transmit time may temporarily be increased by connecting additional capacitance across C9 in the transmitter. Connect a 6-½ inch insulated solid wire antenna to the RF-input terminal of the receiver printed circuit board. Connect the probe of an oscilloscope to pin 9 of IC6. Apply 4.5 volts DC power to the receiver board, using either a set of three alkaline cells connected in series or a well-regulated DC power source. Do not power the receiver with any voltage greater than 5 volts, or you might damage IC6.

When the transmitter is triggered, the oscilloscope display should show a group of 18 positive-going pulses—a replica of the transmitted pulse train observed earlier during transmitter checkout. Repeat the test with the transmitter further and further away. When the transmitter is far enough away to deliver a weak signal to the receiver, adjust C13 to obtain the maximum possible pulse width as indicated by the scope. The transmitter will have to be moved a substantial distance away to obtain a weak signal at the receiver. If you are not able to receive the transmitted signal, the receiver RF board must be visually checked for improper assembly. Every solder joint must be examined, especially those for IC6, L5, R16, and FL1. Verify that the jumpers between the top and bottom of the board near FL1 and L6 have been properly soldered. Check for short circuits and proper component values.

Local-oscillator operating current can be verified by measuring the voltage at pin 5 of IC6. Normal indication is about 0.5-volt DC. A reading of zero means that the local oscillator is not working. If that is the case, check L5, C25, C26, C31, R16, R17, and FL1.

When the RF board is operational, connect it to the decoder board. Three connections are needed: power, ground, and the data line. Disconnect the power supply to the receiver board and follow the parts-placement diagrams for the receiver and decoder boards using 24-gauge stranded insulated wire. If possible, use different colors. Do not use solid wire—it will break.

Disconnect any temporary capacitor connected across C9. Apply power to both the receiver and transmitter. It is OK if the buzzer sounds when the receiver is turned on. Move the transmitter across the room and trigger it as before. Each time LED1 goes out, the buzzer should emit a series of rapid beeps for about 11 seconds. The audio signaling time may be lengthened by increasing the values of either R22, C35, or both.

If the buzzer is silent, check pin 11 of IC7 to verify the existence of the valid data output signal, which remains at 4.5 volts when the transmitter is operating, and zero when it is not. If IC7 is not recognizing the pulse train, check the IC and all components associated with that chip. Verify that the address selected for both encoder and decoder chips match. If the valid data signal is present, check IC8, IC9, and all components associated with those ICs. Manually trigger IC8 with a momentary short between pin 2 and pin 1 (ground). That should cause pin 3 to rise to about 4 volts for a period of 11 seconds. If both IC8 and IC9 work correctly, check the buzzer wiring and the buzzer itself. Once the receiver passes all tests, it may be assembled into the enclosure.

Transmitter And Receiver Antennas. Since they control the maximum attainable operating range, the transmitting and receiving antennas are the most critical parts of a low-power system such as the Guardian. Fortunately, they are easily built.

For portable receiver operation, the receiver antenna is simply a 6-½ inch piece of insulated solid wire that is connected to the RF input terminal of the receiver board, and bent to fit inside the periphery of the enclosure. The length chosen is a ¼-wavelength antenna. For non-portable applications, a ¼-wave or ½-wave (13-inches long) vertical-ground-plane antenna could be used. Note that the greatest possible operating range will be achieved using a well-constructed receiving antenna.

The transmitter antenna is a ¼-or ½-wavelength ground-plane antenna that is driven by MOD1. The shield of the coaxial cable and the vehicle's chassis make a very good ground plane. Most applications will need the transmitter to be placed a short distance away from the antenna. A length of 50-ohm coaxial cable must be used to make the connection. Use Fig. 10 as a guide when constructing the transmitting antenna. Note that extremely short connections must be used when attaching the center wire and shield of the cable to the RF output and common pads of MOD1.

Transmitter Installation. The best place to locate the transmitter is near or under the dashboard of the vehicle so that the length of coaxial cable is short. The enclosure should be secured to the vehicle so that it does not move around when driving. Best operating results will probably be obtained with the transmitting antenna placed in a vertical direction at the center of the windshield of the vehicle. The wire may be secured to the glass using transparent tape or even a quick-setting epoxy or instant-bond glue. Before mounting the antenna permanently, make sure it does not interfere with the driver's view of the road ahead—most, if not all, states have laws about just such a situation. If you wish, other locations for the transmitting antenna may be selected. A little experimentation with position and antenna length will indicate which location in your vehicle will provide the best range for the system.

Power to operate the transmitter is obtained from any wire in the electrical system powered by the 12-volt battery, so that the circuit is energized when the vehicle is parked. In most vehicles, the best selection will be the hot lead that feeds the dome lamps. The ground lead of the transmitter may be connected to any metal part of the vehicle.

Using The Guardian. The transmitter is always on duty, so no attention to it will ever be required. It will automatically transmit a burst of coded pulses each time a door is opened. It will even make one last transmission if a would-be thief disconnects the battery of the vehicle!

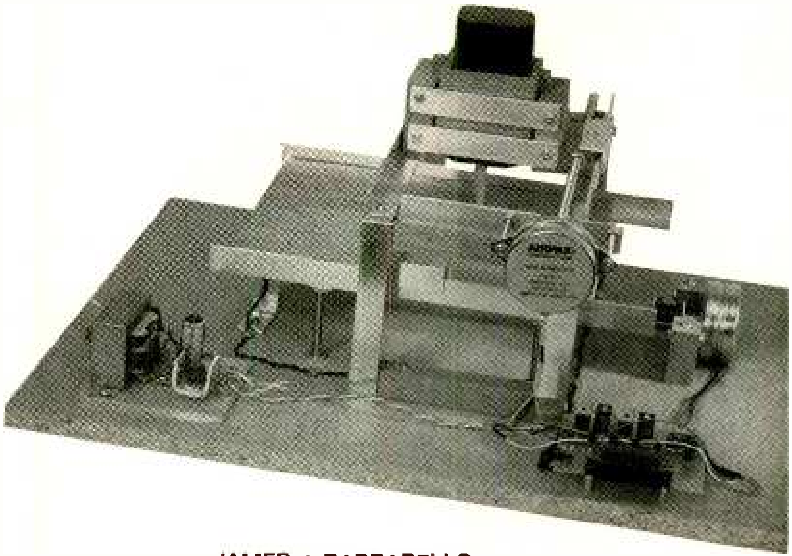
It would be a good idea to have an assistant open and close a door of the vehicle several times while operation of the receiver is checked at different locations. This will provide information as to the range of the system. Tests on the author's prototype demonstrated a useable range in excess of 200 feet for line of sight transmissions, using the portable receiver.

Battery-operated receivers should be turned on only when it is desired to monitor the status of the vehicle, such as when parked nearby out of sight. Upon power-up, the piezo buzzer may emit a series of beeps. When the receiver becomes silent, it is ready to receive a transmission. The receiver's LED indicator is a low-battery warning and it will not illuminate until it is time to replace the battery. If the receiver is powered by a wall-adapter supply, it may be left on continuously so that the vehicle is protected at all times when it is parked nearby.

That's all there is to it! Why not start building your Guardian today so that it can begin watching over your car as soon as possible. Ω

BUILD THE PCDrill

Build a PC controlled drilling table that simplifies the task of making printed-circuit boards.



JAMES J. BARBARELLO

Last month, we showed you the construction details for a stepper-controlled PC-board drilling system that can provide 0.001-inch accuracy in drilling boards as large as 6 by 8 inches, yet costs less than $100 to build. This time, we'll align the device and discuss the software used to control it. We'll also show how to build a low-cost custom power supply that provides the steppers with enough torque to do their job (As discussed last time, the power supply should provide about 5.75-volts DC. A standard 7805-based power supply just doesn't provide sufficient voltage to produce the torque necessary to compensate for minor mechanical resistance from slightly misaligned components.) Last, we'll provide a bonus option that greatly enhances the system's ease of use.

Prealignment Tasks. Before beginning alignment, make sure the following tasks have been accomplished.

1. The threaded rods should be as straight as possible. You can check straightness by removing the rod and chucking it in a variable-speed hand drill. As the rod rotates, note any wobbling of the free end caused by bowing of the rod. Lightly flex the rod in the opposite direction to minimize wobble.

2. The universal shaft coupler should be centered on the threaded rod. Again, chuck the rod (with the universal coupler on the free end) and rotate slowly, noting any wobble. Adjust the set screw and coupler position as necessary to minimize wobble. Re-install the rod.

3. Check whether the mating surfaces of the drivers are parallel with the rod. (The mating surface of the table driver contacts the table bottom. The mating surface of the drill driver contacts the drill caddy.) If not, machine those surfaces to be as parallel as possible with the attached rod.

Table Alignment. The optimum operation of PCDrill occurs at a point that represents a balance among several physical and electrical characteristics of the device. For instance, locating the table guide as close as possible to the table track would minimize sideways movement, but would also make the table prone to binding. Thus, we need to balance the adjustments for the positions of the stepper motors and guides, the positions of the limit switches, and the tightness of the screw holding the table driver to the table.

Table alignment consists of three adjustments: the position of the table stepper motor (MOT1), the position of the table guide, and table-driver screw tightness.

Begin by loosening the screws holding MOT1, allowing it to move slightly in all directions. Place a business or index card vertically between the outside of the table rail and the inside of the table guide. Pull the table and table guide toward the table rail and tighten the table guide screw. Remove the card. The table should be able to move slightly in the y-direction (toward and away from the table rail). Loosen the wood screw holding the table drive so the table can rotate free of the table drive.

Power the unit and connect it to your PC's parallel port. Load and run the PCDRL program shown last time. Using option 1 ("table towards stepper") and 2 ("table away from stepper"), move the table back and forth. If MOT1 "chatters" (stalls or hesitates) at any point, move it slightly. If the table guide binds on the table rail, readjust as necessary.

When you are satisfied that the table moves as freely as possible along its 8-inch travel, lightly re-tighten the MOT1 screws while keeping MOT1 in position. Now move the table so that the edge closest to MOT1 is about 1 inch away from the drill bit. Place the table-zero assembly under the table and slide it toward the table driver until you hear the switch's plunger click. Mark that position and install the table-zero assembly with a single #8 × ¾-inch sheet-metal screw.

Use the software to move the table first toward MOT1, and then away from MOT1. When the table drive contacts the switch, movement should stop. If not, recheck your wiring to ensure that you have not inadvertently connected the table-limit switch to the drill limit switch holes on the PC board.

Drill Alignment. Adjusting the drill is similar to adjusting the table. First loosen the nuts holding the drill stepper motor (MOT2). Place a business or index card vertically between the outside surface of the drill rail and the inside surface of the drill guide. Pull the drill caddy and drill guide toward the drill rail and tighten the guide screw. Remove the card. The drill

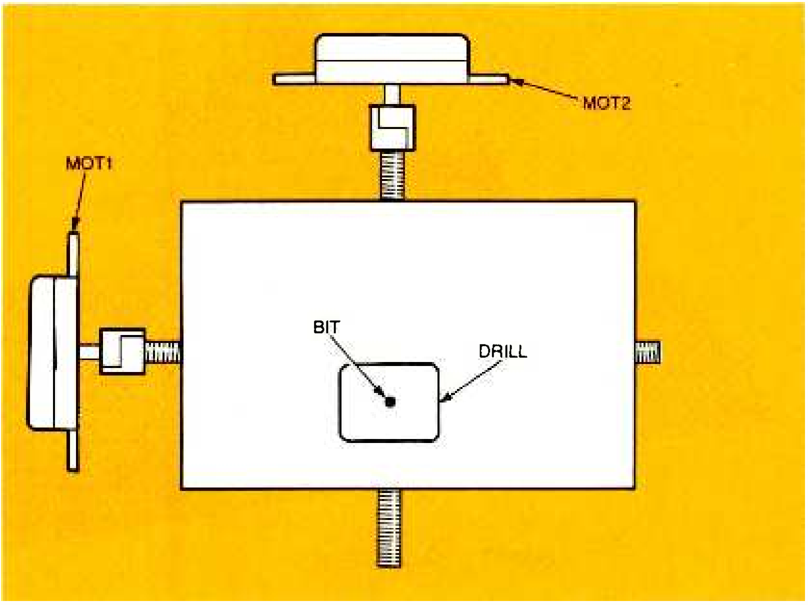


Fig. 1. The marking procedure starts with the drill table in some arbitrary position.

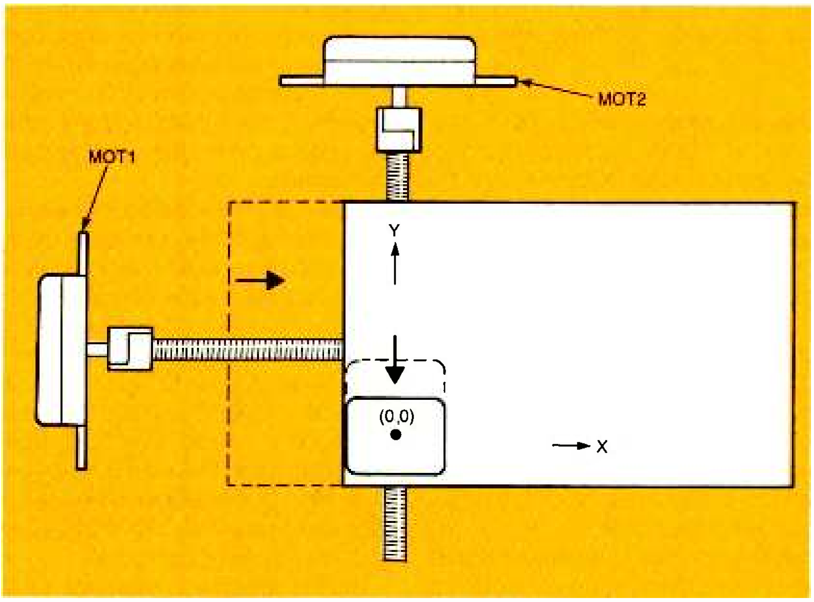


Fig. 2. The first step of alignment is to move the drill under software control to position (0,0) and mark the table at the point where the drill bit makes contact.

should be able to move slightly in the x-direction (toward and away from the drill rail).

Running the software, use option 3 ("drill toward stepper") and 4 ("drill away from stepper") to move the drill back and forth. If MOT2 chatters at any point, move it slightly. If the drill guide binds on the rail, readjust as necessary. Make sure that the drill caddy stays flat against the horizontal surface of the drill rail, and that the threaded rod is equidistant from the vertical surface of the drill rail all along its length. Adjust MOT2 as necessary to obtain that condition.

When you are satisfied that the drill moves as freely as possible along its 6-inch travel, lightly retighten MOT2's nuts. Finally, move the drill caddy away from MOT2 and ensure that it stops when it contacts the limit switch.

Marking the Table. To ensure accurate drilling, the table must be marked with a reference, in this case two perpendicular lines. One line is parallel to the movement of the table; the other, parallel to the movement of the drill. Where the lines intersect is point (0,0). In the data file, all hole positions are specified relative to that point.

Assuming that the table is at some arbitrary position, as shown in Fig. 1, bring the table and drill to (0,0) using the software. With a bit installed in the drill, push the drill down and mark where the bit contacts the table, as shown in Fig. 2.

Using PCDRL option 3 ("drill toward stepper"), move the drill about 5 inches away from (0,0). Push the drill down and mark the table, as shown in Fig. 3. Return the drill to (0,0).

Using PCDRL option 1 ("table toward stepper"), move the Table about 5 inches away from (0,0). Push the drill down and mark the table, as shown in Fig. 4. Return the drill to (0,0). Now draw one line from (0,0) to (0,5), and another from (0,0) to (5,0).

That completes marking the table. When you drill a PC board, you will place its reference corner at (0,0), and its x axis along the y = 0 line, as shown in Fig. 5.

To avoid damaging the table and the drill bit during drilling, cut a piece of cardboard and position it under the PC board. Affix the board to the cardboard with masking tape, and the assembly to the table with more masking tape. When you drill, the bit should penetrate the cardboard only.

The Setup Files. We use two plain ASCII text files to supply data to the program that controls drilling: DRLSETUP provides general setup information, and *.DRL files contain the drill location data. Both files should be stored in the same directory as the PCDrill application program.

The setup data file (DRLSETUP.DAT) provides information on which parallel port to use, stepper speed, rotation to linear-motion constant, and whether the startup message should appear. Each item appears on a separate line in the file. Listing 1 shows a typical setup file.

Line 1 (888) tells PCDrill to use the parallel port located at address 888 decimal. Line 2 (2000) tells PCDrill to delay by a factor of 2000 while energizing the motor. This is a relative value, suitable for use on a 33-MHz 486. By comparison, a 4.77-MHz 8088 would use a value of 1. PCDrill uses Line 3 (869) to convert between coordinate locations in inches to the required number of revolutions of the stepper motor. Unless a different threaded rod is substituted for the 5/16-inch rod specified, the value will always be 869. The fourth entry (Message) tells PCDrill that the startup message should be displayed. To avoid displaying the startup message, the entry can be changed to "NO Message."

You can use the setup file to customize operation to your system and preferences. For example, Listing 2 shows the resulting setup file for using PCDrill on parallel port 2 (956 decimal) on a 75-MHz Pentium with no startup message.

PARTS LIST FOR THE PCDRILL POWER SUPPLY

R1—1000 ohms, ¼-watt, PC mount, trimmer potentiometer
R2—2200 ohms, ¼-watt, 5% carbon resistor
C1—1000-µF, 16-volt, electrolytic capacitor, radial leads
C2—1-µf, 16-volt, electrolytic capacitor, radial leads
IC1—LM317T adjustable regulator, integrated circuit, TO-220 case
D1, D2—1N4003, silicon-rectifier diode
T1—Step-down transformer, 117VAC to 6.3VAC CT, 1.2A secondary
TO-220 heat sink, PC board, wire, hardware, etc.
Note: The following are available from James J. Barbarello, 817 Tennent Road, Manalapan, NJ 07726; Enhanced software (PCD-S, $12, specify disk size); PC Board (PCD-PC, $17); Drill caddy kit, consisting of spring, drill caddy sides, drill caddy slides, and drill holder (PCD-DC, $15). NJ residents must add appropriate sales tax. The author will answer any questions accompanied by a self-addressed stamped envelope.

PARTS LIST FOR THE OPTIONAL SWITCHED OUTLET

SO1—Duplex wall outlet, 117-volts AC
S1—Momentary pushbutton switch, 250-volt, 1-amp (RadioShack 275-618 or equivalent)
6–12 ft. 3-prong extension cord; plastic project box (RadioShack 270-233 or equivalent), strain relief for extension cord mounting (RadioShack 278-1636 or equivalent), mounting hardware, etc.

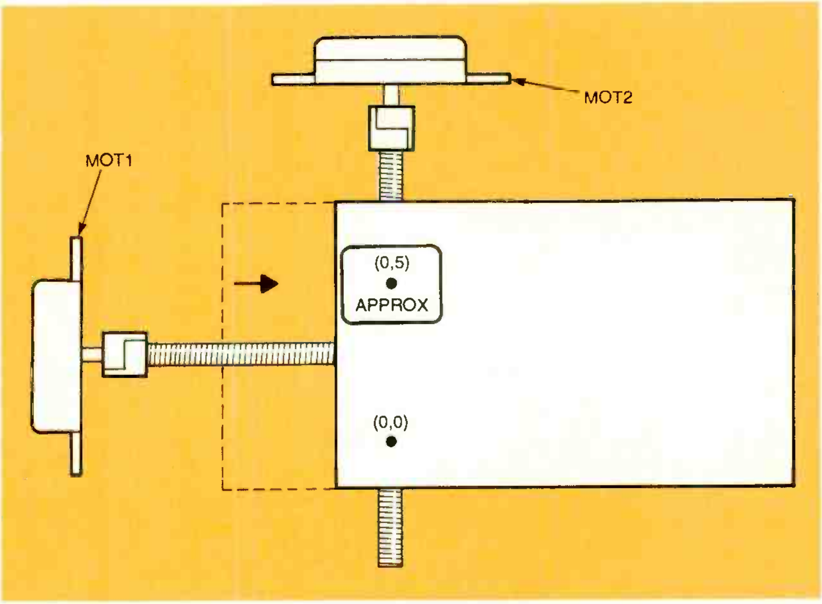


Fig. 3. The next step is to move the drill to (0,5) and mark the table as before. Moving the table is done using option 3 in the PCDRL program presented last month.

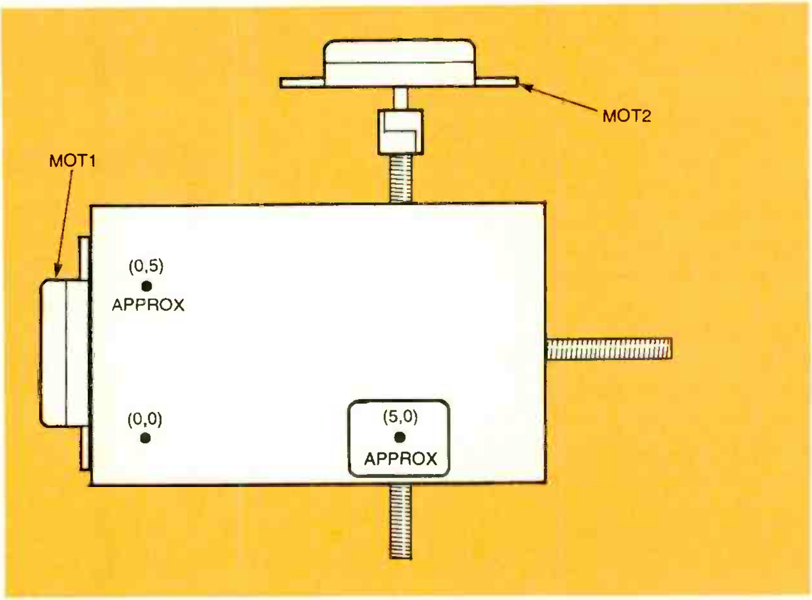


Fig. 4. The third step is to move the drill to (5,0) and mark the table. Then connect the two points back to the origin (0,0).

The value 5000 in line two is an estimate; you'll have to determine the exact value by trial and error. If the motors go too slow, try decreasing the value. If they stay still and whine (meaning they are trying to turn too fast), try increasing the value.

The data file is also a plain ASCII text file. Data files are usually saved with the extension .DRL; an example file appears in Listing 3.

The first two lines contain general information; the remainder of the file consists of coordinate pairs. Line 1 is descriptive text that the program displays on-screen during operation. Line 2 specifies the overall dimension (in inches) of the PC board described in the file. After that come the drill points. In Listing 3, the board is 5.8 inches long by 6 inches wide, with the 5.8-inch dimension flush to the y=0 line (x-axis).

To create the hole data for a board, designate one corner of the board as (0,0). Overlay the board with a 0.1-inch grid. Then, working from the designated corner, measure the X and Y

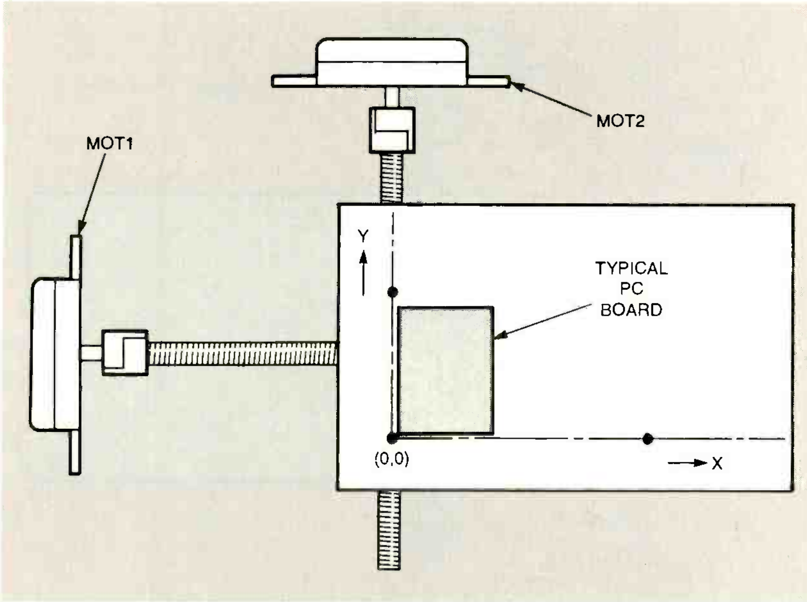


Fig. 5. To use PCdrill once the marking is done, the board is placed with its reference corner at (0,0) and its x axis along the y=0 line.

distances to each hole. Holes do not have to lie precisely on the grid; a value of 3.2145 is perfectly acceptable. PCDrill will use whatever values you specify and move the drill as close as it can to that location. Also, if you use a PC-board layout program that creates an (x,y) drilling location output file (*e.g.*, an Excellon drill file), it can be readily converted to PCDrill format.

Here's a hint to use when creating your data file: To minimize drill and table movement, alternately move up and down the board in regular steps (*e.g.*, up column 1, down column 2, up column 3, and so on) when specifying hole locations.

The Control Software. The opening screen of the PCDrill application program is shown in Fig. 6. The program has an overall Windows-like look and feel, but it's strictly a DOS program that has been tested on everything from a 4.77-MHz 8088 to a 100-MHz Pentium.

There are several options on the application menu. Select one by pressing the Alt key plus the highlighted key (*e.g.*, Alt+F activates the File menu). Both the File and the Drill menus contain submenus; simply press the highlighted key to activate the corresponding item. Table 1 summarizes available commands.

Note: All commands are fully implemented in the version available from the source given in the Parts List. A trial version is available on the **Electronics Now** FTP site (ftp.gernsback.com/pub/

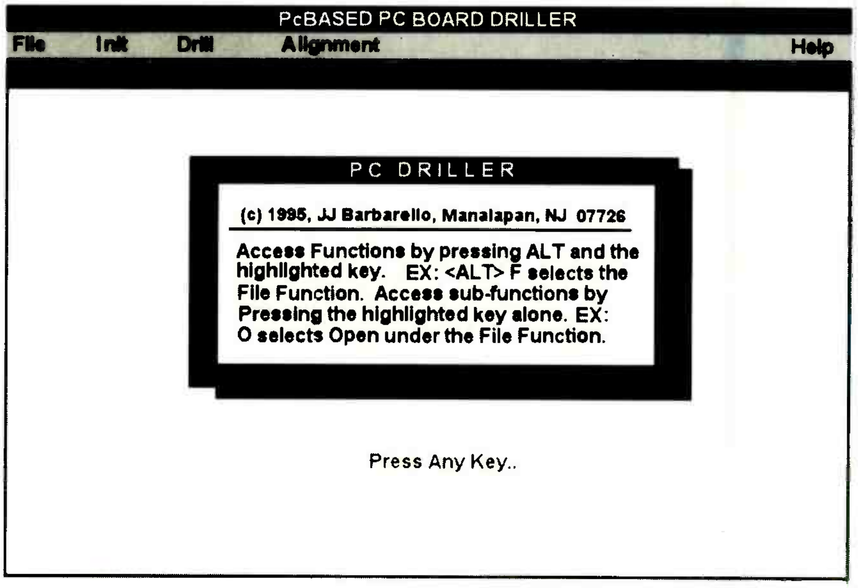


Fig. 6. Here's the opening screen of the full version of the PCdrill application software. Though it has a Windows look and feel, it is DOS based. A trial version is available from this magazine's FTP site (ftp.gernsback.com/pub/EN).

