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Serious Tools for Serious Work.
Breakthrough wireless security system causes industry uproar...

Advanced 360° passive infrared alarm system offers features not found even in systems costing five times as much.

by John Lindner

If the predictions are true, the days could be numbered for traditional alarm systems. In a development which shocked industry insiders, Guardtech unveiled a new wireless security system which challenges even the most sophisticated alarms.

The system, called the Snitch, uses portable infrared motion detectors in conjunction with a base console and key chain remote to offer features never before available—even in systems costing thousands of dollars.

Ultimate protection.
The Snitch's microchip technology gives it the ability to provide superior security without the installation nightmare of traditional alarms. The three components of the Snitch communicate with each other using radio waves, so there are no cumbersome wires to bother with. The whole system can be installed by you in just minutes. What's more, the Snitch gives you the option of linking to a monitoring service—the same one used by systems costing up to $10,000—for ultimate security.

Total flexibility. The Snitch covers up to 1,400 square feet. You can add up to three additional motion detectors for up to 6,000 square feet of protection. Plus, only the Snitch lets you adjust the scope of the infrared detection. Using special blockers, you can adjust the area from 360° down to as low as 90'. The detector also has a built-in height adjustment.

Easy to use. The Snitch is one of the easiest systems to install and operate available. Simply plug it in and follow simple instructions—it sets up in minutes. Then you can arm or disarm by pushing a button on the key chain remote. No more dashing in and out before the alarm is activated—with the Snitch, you can turn it on or off from up to 100 feet, even through walls!

Complete security. The Snitch also gives you the option of activating a 24-hour, professional monitoring service that will dispatch help when the alarm is tripped. The service is just $12.95 a month with no long-term commitment.

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31 GREEN PCs

In today's economic environment, saving money is more important than ever. And the state of the world's ecological environment makes conserving energy another important consideration. You can save money and protect the environment at the same time by choosing and using "green" computers and peripherals. The Environmental Protection Agency (EPA) estimates that PC systems now account for more than 5% of total U.S. electrical power consumption, and that figure continues to increase rapidly. Computer manufacturers have tried to stem the tide, not by selling fewer systems, of course, but by creating energy-saving computer systems that use little or no power when not in active use. PCs and peripherals that meet the EPA's Energy Star guidelines can save you money, and are more ecologically sound than traditional equipment. Here's a close-up look at those guidelines, and what goes into a green PC.

— TJ Byers

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Silicon audio player

NEC Corporation has developed a portable music player that reproduces compact disc-quality sound with instant random access from audio data stored on a semiconductor flash-memory card. Silicon Audio is more compact and weighs less than standard cassettes or digital audio tape, and it requires no moving parts to be played. That eliminates unwanted vibrations and jumping problems that plague compact disc, and tape playback systems.

The memory cards are the size of credit cards. The prototype unit can compress a 20-kHz, 770-kilobyte-per-second audio signal to one-eighth of its uncompressed length. This permits 24 minutes of recording from a 23-megabyte memory card.

According to NEC, the semiconductor memory card can also store text, still pictures, and moving images. NEC plans to introduce the Silicon Audio player within two years.

Approaching world's most powerful magnet

Researchers at Los Alamos National Laboratory in New Mexico have successfully tested two of nine coils of a multiton magnet. When completed later this year, the magnet will be the most powerful magnet of its kind in the world. Recent tests by the laboratory have validated the magnet coil design and manufacturing procedures.

The tests also demonstrated that the coil material will reliably and safely withstand the electrical and mechanical stresses of the new 60-tesla magnet. A 60-tesla magnetic field is 1.2 million times the strength of the Earth’s magnetic field. This value is nearly one-and-a-half times stronger than the field of its closest rival, a magnet at the University of Amsterdam.

The 60-tesla magnet will be an important resource at the new National High Magnetic Field Laboratory, located at Florida State University in Tallahassee. The laboratory is sponsored by a consortium made up of Florida State University, the University of Florida, and Los Alamos National Laboratory. It is financed by the National Science Foundation.

Scientists make use of high magnetic fields to reveal the fundamental electronic and optical properties of matter, learn how materials behave in high magnetic fields, and study the makeup of atomic and molecular material. Higher magnetic fields lead to more comprehensive data.

The magnet will become a research tool that will fill the void between two existing extreme magnetic field conditions: large fields that last only microseconds or smaller fields that can be sustained for days. The new magnet will be able to produce a steady 60 tesla for a tenth of a second; it will also be able to produce pulsed and variable fields.

The magnet, designed by Los Alamos scientists, consists of nine nested coils that are mechanically independent. The copper-alloy coils not only are improvements on previous magnetic coils, but they have also solved earlier insulation and heat dissipation problems that have occurred in high-field, pulsed magnets.

The coils are combined electrically into three groups and will be pulsed sequentially to reduce heating and allow rapid cooling and turnaround time. This configuration will allow researchers to pulse the magnet again in less than an hour after it has been a pulsed.

The magnetic field behavior can be customized and optimized for different experiments. The designers report that their design concept can be expanded to generate 100 tesla without having the magnet destroy itself.