TABLE 1—PCDrill PROGRAM OPTIONS

Option	Sub-Option	Action
File	Open	Open a drill file and load in the drilling data.
	Exit	Exit the program (End).
	DOS shell	Access DOS from withint the program.
Init	Manual	Initialize hardware to 0.0 when this sub-option is selected.
	Auto	Initialize hardware to 0.0 when the Drill, Auto sub-function is executed.
Drill	Manual	Move hardware to any x,y location manually entered.
	Auto	Executes a previously-loaded drill file. Drilling can begin at any hole number.
Alignment		Provides complete control over the table or drill movement.
Help		Reads and displays the DRLHELP.DAT file.

LISTING 1—EXAMPLE SETUP FILE

```
888
2000
869
Message
```

LISTING 2—EXAMPLE SETUP FILE

```
956
5000
869
NO Message
```

LISTING 3—EXAMPLE DATA FILE

```
MY PC BOARD. Version 2.0. For use
with Project 123. Last revision: 2/1/96
5.8,6
.5,.1
1.2,1
```

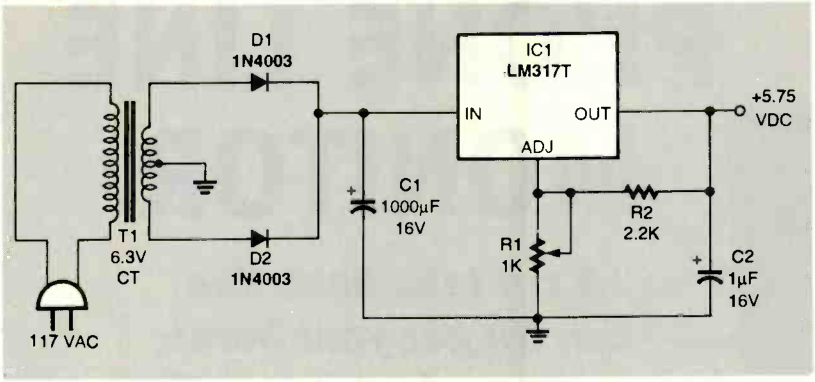


Fig. 7. This adjustable power supply uses an LM317 to provide a regulated source for driving the stepper motors.

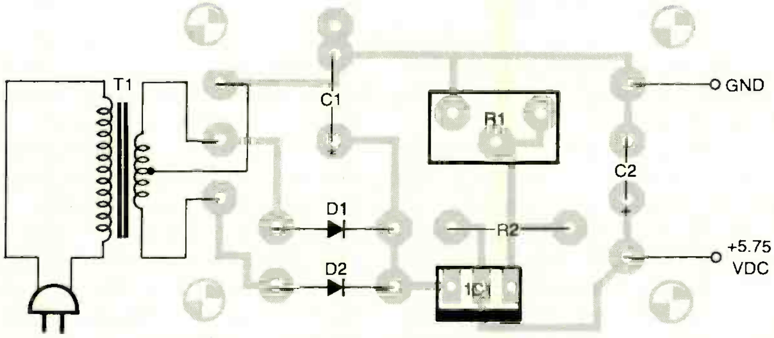
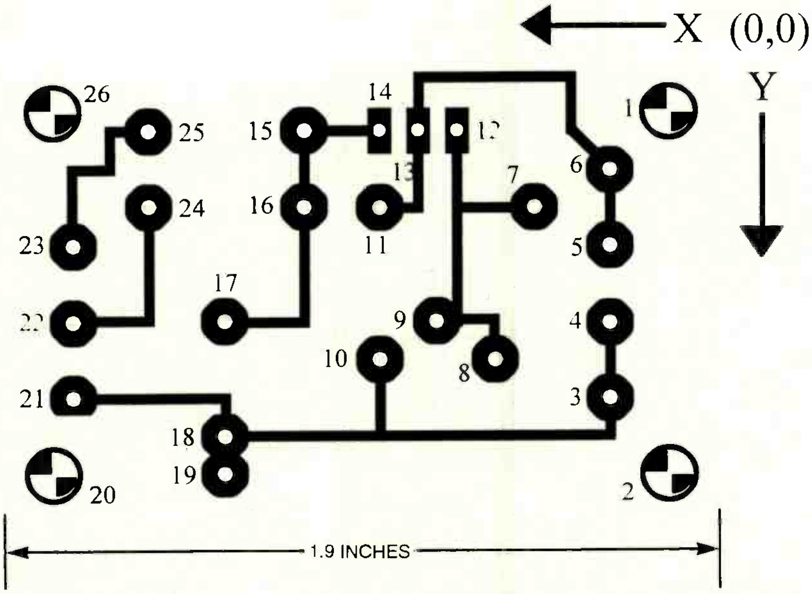


Fig. 8. Use this parts-placement diagram when mounting parts on the power supply's PC board.



Here's the foil pattern for the power supply PC board. To make it easy to follow, it is shown at 200%.

EN/pcdrill.zip). The trial version does not include Init, Alignment, or Help menus. In addition, the File Open submenu is not implemented, as the trial version automatically loads a file named PCDRILL.DAT. Also, the trial version only reads files with a maximum of 32 holes. Last, the Drill menu contains only the Auto submenu.

Power Supply. Figure 7 is the schematic of a simple adjustable power supply that costs around $10 to build. The transformer can be any model with a center-tapped voltage between 6.3 and 9. The circuit includes full-wave rectification, filtering, and an adjustable voltage regulator (IC1, an LM317). With a 1000-ohm potentiometer for R1, the output can be adjusted between about 1.2- and 6.65-volts DC.

We need an example to show end-to-end operation of PCDrill, so we may as well use the PC board for the power supply. For convenience in developing the data file, each hole in the layout, which is found elsewhere in this article, is numbered, and the layout is shown at twice size (200%) to make it easy to follow. The data file (PCBOARD.DRL) appears in Listing 4.

(Continued on page 66)

LISTING 4—PCdrill POWER-SUPPLY PCB FILE

```
PCDrill POWER SUPPLY PCB - V951128
1.9,1.25
.15,.15
.15,1.1
.3, .9
.3,.7
.3,.5
.3,.3
.5,.4
.6,.8
.75,.7
.9,.8
.9,.4
.7,.2
.8,.2
.9,.2
1.1,.2
1.1,.4
1.3,.7
1.3,1
1.3,1.1
1.75,1.1
1.7,.9
1.7,.7
1.7,.5
1.5,.4
1.5,.2
1.75,.15
```

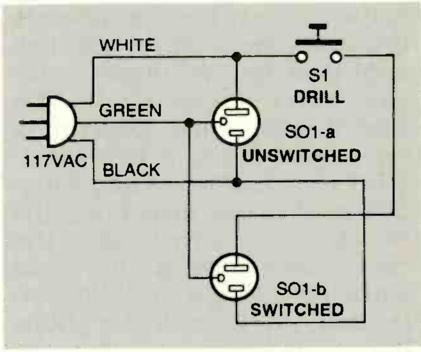
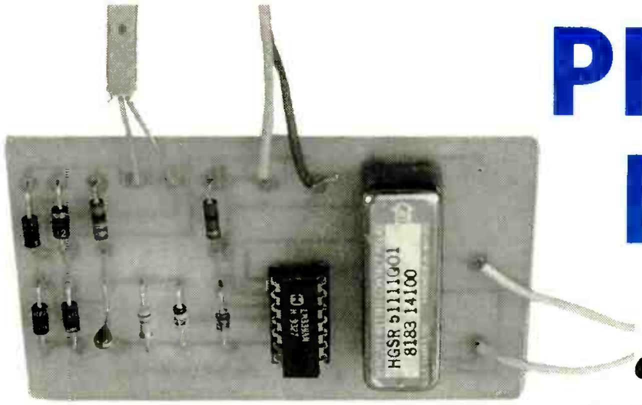


Fig. 9. The optional AC outlet switcher allows you to apply power to the drill only when needed.



PHONE LINE MONITOR

A cut telephone line can trigger your home security system into action.

JAMES MELTON

MANY SECURITY SYSTEMS CAN AUtomatically call a central monitoring station to report a problem. But what do you do if the burglar, who is always trying to stay one step ahead of technology, walks up to your telephone line at the side of your home and cuts the wires? Access to most phone lines can be accessed and cut easily. Consider the degree of freedom given to the utility meter reader who records your meters' readouts for gas, water or electricity. The thief has the same opportunity for access. Here's a new twist: With the new telephone interface used in overhead lines, the burglar can easily unplug the central office line to your home without cutting a wire! No matter how you slice it, the phone line is vulnerable.

The Phone Line Monitor is an easy-to-build electronic gadget that will detect when the phone line has been cut. It ignores normal phone signals such as the phone being off hook and the ringing voltage. The Monitor is designed to work with virtually any security system, and will provide a signal to your home alarm system any time the phone service is interrupted.

The circuit

A typical phone line from telephone company's central office has from 24 to 48 volts DC on it when all telephones are on hook. When you take a phone off hook (pick up the phone), loop current flows in the circuit and the line voltage drops to between 7 and 14 volts. This is the voltage the telephone set uses to dial out and power any extras (such as a speakerphone) while you are talking.

When you receive a call, an AC voltage of approximately 90 volts at 20-30 Hz is impressed on the DC voltage. For this reason, any monitor you build for your phone line must be able to ignore the ringing voltage, otherwise you will get false alarms every time someone calls you.

Figure 1 is the schematic diagram of the Phone Line Monitor. Note that 12-volt DC power is connected to the unit via solder pads C (positive) and G (ground) on the PC board. This power should be supplied from your home security system, since it will have battery backup and thus will be as reliable as your base security system. The input from the telephone line is fed to pads A and B. Polarity is not important to the monitor because the input is rectified by the full-wave bridge rectifier formed by diodes D3-D6. Connecting the phone line to the Phone Line Monitor in no way diminishes

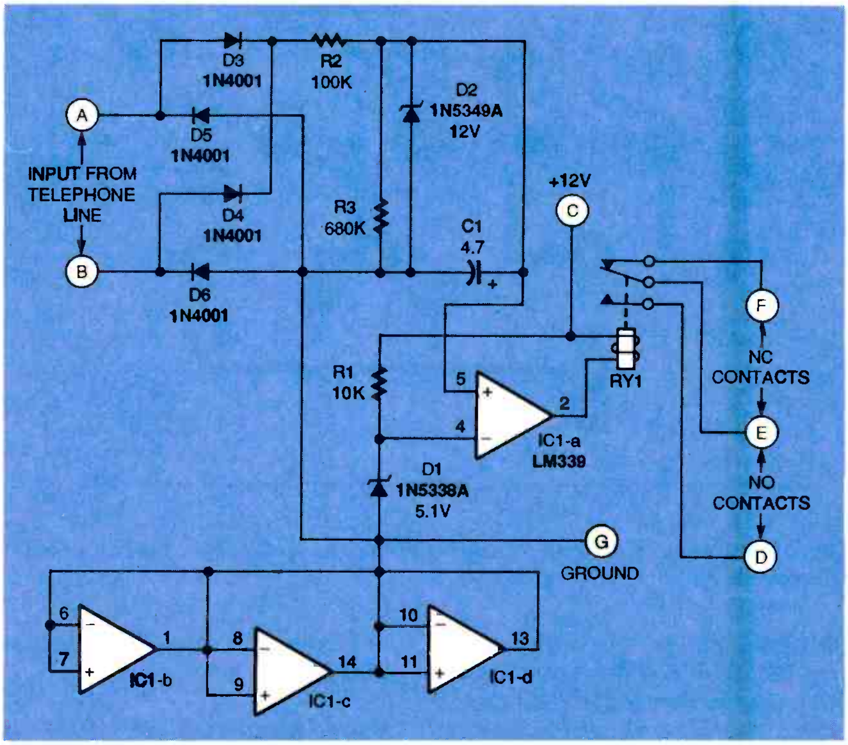


FIG. 1—SCHEMATIC DIAGRAM for the Phone Line Monitor. Notice that three of the unused comparators have their inputs and outputs connected together and then to ground.

A Small View of Telephone History

Until the 1970's, there was only one instrument you could connect to the telephone line—the telephone supplied and installed by the phone company. As technology advanced, the phone company would interconnect an acceptable telephone answering machine. That was about it. Then, equal access and the breakup of the phone company produced two extremely significant events: Modular wiring, and competition. Not enough good words can be written to cover how handy, reliable and versatile the modular wiring concept has become. From voice grade analog basic telephone service to the 100-150 megabit and higher ATM (asynchronous transfer mode) digital service being proposed, one basic style of connector can handle it all!

Then there was the concept of equal access. Not only did other big companies have equal access to providing you long distance or even local access service, but local independent companies had the right to provide you with home or office wiring. You could even do the wiring yourself! No one who has grown up after the concept of equal access took root can realize how jealously the telephone company guarded its phone lines before that time.

Equal access had one other significant benefit for the consumer at home: Other companies could sell you equipment you could attach to the phone system (modular plugs to the rescue again) and, as long as the equipment did not cause interference to the central office equipment, everyone was happy. Now, commercial equipment manufacturers have some strict rules they must adhere to in the area of protection and interference.

Most of the rules require that the equipment does not do any harm to the phone company equipment. Here's the legal loophole: If you are not making equipment commercially, and you are using a self-made project for your own home, you are within the limits of the rules as long as the equipment does no damage.

If the project you made or purchased and attached to the telephone line creates a problem with the circuit, the telephone company will ask you to remove it. You are obligated to do so. If you do not, the telephone company will disconnect your phone service, so you might as well do what is required and fix the offending gadget or appliance. Ω

PARTS LIST

C1—4.7µF, 25V aluminum electrolytic
D1—1N5338A Zener diode, 5.1 volt, 5 watt, axial leads
D2—1N5349A Zener diode, 12 volt, 5 watt, axial leads
D3-D6—1N4001 silicon diode, 50 V, 1A
IC1—LM339N quad comparator
R1—10,000-ohm, ¼-watt, 5% resistor
R2—100,000-ohm, ¼-watt, 5% resistor
R3—680,000-ohm, ¼-watt, 5% resistor
RY1—Relay, mercury-wetted, 12-VDC coil, (Claire HGJJM5111 p00, or equivalent)
A complete kit of parts including the mercury-wetted relay is available from SolarWorks, PO Box 541132, Grand Prairie, TX 75054-1132 for $69.95. Add $3.00 for postage and handling per order.

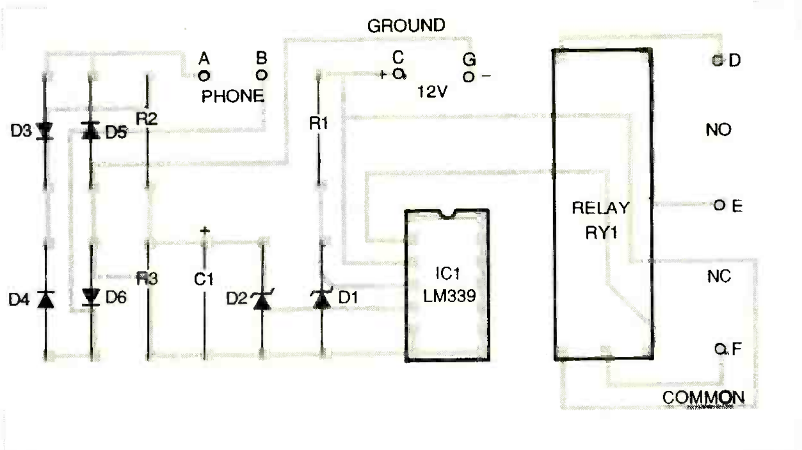
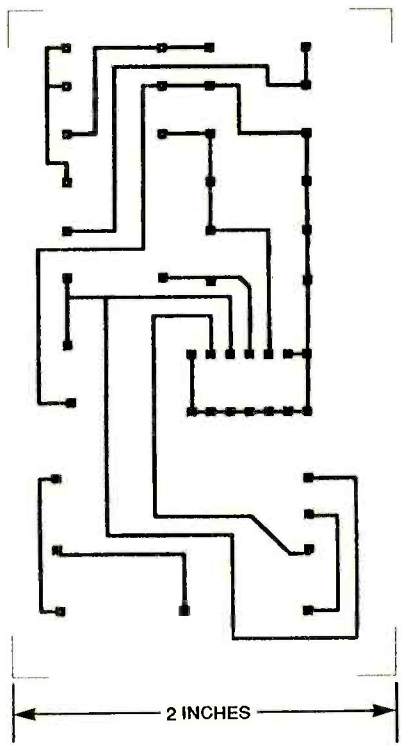


FIG. 2—PC BOARD SILK SCREEN diagram on the non-foil side of the board locates placement and polarization of parts. Location of pads for external connections are pin pointed.



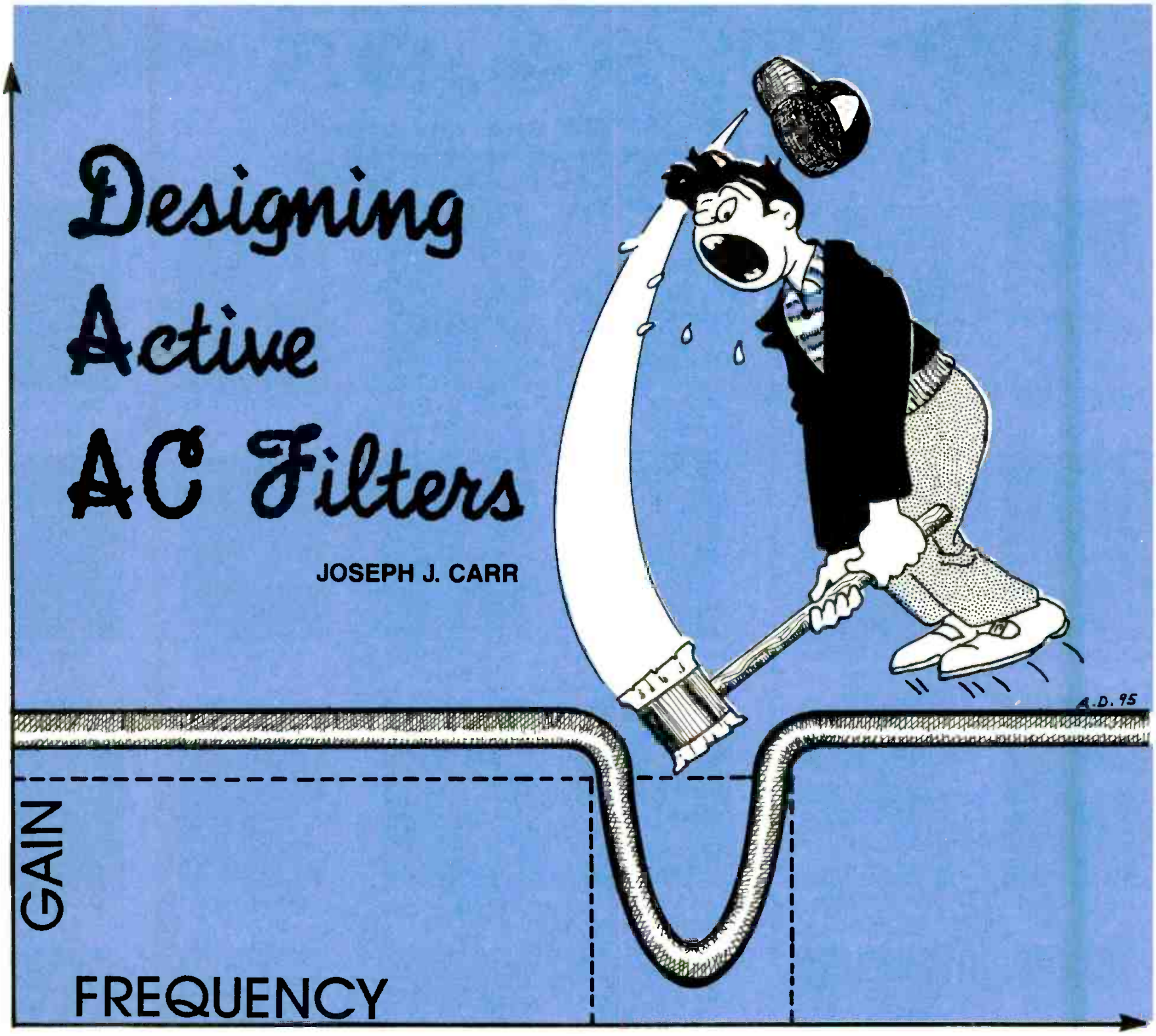
FOIL SIDE VIEW of the printed circuit board shown same size.

phone service and its presence on the line will be unnoticed by you and those who call you.

The rectified or polarized voltage from the bridge rectifier is fed to a long time-constant filter formed by R2 and C1. This filter includes a Zener diode (D2) that limits the voltage maximum charge on C1 to 12 volts during normal operation. Resistor R3 provides a high-resistance shorting path to drain the charge from C1 when there is no input voltage. This is the resistor that sets the time delay for activating the alarm.

The trigger voltage for comparator IC1-a is generated by R1 and D1. Diode D1 is a 5.1 volt Zener whose output is fed to the inverting input (pin 4) of IC1-a. With the inverting input at 5.1 volts, any voltage above 5.1 on the non-inverting input (pin 5) will cause the output of the comparator to go high. Since the output of IC1 is tied to the relay

Continued on page 124



Designing Active AC Filters

JOSEPH J. CARR

Low-pass, high-pass, band-pass and notch—they're all here!

ELECTRONIC FREQUENCY-SELECTIVE AC filters (*filters*) are circuits that favor some frequencies and discriminate against other frequencies. Frequencies that pass through the filter with little attenuation are the *passband*, while attenuated frequencies are the *stopband*.

Filter circuits are classified in several ways: Passive vs. active, analog vs. digital vs. software, by frequency range (e.g. audio, RF, or microwave), or by passband characteristic. *Passive filters* are made of various combinations of passive components such as resistors (R), capacitors (C), and inductors (L). In general, passive filters are lossy; they attenuate the signal and amplification might be ultimately required. *Active filters*, on the other hand, are based on active electronic devices such as a transistor or an operational amplifier along with passive components (R, C, and L) that determine frequency. The passive components are customarily composed of resistors and capacitors for they are cheaper and easier to obtain than inductors.

There are all kinds of filters. *Active filters* use analog linear-circuit techniques such as those applying to operational amplifiers. *Digital filters* use digital IC devices, and are often based on capacitor-switching techniques. *Software filters* implement solutions to frequency-selective equations using computer programming techniques.

Filters are also classified by frequency range. *Audio filters* operate from the sub-audio to ultrasonic ranges (near-DC to about 20-kHz). *RF filters* operate at frequencies above 20-kHz, up to about 900-MHz. *Microwave filters* operate at frequencies greater than 900-MHz. These range designations are not absolute, but do serve to indicate approximate points at which a change of design technique generally takes place. The filter circuits discussed in this article are audio-active filters that have a passband between the sub-audio and the low-ultrasonic regions.

Finally, filters are classified by the nature of their frequency-response characteristics. This method of categorizing filters takes note of the filter's passband and stopband. Low-pass filters, high-pass filters, band-pass filters, and stopband filters will be discussed in this article.

Filter characteristics

Figure 1 shows the frequency-range categories for *ideal* filters. A low-pass filter has a passband from DC (zero Hertz) to a specified cut-off frequency (f_1). All frequencies above the cut-off frequency are attenuated, so they are in the stopband. A band-pass filter has a passband between a lower limit (f_2) and an upper limit (f_3). All frequencies lower than f_2 or greater than f_3 are in the stopband. A high-pass filter has a stopband from DC to a certain lower limit (f_4). All frequencies greater than f_4 are in the passband.

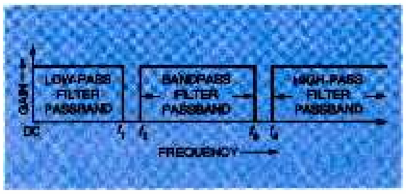


FIG. 1–IDEALIZED frequency-responses curves for low-pass, bandpass and high-pass AC filter circuits.

A stopband filter response is shown in Fig. 2. This filter attenuates frequencies between lower and upper limits (f_5 to f_6), but passes all others. When the stopband is very narrow, the stopband filter is called a notch filter. This filter type is often used to remove a single, unwanted frequency. An example of such an application is removal of unwanted 60-Hz interference (AC hum) caused by proximity to the AC power line.

Ideal vs. practice

The frequency-response

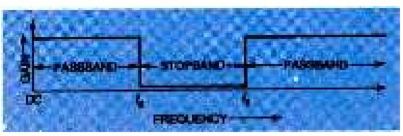


FIG. 2–IDEALIZED frequency-response curve for stopband AC filter circuits.

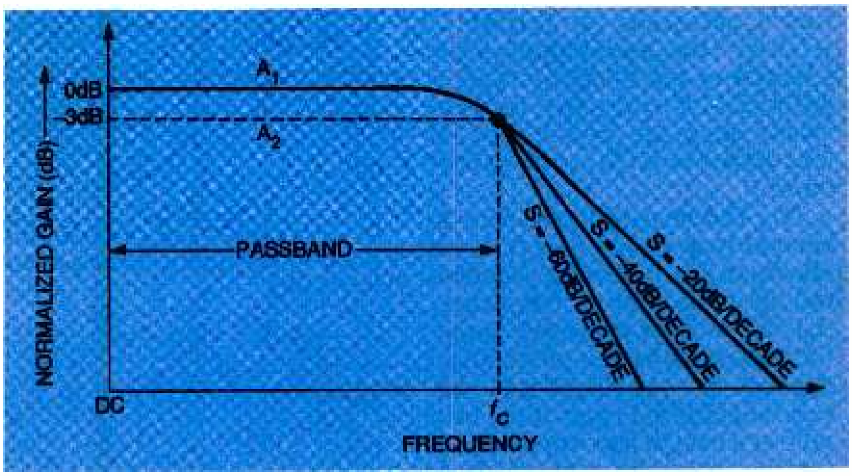


FIG. 3–TYPICAL LOW-PASS FILTER passband frequency-response curves for first, second and third-order Butterworth filters.

curves shown in Figs. 1 and 2 are idealized. In real life the corners of the curves are rounded and not squares, and the vertical lines are gentle to steep slopes as illustrated in Fig. 3. The Butterworth, Chebyshev, Cauer (also sometimes called elliptic), and Bessel filters are among the typical filters used. The ideal Butterworth frequency-response curve is shown in Fig. 3. The noteworthy properties of the Butterworth filter is that both the passband and stopband are relatively flat, and the transition region slope between them is continuous.

Standard practice in filter nomenclature is to specify the passband between frequencies where the frequency response falls off 3 dB from the mid-passband gain. In Fig. 3, the cut-off frequency (f_c) is at the point where gain (A_2) falls off by a factor of 0.707 to a designated gain value called A_1. At that spot in the frequency-response curve, the reference point is called the *−3-dB point*.

At frequencies greater than f_c, the gain falls off linearly at a rate that depends on the order of the filter. The slope (S) of the fall off is measured in either decibels per octave (a 2:1 frequency change) or decibels per decade (a 10:1 frequency change). Note that these two specifications can be scaled relative to each other: −6- dB/octave has the same slope as −20-dB/decade. The slopes shown in Fig. 3 cover three Butterworth cases. A first-order filter has a roll-off of −20-dB/decade, a second-order filter has a roll-off of −40-dB/decade, and a third-order filter has a roll-off at −60-dB/decade. These slopes are the same as 6, 12 and 18-dB/octave, respectively.

It might appear that only third-order filters are used because the transition from passband to stopband is most rapid (steep). But higher-order frequency-response filtering is obtained at the cost of more complexity, greater sensitivity to component value error, and difficult design configurations. Some higher-order filter designs are also more likely to oscillate than lower-order equivalents. The selection of filter order is a trade-off between system needs and complexity.

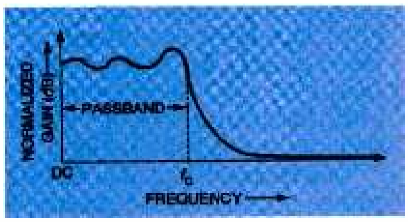


FIG. 4–PASSBAND FOR LOW-PASS Chebyshev AC filter reveals a rapid gain fall-off at the cut-off frequency, f_c.

The steepness and shape of the roll-off curve is a function of the filter's damping factor. Butterworth filters tend to be heavily damped, which explains the gradual roll-off in the response curve. The Chebyshev filter frequency-response curve shown in Fig. 4 is lightly damped, so it has a variation (or "ripple") within the passband. The Chebyshev filter offers a faster gain roll-off than the Butterworth filter, but at the cost of less flatness within the passband.

The Cauer or elliptic filter's frequency-response curve shown in Fig. 5 offers the fastest roll-off at the cut-off frequency (f_c), as well as relatively good flatness within the passband. Notches of -40 dB to -60 dB can be achieved close to f_c, but only at a cost of less attenuation further into the stopband. A typical Cauer filter response has a deep notch close to f_c, rises to a peak at some high frequency, and then gradually falls off for even higher frequencies at a rate of -20-dB to -40- dB/decade.

The frequency-response curve for the Bessel filter is shown in Fig. 6. Although it appears similar to the Butterworth response, its gain is not flat within the passband. The benefit of the Bessel filter is a flat phase response across the passband.

Filter phase response

Most filter circuits exhibit a phase change over the passband. The responses for the Butterworth and Bessel filters are shown in Fig. 7. Note that the maximal flat Butterworth curve exhibits a decidedly nonlinear phase response in both passband and stopband. The frequency dependent phase shift of a low-pass filter is -45 degrees at f_c, and increases by a factor of -45 degrees for each additional increase of -20-dB/decade in the roll-off slope.

The Bessel filter also shows a phase shift over the passband, but it is nearly linear. A useful feature of this characteristic is that it allows a uniform time delay all across the passband. As a result, the Bessel filter offers the ability to pass transient pulse wave forms with minimum distortion. The Bessel filter is said to work best at the frequency where $f = f_c/2$.

Low-pass filters

A diagram for a low-pass filter circuit is shown in Fig. 8. This filter is called the voltage-controlled-voltage-source (VCVS) filter. The basic configuration is a non-inverting-follower operational amplifier (IC1). The operational amplifier selected should have a high-gain bandwidth, relative to the cut-off frequency, in order to permit the filter to operate properly. The gain of the circuit is given by:

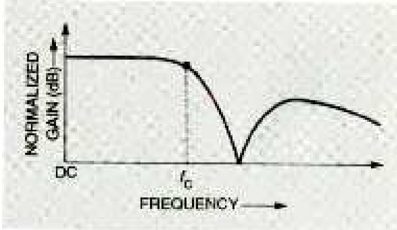


FIG. 5–PASSBAND for the Cauer or Elliptic AC filter.

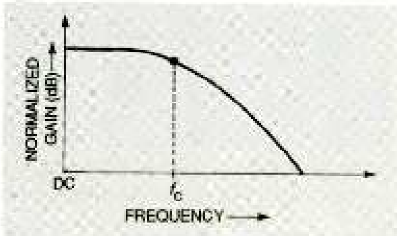


FIG. 6–PASSBAND for the Bessel AC filter.

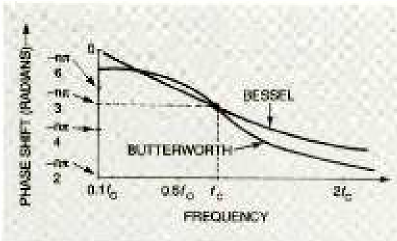


FIG. 7–COMPARISON of signal phase response for the Butterworth and Bessel AC filters.

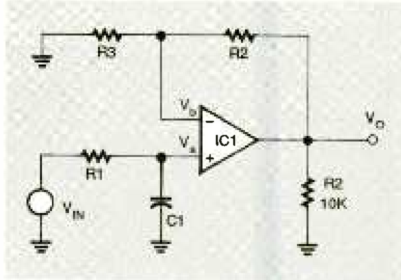


FIG. 9–FIRST-ORDER VCVS low-pass filter circuit using a typical operational amplifier.

$$A_v = (R_f/R_{in})$$

When $R_{in} = R$:

$$R_f = R(A_v - 1)$$

In some circuits, the gain may be unity. In those circuits the resistor voltage-divider feedback network is replaced with a single connection between output and the inverting input.

The input circuitry of the generic VCVS filter consists of a network of impedances labeled Z1 through Z6. Each of these blocks will be either a resistance (R) or a complex capacitive reactance ($-jX_c$). Which element becomes which type of component is determined by whether the filter is a low-pass or high-pass type.

The order of the filter, denoted by *n*, refers to the number of *poles* in the design, or in practical terms, the number of RC sections. A first-order filter ($n = 1$) consists of Z3 and Z6 (Fig. 8), a second-order filter ($n = 2$) consists of Z2, Z3, Z5 and Z6, and a third-order filter ($n = 3$) consists of all six impedances (Z1 through Z6). Higher order filters (n greater than 3) can also

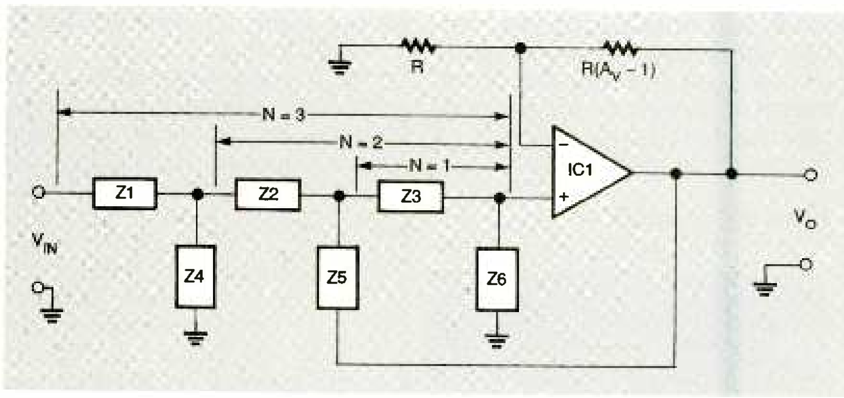


FIG. 8–HERE'S A SIMPLIFIED SCHEMATIC for a low-pass design known as a voltage-controlled-voltage-source (VCVS) filter.

be built. In a low-pass filter Z1 through Z3 are resistances, while Z4 through Z6 are capacitances. The component types are reversed in high-pass filters.

First-order low-pass filters

The first-order low-pass VCVS filter is shown in Fig. 9, and its frequency-response curve is shown in Fig. 3 (slope S = −20-dB/decade). The filter consists of a single-section RC low-pass filter driving the non-inverting input of an operational amplifier. The gain of the operational amplifier is [(R2/R3) +1]. The high-input impedance of IC1 prevents loading of the RC network. The general form of the transfer equation for the gain vs. frequency response for the first-order filter is:

$$A_{dB} = 20LOG(A_v) - 20LOG[1 + (\omega_o)^2]^{1/2}$$

where: A_{dB} is the gain of the circuit in decibels; A_v is the voltage gain within the passband; LOG denotes the base-10 logarithms; f_o is the ratio of the input frequency to the cut-off frequency ($f_o = f/f_c$).

The voltage at the output of the RC network (V_a) is found from the voltage divider equation:

$$V_a = -jX_cV_{in}/(R - jX_c)$$

where: $-jX_c = 1/(j2\pi fC)$ and j is the imaginary operator $[(-1)^{1/2}]$.

Substituting the value for −jXc:

$$V_a = [V_{in}/j2\pi fC]/R + [1/j2\pi fC]$$

which simplifies to:

$$V_a = V_{in}/[1 + \pi fCR]$$

If the transfer function of the non-inverting follower is:

$$V_o = V_{in}[(R2/R3) + 1]$$

and since $V_{in} = V_a$:

$$V_o = [V_{in}/(1 + 2\pi fCR)] \times [(R2/R3) + 1]$$

The above equation is put into a more workable form:

$$V_o/V_{in} = [A_v/(1 + jf/f_c)]$$

where: V_o is the output signal voltage; V_{in} is the input signal voltage; A_v is the passband gain [(R2/R3) +1]; f is the signal frequency; and f_c is the −3-dB frequency (1/2πRC).

The filter parameters are required to define the operation of any particular circuit. The *gain magnitude* and *phase shift* are found from the following equations:

Gain magnitude:

$$V_o/V_{in} = A_v/[1 + (f/f_c)^2]^{1/2}$$

and *phase-shift angle* (in radians):

$$\phi = -\mathrm{Tan}^{-1}(f/f_c)$$

Because the filter characterization depends in part on the ratio f/f_c, the equations take different forms at different values of f and f_c. These can be reduced as follows:

At low frequencies that are well within the passband (f is less than f_c):

$$V_o/V_{in} = A_v = (R2/R3) + 1$$

At the −3-dB cut-off frequency ($f = f_c$):

$$V_o/V_{in} = 0.707A_v$$

At a high frequency that is well above the −3-dB cut-off frequency (f greater than f_c):

$$V_o/V_{in} < A_v$$

Table 1 shows the characteristics of first-order filters at several different ratios of f/f_c.

Designing a first-order low-pass filter

There are two basic ways to determine the component values for the low-pass filter shown in Fig. 9: ground-up and frequency-scaling methods. The following is the ground-up method:

1. Select the −3-dB cut-off frequency (f_c) required.
2. Select a standard-value capacitor value.
3. Calculate the required resistance for R1:

$$R1 = 1/2\pi f_cC$$

4. Select the passband gain for f less than f_c.
5. Select a value for R, and
6. Calculate R_f from:

$$R_f = R(A_v - 1)$$

Example

A low-pass filter shown in Fig. 9 is needed to process a transducer signal. The cut-off frequency should be 100-Hz, and the gain should be 5. The solution is:

1. F_c = 100-Hz
2. Select trial value for C1: 0.1-μF
3. Calculate R1:

$$R1 = 1/2\pi F_cC1$$

$$R1 = 15{,}923 \text{ ohms}$$

4. Select a trial value for R1: 10,000 ohms. Then calculate R_f:

R_f = 40,000 ohms

Design by normalized model

The filter design can be simplified by using a normalized

TABLE 1—FILTER CHARACTERISTICS

Applied Frequency (Hz)	Gain Magnitude A_v	Gain Magnitude dB	Phase Shift (degrees)
10	2.00	6.020	−0.57
20	1.999	6.018	−1.15
50	1.998	6.009	−2.86
80	1.994	5.993	−4.57
100	1.990	5.977	−5.71
200	1.961	5.850	−11.31
500	1.789	5.052	−26.57
800	1.561	3.872	−38.66
1000	1.414	3.010	−45.00
2000	0.894	−0.969	−63.43
5000	0.392	−8.129	−78.69
8000	0.248	−12.109	−82.87
10000	0.199	−14.023	−84.29
20000	0.100	−20.011	−87.14
50000	0.040	−27.960	−88.85
80000	0.025	−32.042	−89.28
100000	0.020	−33.980	−89.43

model. First, design a filter for a standardized frequency (e.g. 1-Hz, 10-Hz, 100-Hz, 1000-Hz or 10,000-Hz) and list the component values. The values for any other frequency can then be computed by a simple ratio and proportion. An example of a first-order low-pass Butterworth filter is shown in Fig. 10 with the component values normalized for 1 kHz. The actual required component values (R1' and C1') are found by dividing the normalized values shown by the desired cut-off frequency in kilohertz:

$$C1' = (C1)(1\text{-kHz})/f$$

or

$$R1' = (R1)(1\text{-kHz})/f$$

Note: The value for f in above two equations is in kilohertz (kHz) units.

Leave one of the values alone, and calculate the other. In general, it is easier to obtain precision resistors in unusual values (or the value obtained by a potentiometer), so it is common practice to select a standard capacitance and calculate the required resistance.

Example:

Change the frequency of the normalized 1-kHz filter to 60 Hz (i.e. 0.06 kHz).

$$C1' = (C1)(1\text{-kHz})/f = 0.265\ \mu F$$

Second-order low-pass filters

The circuit for a second-order, low-pass filter is shown in Fig. 11, while the response curve with a −40-dB/decade slope is shown in Fig. 3. This circuit is similar to the first-order filter (Fig. 10), but with an additional RC network in the frequency-selective portion of the circuit. The circuit is wired for unity gain.

The purpose of R3 in Fig. 11 is to help counteract the DC offset at the output of the operational amplifier that is created by input bias currents charging the capacitors in the frequency selective network. The value of R3 in the unity gain case is 2R, where R is the value of the resistors in the frequency selective network. In cases where DC

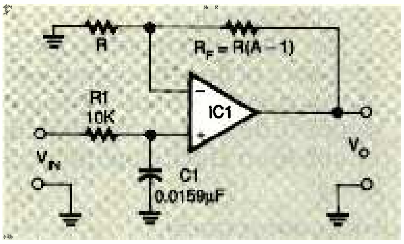


FIG. 10–FIRST-ORDER VCVS low-pass filter circuit normalized to 1-kHz by the selection of component values.

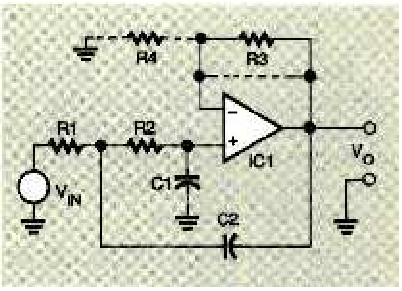


FIG. 11–SECOND-ORDER VCVS low-pass filter circuit normalized to 1 kHz by the selection of component values.

offset is not a problem, resistor R3 can be replaced with a short circuit between the operational amplifier output and the inverting input. If passband gain for the second-order, low-pass filter is required, then resistors R3 and R4 are used.

The second-order VCVS filter is by far the most commonly used type. Its −40-dB/decade roll-off, coupled with a high degree of stability, results in a generally good trade- off between performance and complexity.

The general form of the second-order filter transfer equation is similar to the expression for the first-order filter:

$$A_{dB} = 20LOG(A_v) - 20LOG[(\omega_o)^4 + (a^2 - 2)(\omega_o)^2 + 1]^{1/2}$$

where a is the damping factor of the circuit, and other terms are as defined earlier for the first-order case.

The damping factor (a) is determined by the form of filter circuit. For the Butterworth design the value of a is 1.414.

The passband gain for this circuit is the normal gain for any non-inverting follower/amplifier. If the output is strapped directly to the inverting input, or if R3 (but not R4) is used in the feedback network, then the gain is unity ($A_v = +1$). For gains greater than unity (A_v 1), the following is true:

$$A_v = (R3/R4) + 1$$

The cut-off frequency (f_c) is the frequency at which the voltage gain drops −3 dB from the passband gain. This gain is found from:

$$A_v = 1/[2\pi(R1R2C1C2)^{1/2})$$

The gain magnitude (V_o/V_{in}) is found in a manner similar to the first-order case:

$$V_o/V_{in} = A_v/[1 + (f/f_c)^4]^{1/2}$$

There is no requirement in VCVS filters that like components (R or C) in the frequency selective network be made equal, but such a step simplifies the design procedure. If R1 = R2 = R, and C1 = C2 = C, then:

$$f_c = 1/2\pi RC$$

A constraint on this simplification is that the Butterworth response is guaranteed only if A_v is equal to or greater than 1.586.

Design procedure

1. Select the −3-dB cut-off frequency (f_c) based on the circuit requirements and applications.
2. Select a standard value capacitance.
3. Calculate the required resistance from:

$$R1 = 1/2\pi f_c C$$

4. Select the passband gain for f less than f_c.
5. Select a value for resistor R4, and
6. Calculate R3 from:

$$R3 = R4(A_v - 1)$$

The normalized 1-kHz trial values for doing scaling design of the second-order low-pass filter are shown in Fig. 11. The design here is based on a more complex arrangement whereby C2 = 2C1. Some designers maintain that this is the superior design. The same scaling rule is applied to the second-order filter as used in the first-order design.

Now that you know a little smoke about the low-pass filter we are going to change gears and look at the high- pass and band-pass filter circuits.

High-pass filters

The function of the high-pass filter is the inverse to that of the low-pass filter, so one can reasonably expect its frequency-response characteristic to mirror that of the low-pass filter response. Figure 12 shows the high-pass filter response with roll-off slopes of −20-, −40-, and −60-dB/decade. Compare the frequency-response curves in Fig. 12 to those in Fig. 3. The passband of the high-pass filter are all frequencies above the cut-off frequency f_c. As in the low-pass case, f_c is the frequency at which passband gain drops −3 dB; that is $A_{vc} = 0.707A_v$.

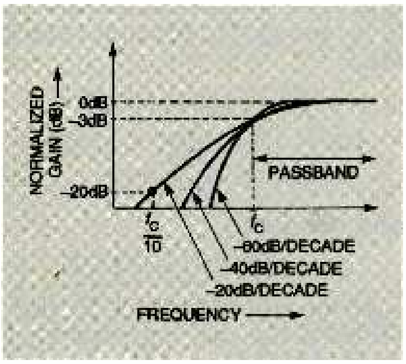


FIG. 12–FREQUENCY RESPONSE characteristic for first-order, second-order and third-order VCVS high-pass AC filters.

The cut-off frequency phase shift in a high-pass filter has the same magnitude as the low-pass case, but the sign is opposite. At f_c, the high-pass filter exhibits a phase shift of +45 degrees per 20-dB/decade of roll-off. Put another way, the phase shift is (n × 45-degrees), where n is the order of the filter.

The high-pass versions of the VCVS filters are of the same form as the low-pass filter. In the case of the high-pass filter, however, impedances Z1 through Z3 are capacitances, while Z4 through Z6 are resistances (Fig. 8). In the high- pass filter the roles of the resistors and capacitors are reversed.

First-order high-pass filters

The circuit for a first-order high-pass filter is shown in Fig. 13. This circuit is identical to the first-order low-pass filter in which the roles of C1 and R1 are interchanged (see Fig. 10). The high-pass filter shown here is normalized for 1 kHz. Passband gain of this circuit is:

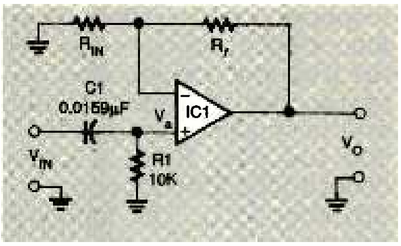


FIG. 13–FIRST-ORDER VCVS high-pass filter circuit normalized to 1-kHz by the selection of component values.

$$A_v = (R_f/R_{in}) + 1$$

The voltage at the non-inverting input of the operational amplifier (V_a) is developed across resistor R1, and is given by:

$$V_a = j2\pi fR1C1V_{in}/ \div (1 + j2\pi fR1C1)$$

The transfer equation for the circuit is:

$$V_o = A_vV_a$$

$$V_o = [(R_f/R_{in}) + 1] \times [j2\pi fR1C1V_{in}/(1 + j2\pi fR1C1)]$$

And, in the traditional form, the equation becomes:

$$V_o/V_{in} = A_vj(f/f_c)/[1 + (f/f_c)]$$

As in the previous cases, the cut-off frequency f_c is found from:

$$f_c = 1/2\pi R1C1$$

The gain magnitude of this circuit is the absolute value of the traditional form of the transfer equation:

$$V_o/V_{in} = A_v(f/f_c)/[1 + (f/f_c)^2]^{1/2}$$

The VCVS high-pass filter shown in Fig. 6 is normalized to 1 kHz. The same scaling technique is used for this circuit as was used for the low-pass filters discussed earlier.

Second-order high-pass filter

The second-order high-pass filter offers a roll-off slope of −40 dB/decade as illustrated in Fig. 12. This VCVS filter circuit (Fig. 14) is, like its low-pass counterpart, probably the most commonly used form of high-pass filter. The circuit is similar to the low-pass design except for a reversal of the roles of capacitors and resistors. The cut- off frequency is the frequency at which gain falls off −3 dB, and is found from:

$$f_c = 1/2\pi[R1R2C1C2]^{1/2}$$

or, in the case where R1 = R2 = R, and C1 = C2 = C:

$$f_c = 1/2\pi RC$$

The gain magnitude of the circuit is found from:

$$V_o/V_{in} = A_v/[1 + (f_c/f)^4]^{1/2}$$

Example

Calculate the cut-off frequency of a filter shown in Fig. 14 in which C1 = C2 = 0.0056 µF and R1 = R2 = 22,000 ohms.

$$f_c = 1/2\pi RC$$

$$f_c = 1/(7.74) \times 10^{-4} = 1{,}293 \text{ Hz}$$

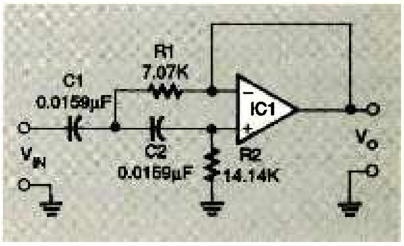


FIG. 14–SECOND-ORDER VCVS high-pass filter circuit normalized to 1-kHz by the selection of component values.

Band-pass filter

The band-pass filter is a circuit that has a passband between an upper limit and a lower limit. Frequencies above and below these limits are in the stopband. There are two basic forms of band-pass filters: Wide band pass and narrow band pass. These two types are sufficiently different that they offer different frequency response characteristics. The wide band-pass filter may have a passband that is wide enough to be called a band-pass amplifier rather than a filter and its frequency

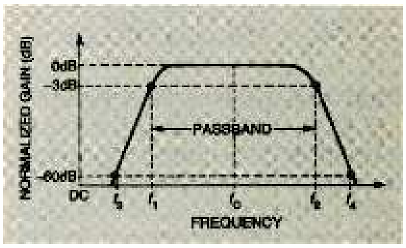


FIG. 15–TYPICAL BANDPASS curve for a wide-band filter.

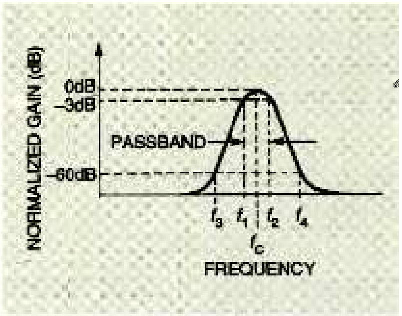


FIG. 16–TYPICAL BANDPASS curve for a narrow-band filter.

response curve is shown in Fig. 15. The narrow band-pass frequency response is shown in Fig. 16. The passband is defined as the frequency difference between the upper −3-dB point (f_2), and the lower −3-dB point (f_1). The bandwidth (BW) is:

$$BW = f_2 - f_1$$

The center frequency f_c (not to be confused with the cut-off frequency f_c) of the band-pass filter is usually symmetrically placed between f_1 and f_2, or $(f_2 - f_1)/2$. If the filter is a very wide-band type, however, the center frequency is:

$$f_c = [f_1 f_2]^{1/2}$$

Band-pass filters are sometimes characterized by the figure of merit, or Q that is a factor that describes the sharpness of the filter, and is computed from:

$$Q = f_c/BW = f_c/(f_2 - f_1)$$

The Q of the filter tells us something of the passband characteristic. Wide-band filters generally have a Q less than 10, while narrow-band filters have a Q greater than 10.

The *shape factor* of the filter characterizes the slope of the roll-off curve, so is obviously related to the order of the filter. The shape factor (SF) is defined as the ratio of the −60-dB bandwidth to the −3-dB bandwidth:

$$SF = BW_{-60dB}/BW_{-3dB}$$

First-order band-pass filters

A wide-band first-order band-pass filter frequency response is obtained by cascading first-order, high-pass and low-pass filter circuits, as shown in Fig. 17. This arrangement overlays, or superimposes, the frequency response characteristics of both filter stages into one stage. Figure 18 shows the filter's frequency response when cascade high- and low-pass filters are used. The low-pass filter response (solid line) is from DC to the −3-dB point at f_2. The high-pass filter response (dashed line) is from the highest possible frequency within the range of the circuit down to the −3-dB point at f_1. The passband is the intersection, or overlay, of the two sets: high and low-pass characteristics, which falls between f_1 and f_2.

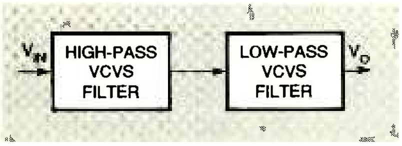


FIG. 17–BANDPASS FREQUENCY response can be achieved by cascading low-pass and high-pass AC filter stages

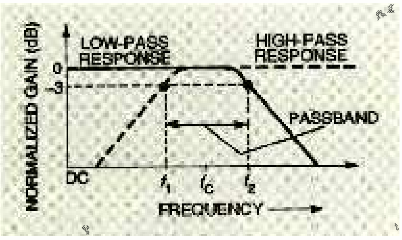


FIG. 18–THE PASSBAND is the overlapping of two separate frequency response curves.

The gain of the overall band-pass filter within the pass band is the product of the two individual gains:

$$A_{vt} = A_{VL} \times A_{VH}$$

The gain magnitude term of this form of filter is found by:

$$V_o/V_{in} = A_{vt}(f/f_1)/[(1 + (f/f_1)^2 \times (1 + (f/f_c)^2]^{1/2}$$

where V_o is the output signal voltage; V_{in} is the input signal voltage; f is the applied frequency; f_1 is the lower −3-dB frequency; f_2 is the upper −3-dB frequency; and A_{vt} is the total cascade gain of the filter.

Cascading low and high-pass filter sections can be used to make wideband filters, but because of component tolerance and other problems it becomes less useful as Q increases above about 10 or so. For narrow-band filters a multiple-feedback-path (MFP) filter circuit such as shown in Fig. 19 can be used. This filter circuit (Fig. 19) offers first-order performance and relatively narrow band-pass. The circuit will work for values of Q more than or equal to 10 and Q less than or equal to 20, and gains up to about 15. The center frequency of the MFP band-pass filter is:

$$f_c = (1/2\pi)[1/R3C1C2(1/R1 + 1/R2)]^{1/2}$$

To calculate the resistor values it is necessary to first select the passband gain (A_v) and Q. It is the general practice to select values for C1 and C2, and then calculate the required resistances for the specified values of f_c, A_v and Q. The resistor values are:

$$R1 = 1/2\pi A_v C2 f_c$$

$$R2 = 1/2\pi f_c(2Q^2 - A_v)C2$$

$$R3 = 2Q/2\pi f_c C2$$

and the gain

$$A_v = R3/R1(1 + C2/C1)$$

These equations can be simplified if the two capacitors are made equal (C1 = C2 = C), and assuming that Q is greater than $(A_v/2)^{1/2}$:

$$R1 = Q/2\pi f_c A_v C$$

$$R2 = Q/2\pi f_c C(2Q^2 - A_v)$$

$$R3 = 2Q/2\pi f_c C$$

$$A_v = R3/2R1$$

Example

Design an MFP band-pass filter with a gain of 5 and a Q of 15 when the center frequency is 2,200-Hz. Assume that C1 = C2 = 0.01-µF. *Solution:*

$$R1 = Q/2\pi f_c A_v C$$

$$R1 = 217{,}140 \text{ ohms}$$

$$R2 = Q/2\pi f_c(2Q^2 - A_v)$$

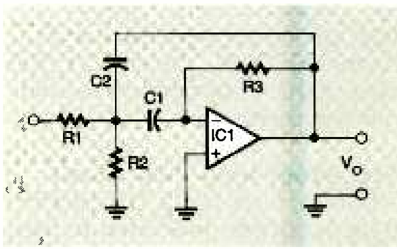


FIG. 19–MULTIPLE-FEEDBACK-PATH (MFP) filter achieves narrow-band band-pass response.

$$R2 = 15/0.062 = 240 \text{ ohms}$$

$$R3 = 2Q/2\pi f_c C$$

$$R3 = 217{,}140 \text{ ohms}$$

The band-pass filter is capable of being tuned using only one of the resistors. When R2 is varied, the center frequency will shift, but the bandwidth, Q, and gain will remain constant. To scale the circuit to a new center frequency ($f_{c'}$) using only R2 as the change element, select a new value of R2 according to:

$$R2' = R2(f_c/f_{c'})$$

Notch filters

A band-reject or notch filter is used to pass all frequencies except a single frequency (or small band of frequencies). A common application for this circuit is to remove 60-Hz interference from sensitive electronic instruments. For example, the medical electrocardiograph (ECG) machine suffers 60-Hz line interference. These devices often include a switch-selectable 60-Hz notch filter to reject the interference.

Figure 20 shows a typical active-notch filter, while Fig. 21 shows the frequency-response curve for that circuit. Note that the gain is constant throughout the frequency spectrum except in the immediate vicinity of f_c. The depth of the notch is infinite in theory, but in practical circuits precision matched components will offer −60 dB of suppression, while ordinary components can offer −40 to −50 dB of suppression. The resonant frequency of this notch filter is found from:

$$f_c = 1/2\pi RC$$

The gain of the circuit is unity, but the Q can be set according to the following equations:

$$Q = R_a/2R$$

or

$$Q = C/C_a$$

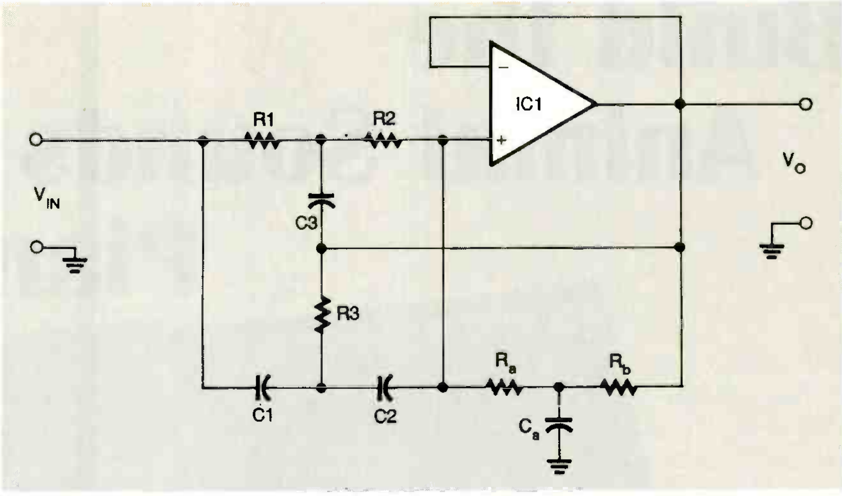


FIG. 20–A TYPICAL UNITY-GAIN, active-notch filter circuit based on the twin-tee network and an operational amplifier.

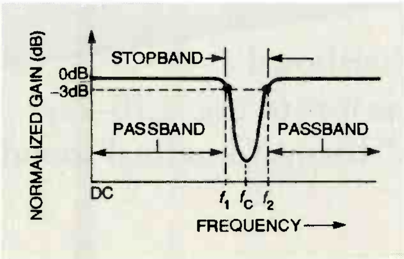


FIG. 21–FREQUENCY-RESPONSE curve for the MFP filter circuit displays a narrow frequency notch.

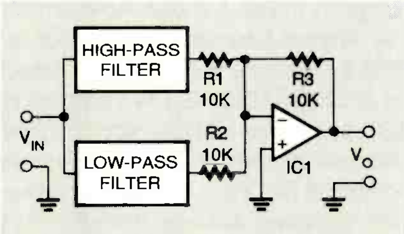


FIG. 22–BAND-REJECT FILTER is made by summing the high-pass and low-pass filter circuit elements into one circuit.

Bandstop filter

A bandstop filter is an example of a notch filter with a wider stopband. Just as the wide band-pass filter can be made by cascading high- and low-pass filters, the wide-band notch (or stopband) filter can be made by paralleling high- and low-pass filters. Figure 22 shows a bandstop filter in which the outputs of a high-pass filter and a low-pass filter are summed together in a two-input, unity-gain, inverting-follower amplifier circuit. The frequency-response curves of the two filter sections are superimposed to eliminate the undesired band. When designing the bandstop filter, select the −3-dB point of the high-pass filter equal to the upper end of the stopband, and the −3-dB point of the low-pass filter equal to the lower end of the stopband.

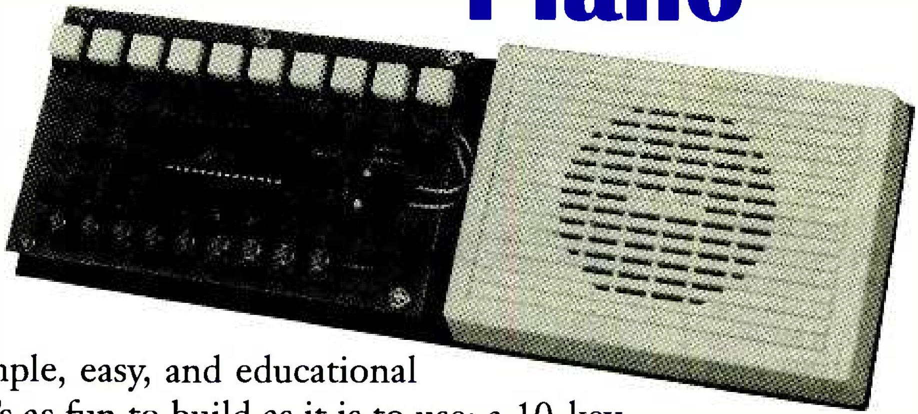
Summary

The subject of AC filter circuits is often presented as a mystical art. Indeed, the actual mathematical basis for these circuits is a bit esoteric; nonetheless, the truth is that most people can design and build practical filter circuits using only simple algebra. In fact, if you use the method of the normalized model even that math is avoided. Now, there is no reason to avoid using these very useful circuits in your own designs. Why not give it a try at your next opportunity. Ω

FilterMaker Software

Now available on the *Electronics Now* FTP site is FilterMaker, a software program that is an extension of this article. FilterMaker has two subsections: Passive L-C Filters and Active Op-Amp Filters. The latter offers circuit diagrams of the filter circuits covered in this article. The component values can be changed automatically for different frequencies at the touch of a screen button. Designing the circuits leaves the computations for your computer to resolve in the blink of an eye. You can get FilterMaker by connecting to the FTP site (ftp.gernsback.com/pub/EN) and downloading the file FILTERS.ZIP. After unzipping, you can install the program on computers running Windows 3.0 or better. From the Program Manager, click on FILE, then RUN, type A:SETUP and press ENTER. (This assumes that the unzipped version of FILTERS.ZIP is allocated on a disk in your A drive.) An icon will appear on the Program Manager screen that you can click to activate the program.

Build the Animal Sounds Piano



Here's a simple, easy, and educational project that's as fun to build as it is to use: a 10-key music synthesizer that "plays" barnyard-animal sounds!

DAVID WILLIAMS

If you want to give your youngsters hours of fun and entertainment away from the television set, then the Animal Sounds Piano might be just the project you're looking for. This unique device is a music synthesizer that has ten keys for playing notes of the scale from A below middle C (A3) to C above middle C (C5). In the normal piano mode, each key press produces a piano-like note from the speaker. However, the real fun begins when you select an animal sound and play musical notes that sound like a cat, dog, pig, bird, chicken, duck or even a sheep!

For those lacking musical ability, there is also a demo mode that plays three different songs using all of the different animal sounds. The entire circuit runs on 2 AA batteries, and automatically shuts power off after one minute of inactivity. Since the Animal Sounds Piano is very simple to build, it makes a great learning project for kids of all ages and once built, will provide hours of fun and entertainment.

Circuit Description. The schematic diagram in Fig. 1 shows how simple the Animal Sounds Piano circuit is. That is because the circuit is based on a CMOS Large-Scale Integration (LSI) chip, the HT3106, from Holtek Microelectronics, Inc. That integrated circuit (IC1) is a music synthesizer with sampled sounds stored in an internal ROM. It also contains a built-in oscillator and a 128-byte ROM that holds the notes for the demo songs. The chip also contains an automatic power-off function. An internal timer in the HT3106 puts the chip in a power-down mode when no key has been pressed for more that one minute. The current animal sound selection is held during power-down.

The entire circuit runs on a 3-volt battery supply. Capacitor C1 provides power filtering for the circuit. Resistor R5 sets the internal oscillator frequency for the HT3106. Resistor R3 and capacitor C2 feed the output signal from pin 19 back into pin 28 to filter and shape the sound waveform. Transistor Q1 amplifies the output and drives SPKR1, an 8-ohm speaker.

Pins 6 through 15 are CMOS inputs with internal pull-up resistors. Pressing any of switches S1 through S10 forces the corresponding input to go low, causing the desired note to be played. Pins 16-18 and pins 20-23 are used to select the animal sounds. Those pins are bi-directional, which means they can operate as both inputs and outputs. Figure 2 shows how the internal circuitry is arranged. Normally, the IC pin is driven high when transistor QA is on and transistor QB is off. With the pin at a high-voltage level, the LED connected to that pin is off because there is no current flow through the LED.

Pressing one of switches S11 through S18 pulls the pin low by shorting it to ground. That low signal is detected by the internal CMOS inverter, and the internal circuitry immediately switches QA off and QB on. Turning QB on latches the pin low and the corresponding LED comes on to indicate that a new

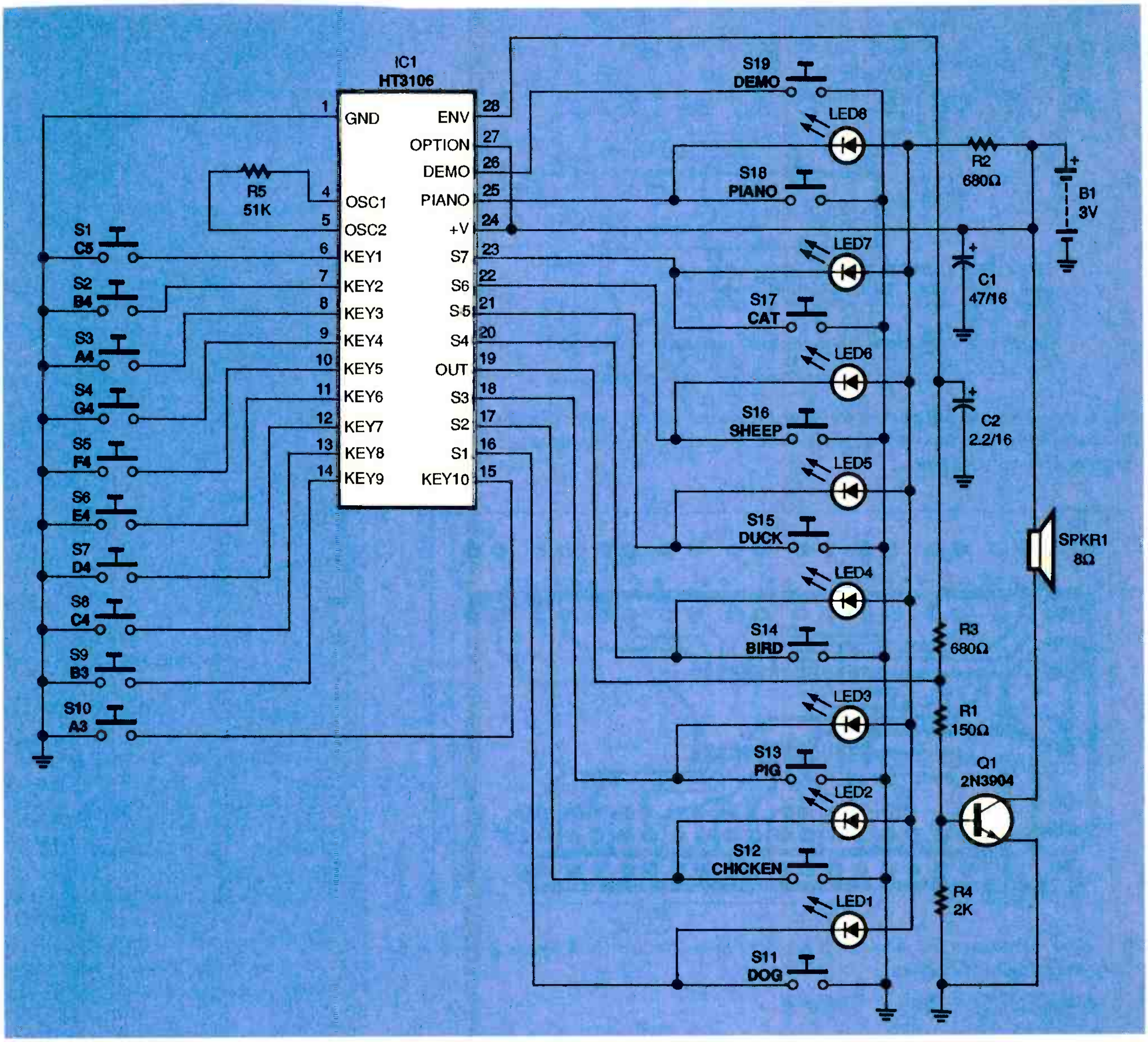


Fig. 1. The schematic diagram for the Animal Sounds Piano is very simple because of the extreme amount of integration on IC1. All active circuits are included in the integrated circuit. Only a handful of external components are needed for the complete circuit.

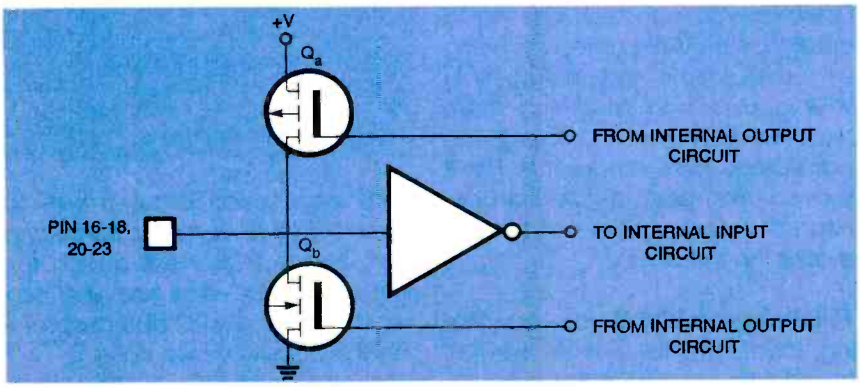


Fig. 2. Thanks to this internal drive circuit on the HT3106, the voice-select pins do double duty as both input from the selection switches and output to the LED indicators. The pin is normally held high by drive transistor QA., When the pin is forced low by an external switch, the internal circuit senses that condition and changes the output drive from QA to QB, holding the pin low. All other input/output pins are driven high at the same time.

animal sound has been selected. The internal circuitry also clears any previously latched pins.

Assembly Instructions. The easiest way to build the Animal Sounds Piano is to use an etched circuit board. The circuit is simple enough that a single-sided board can easily make all the interconnections. If you don't want to fabricate your own board, a pre-etched and drilled board can be purchased from the source shown in the parts list. Locate all the components shown in the parts list and use Fig. 3 to determine component place-

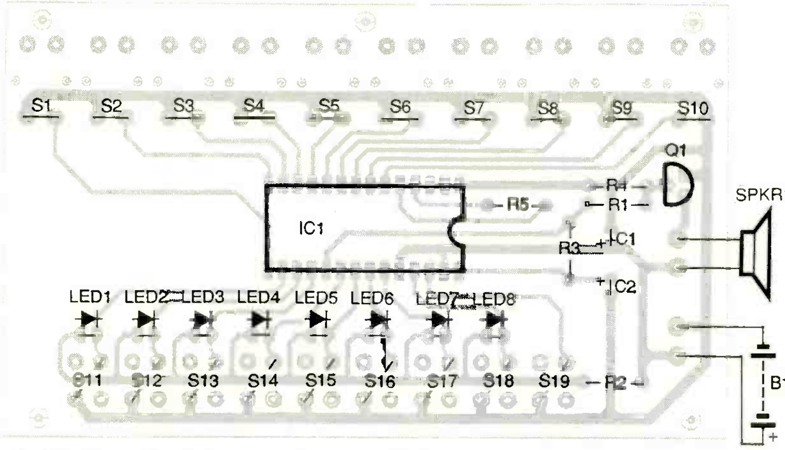
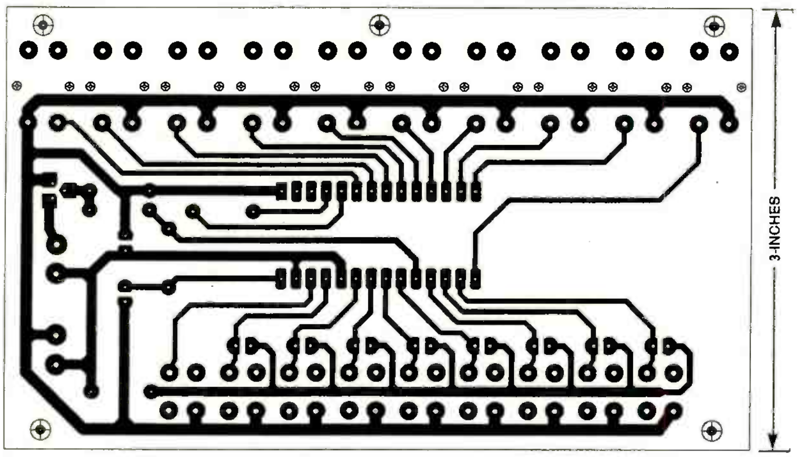


Fig. 3. If you use the foil pattern for your PC board, use this parts-placement diagram. Be careful to orient the polarized parts correctly, or they might be damaged when power is applied for the first time.



Here's the foil pattern for the Animal Sounds Piano. The circuit is simple enough to fit easily on a single-sided board.

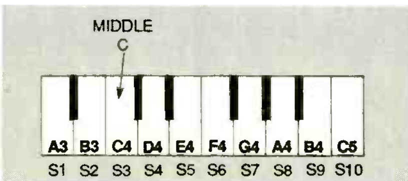


Fig. 4. For those that are familiar with a piano or organ keyboard, this diagram shows which switch is which key on a musical keyboard.

PARTS LIST FOR THE ANIMAL SOUNDS PIANO

SEMICONDUCTORS

IC1—HT3106 10-Key Voice Piano (Holtek)
LED1–LED8—Light-emitting diode, red
Q1—2N3904 NPN transistor

RESISTORS

(All resistors are ¼-watt, 5% units.)
R1—150-ohm
R2, R3—680-ohm
R4—2,000-ohm
R5—51,000-ohm

CAPACITORS

C1—47-µF, 16-WVDC, electrolytic
C2—2.2-µF, 16-WVDC, electrolytic

ADDITIONAL PARTS AND MATERIALS

B1—3-volts, 2 AA cells
SPKR1—8-ohm speaker
S1–S10—Pushbutton switches (Digi-Key SW413-ND or similar)
S11–S19—Miniature pushbutton switches (Digi-Key SW403-ND or similar)
Caps for S1–S10 (Digi-Key SW259-ND or similar), printed-circuit board, wire, solder, battery holder (2 AA), 28-pin IC socket, etc.

Note: The following items are available from: LNS Technologies, 20993 Foothill Blvd., Suite 307R, Hayward, CA 94541-1511, Tel: 1-800-886-7150: ASP-KIT (complete kit of parts for the Animal Sounds Piano, including etched and drilled printed circuit board, speaker, battery holder, IC, and all other components listed above), $29.00; ICHT3106 (10-Key Voice Piano IC), $ 7.00; ASP-PCB (PC board for Animal Sounds Piano) $10.00. Please add $5.00 shipping/ handling. California residents must add local sales tax. MC/VISA orders accepted. No C.O.D. orders. The HT3106 IC is also available from: Alltronics, 2300 Zanker Rd, San Jose, CA 95131.

ment on the PC board.

First install and solder resistors R1 through R5 in place, one at a time. Trim the excess leads before proceeding to the next step. Solder a 28-pin IC socket at the location for IC1. Next, install Q1, C1, C2, and LED1 through LED8. Be sure to follow the correct orientation for each device according to Fig. 3. When installing Q1, it may be necessary to bend the leads to fit the PC board.

The switches specified in the Parts List for S1–S10 and S11–S19 are designed to be soldered directly on the printed circuit board. However, you can also choose to customize the Animal Sounds Piano by using momentary switches of your choice and mounting them remotely from the PC board. The parts-placement diagram in Fig. 3 shows which pads should be connected if you choose to remote-mount the switches.

Final Assembly. Before continuing, clean the foil side of the PC board with alcohol or flux remover. Then refer to Fig. 3 for details on wiring the speaker (SPKR1) and the battery holder (B1). Cut two pieces of 26-gauge wire about 5-inches long and strip ¼ inch of insulation from each end. Solder a wire to each terminal of the speaker and then to the PCB. Next, attach the red and black wires from the battery holder to the PC board, observing the polarity shown in Fig. 3.

Finally, insert IC1 into the socket. Since IC1 is a CMOS device, it can be easily damaged by static electricity. Take proper anti-static precautions when handling the chip.

(Continued on page 66)

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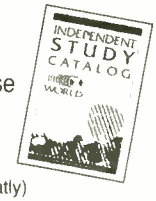

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ANIMAL SOUNDS PIANO

(Continued from page 62)

Refer again to Fig. 3 before installing IC1 to make sure of the proper orientation of pin 1, then press the IC firmly into the 28-pin socket.

Operation. Install two AA batteries and press S19 to start the demo mode. As the internal songs play through the speaker, the LEDs that correspond to each animal sound will light. The demo songs can be stopped at any time by pressing any one of the input keys. If you have any familiarity with a piano or organ keyboard, Fig. 4 shows the musical notes associated with each of the input keys.

When you're ready to play your own songs, just select one of the synthesized sounds from switches S11-S18. Then try playing the following note sequence and see if you can recognize the song "Happy Birthday":

C4 C4 D4 C4 F4 E4
C4 C4 D4 C4 G4 F4
C4 C4 C5 A4 F4 E3 D4
C5 C5 A4 F4 G4 F4

That's all there is to it. You are now ready for hours of musical fun. Ω

PCDRILL

(Continued from page 45)

The finished board actually measures 1.9 inches wide by 1.3 inches deep, and it has 26 holes.

To make the board, cut some single-sided PC-board stock to the correct size. Position the blank on the PCDrill table, copper side up, with the 1.9-inch dimension along the x-axis (y = 0 line). Load and execute PCDrill. Select File, Open, and then enter the file name of the data file. After successfully opening the file, the program will prompt you to press any key to continue.

Select Auto from the Drill menu. The application then initializes the hardware to the 0,0 position, and prompts you for the starting hole (1–26). Enter "1" and motion begins. When hole 1 is beneath the drill, press the drill to form the hole, release the drill, and then press any key to proceed to the next hole.

The above procedure drills all 26 holes the same size, but some actually need to be larger; those are the mounting holes (1, 2, 20, and 26), and the voltage-adjust potentiometer holes (8, 9, and 10). To take care of that, install a larger drill bit, then choose Auto from the Drill menu. When the hardware is in position, drill holes 1 and 2. Then press Esc to exit. Restart Auto Drill, and drill holes 8, 9, and 10. Exit, restart, and drill hole 20. Then skip the remaining holes (by just pressing a key) until you get to 26, and then drill it.

Next use a resist pen and a circle template to draw the foil pattern onto the drilled blank. You'll end up with a board ready for etching. Figure 8 shows the parts-placement diagram for the completed board.

AC Switch. You may have noticed, during drilling, that the drill runs constantly, creating some vibration and quite a racket! Actually, the drill need only run for a short time as each hole is drilled. Another minor inconvenience is that you must have two AC outlets available (one for the power supply and one for the drill), and you probably need an extension cord because the drill's cord isn't very long.

Our solution to those problems is a simple AC outlet switcher. The circuit appears in Fig. 9. To build it, you'll need a standard duplex AC wall outlet, a three pronged extension cord, a plastic project box (such as RadioShack's 270-233), and a momentary pushbutton switch (RadioShack 275-618 or similar).

After forming an appropriate opening, mount the outlet on one long side of the box. Mount the switch in a hole on top of the box. Form another hole to pass the extension cable. Clip the female end of the extension cable and pass it through the hole. Form a strain relief, leaving enough lead length to make subsequent connections.

The outlet has one set of silver screws (neutral), one set of brass colored screws (line), and a single green screw (ground). Note the tab that electrically and mechanically connects the two brass colored screws. Remove the tab or break it by rocking it back and forth.

Connect the green wire to the green screw, and the white wire to either of the silver screws. Then connect the black wire to the brass colored screw closest to the green screw. The corresponding outlet (SO1-a) will be powered continuously; use that for PCDrill's power supply.

Solder short lengths of #18 AWG wire to each switch contact. Then connect the free ends to the corresponding contacts. The switch now controls power to the upper outlet (SO1-b). Check your wiring carefully, and seal the box. Plug the power supply into the unswitched outlet, and the drill into the switched outlet. In use, simply press and hold the switch while drilling a hole. Then release the switch to shut off the drill. Ω

BY DON LANCASTER

The Idea-Mortality Curve, Table Lookups, and More

I HAVE RECENTLY BEEN LISTED AS A "COMMERCIAL INVENTION ASSISTANCE PROVIDER" IN THE FREE DIRECTORIES YOU CAN GET FROM R. L CONGER AT *BATELLE PACIFIC NORTHWEST*. BECAUSE OF THAT, AS YOU MIGHT GUESS, I GET LOTS OF CALLS. THE MAJORity of those callers have gotten totally sucked into all of that ludicrously absurd and dead wrong urban lore surrounding patents. Several recent callers were told by invention-marketing firms that their inventions had merit, and, for a huge fee, must be immediately patented by them.

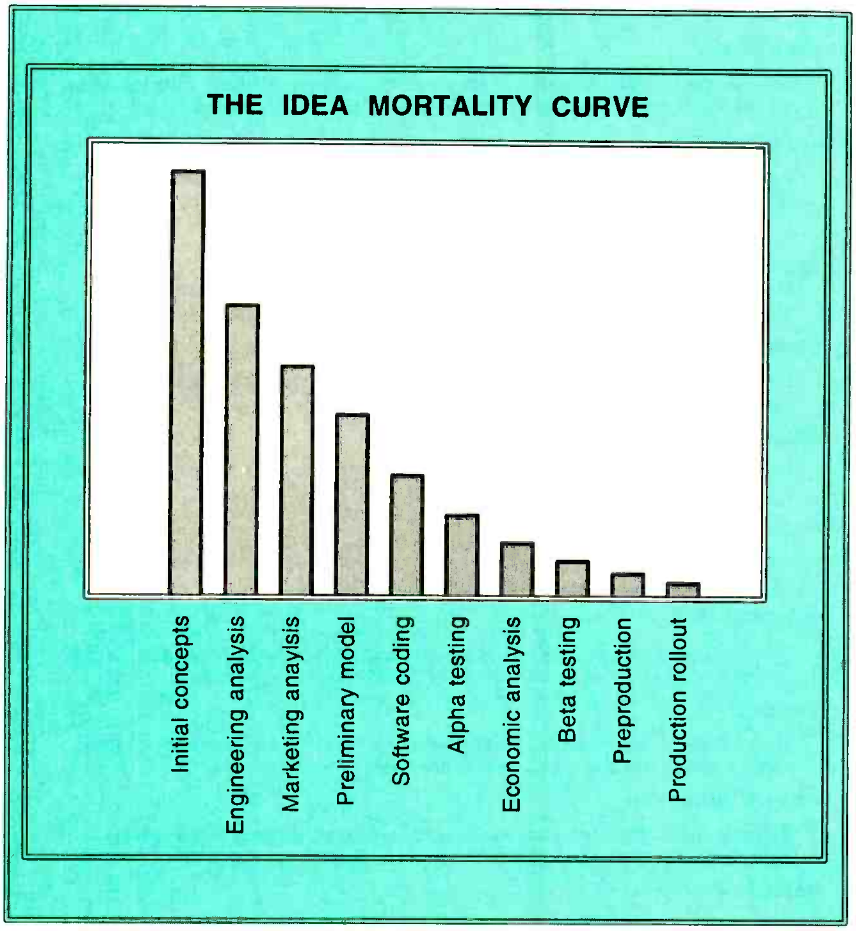

FIG. 1—THIS "FLUSH THE LOSERS" CURVE clearly shows us why untested and undeveloped ideas are worth less than ten cents a bale in ten bale lots. Typically, less than one concept in 500 ever makes it all the way.

"Golly gee, Mister Science!" Going to some of those firms to inquire about getting your invention patented is like going to your local used-car dealer and asking if you should buy a car. Or perhaps more like asking your local mugger if you need to be mugged.

But what if you genuinely believe you have a concept that could be developed? What should you do? First and foremost, recognize that the creative part of the enterprise—that is, the time and effort you invest in coming up with the concept in the first place—is less than *0.1 percent* of the total time and effort needed to generate a net positive cash flow.

If you want to succeed, an awful lot more of your own time and effort is going to be needed. The reason for that extra effort is known as the *idea-mortality curve*, which I have shown in Fig. 1.

Typically, only one concept in 500 ever makes it all the way through the process. The more of those steps that you do by yourself, the better your odds of success. Paying others to handle most of the early stages on that idea-mortality curve is sheer stupidity. Why? Because the odds of success are so outrageously low. The further to the right you get on the curve, the more sellable your product becomes.

In fact, I think even calling yourself an "inventor" is really dumb. I prefer to focus on all the earlier stages of the mortality curve and refer to myself as a "purveyor of risk reduction." More on that can be found in RISKDOWN.PDF, which can be found on my www.tinaja.com Web site.

The names and exact sequence of the

hurdles on the curve very much depend on the idea being developed. But there will always be around a dozen steps, each one of which will slash the remaining candidates.

Naturally, I'll try to sell any caller my *Incredible Secret Money Machine II* or my *Case Against Patents* books. But before that, I first ask that they read and study my free WHEN2PAT.PDF document on www.tinaja.com. Then, I'll have them surf the web for everything they can find that is even remotely related to their idea. These days, it is categorically impossible to develop any new concept without aggressive use of the net!

Next, I'll tell them to get informal opinions from a few industry insiders familiar with how similar products are distributed and actually used. It should go without saying that anyone developing *any* concept must already be a long term subscriber to all the field's free trade journals. As before: It is categorically impossible to develop any new concept without aggressively subscribing to all of the essential industry trade journals! Just in case they did not, I steer them on through *Ulrich's Periodicals Dictionary*, the *International Standard Periodicals Dictionary*, or the *Encyclopedia of Associations*. For instance, if your fresh concept involves retail merchandising, *P-O-P & Sign Design* is an essential tool. You would also get catalogs from leading display suppliers, such as Outwater Plastics.

Beyond that, I do try to get them to recognize that: "If you can't sell a few copies to your friends, then there is no way you will sell lots of them to your enemies." The process of carefully plac-

OPTION PICKER–

Lets you jump six ways from Sunday at some point in a program. Sometimes called a *case* command in certain languages. Here is a PostScript example...

[{proc0}{proc1}...{procn}] exch get exec

KEY FILTER–

Lets you assign a task to each and every possible user key response. Both inclusive and exclusive. Table advantages include flexibility and easy reprogramming.

HEX CONVERTER–

A sixteen entry ASCII table greatly simplifies reporting bytes as Hexadecimal. Here's another PostScript example that converts a stack numeric to a character...

[(0)(1)(2)(3)(4)(5)(6)(7)(8)(9)(A)(B)(C)(D)(E)(F)] exch get

MESSAGE STASH–

Usually involves a double table lookup. First you convert a message number to a starting address. From there, you output a sequential ASCII message.

SONG PLAYER–

For tune generator apps where MIDI is overkill, a table entry can hold the note to play (or a not playing pause) and its duration.

LINEARIZER–

Correction curves for temperature sensors or other nonlinear loads are easily handled with table lookups. Works particularly well with thermocouples.

UNLINEARIZER–

Similarly, intentionally nonlinear outputs can be created. Such as logs, square roots, time-to-frequency inverses, equalizations, or other fancy results.

REVERSE TABLES–

Search times of long documents can be ridiculously shortened by relisting words in an alphabetical order table. This is the key to full library fuzzy searches.

TRIG STUFF–

Digital sinewaves can be generated by entering a table with an angle and returning with the sine of that angle. Usually only one quadrant is needed.

FOURIER SERIES–

Fancy analysis of digital signals can be sped up by precalculating blocks of table based answers. Sometimes, the DFT can end up much faster than a FFT.

MAGIC SINEWAVES–

Low distortion sinewaves from serial ones and zeros. $009034C3E6BBDDF7F7 is one quadrant of a delta friendly 288-bit magic sinewave of 0.0301% distortion.

FIG. 2—TABLE LOOKUPS are incredibly powerful software or firmware tools for any and all computer languages. Here are a few of their many uses.

ing a few early copies of your product with end users is called "beta testing." And until you get out of beta test, you have absolutely zilch, nothing, and *nada*.

Protection? If you have the time to worry about such an illusory fantasy, then your concept is flat out not at all worth protecting. If your concept is too good, it *will* be stolen, and there is absolutely *no way* to prevent that from happening. All patenting does is formalize and then drag out the rip-off process—-at least for most individuals most of the time. Thus, you'll instead use the "hit it fast and hard; then get out" alternate approach. Besides, the chances are that somewhere in your next 500 designs, there will be an even better one or two. But assume your first 2000 ideas are throwaways—an essential part of a learning and skill building process.

Table Lookups

One of my favorite software tools is *table lookup*. Using table lookup, you find a previously stashed answer instead of calculating it from scratch. Table lookups can be amazingly fast. Lookups also make all your software and firmware more orderly, easier to design, and far simpler to change. In short: *Never calculate what you can look up instead!*

Here are some basics: An *address* is some location in memory. *Data* gets stored into one or more sequential address locations. Separately, a *program* is a sequence of instructions to handle some task, such as accessing the data in any table. Programs get *executed*. Data is *accessed*.

Tables are examples of *files*, but, compared to the "anything goes" of a general file, a table is usually shorter. Tables often have *fixed* content that is generated when the program is written or compiled.

In a *direct* table, you enter your table with an address. The table then returns the data or commands at that single address. In an *indirect* table, you first go to an *address stash*. The address stash gives you the *starting location* of a *sequence* of bytes.

For instance, you can enter a direct table with an "angle" and return with the "sine" of that angle. Or you can enter an indirect table using a link to deliver message #43. The address stash sends you to the first byte of the message. As many bytes as are needed for the message are then output, ending with a length countout, an end-of-file character, or a shift

```
; Enter MYTABLE with address offset of needed data in W register.
; Exit MYTABLE subroutine with needed data returned to W register.
MYTABLE     ADDWF       PC,1        ; Add offset to program counter
            RETLW       #$03        ; Data value "0"
            RETLW       #$FF        ; Data value "1"
            RETLW       #$C6        ; Data value "2"
            RETLW       #$47        ; Data value "3"
            ....
            RETLW       #$22        ; Data value "M"
            RETLW       #$5A        ; Data value "N"
; Use example:
GETDATA     MOVLW       #$06        ; Pick seventh table value
            CALL        MYTABLE     ; and get table value
```

FIG. 3—HOW TO STASH A TABLE on the "program side" of a PIC.

from low to high ASCII, or some similar scheme.

Those table lookups are extremely important in any computer language, but I especially like to apply them in the superb general purpose PostScript language, or in PIC machine language. I also did a lot with lookups back in the old 6502 glory days.

Some examples of neat things you can do with table lookups appear in Fig. 2. Let's go through them one by one.

The option picker—Lets you jump six ways from Sunday at some point in a program. Sometimes known as a *case* command in other languages.

The key filter—Lets you assign a task to each and every possible user key response. It is easily changed.

The hex converter—A sixteen entry table 01..9A..EF greatly simplifies reporting bytes as Hexadecimal.

The message stash—A double table lookup: First you convert a message number to a starting address, Then you output sequential ASCII.

The song player—For tune apps where MIDI is overkill, a table entry can hold notes and durations.

Linearization—A correction curve for a temperature sensor or whatever can be easily done by table lookups.

Non-linearization—Similarly, some intentionally nonlinear outputs can be created. Those include such things as logs, square roots, time-to-frequency, etc.

Reverse tables—Your search times of longer documents can be greatly shortened by re-listing words in an alphabetical-order table.

Trig stuff—Digital sinewaves can be generated by entering a table with an angle and returning with its sine.

Fourier Series—Fancy analysis of digital signals ends up much faster if you pre-calculate answers.

Magic Sinewaves—My new scheme for low-distortion sinewaves by using serial ones and zeros needs heavy use of table lookups.

You'll find bunches more on my Magic Sinewaves on www.tinaja.com. Or you can write or call me for a free reprint. A development proposal is also available.

Reducing Table Sizes

An 8-bit table lookup requires 256 bytes—not bad. A 12-bit table lookup takes 4096—kind of ugly. A 16-bit table lookup requires at least 65,536 bytes—usually unacceptable. What can be done to shorten your tables?

There are all sorts of compacting tricks you can use. On any sinewave, you can use symmetry to allow a one quadrant lookup for a size reduction of 4:1. For a cosine, you simply read the same table backwards.

Other times, you can interpolate between entries. With interpolation, you work out the distance you went between two defined points by using a straight line approximation, or even better (but slower), a four-point parabolic fit.

Some sort of compression can also be used, but that might slow you down. For instance, long English text can ultimately be squashed down into as few as 1.2 bits per character. Yet another sneaky trick is known as *factoring*. In factoring, you split the problem up into repeated accesses of one or more much shorter tables. As an example, an 8 × 8 multiply needs a double-wide 65,536 table for direct lookup. But factor (A)(B) into $(a_h + a_l)(b_h + b_l)$ and a single 256-byte table

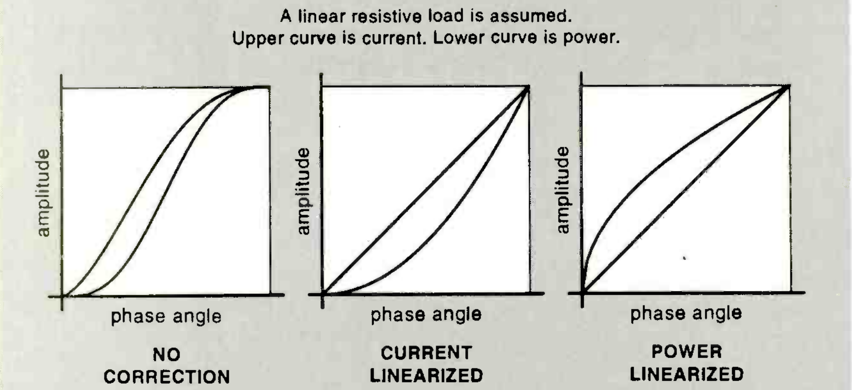

FIG. 4—TABLE LOOKUP greatly improves the linearity of an ac phase power control. These options linearize for rms current or total power.

VACUUM TUBE AUDIO RESOURCES

Antique Electronic Supply
6221 South Maple Ave.
Tempe, AZ 85283
(602) 820-5411

Antique Radio Classified
PO Box 802
Carlisle, MA 01741
(508) 371-0512

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

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

FI
30 Veranda Place
Brooklyn, NY 11201
(718) 625-7353

Giltronics
220 Nalomeli Pl.
Kapaa, HI 96746
(800) 682-2778

Glass Audio
PO Box 876
Peterborough, NH 03458
(603) 924-9464

Handmade Electronics
124 S 12th Street
Allentown, PA 18102
(610) 432-5732

Horn Speaker
PO Box 1193
Mabank, TX 75147
(903) 848-0304

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

Peavey Electronics
711 A Street
Meridian, MS 39301
(601) 483-5365

Positive Feedback
4106 NE Glisan
Portland, OR 97232
(503) 257-2002

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

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

Sonoran Audio Designs
3419 E Grant Road
Tucson, AZ 85716
(520) 326-9938

Sound Practices
Box 180562
Austin, TX 78718
(512) 339-6229

Steinmetz
7519 Maplewood Avenue
Hammond, IN 46324
(219) 931-9316

Svetlana
8200 S Memorial Pkwy.
Huntsville, AL 35802
(205) 882-1344

Western Electric
1230 Peachtree St. #3750
Atlanta, GA 30309
(404) 874-4400

Whirlwind
99 Ling Road
Rochester, NY 14612
(716) 663-8820

can be used instead. The only drawback is that it will be somewhat slower because four passes will now be needed.

Arranging the widths and lengths of all table entries to exactly "fit" a microprocessor's bit, nibble, word, and page boundaries form other non-obvious compacting tricks. Matching address modes to the table is also a good idea, as can be stuffing subroutines or anything else handy around the table to eliminate wasted bytes. As always, your secret is to think creatively, letting you go beyond brute force lookup.

The PIC Access Method

As I may have noted a time or two before, PIC microcontrollers are *the* components of the decade. But PICs use a special RISC architecture that keeps program instructions in one memory area and user data in a totally separate area.

So, how can you stash a table when there is no table stash area? Simply by using the PICs unusual RETLW series of commands. RETLW is a return from subroutine. It returns eight internal data bits to the W register on command. To do a PIC table lookup, you string a group of RETLW commands together, each of which has the data value for a given table entry. At the top of the table, you add an *index* or *offset* value to shift the PC program counter to the desired return. Full details are shown in Fig. 3.

A Linear Power Control

Let us look into how a simple table lookup opens up entire new worlds of applications. Last month, we saw how the phase controllers for AC Triac power loads were highly nonlinear. Can table lookup help us here?

Take a look at Fig. 4. The right-hand graph shows us a repeat of the nonlinear phase-controller response we saw last month. The center graph shows us a lookup correction that gives us linear current with phase angle. What happens is that you enter a table with a wanted phase angle and return with the corrected one.

Being linear with current is quite handy for psychedelic lighting or other 60-Hz AC amplifiers, even servos. As an option, the left-hand graph shows us a table lookup correction that gives us linear power with input phase angle. Among other uses, that stunt can let you directly dial in the wattage of a precision soldering iron.

Naturally, there's zillions of other

possibilities here. For instance, linear current or power can be modified to compensate for load non-linearities. Or you can use a randomized lookup to simulate a candle flame. The new baby PIC from MicroChip Technology is ideal for that sort of thing. I have consulting services available on these concepts.

Adobe's Newest Acrobat 3.0

Adobe Systems has just released their net friendly *Acrobat 3.0*. That software is a quantum leap over anything ever seen for delivering technical content on or off line. Acrobat makes HTML look like a cruel joke.

For openers, Acrobat can let you control *exactly* what your end users will see, including all artwork, text, and a near-infinite variety of fonts. It can even handle animation, movies and sound. The output is a single, device-independent file that is easily and directly viewable online from inside a *Netscape* window or other modern browser, or offline at your convenience.

Acrobat 3.0 gives by far the most legible information you'll see online—full camera-ready resolution. Thanks to an anti-aliasing scheme that Adobe calls *text smoothing*, you can easily view three columns of text on even a lower-resolution monitor. You can also magnify as needed for more detail.

A new compression scheme makes your files significantly shorter than before—the average compressed page size is 11K. In addition, there's a brand new option called *byte-range retrieval* that can ridiculously speed up your online access. Say, for example, you have a hundred page document. With byte-range retrieval, only the text for page one is downloaded and then displayed. That is followed by the art for page one. Your following pages get invisibly downloaded while you are reading your first page.

There are several elements to Acrobat 3.0. First and foremost is the free *Reader 3.0*, which lets you view and print files. There is a charge for the rest of Acrobat, which comes on a PC, UNIX, or Mac CD ROM. Included on this CD are *Distiller*, which lets you transform PostScript files into Acrobat files; *Writer*, which lets other applications create Acrobat files; *Exchange*, which lets you edit files, print them, or convert them back to standard PostScript; *Catalog*, which lets you create an index for a group of Acrobat files; and *Scan* and *Capture*, which let you read existing printed pages and transform them into .PDF format files. There's also the Reader software mentioned earlier, *Adobe Type Manager*, and a bunch of applications notes, drivers, examples, and other goodies. I'm totally sold on Acrobat 3.0—to the point where I'm trying to use my www.tinaja.com site as an Acrobat 3.0 showcase site. You'll find hundreds of example files there.

Even so, I do have several complaints. In both Exchange and Reader, there's this great full-screen mode that shows *only* your document—including even fancy wipes and optional "slideshow" modes. But that wonderful full screen feature can be used from inside a Netscape window. Acrobat to Acrobat links work just fine, but it is rather tricky to get from an external HTML or whatever source to a particular spot and magnification inside of an Adobe Acrobat document.

Next, while you can do limited editing (such as correcting spelling errors or changing fonts), the editing ability is weak and poorly documented. The indexing file structures of Acrobat Catalog are not documented. Catalog would be a lot more useful if you could edit word lists, or, better yet, be able to directly extract that word and page information for a printed book index. Phrases in addition to words would sure be handy, as would intelligent hyphen removal.

Even with those problems, Acrobat 3.0 is a stupendously great watershed product. A must use. You can download a free Acrobat 3.0 reader from www.adobe.com. Information on byte-range retrieval can be found at www.tinaja.com.

NAMES AND NUMBERS

Adobe Acrobat
1585 Charleston Rd.
Mountain View, CA 94039
(800) 833-6687

Aerocon
PO Box 432
Los Gatos, CA 95031
(408) 450-0704

Batelle Pacific Northwest
Box 999 RL Conger
Richland, WA 99352
(509) 372-4274

DTM
1611 Headway Cr,, B2
Austin, TX 78754
(512) 339-2922

EDLCO
PO Box 5373
Asheville, NC 28813
(704) 255-8765

EMC Test & Design
6300 S Syracuse Way
Suite 650
Englewood, CO 80111
(303) 220-0600

Encyclopedia Associations
835 Penobscot Bldg.
Detroit, MI 48226
(313) 961-2242

Environmental Building News
RR 1 Box 161
Brattleboro, VT 05301
(802) 257-7300

Game Developer
600 Harrison Street
San Francisco, CA 94107
(415) 905-2200

Joiners' Quarterly
PO Box 249 Snowville Road
Brownfield, ME 04010
(207) 935-3720

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

Netscape
501 E Middlefield Rd.
Mountain View, CA 94043
(415) 528-3777

Outwater Plastics
4 Passaic St.
Wood Ridge, NJ 07075
(800) 526-0462

P-O-P & Sign Design
7400 Skokie Blvd.
Skokie, IL 60077
(708) 675-7400

SME
One SME Drive
Dearborn, MI 48121
(800) 733-4763

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

Ulrich's Dictionary
121 Chanlon Rd.
New Providence, NJ 07974
(908) 771-7714

Woodcraft
PO Box 1686
Parkersburg, WV 26102
(800) 225-1153

Vacuum Tube Resources

To me, it has always seemed that all vacuum tubes can do is add hum, noise, and distortion to an otherwise clean audio channel—tasks that are much easier done these days with a decent DSP algorithm. Way back when I was building tube-type amplifiers, I never found any two that sounded even remotely alike. So, I guess I do not have the slightest idea what a "vacuum-tube sound" is.

That said, there are a lot of you out there that are still interested in vacuum tubes. So, I have gathered a lot of vacuum tube information sources together for you as this month's resource sidebar. The definitive book on all of this remains the *Radiotron Designer's Handbook*, which is by far the greatest technical book of all time. A very few copies still remain available through antique electronic suppliers.

There's also scads of vacuum tube stuff on the net. For example, there's *The Vacuum Tube Audio Page*, which you should find at www.realtime.net/~joe/index.html. Another page to try is www.qnx.com:80/ ~danh/info.html.

By the way, I still have a stash of classic, collectible, vacuum-tube era test gear left. Among the collection is gear from HP, Tektronix, B&K, Singer, Bendix, and Heath. Call for details (see the Help box) if you are interested in any of those.

New Tech Lit

A free Santa Claus Machine video on rapid prototyping is offered by DTM. One leading source for rapid prototyping books is SME, short for Society of Manufacturing Engineers.

Two wildly different trade journals for this month are *Game Developer* and *EMC Test & Design*. The latter is on shielding and FCC specs.

Rocketry parts and supplies are sold by Aerocon. They offer a free flyer.

Exotic woods are stocked in depth by Woodcraft in their Back of Rack service. Among the types stocked are Anigre, Muhuhu, Bocote, Bubinga, Ovangkol, Wenge, and Paduak. And, yes, they also have Pine. One competitor is EDLCO.

A superb web site for alternate or green construction materials is up at www.oikos.com. You'll find lots more of the same in *Joiners' Quarterly*. *Environmental Building News* is a bimonthly newsletter that zeros in on environmentally sustainable design and construction. Their Website is www.ebuild.com.

I guess my *CMOS Cookbook* has been a tad scarce recently. But thanks to Butterworth-Heinemann, we now have a brand new publisher. I've now got great heaping bunches of fresh copies, as do most technical bookstores. That classic is rapidly approaching one million copies in print. Autographed copies are available through my Synergetics Press, either by themselves, or as part of my bargain priced "Lancaster Library."

As usual, most of the mentioned names show up in our Names and Numbers or Vacuum-Tube Resources sidebars. Be sure to check those out before visiting our www.tinaja.com Web site or calling our no charge US helpline service. EN

NEED HELP?

Phone or write all your US Tech Musings questions to:

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Synergetics
Box 809-EN
Thatcher AZ, 85552
Tel: 520-428-4073

US email: don@tinaja.com
Web page: http://www.tinaja.com

BY CARL J. BERGQUIST

Modulating a Laser Beam

THIS MONTH, LET'S TURN OUR ATTENTION TO A DIFFERENT TYPE OF LASER APPLICATION—USING A LASER TO TRANSMIT SOUND. WE WILL LOOK AT A COUPLE OF DIFFERENT APPROACHES TO DOING THAT. EITHER APPROACH COULD MAKE a great beginning for a winner of a "science-fair" project" or a starting point for further experiments.

Electronic Modulator

Our initial effort uses electronic modulation to send an audio signal over a laser beam. The technique we'll use provides a free-air transmission with a range of several hundred feet.

Of course, we need some way to decode the received beam and retrieve the signal. Take a look at the basic LM386 amplifier circuit shown in Fig. 1. To use that circuit as our laser "receiver," connect a silicon solar cell across the input and a small 8-ohm speaker or headset across the output. Now enclose the circuit in a project box, and your receiver is ready. If you need to increase the range add a collimator tube at the input. It will also help improve audio clarity.

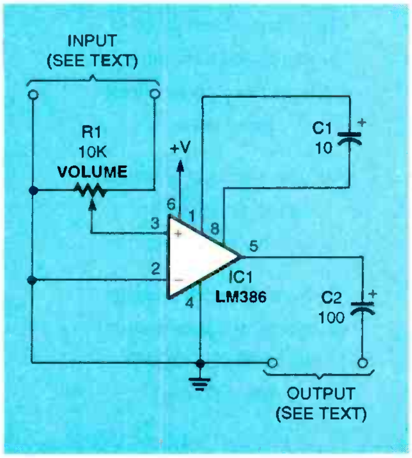

FIG. 1—THIS SIMPLE LM386 AMPLIFIER forms the basis for both a laser receiver and a laser modulator.

Now, how are we going to modulate the laser in the first place? The answer is another LM386 circuit. This time, we'll connect a microphone or another audio source to the input of the circuit in Fig. 1. To modulate the laser, we'll use the scheme illustrated in Fig. 2. As that circuit shows, the amp's output is connected to the 8-ohm winding of a small audio transformer. The 2000-ohm winding is connected between the laser's anode and the high-voltage power supply as shown.

With that set-up, the power fed to the laser will vary with the audio output of the LM386 circuit. Place the receiver so that the laser illuminates its solar-cell input, and whatever audio signal is introduced to the electronic modulator will be picked up and decoded by the receiver. Note that any audio-amplifier circuit could be used for this application, but the LM386 circuit is simple, compact, and inexpensive—both units can be built for under five dollars.

Try using mirrors to deflect the beam around objects, or bend it around a corner. The laser beam can also be sent out to a reflector and back to the receiver. However you set it up, the system makes for an interesting demonstration.

WARNING! ! !

This article deals with and involves subject matter and the use of materials and substances that may be hazardous to health and life. Do not attempt to implement or use the information contained herein unless you are experienced and skilled with respect to such subject matter, materials and substances. Neither the publisher nor the author make any representations as for the completeness or the accuracy of the information contained herein and disclaim any liability for damages or injuries, whether caused by or arising from the lack of completeness, inaccuracies of the information, misinterpretations of the directions, misapplication of the information or otherwise.

Build the Photophone

Our second demonstration/experiment involves a mechanical modulation device often referred to as the Photophone. Invented by Alexander Graham Bell in 1880, he often expressed the opin-

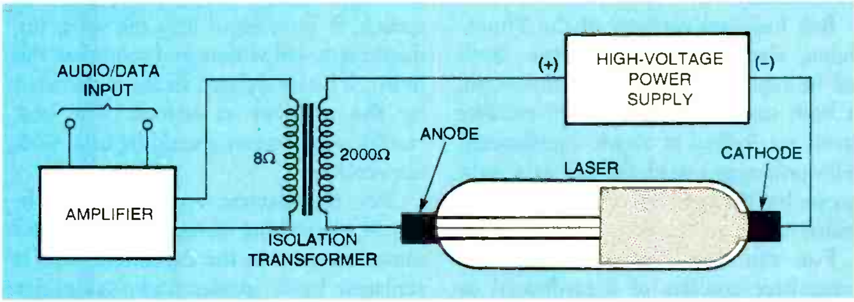

FIG. 2—USE THIS SCHEME when using the LM386 amplifier to modulate a laser.

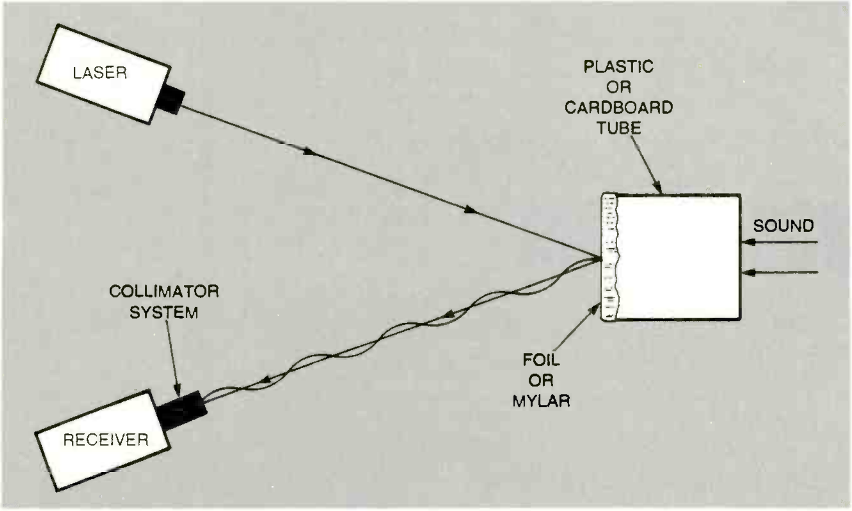

FIG. 3—BASED ON A PRINCIPLE developed by Alexander Graham Bell, this mechanical Photophone will modulate any beam of light, including a laser. The receiver is the same one used in our previous experiment.

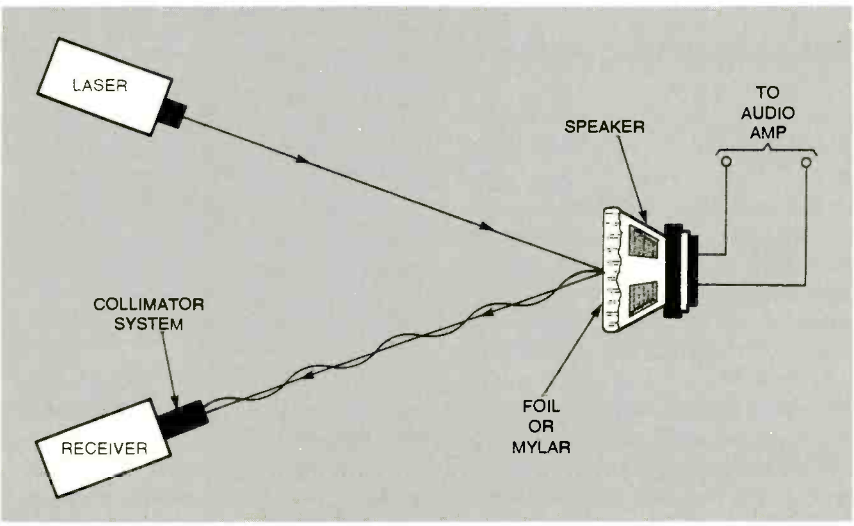

FIG. 4—SIMILAR TO THE MECHANICAL PHOTOPHONE, this electronic version replaces the tube with a speaker.

ion that the photophone was a more important invention than the telephone. Functioning on the same principle as the speaker modulator discussed in earlier installments of this column, the Photophone relies on the vibration of a metallic foil or Mylar diaphragm for the beam modulation.

Bell had two versions of the Photophone, electric and non-electric. Both will be replicated in this demonstration. In both cases, use the LM386 receiver circuit we looked at above. Incidentally, Bell's prototypes used the sun as a light source, but the laser is far superior in reliability, range, and clarity.

For the non-electric model, the transmitter consists of a cardboard or plastic tube with foil or Mylar stretched tightly over one end and secured with tape or contact cement; see Fig. 3. The tube must be fastened to a tripod or other, similar support, so it will remain steady during use.

The laser and receiver are then set up so that the beam bounces off the center of the foil or Mylar and onto the receiver's solar cell. When sound, such as speech, is introduced into the tube, the diaphragm will vibrate and modulate the beam. The modulated beam is decoded by the receiver as before. For best results, a collimator should be used with the receiver.

For the electric version, shown in Fig. 4, everything remains basically the same, except that the cardboard tube is replaced by a speaker/audio amplifier assembly. The foil or Mylar is tightly stretched over the front of the speaker and vibrates in sync with the speaker. Again, for best results, aim the laser at the center of the reflector and use a collimator with the receiver.

While innovative for its time, the Photophone is relatively simple in principle. Since its invention, numerous variations have been used, especially in the communications field. Can you think of any variations or experiments based on this principle? If you can, why not drop us a note and let us know. Write to Laser Editor, **Electronics Now**, 500 Bi-County Blvd., Farmingdale, NY, 17735 or via e-mail to lartronics@aol.com. We hope to hear from you soon! EN

PROFESSIONAL DESOLDERING with the

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.

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.

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.

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Bob Sorrels CET/CSM Polytronics Microcomputer - Shreveport LA
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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%.

Don Cressin - Certified Electronics Serv ice - Ellicott City MD 301-461-8008
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Randy Whitehead - Service West - Salt Lake City UT 801-262-4069
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Timothy Kraft - Monikraft, Inc. - Cherry Hill NJ 609-751-3252
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Alan P. Dunasky - Al's TV, VCR, & Computer Service -Cleveland, 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.

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Don Scott - LAV Electronics Healeah-Miami Lakes FL
I am a constant user of the SC7000 Desoldering Tool and for quick component removal, this unit has no equal. It also comes with excellent company support. I am very satisfied and highly recommend it to anyone in the servicing field.

Gale TV, Inc. Gale Holloway Virginia Beach VA 804-486-3562
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Daryl Baker Servus Electronics Wichita KS
The SC7000 is a better product than advertised. It has more than paid for the initial investment. We highly recommend the SC7000 Desoldering Tool.

Steve Hall Telco Electronics, Inc. Boise ID 208-322-3304
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- **Motor Output** — 2W
- **Vacuum Attained** — 600mmHg
- **Temperature Range** — 300°C—400°C (572°F—842°F)
- **Air Flow Rate** — 15 Liter/Minute (Open)
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- **Control System** — Feed Back Zero Cross-over Type
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BY RAY FURLONG*

More On Troubleshooting Camcorder Zoom Lenses

LAST MONTH, WE BEGAN OUR LOOK AT TROUBLESHOOTING CAMCORDER ZOOM LENSES BY LOOKING AT HOW A MODERN ZOOM LENS WORKS. THIS MONTH, WE'LL TURN OUR ATTENTION TO SOME REAL-LIFE SERVICING PROBLEMS AND HOW to solve them. We'll start out with a look at the camcorder's iris mechanism. (Note, while the specific systems discussed here are used in Hitachi camcorders, essentially similar systems are found in units from other manufacturers.)

Problems With The Iris

The camcorder lens has an iris diaphragm that is opened and closed to control the amount of light reaching the sensor, thus controlling the exposure. As shown in Fig. 1, a Hall-effect device mechanically connected to the iris motor monitors the iris opening and provides an accurate feedback of the opening size. The opening size is called the *f*-stop and is assigned a number (*f*1.2, *f*1.4, *f*1.8 . . . *f*11, etc.) that relates to the ratio of the focal length of the lens to the diameter of the lens opening.

A lens with a given *f*-stop number will always allow the same amount of light per unit area to strike the sensor regardless of the focal length of the lens. In video cameras the iris opening is not as round as in film-type cameras. As a result, a specific iris opening will equate to a specific *f*-stop, and the Hall-effect sensor will produce a voltage (F-DET) that corresponds to the *f*-stop. This voltage will range from 3 volts down to 1 volt. A typical calibration graph is shown in Fig. 2.

*Hitachi Hi-lite
Hitachi Home Electronics (America), Inc.
Suwanee, GA 30174

Let's go back to Fig. 1 for a moment. It is a functional block diagram of the iris-drive and -control circuits. A digital microprocessor inside the camera creates a pulse width modulated (PWM) iris-drive signal. That signal is fed to the iris-drive amplifier, which smoothes the voltage before it is applied to the iris motor. The duty cycle of the PWM signal determines the size of the iris opening. The higher the duty cycle, the more the iris opens. The lower the duty cycle the less the iris opens. As the iris moves, the Hall device connected to the motor produces a voltage. That voltage is fed through three amplifiers to produce the F-DET voltage that tells the microprocessor the status of the iris motor movement.

As the iris closes (*f*-stop increases) the voltage produced by the Hall-effect sensor decreases. The calibration graph in Fig. 2 shows that a small change in the F-DET voltage results in a relatively large change in the *f*-stop. To counteract

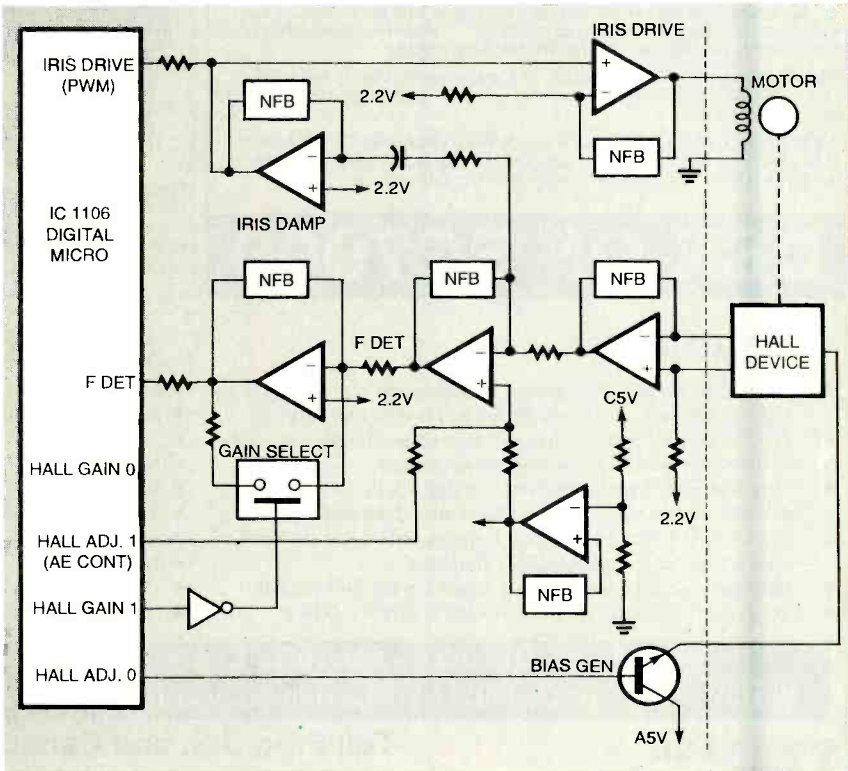

FIG. 1—AS SHOWN IN THIS BLOCK DIAGRAM of the iris drive circuit, a Hall-effect device is mechanically connected to the iris motor.

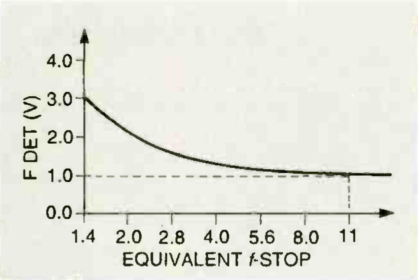

FIG. 2—THIS CALIBRATION CHART shows how the F-DET voltage corresponds to the camera *f*-stop.

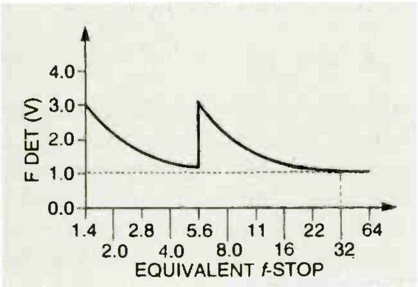

FIG. 3—HERE'S THE SAME CHART used in Fig. 3, but this time showing the effect of the gain-up circuit.

that problem a gain-up circuit brings the voltage back up to 3 volts and restarts the curve. The gain-up circuit is controlled by the Hall gain 1 output from the microprocessor. Notice that there is also a Hall gain 0 in the block diagram. Some earlier camcorders have a two-stage gain-up circuit. The second stage in those cameras is controlled by the Hall gain 0 output.

Figure 3 is similar to Fig. 2. It shows the effect of the gain-up circuit. Note that the range of *f*-stops has increased dramatically for a given range of F-DET voltages. That increased range allows better calibration of the iris, especially when used in conjunction with the electronic shutter

The braking portion of the motor circuit that controls excessive movement is called the *iris damp*. It prevents the violent opening and closing of the iris under bright light conditions. A negative feedback loop is derived from the Hall device, and that feedback is added directly to the iris drive PWM output to provide that protection.

Shutter Troubleshooting

The shutter in a video camera/camcorder does not use mechanical parts to shutter the incoming light. The sensor "sees" incoming light all the time. To change the shutter speed of a video camera the sensor must be read at specific time intervals. Since video is a frequency-based function, and frequency is based on time, the standard read time for a sensor is 1/60 second (NTSC format). The faster the sensors are, the faster the shutter speed. The most common shutter speeds for camcorders are 1/60 (standard), 1/120, 1/180, 1/250, 1/500, 1/1000, 1/2000, 1/4000 and 1/10,000th of a second.

Shutter speeds of 1/250th second and higher are not in sync with the 60-Hz line frequency of household AC voltage. Therefore, they are a problem during the iris and shutter alignment procedure. During every AC cycle, fluorescent lights used in conventional light boxes go on and off twice, producing a lighting frequency of 120 Hz (2 × 120 Hz = 240 Hz). That represents only a 10-Hz deviation from the 1/20th second shutter speed. That means that the sensor can sometimes read the incoming light at the off-time of the fluorescent light, and adjust to produce a darkening of the video image. As the iris is calibrated, the shutter speeds automatically change and the sensor will sometimes be read during the off-time of the fluorescent lamps in the light box. That can cause an error in the alignment of the iris calibration.

To prevent such errors, a special light box, that has a high-frequency switching ballast, must be used. Since the normal frequency of a high-speed switching ballast is around 32 kHz, the sensor is no longer reading during the off-time of the light box. At such a high frequency, there is virtually no off-time that even the highest available shutter speed of the camcorder can see.

In modern camcorders the shutter speeds are automatic, but not all of the shutter speeds mentioned are available in all models. An automatic function (Auto Exposure or AE) works in conjunction with the iris to automatically select the best shutter speed. That system works as follows: The microprocessor looks at the F-DET voltage to eval-

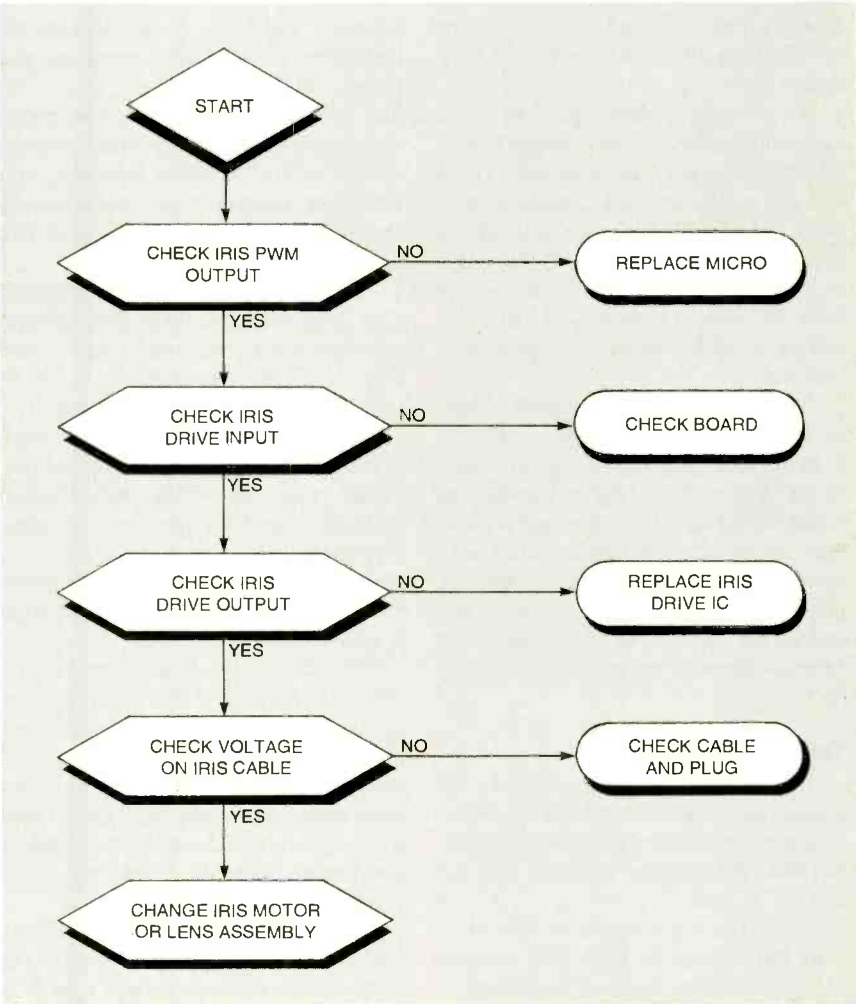

FIG. 4—THIS IRIS/SHUTTER troubleshooting chart presents a step-by-step procedure that simplifies the task of isolating a defect.

continued on page 80

BY JEFF HOLTZMAN

Can Electronic Commerce Pass The ACID Test?

MANY COMPANIES WANT TO PART YOU FROM YOUR HARD-EARNED CASH VIA THE INTERNET. SOME ARE EVEN SUCCEEDING. FOR EXAMPLE, YOU CAN PURCHASE AUDIO CDs ON-LINE FROM CD-NOW. MOST COMPANIES, HOWEVER, ARE STILL WAITING for a real market—paying customers—to emerge. But for those markets to emerge, customers (and businesses) must be confident about the security of their transactions.

In a nutshell, there are four main issues of contention: Authenticity, Confidentiality, Integrity, and Delivery. Those are the necessary and sufficient conditions, the "ACID" test, so to speak, for electronic commerce (EC) to become a widespread phenomenon. Until robust solutions arise in each area, EC will remain a niche means of conducting business.

This month, let's examine the technical issues, and see what types of solutions are emerging. Space does not allow us to discuss these topics in any real detail here, but Table 1 contains a list of pointers to relevant Internet sites with tons of information. We will, however, provide a quick overview of public-key encryption systems, as much upcoming Internet security seems destined to rely on it.

THE ISSUES

In the discussion that follows, the term *message* may refer to both customer-to-business and business-to-business transactions. (Business-to-business EC has actually existed for more than a decade using a technology known as Electronic Data Interchange, or EDI. EDI is rapidly being forced to become Internet-savvy . . . but that's another story.)

The first issue is *authenticity*. How can I be sure this message came from whom it claims to be from? Can my recipients be sure that messages that claim to be from me really came from me? In other words, I don't want people to assume my identity and purchase things on my account. Likewise, as a merchant, I want to have total assurance that I'm shipping goods to real, live, paying customers.

The second issue is *confidentiality*. Can I be sure that only the intended recipient sees my message? Can I be sure that only I see messages intended for me? Can messages be intercepted or "eavesdropped?" If so, can they be interpreted? In other words, I don't, as a consumer, want my credit card numbers floating around the Internet in an unencrypted form. And as a vendor, I have a responsibility to my customers to ensure that the confidentiality of their messages is maintained.

The third issue is *integrity*. Did my message arrive? Did the whole message arrive? Did the message arrive unchanged (no additions, deletions, or changes)? If your credit card number and mine differ by a single digit, I don't want to be mistakenly charged for something you bought. Nor do I want my orders misinterpreted.

The fourth and final issue is delivery. Did my message arrive? Did only one copy of the message arrive? Can I be notified if it arrived? Can I be notified if it did not arrive? Can delivery be guaranteed? Who can I turn to for help in case of problems? When I place an order by phone, I usually get an order number for tracking. Internet commerce needs the equivalent. I also need to be sure that I don't get duplicates.

PUBLIC KEY CRYPTOGRAPHY

Before we talk about solutions, we need to take a brief digression and discuss encryption and public-key cryptography. Encryption algorithms are a hot topic, for technical, business, and political reasons. Politically, the U.S. Government currently considers encryption algorithms as being in the same category as munitions, thus it tightly regulates the export of advanced or highly secure algorithms. Security is primarily defined by the length (in bits) of the key used to encode a message. The longer the key, the harder the encryption is to break. Algorithms that use keys longer than 512 bits are currently prohibited from being exported.

The simplest type of cryptography uses a single key that is used to encode the message. The sender and the receiver must share that key, and if necessary provide a means of sharing it. For informal, low-volume work, that might be the simplest solution. But it is unacceptable for widespread communications over open lines. Thus was born public-key cryptography.

PKC uses two keys, one public and one private. Depending on purpose, a message can be encrypted with either. Suppose you and I want to exchange messages securely. Each of us has a public key and a private key. Both of us publish our public keys, and keep our private keys private. If you want to send me a private message, you encode it with your private key, and I decode with your public key. If

I want to send you a secure message, I encode it with your public key, and you decode it with your private key.

There are several important points about PKC. One is that it is an asymmetric process. That is, it takes much longer to encrypt than to decrypt a message. For that reason, it is often impractical to encode large messages using PKC. One workaround is to establish a connection between two parties using PKC, then use a PKC message to ship a key for a quicker algorithm, encode the data using the second algorithm, and then ship the encrypted data. You could, for example, and many people do, use RSA as the PK algorithm, and DES, a government standard for the bulk encryption.

According to RSA Laboratories, the primary company that has commercialized the RSA algorithm, DES runs 100 times faster than RSA in software, and as much as 10,000 times faster on dedicated hardware.

SOLUTIONS

There is no plug-and-play one-size-fits-all solution that addresses all the subtleties of the ACID test. In fact, there are multiple, sometimes overlapping solutions to various facets of the problem.

Digital certificates and digital signatures are a means of verifying that all parties to a transaction are who they say they are. A digital signature is a portion of a message that is encrypted with a user's private key. Anyone with the corresponding public key can decrypt the message and thereby verify the identity of the owner. A digital certificate is a "credential" that is issued by a third party, and that certifies that the owner of a public key is whom it claims to be. A digital certificate is analogous to a passport. An international standard (X.509) governs accepted use of digital certificates. Several commercial organizations have arisen to issue digital certificates, notably Verisign (www.verisign.com).

As a practical example, Microsoft is planning to use digital certificates to verify that software components downloaded from the Internet are trustworthy, and not virus laden or otherwise destructive. Sun and other companies counter that the totally isolated "sandbox" in which Java applications execute provides a much safer alternative. It is currently too early to tell whether the authenticated (Microsoft) or the Sandbox model will prevail in the market. We could end up with either, both, or something entirely different.

All the confidentiality issues come down to one thing: encryption. Encryption can be performed in many ways, and at many levels of the communications infrastructure. For example, there is a low-level standard called Secure Sockets Layer (SSL) that basically encrypts everything exchanged between two TCP/IP endpoints. At the highest level, applications can provide their own encryption features, *e.g.*, password-protecting document and spreadsheet files.

Integrity ensures that what we receive is the whole message and nothing but the message, or at least we will be warned if that is not the case. Integrity partially depends on low-level networking infrastructure, such as the part of TCP/IP that ensures packet integrity. Higher-level means can also be applied. For example, there is an international e-mail standard called MIME that allows transfer of binary files over seven-bit channels. A secure version, S/MIME, is being implemented to help ensure overall message security and integrity.

Delivery concerns the shipment of bits. Without reliable delivery, all the encryption in the world won't buy you anything. No one disputes that the current "open" Internet produces reliable delivery. The EDI world has for years relied on what are called Value Added Networks (VANs), which function like a FedEx of electronic message passing. With a VAN, every transaction can be tracked, traced, and verified. However, VANs are expensive and proprietary. In my opinion, the Internet world at large, and the EC portion in particular, desperately needs a range of levels of service, ranging from bulk (like fourth-class mail) with no guarantee of delivery, to FedEx-like tracking, probably with several intermediate levels.

So now we know what it takes to do electronic commerce the right way: Authenticity, Confidentiality, Integrity, and Delivery.

TABLE 1—INTERNET SITES AND SPECIFICATIONS

Document	Description
Good overview about RSA and DES encryption.	http://rsa.com//rsalabs/faq/faq_fsa.html#rsa.12
Good overview of digital signatures and certificates	http://www.cylink.com/products/security/x509.htm
Requirements for Inter-operable Internet EDI	ftp://ftp.ietf.org/internet-drafts/draft-ietf-ediint-req-00.txt*
SSL	http://home.netscape.com/newsref/std/SSL.html
S-HTTP	ftp://ds.internic.net/internet-drafts/draft-ietf-wts-shttp-02.txt
X.509 (digital signatures and certificates)	ftp://ftp.ietf.org/internet-drafts/draft-ietf-pkix-ipki-part1-02.txt*
ISO/IEC 9594-8:	See X.509
Public key cryptography systems (PKCS) FAQ	http://www.rsa.com/pub/pkcs
"The Microsoft Internet Security Framework," Version 2.3, July 9, 1996.	Description of Microsoft's intranet, Internet, and consumer-oriented security support. See http://www.microsoft.com/ intdev/security, and http:// www.microsoft. com/ecommerce for this and related documents.
RFC1767 (MIME Encapsulation of EDI Objects)	
RFC1865 (EDI/Internet FAQ)	
RFC1521 (MIME Specification)	
S/MIME FAQ	http://www.rsa.com/rsa/S-MIME/home.html
Digital signatures and certification technology	http://www.verisign.com, http://www.cylink.com
EDI-Internet mailing list	http://www.imc.org
EDI-Internet mailing list archive	http://www.imc.org/ietf-ediint
SET specs	http://www.visa.com and http://www.master.com
IETF-EDIINT Security Decision Matrix	Detailed comparison of PGP/MIME, S/MIME, MOSS, DMS across 34 categories.
Netscape LivePayment White Paper	Search for livepay_white_paper.html at http://home.netscape.com

* All IETF documents are available from ftp://ftp.ietf.org/internet/internet-drafts/.

HARDWARE RED ALERT

Last month I mentioned problems friends of mine had been having with the Seagate 43400N, a 5¼ 3-GB SCSI hard drive available for around $350. I also have one, but at that point had had no trouble.

Since then, however, I have had a few "incidents." The machine that contains that drive functions as the server for my network. The server started crashing, not often, but with gradually increasing frequency. Of course it never happened when I was around to try to glean some diagnostic symptoms. Then one day it happened while I was using it. I immediately opened the case, and found that the drive was extremely hot. That case happened to have a second fan, fortunately mounted almost directly across from the drive. After allowing things to cool down, I spliced the fan into a power cable, hooked things back up, sealed the case, and have now gone several weeks without incident. But I will be replacing that drive as soon as cash flow allows.

That's all for now. Until next time, you can stay in touch by e-mailing me at jkh@acm.org. EN

SERVICING

continued from page 77

uate the position of the iris and selects the appropriate shutter speed. It also controls the Hall-effect device and the F-DET voltage through outputs Hall adj 0 and Hall adj 1.

Troubleshooting the iris/shutter circuit is simple. Start by aiming the camera at something dark and observe the shutter setting and the F-DET voltage. Increase the light and check to see if the shutter speed and F-DET voltage increase. Follow the flow chart in Fig. 4 for the exact procedure to isolate the defect.

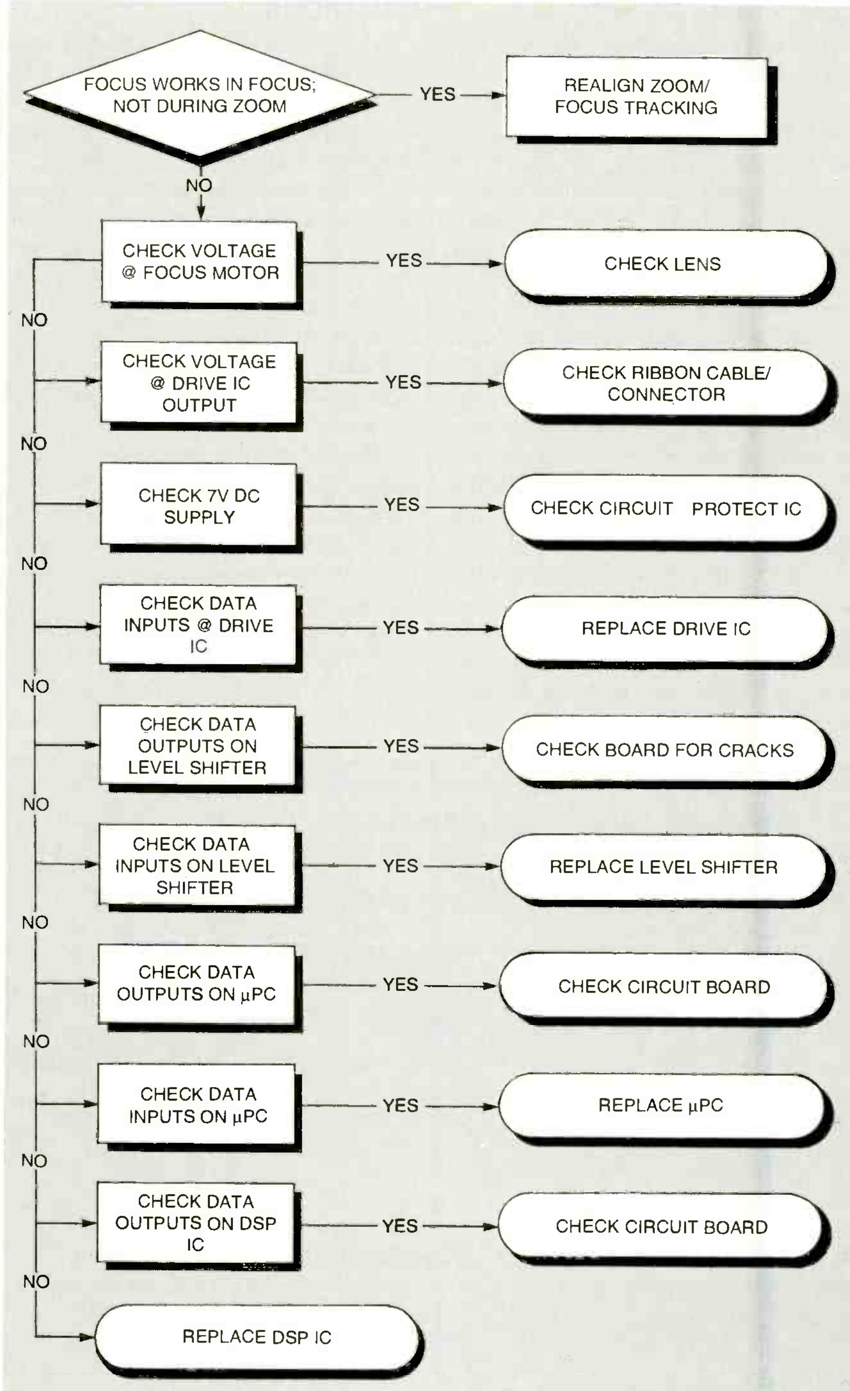

FIG. 5—THIS FLOW CHART for troubleshooting the zoom lens in camcorders begins by evaluating the output of the focus procedure.

Troubleshooting The Zoom/Focus Drive

At the end of last month's installment, we discussed the zoom/focus drive circuitry. In troubleshooting any electro-mechanical device, the first step is to isolate and identify the origin of the defect. In a camcorder-lens system, that means that we must first determine if the fault is in either the electronic or the mechanical systems. To do so we must carefully evaluate the systems involved. For example, does the focus operate only during a focus operation and *not* during a zoom operation? If so, the problem likely lies with the zoom/focus tracking alignment.

The troubleshooting flow chart in Fig. 5 outlines a proven fault-isolation process. Note that it begins by evaluating the output of the focus procedure—the voltage applied to the focus motor. That single step effectively isolates the mechanics of the assembly. Now the process continues as we methodically work our way back through the control circuitry as well. As the zoom and focus circuits are almost identical, you can use the same procedure to isolate defects in the zoom circuitry.

That concludes our look at servicing camcorder zoom-lens systems. We hope that you found it helpful. Look for similar troubleshooting tips and hints in future installments of this column. EN

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2SD-1398	SANYO	10	1.49
2SD-1650	SANYO	5	1.69
STRD-1005	SANKEN	1	4.15
STR-30130	SANKEN	1	2.66
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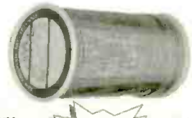

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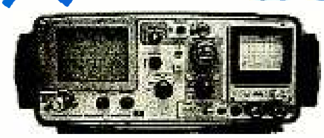

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100 MHz, Dual Channel
Includes 2 7A18's & 1 7B53, Probes, and manual (calibration not included)
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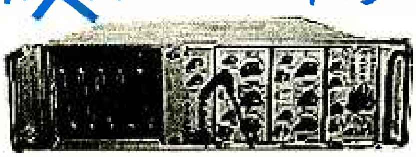

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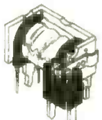

Potter & Brumfield # T90N5D12-24 24 Vdc, 675 ohm coil. SPDT contacts rated 20 amps (N.O.), 10 amps (N.C.) @ 240 Vac. 1.15" X 0.09" X 0.65". PC terminals. UL and CSA listed.

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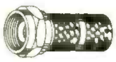

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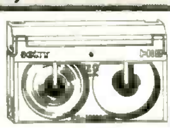

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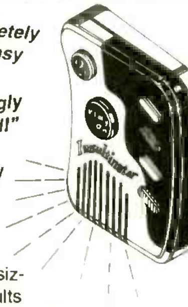

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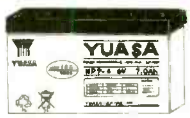

$15.00 each **CAT# GC-67**

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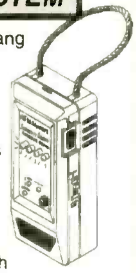

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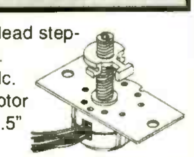

Unipolar, two phase, 6 lead stepper motor. 53 ohm coil. Operates well on 12 Vdc. 15 degree per step. Motor body is 1" diameter X 0.5" 0.08" (2mm) diameter shaft is 0.365" long. The shaft is covered with a threaded plastic sheath (0.25" dia X 0.75" long) which acts as a worm gear. This mechanism, if not required, is easily removable. Rectangular mounting bracket, 1.73" X 1.10".

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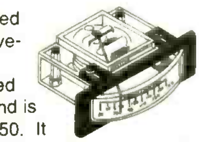

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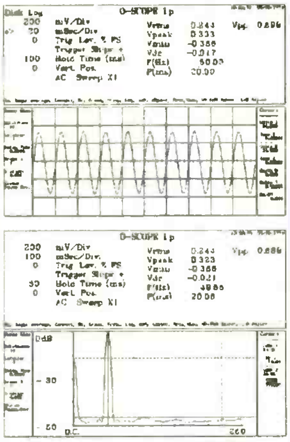

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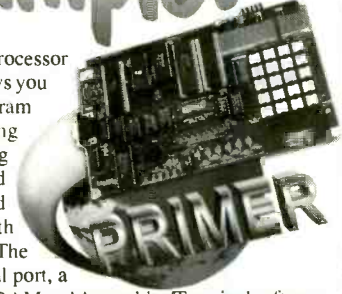

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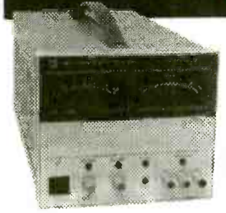

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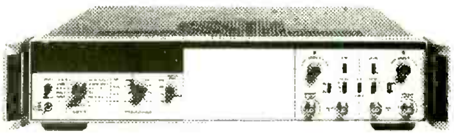

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Capacitance: 5nF-50mF
Measure AC volt to 20kHz
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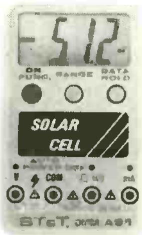
Ruggerdized case
Rubber holster included



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Fluke 79 II $175
Fluke 29 II $175
Fluke 76 $175
Fluke 87 $287
Fluke 867 $1199

Scope Meter
Fluke 97 $1785
Fluke 105 $2799

LCR Meter 131D $229.95

Most Advanced LCR

Dual display: L/Q or C/D
Inductance: 10mH-10,000H
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Resistance:10Ω-10MΩ
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Relative mode for comparison and to remove parasitics
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Best for design, incoming testing & production
SMD and chip component test probe $25.00

LCR Meter 814 $189.95

Best Resolution LCR

Inductance: 200uH-200H
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Resistance: 2Ω-20MΩ
Resolution of 0.1uF, 0.1pF, and 1mΩ are useful for high frequency and SMD
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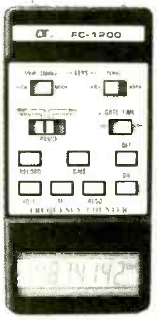

Frequency Counter FC-1200 $129.95

Frequency:10Hz-1.25GHz
Display: 8 digit LCD
Period: 0.1µs-0.1s
Records Max/Min/Average
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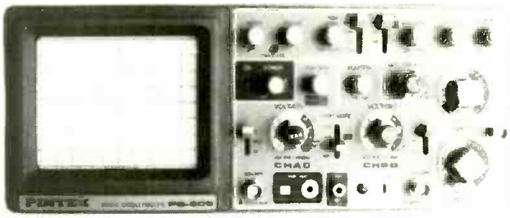

20 MHz Oscilloscope with Delay Sweep PS-205 $429.95

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.

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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
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DS-303 30MHz, 20M Sample/sec $849.95

DS-303P w/ RS-232 interface $1,049.95

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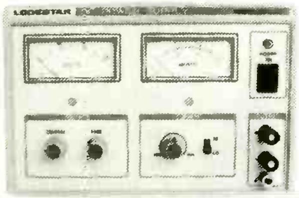
2 K word per channel storage
8 bit vertical resolution (25 Lerel/div)
Expanded Timebase 10ms/div - 0.5 s/div
Refresh, Roll, Save all, Save CH2, Pre-Trig
Plotter control



DC Power Supply PS-303 $159.00

0-30 VDC, 0-3A output

Constant voltage & constant current mode
0.02% + 2mV line regulation
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1 mVrms noise and ripple
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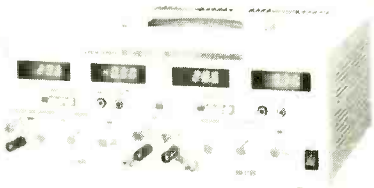
PS-8200 with digital voltmeter $179.00
Also available: 30V/5A, 60V/3A, 60V/5A 16V/10A, 30V/10A



DC Power Supply Triple Output PS-8202 $499.95

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One fixed 5VDC, 3A output
Capable of independent or tracking operation
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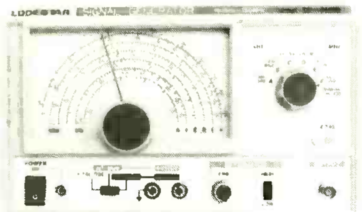
Also available: 30V/5A triple output $549.95
Dual tracking 30V/3A, 30V/5A, 60V/3A, 60V/5A



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
Output Impedance: 50 Ohm
Size: 5.9"H x 9.8"W x 8.1"D

RF Signal Generator Counter SG-4162AD $229.95

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

Audio Generator AG-2601A $124.95

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

Audio Generator/Counter AG-2603AD $229.95

Generates audio signal same as AG- 2601A
6 digit frequency counter 10Hz-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/ramp
Output: 5mV-20Vp-p
1% distortion, DC offset ± 10V
VCF: 0-10V control freq. to 1000:1

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* 2 probes(x1, x10)

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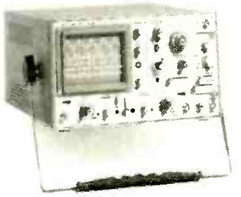

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* Sweeps to 2ns/div, Delayed sweep
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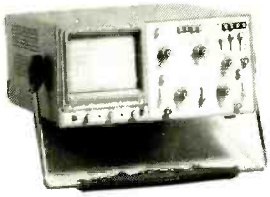
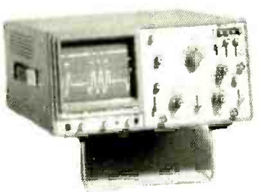
* TV sync., Z-axis input
* A and B gate output
* Best price 100 MHz scope
* 2 probes(x1, x10)

50 MHz Triggering Oscilloscope
OS-653 $699.95



* Dual Channel
* Hold Off Function
* Delayed Sweep
* Built-in Delay Line
* TV Sync
* ALT Triggering
* High sensitivity 1 mV/div
* Trigger level lock function
* Z-axis input, CH1 output
* 2 probes(x1, x10)

20 MHz Oscilloscope
OS-622B $344.95



* Dual trace, X-Y operation
* TV Sync., Z-axis input,CH 1 output
* High sensitivity 1 mV/div
* Trigger level lock
* 2 probes (x1, x10)

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* Auto serial and parallel operation (PPT series)
* Auto tracking (PPT series), IEEE-488.2 and SCPI compatible command set (optional)

PPS-1860G: (0-18V, 0-6A).................$1099.95
PPS-3635G: (0-36V, 0-3.5A).................$1099.95
PPS-6020G: (0-60V, 0-2A).................$1099.95
PPT-1830G: (0-18V, 0-3Ax2, 0-6V, 0-5A).................$1399.95
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FG-8016G $239.95

* Frequency Range: 0.02Hz to 2MHz
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* Built-in 6 digit counter with INT/EXT function
* 1000:1 tuning range
* Variable DC offset control

FG-8015 Function Generator
* 0.02Hz-2MHz (No Counter).................$189.95
FC-8131 Intelligent Counter 1.3GHz.................$469.95
FC-8270 Intelligent Counter 2.7GHz.................$629.95
UC-2010G Universal Counter.................$294.95

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* Measures ACV to 50 kHz.................$339.95
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* 0.3% DCV accuracy

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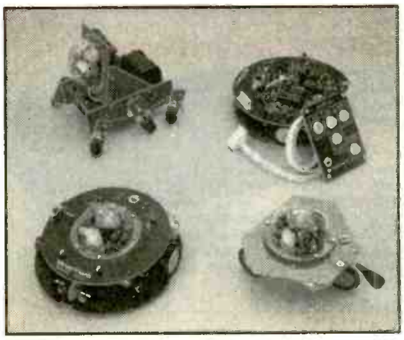

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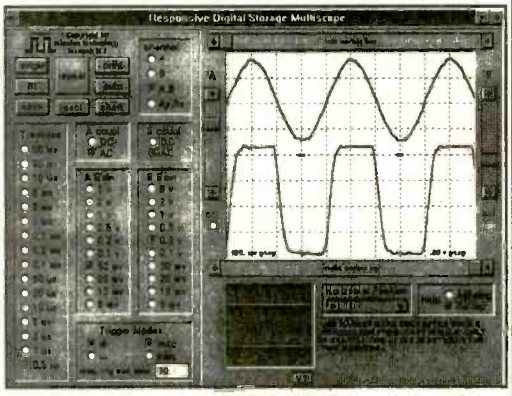

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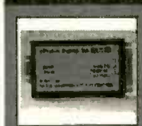

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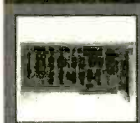

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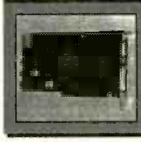

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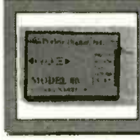

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"This is the only card that will function in every system on the market. The documentation is extensive...covers the expected POST Codes for different BIOS versions...includes a detailed reference to the bus signals monitored by the card." —**Scott Mueller from *'Upgrading & Repairing PCs, 2nd Edition'***

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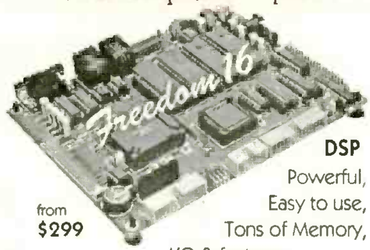

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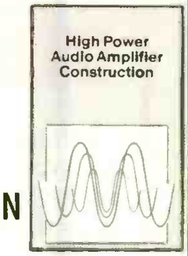

BP277—Here's background and practical design information on high power audio amplifiers capable of 300±400 watts r.m.s. You'll find MOSFET and bipolar output transistors in inverting and non-inverting circuits. To order your copy send **$6.25 plus $3.00** for shipping in the U.S. and Canada to **Electronic Technology Today Inc., P.O. Box 240, Massapequa Park, NY 11762-0240**. U.S. and Canada only. Payment in U.S. funds by US bank check or International Money Order. Please allow 6-8 weeks for delivery. MA03

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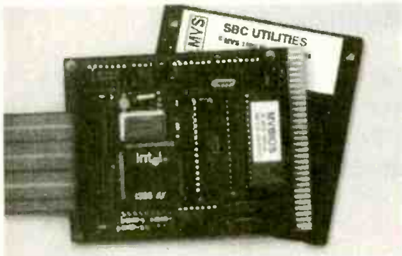

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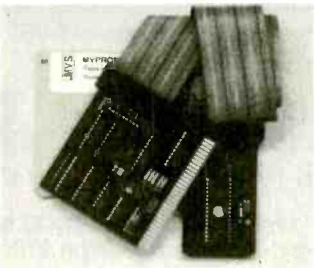

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General

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(NEDA 1604)
Low Battery Indication: BAT on Left of LCD Display
Dimensions: 188mm long x 87mm wide x 33mm thick
Net Weight: 400g

$19.00 any qty

DC Voltage (DCV)

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

Maximum Allowable Input: 1000V DC or Peak AC.

DC Current (DCA)

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

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

AC Voltage (ACV)

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

Frequency Range: 45Hz-450Hz
Maximum Allowable Input: 750V rms
Response: Average Responding. Calibrated in rms of a Sine Wave.

Resistance (Ω)

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

Maximum Open Circuit Voltage: 2.8V

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

ohFE Test
Measures transistor hFE.

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

Switchable Scope Probe Sets

(Selectable X1/Ref/X10) These high quality scope probe sets are for oscilloscopes up to 60MHz (model HP 9060) or 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 SetDC~150MHz	24.95	21.95	18.62

Etching Chemicals/Ferric Chloride

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

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

Positive Photo Resist Pre-Sensitized Printed Circuit Boards

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

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

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

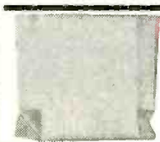
Single-Sided, 1oz. Copper Foil on Fiberglass Substrate

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

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

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

Developer



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

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

Etching Tank

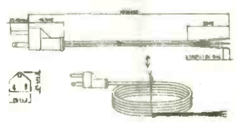
This handy etching system will handle PC boards up to 8" x 9", two at a time. Ideal for etching your PCB's! System includes an air pump for etchant agitation, a thermostatically controlled heater for keeping etchant at optimum temperature and a tank that holds 1.35 gallons of etchant. A tight fitting 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

AC Power Cords

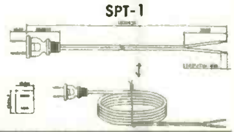
SPT-2



Our power supply cords are economical and practical for OEM and replacement applications. We stock 6' lengths, with the open end conveniently stripped and tinned (5mm).

CAT NO	SIZE	TYPE	RATING @ 125V (A)	LENGTH (ft)	COLOR	TEMP
SPT-1BLACK	18/2	SPT-1	10	6	Black	60°
SPT-1GRAY	18/2	SPT-1	10	6	Gray	60°
SPT-2BLACK	18/3	SPT-2	10	6	Black	60°

SPT-1



CAT NO	PRICE EACH 1	10	100	500
SPT-1BLACK	$ .88	$ .57	$ .51	$ .46
SPT-1GRAY	.92	.61	.55	.49
SPT-2BLACK	1.97	1.21	1.07	.97

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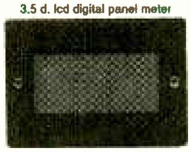
Digital Panel Meters (LCD & LED)

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



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

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

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

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

Specifications - PM-128/PM-129

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

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

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

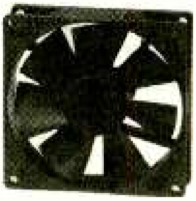
Features
- 200.00mV Full Scale Input Sensitivity
- Single 9V DC Operation
- Decimal Point Selectable
- 11mm LCD Figure Height
- Automatic Polarity Indication
- Low Battery Detection and Indication
- High Input Impedance (>100 Mohm)

Specifications - PM-328

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

AS LOW AS $5.25 ea.

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



Ball Bearing 12V DC Fans

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

INDUSTRY BEST PRICING!

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

Specifications

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

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

Tired of Paying Inflated Prices for Solder?

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

CCD Camera - IR Responsive

As Low As $85!!

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

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

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

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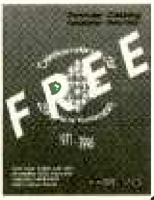

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LG-1983	2¼x19x8"	35.25
LG-1923	3x19x11½"	36.50
LG-1927	7x19x11½"	50.50

LG- Black anodized rack cabinet

New

*LL-1923B	2¾x19x12"	69.50
*LL-1925A	5x19x12"	79.50

*LL- High quality full Aluminum Cabinet
*LL- Front panel .157" & other panels .078"
*LL- Gold plated cap screw for front panel
- Dimensions in inches ±.05
- Custom-made for other dimensions if over 100 pcs for single model !

Modular Desktop Consoles

	L x W x H	
LE-453	4x4¾x3"	$ 7.50
LE-653	6x4¾x3"	9.75
LE-853	8x4¾x3"	11.75

LE- Black finished aluminum panel 1mm thick.

Camera Housing

*LD-1244	2¾x10¾x4"	$55.00
**LD-1516	3¾x13¾x4"	29.50
**LD-1565	4x13¾x5¼"	31.75

*LD- Stainless Steel 0.7mm
**LD- Sheet Metal 1mm

Alarm Box with Lock

Mejor Compra !

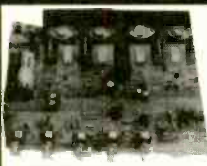
LB-1085	8¼x10¼x5"	$18.75
LB-1395	9¼x13¼x5"	25.50
LB-1525	12¼x15¼x5"	35.25
*LB-1494	9¼x14¼x4¼"	21.50
LB-1383A	8½x13¼x4"	23.25

*No lock & LB- Sheet Metal 0.8mm

Power Transformers &**Toroidal Transformer

001	28/30V x 2	6A	$ 30.00
002	36V x 2	3A	25.00
003	40V x 2	6A	32.00
**008	28/30V x 2	6A	40.00
**009	48/53V x 2	8A	66.00
**012	33/40/42Vx2	6A	48.00

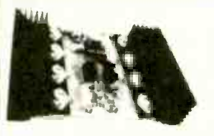
TA-800MK2 ▲▲ 120+120W Pre & Main Stereo Amp. (4 lbs.)



Kit:$ 67.92
Asmb.$ 86.95

Power Output:120W into 4 ohms RMS. 72W into 8 ohms RMS. Frequency Response:10-20KHZ. THD: <0.01%. Tone Control: Bass ±12dB, Mid & Treble ±8dB. Sensitivity: Phono Input, 3mV into 47K. Line, 0.3V into 47K. Signal to Noise Ratio: 86dB. Power Requirement: 40VDC @ 6A. Suggested Mark V model 001 or 008 transformer. Recommended Metal Cabinet LG-1924.

AF-3 ▲▲▲ 300W MOSFET High Power Mono Amp. (7 lbs.)



Kit:$ 165.00 Asmb.$ 195.00

Power Output: 300W into 4 ohms RMS. 200W into 8 ohms RMS. Frequency Response: 10HZ-20KHZ. THD: <0.03%. Signal to noise ratio: 91dB. Input Sensitivity & Impedance at 1KHZ, 1V 47K. Load Impedance 4-16 ohms. Power Requirement: ±55 to ±65VDC 8A. Suggested Mark V model 009 Transformer. Capacitor 10,000uf 80-100V model 016 or 019. Recommended Metal Cabinet LG-1925 for each channel.

TA-388 ▲▲▲ Class A FET Dynamic Buffer Stereo Pre-Amp (1 lb.)

Best Pre-Amp

Kit:$64.00 Asmb.$ 80.00

Frequency Response (at rated output): Overall 10HZ-100KHZ +0.5dB-1dB. THD: Overall <0.007% at or below rated output level. Channel Separation (at rated output 1KHZ): Overall better than 70dB. Hum & Noise: Overall better than 90dB. Input Sensitivity (1KHZ for rated output): 300-600mV. Maximum Output Level: Pre-Amp output 1.8V (0.1% THD). Power Requirement: 30V X 2 AC 500mA.

SM-100 ▲▲▲ 150 MHZ 8 Digit Frequency Counter (2 lbs.)

Best Buy

Kit:$ 79.00
Asmb.$ 99.00

Frequency Range: 10HZ-150MHZ. Gate Time: 0.01s, 0.1s, 1s, 10s. Input Sensitivity: KHZ range 10HZ-10MHZ 20mV(min.). MHZ range 1MHZ-120MHZ 20mV(min.), 120MHZ-150MHZ 35mV (min.), 150MHZ-200MHZ 40mV(typical). Time Base: 10MHZ crystal, ±10 ppm. Input Impedance: 1M ohm. Response Time: 0.2s. Resolution: 0.1 HZ: 10s gate time, 1HZ: 1s gate time, 10HZ: 0.1s gate time, 100 HZ: 0.01s gate time. Hold the last input signal. Reset counter to 0. DC 9V power adapter not included.

School Educational Kits Source ...

KA-901 30-In-one electronic lab kit $ 15.99

No soldering is required! Build a radio, alarm, timer... Earphone for private listening. Uses safe battery power. Requires 4 "AA" batteries*.

KA-902 130-In-one electronic lab kit $ 29.99

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KA-904 500-In-one electronic lab kit $ 98.99

Contains its own computer with a simple explanation of the basic(Assembler) language required for operation. Compile programs to discover how computers operate while gaining an understanding of hardware & software. With easy-to-follow manual which explains by comprehensive diagrams.Requires 6 "AA" batteries*

KA-905 75-In-one electronic lab kit $ 24.99

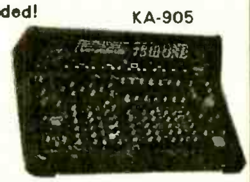
Build strobe light, touch switch, metronome, sound-level meter... No special tools or soldering required. Requires 4"AA" batteries*.

KA-906 300-In-one electronic lab kit $ 59.99

Learn about transistors, capacitors & electronic circuits. Build electronic games, battery checker... It even includes a breadboard for adding your own components. Complete with easy-to-follow manuel. Requires 6"AA" batteries*.

*Batteries are not included!

KA-906



KA-905

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- Prints via RS-232 port to any HP-GL plotter

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- 20MHz analog bandwidth
- 20MS/s sampling rate
- 2K memory per channel
- 300MHz equivalent time sampling
- Pre-trigger capture

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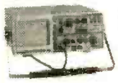
100MHz THREE-TRACE
Model 2190A



- 1mV/division sensitivity
- Sweeps to 5ns/division
- Dual time base
- Signal delay line
- 15KV accelerating voltage

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Model 2160A

- 1mV/division sensitivity
- Sweeps to 5ns/division
- Dual time base
- Signal delay line
- V mode-displays two signals unrelated in frequency.
- Component tester

$949.95

40MHz DUAL-TRACE
Model 1541C

- 1mV/division sensitivity
- Video sync separators
- Z-axis input
- Single Sweep
- V mode displays two signals unrelated in frequency
- Component tester

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Model 2260

- Cursors and readouts
- 1mV/div sensitivity
- 23 calibrated ranges - main time base
- 19 calibrated ranges - delayed time base
- Signal delay time
- V-mode - displays 2 signals unrelated in frequency.
- Component tester
- Z-axis input
- Single sweep

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20MHz DUAL-TRACE
Model 2120 - 2 Year Warranty
Special $389.95
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- 1mV/division sensitivity
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DS-603 $1350
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S-1360 $749
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40MHz

S-1345 $569
- Analog with Delayed Sweep

S-1340 $475
- Analog

2 Year Warranty

25/30MHz

DS-303 $1095
- Analog / Digital Storage

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

S-1325 $325
- 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-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

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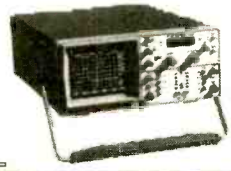
500MHz Series
Model 2615 - $1595
Model 2620 w/ tracking generator - $1895

1.05GHz Series
Model 2625 - $2395
Model 2630 w/ tracking generator - $2995



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V-209 - 20MHz Battery Operated Was $1505, NOW **$1095 Save $410**

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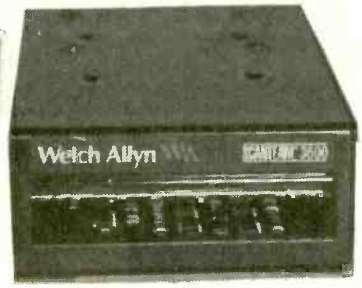
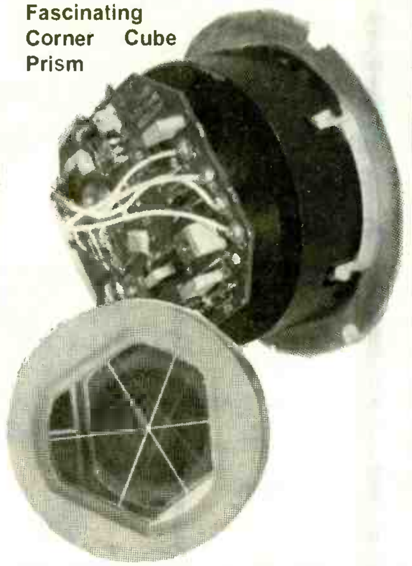
Welch Allyn Bar Code Reader



Dreaming about using bar code? Here is your big chance. this late model bar code reader is the Welch Allyn Scanteam 3600. Uses standard product barcode, easy to use, requires only 5 VDC. With full technical manual, works with standard bar code software. **$49.00** Postpaid. Unused.

Fascinating Corner Cube Prism



One of the most fascinating optical components, the corner cube directs light back to its source. Used by surveyors, planted on the moon by Apollo astronauts, these beautiful gem-like prisms are usually quite expensive. We have two types available:

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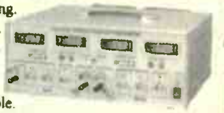
PS-305 $219.95, 0-30VDC, 0-5A.

PS-305D $399.95, dual, tracking.



8110 $289.95 0-60VDC, 0-3A.

8112 $399.95 0-60VDC, 0-5A.

8108(8109) $549.95($699.95) 0-60VDC, 0-3A(5A), dual, independent tracking. Low ripple.

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PS-2243(2245) $139.00($159.00) 0-12/0-24VDC,3A(5A).

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AM/FM SWEEMAR SCOPE

SM-6225B/C $1999.95
Freq Range: (AM)490KHz; (FM) 10-11.4MHz; *Acuracy*: ± 0.1% *Marker*: (AM)455KHz, ±5KHz, ±10KHz; (FM)10.7MHz, ±7.5KHz, ±150KHz.

STEREO SCOPE OS-7505B $369.00 trigger, 0-10MHz.

ALIGMENT SCOPE OS-7001A $369.00 0-200KHz.

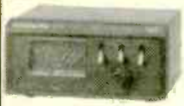
AM/FM STD SIGNAL GEN.

SG-4110A $1799.00
Freq: 100KHz-110MHz
Display: 6-digit LED
Accuracy: <±(5x10-E5 ±1 count)
Resolution:100Hz (100-34.99MHz); 1KHz (35MHz-110MHz).
Output: -19dBu, -99dBu, 1dB steps. *Impedence*: 50Ω VSWR 1.2.

NTSC TV COLOR BAR PAT. GEN.

CPG-1366A $159.95
VHF NTSC;
Freq.: 45.75, 175.25, 187.25 MHz;
RF Output: 10mV.
Impedence: 75 Ohm;
Video Output: BNC, 1Vp-p

SWR/RF/mW POWER METER



310 $89.95
Freq.Range: 1.8-150MHz.
RF Power: 0-4W/20W/200W
SWR Measure.: 1.0 - ∞, 4W min.
Accurcy: 5%-10%; SO-239 plugs.
Insertion Loss: 0.3dB.
Input/Output Imp.: 50Ω.

320 $89.95, 130-520MHz.
330 $119.95, 1.8-520MHz.
SWR-3P $26.95 1.7-150MHz; *RF Power*: 0.5-10W, 0.5W-100W.
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RT-8817U $359.00, UHF, 950MHz, 81dB, 75Ω, 0.5W.
085E-2 $499.00, UHF, 950MHz, 61dB, 50Ω, 0.5W.
087E-2 $499.00, UHF, 950MHz, 61dB, 75Ω, 0.5W.

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RF SIGNAL GENERATOR

SG-4160B $124.95
100KHz-150MHz up to 450MHz on 3rd harmonics; 6 ranges; AM modulation. *RF Output*: 100mVrms to 35MHz. *Modulation*: Int. 1KHz AM, Ext. 50Hz-20KHz AM.
Audio Output: 1KHz, 1Vrms.

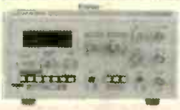
SG-4162AD $229.95, with Freq. Counter 1Hz-150MHz, 6 digits, for internal & external signals. Specification see SG-4160B above.

AUDIO GENERATOR

AG-2601A $124.95
10Hz-1MHz, 5 ranges;
Output Level: sinewave 0-8Vrms, square 10Vp-p.
Output Impedence: 600 Ohm.
Distortion: <0.05% 500Hz-50KHz; <0.5% 50KHz-500KHz.

AG-2603AD $229.95, with Freq. Counter 1Hz-150MHz, 6 digits, for internal & external signals. Specification see AG-2601A above

FUNCTION GENERATOR



FG-2100A $169.95
0.2Hz-2MHz in 7 ranges; Sine, Square, Triangle, Pulse & Ramp
Output: 5mVp-p-20Vp-p, 1% distortion.
VCF: 0-10V control freq. to 1000:1.

FG-2102AD $229.95 generates signals same as FG-2100; 4-digit counter display, TTL & CMOS outputs, 30ppm ±1 count accuracy.
FG-2020B $159.00 0.5Hz-500KHz; Sine, Square, Triangle.
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FG-513 $719.95, Digital sweep generator; Sine, Square, Triangle, Pulse, Ramp, TTL & DC; 2Hz-13MHz in 7 ranges; ±(.01%+1dgt). *Freq. Counter & TCXO*: 5Hz-100MHz, 6.5 digits, x1 & x20 attnt.

FM STEREO MODULATOR

AG-2011A $549.00
RF SECTION:
Carrier: 98MHz ±2MHz;
Output: 10mV, 1mV & 0.1mV
COMPOSITE SIGNALS:
Pilot: 19KHz ±2Hz, 0.8Vrms
INT. MODULATION: 400KHz, 1KHz ±1%, 1Vrms, distortion < .5%;*L-R Seperation*: >50dB.
EXT. MODULATION: *Freq.*: 50Hz-15KHz
L-R Seperation: >45dB 100Hz-3KHz; >35dB 50Hz-15KHz..

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MV-3100A $159.95 wide band 5Hz~1MHz, 3 scales, mV, dB &dBm; 300µV~100V in 12 ranges, 10µV resolution; -70~40dB in 12 ranges. 0dB=1Vrms,0dBm=0.755V); ±3% accuracy; Input impedence 10MΩ; Noise <2%. **MV-3201B $309.95** dual channels, simultaneous measurement..

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OS-7305B $249.00 DC~7MHz;

Vertical: 10mV/Div; Horizontal: 250mV/Div, 10Hz~100KHz in 4 ranges; 3" CRT;Internal and External Sync.; Input: 1MΩ/35pF.
OS-7010A ~~$369.0~~ $299.95 10MHz, 5" CRT, 10mV/Cm~10V/Cm, 1MΩ.
OS-622B $344.95 20MHz/dual trace.
OS-653 $699.95 50MHz, dual, delay sweep, ALT trigger, TV syn.
OS-6100B $1329.95 100MHz, 4ch, 8 traces, delay sweep,best buy.

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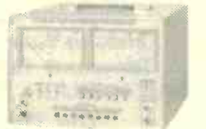
DMM-120 $24.95, 3½ digit, 600VDC/AC, 2ADC, 2MΩ, hFE/diode test.
DMM-123+Capacitance $44.95, 3½ digit, 600VDC/AC, 10ADC/AC, 2GΩ, 20µF, hFE/diode test, continuity beeper.
DMM-125 $54.95, Autorange/Bar Graph, 600VDC/AC, 2ADC/AC, 32MΩ, continuity beeper.
MIC-35 $59.95, Autorange, 3½ digit, LCD, 1000VDC/750VAC, 20MΩ, 20ADC/AC, diode/continuity check, data hold.
MIC-39 $149.95, Autorange/Bar Graph, True RMS, 3¾ digit, LCD, 40MΩ, 40µF, 1000VDC/750VAC, 20ADC/AC, 600KHz Freq. Counter, Data Hold, Drop-prove, Sleeping Mode, Memory & Read Functions.

GRID DIP METER

DM-4061 $89.95 1.5-250MHz, 6 bands;6 plug-in coils, 2 transistor, and 1 diode.
Modulation: ≈ 2KHz Sinewave. *Crystal Oscillator*: 1-15MHz. Wave absorption meter. Using 9VDCpower supply.

AUTO DISTORTION METER



DM-3104A $799.95
MEASUREMENT:
Range: 0.01%-30%, 0.1/0.3/1/3/10/30% full scale.
Freq.: 400Hz±10%, 1000Hz±10%(HPF).
Input: 3mV-100V, ratio measuring 20dB.
Auto. Switching Ranges: Fundamental Freq. = (fo)±10%;
Fund. Rejection: >-80dB at (fo)±5%; >-70dB at (fo)±10%.
Harmonic Accuracy: ±0.5dB, 1.8(fo)-20KHz.
DM-3204 $1,599.00 dual channels.

FREQUENCY COUNTER

FC-5250C $119.95
Freq. Range: 10Hz-220MHz: (HF)10Hz-20MHz, (VHF)10MHz-200MHz
Gate Time: 0.1 & 1sec.
Max. Input: 10Vp-p.
Input Sensitivity: 35mV 10Hz-200MHz. *Display*: 7-digit LEDs.
Input Imped.: (HF) 1MOhm, (VHF) 50Ohm.

FC-5260A ~~$146.00~~ $129.95 10Hz-600MHz. 7-digit LEDs.
FC-5270 $149.95 10Hz-1.2GHz. 8-digit LEDs.
FC-5600B ~~$321.00~~ $299.95 10Hz-600MHz. 10-digit LEDs.
(FC)5700 $329.95 10Hz ~ 1.3GHz. 10-digit LEDs.

SIGNAL TRACER/INJECTOR

SE-6100 $134.95
TRACER: Gain Max. 60dB
Attenuation: 0/20/40/60dB
Input Imped.: 100KOhm
Output Imped.: 600Ohm;
Speaker: 8 Ohm.
INJECTOR: *Freq.*: 1KHz Squarewave; *Output Level*: Continuously variable 0 - 4.5Vp-p.

AUTO. CAPACITANCE METER

CM3300A $139.00 10 ranges, 99.9pF ~ 99.9mF, fully automatic.

Resolution: 0.1pF lowest, 0.1% full scale.
Accuracy: 0.5% of full scale±1digit to 99.9µF, 1% of full scale±1digit to 99.9µF.
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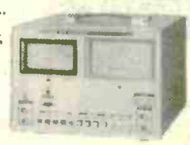
Unit Indicator: pF, nF, µF, mF. Overrange indicator.

WOW-FLUTTER METER



WF-3103A $699.95
Freq. Range: 3KHz±10% JIS/CCIR: 3.15KHz±10% DIN.
Range: 0.03/.1/.3/3% full scale.
Accuracy: ±5%.
WF-3105A $799.95, digital;
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8051/8052 Embedded Microcontroller $979.00 BGC-8052, teach yourself Intel 8051/8052 Microcontroller controls. 8051/8052 is one of the most popular Microcontroller used in today's appliance controls and is compatible with the new powerful MCS 251. Step-by-Step Learning Guide included.

CIC-100 $549.00 I/O control applications, learn Assembly, C, and BASIC programming languages, 800-pin solderless breadboard for circuit design and test, I/O drivers for controlling relay, step motor, LED, speaker, sensor, ..etc.. Application control modules available.

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TEK 7854 400 MHZ DIGITAL STORAGE FRAME	$500.00
TEK 7904 500 MHZ MAIN FRAME	$250.00
TEK 7104 1GHZ FRAME WITH- (7A29,7A29,7B10,7B15)	$2750.00
GENRAD 1657 RLC BRIDGE	$750.00
TEK 577 D1/177 CURVE TRACER	$1500.00
TEK 7D20 PROGRAMABLE DIGITZER	$500.00
TEK 465 100 MHZ OSCILLOSCOPE	$400.00
TEK 465B 100 MHZ OSCILLOSCOPE	$450.00
TEK 2335 100 MHZ OSCILLOSCOPE	$1200.00
TEK 834 DATA COMMUNICATION TESTER	$130.00
HP 5359A TIME SYNTHESIZER	$1000.00
HP 6033A 0-20V/0-30A POWERSUPPLY	$1200.00

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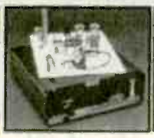
Synthesized FM Stereo Transmitter

Microprocessor controlled for easy freq programming using DIP switches, no drift, your signal is rock solid all the time - just like the commercial stations. Audio quality is excellent, connect to the line output of any CD player, tape deck or mike mixer and you're on-the-air. Foreign buyers will appreciate the high power output capability of the FM-25; many Caribbean folks use a single FM-25 to cover the whole island! New, improved, clean and hum-free runs on either 12 VDC or 120 VAC. Kit comes complete with case set, whip antenna, 120 VAC power adapter - easy one evening assembly.

FM-25, Synthesized FM Stereo Transmitter Kit........$129.95

Tunable FM Stereo Transmitter



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

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

RF Power Booster Amplifier

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

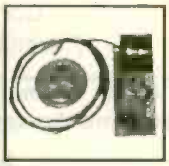
LPA-1, Power Booster Amplifier Kit.................$39.95
CLPA, Matching Case Set for LPA-1 Kit..............$14.95
LPA-1WT, Fully Wired LPA-1 with Case...............$99.95

Micro FM Wireless Mike

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

FM-5 Micro FM Wireless Mike Kit...................$19.95

Crystal Controlled Wireless Mike



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

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

Call for our Free Catalog !

RAMSEY

Super Pro FM Stereo Radio Transmitter

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

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

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

Speech Descrambler Scrambler

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

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

Tone-Grabber Touch Tone Decoder / Reader

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

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

Mini-Peeper Micro Video Camera

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

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

MicroStation Synthesized UHF TV Transmitter

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

MTV-7A, UHF TV Channel 52 Transmitter Kit..........$159.95
MTV-7AWT, Fully Wired Channel 52 Transmitter.......$249.95
MTV-7A4, 439.25 MHz TV Transmitter Kit............$159.95
MTV-7A4WT, Fully Wired 439.25 MHz Transmitter......$249.95
MTV-7A9, 911.25 MHz TV Transmitter Kit............$179.95
MTV-7A9WT, Fully Wired 911.25 MHz Transmitter......$269.95
ATV-74, 439.25 MHz Converter Kit..................$159.95
ATV-74WT, Fully Wired 439.25 MHz Converter.........$249.95
ATV-79, 911.25 MHz Converter Kit..................$179.95
ATV-79WT, Fully Wired 911.25 MHz Converter.........$269.95

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PHONE LINE MONITOR

continued from page 47

coil of RY1, and the other end of the relay is tied to + 12 volts DC, the relay coil is not energized. When the voltage from the input filter drops below 5.1 volts, the output of IC1-a goes low and energizes the relay. The contacts of RY1 (either the normally-open set or the normally-closed set) could also be used to trigger the home's security system.

Construction

Wire wrapping or point-to-point wiring could be used to assemble the project, but using a PC board promotes neatness, compactness and increased success in first-time testing. An appropriate PC pattern is provided. Note that a relatively expensive mercury-wetted relay is called for in the Parts List. These relays are extremely reliable at low voltages, and since this is a security device, the best available relay should be used. From the circuit's parts placement diagram (Fig. 2) you can see that the mercury relay must be positioned with one end up. This is necessary so the mercury will be in the correct position relative to the contacts inside the relay. False alarms or no alarms may result if the relay is lying on its side.

The Phone Line Monitor can be housed in any type of metal or plastic utility box. It might be possible to install the Phone Line Monitor in the housing of your current home security system, provided there is ample space. This type of installation will make the 12-volt DC power supply and alarm point connections easier to achieve.

Operation

The Phone Line Monitor requires no calibration. To hook the Monitor to the phone line, you will need to obtain an RJ-11 jack from an electronics or hardware store, and wire it in parallel to the phone line. In most home wiring (I have found no exceptions yet) the live pair from the central office is the two center conductors of the hookup wire, and these are generally the red/green pairs.

To test for proper operation, unplug the telephone jack from the monitor, and verify that you get an alarm within ten seconds to the security system. That is all that is required to test your unit.

Consider the following very carefully. When your phone line is cut, your alarm system won't be able to call you or the central monitoring station. Therefore, you should use the output of the Phone Line Monitor to drive some kind of house-wide alert, such as a siren or blinking lights throughput the house. Let everyone on the outside know that you phone line has been disconnected and a burglar might be at work. Alternately you might want to install a cellular phone to your alarm system so that an alarm can be transmitted to the central monitoring station or elsewhere without the use of the phone line. The alarm will be transmitted even before forced entry is begun, giving the police an opportunity to catch the thieves! Ω

Robotic Arm Kit $195.00

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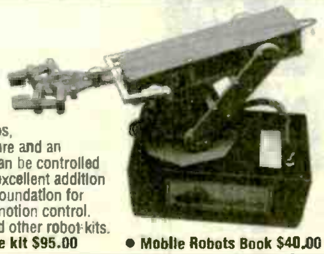

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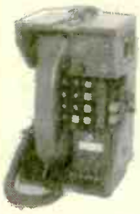

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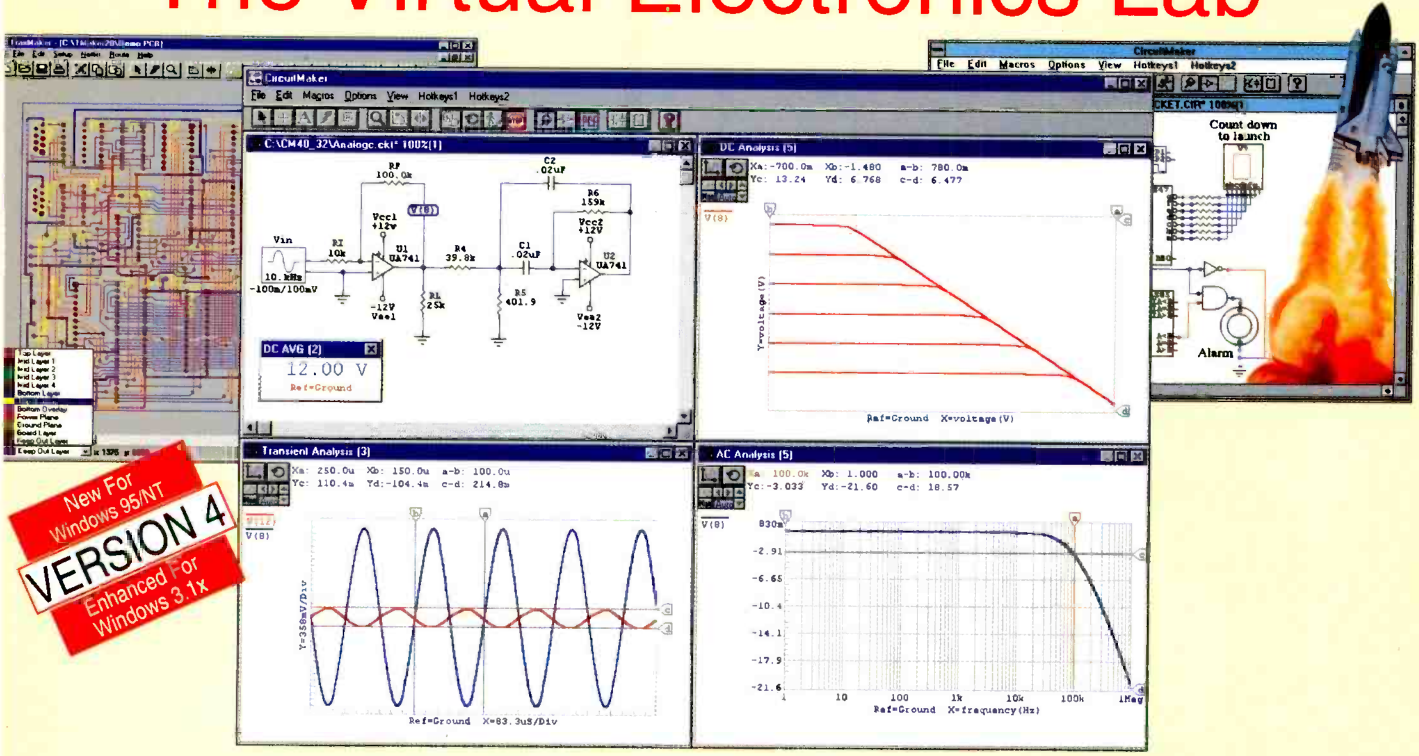

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