The longer high-field pulse length and relatively large sample chamber require high energy—more power than can be supplied by a commercial power grid. A 1.4-billion-watt electrical generator, intended for a nuclear power plant in Tennessee that was canceled, will power the magnet.

IBM sets patent record

IBM was issued more U.S. patents in 1994 than any single company has ever received in a calendar year. According to IFI/Plenum Data Corporation, IBM received 1298 patents in 1994, topping its closest competitor, Canon of Japan, by 199 patents. IBM also ranked first in U.S. patents awarded in 1993, the first year since 1985.
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**DVD coup.** Sony and Philips, proprietors of basic patents on the compact disc and its variations, including CD-ROM, were shocked by an apparent coup d'etat when major Hollywood and consumer-electronics interests backed a competing proposal for a digital video disc (DVD) system over their proposal, which had generally been considered the favorite. Working quietly behind the scenes, Toshiba and Time-Warner mustered the support of MCA, MGM/UA, and Turner Home Entertainment (in addition to Warner Brothers) from the movie-making community, and Matsushita (Panasonic), Thomson Consumer Electronics (RCA and GE), Pioneer, Hitachi, JVC, and Nippon Columbia (Denon) from among consumer-electronics manufacturers—in addition, of course, to Toshiba.

Both the Sony-Philips and the Toshiba-Time Warner systems were designed to extend the capabilities of the 5-inch compact disc to accommodate full-length movies in digital storage with quality exceeding that of the laserdisc. Both formats were carefully screened by Hollywood studios as the potential successor to tape as the chosen format for prerecorded entertainment—particularly movies. However, the chosen format also has implications for other types of storage, particularly as a CD-ROM with five to seven times the capacity of today's version. As reported here (Electronics Now, March 1995), the Sony-Philips proposal envisioned a single-sided, high-density disc, 1.2 mm thick, capable of storing 3.7 gigabytes of data and claimed to be capable of holding a 135-minute movie. There is the possibility of doubling the capacity some time in the future by switching to a dual-layer disc, using a reflective-transparent coating for the top layer, with the focus of the playback laser variable to read either the top layer or the bottom layer recording.

The Winner? Sony admittedly was taken by surprise when the competitive system was presented—at simultaneous news conferences in Los Angeles, Tokyo, and Osaka. The Toshiba-Time Warner disc demonstrated at all three locations was a double-sided disc. Its two 0.6mm sides, laminated together, had a data capacity of five gigabytes per side, for a total of ten gigabytes, designed to hold a 135-minute movie on each side, or various combinations—for example, a movie on one side, a video game based on the movie on the other side.

Taken aback, Sony first said the system was more difficult to produce than the 1.2mm disc. However, Warner said that it had already produced 50,000 discs in trial runs at its CD-pressing facility, and the estimated cost in mass production would be about 25% higher than an audio CD. Toshiba and Time Warner said that the additional capacity of their disc over the Sony-Philips version would make possible higher quality recordings, particularly of movies that are difficult to digitize because of rapid scene changes and fast action.

The Toshiba disc has an average playback rate of 4.94 megabits per second (Mbps) for a 135-minute movie. That can be extended to 142 minutes at a lower rate of 4.69 Mbps. In either case, it can accommodate Dolby AC-3 digital audio, three language channels, and four subtitle channels. As demonstrated at the news conferences side-by-side with laserdisc, the DVD images were noticeably sharper, with more subtle texture gradations and far better color. As shown alongside the same movie played back from a digital D-1 broadcast videocassette recorder, the difference was indistinguishable to observers.

Warner says that it will produce movies on the new format for sale at the same price as it does videocassette movies, and both Matsushita and Thomson said that they plan to introduce players in the second half of 1996 to retail at about $500. The players will be "backward compatible" with audio CDs—that is, they will be able to play audio CDs, but the digital video discs will not be playable on today's CD players. Movie interests forecast that the launch will be accompanied by 250 movie titles.

The system obviously can't be a

Continued on page 121
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**ONE FOR THE BIRDS?**

I want to build an incubator for hatching birds’ eggs. This requires that the eggs be gently moved about once an hour. I have a reversible AC motor, geared down to 1 rpm. I need a circuit to run the motor forward for 10 seconds, wait an hour, run it backward for 10 seconds, wait, run it forward again, and so on. Can you help?—R. Weaver, Albuquerque NM.

Actually, this sounds like a job for a stepper motor and a microcontroller, but since you already have the reversible AC motor installed, try the circuit in Fig. 1.

One cycle every two hours is much too slow for an ordinary RC oscillator; it would require an enormous (and unstable) capacitor. Accordingly, the circuit has a 4060 CMOS long-period timer, which consists of an oscillator plus a series of binary counters that divide the frequency by 2, 4, 8, and so on up to 16,384. The oscillator runs at a comfortable 2 hertz (2 cycles per second), controlled by a capacitor and two resistors, and the binary counter divides this down to produce a square wave that has only one cycle every 2 hours, as well as another one that oscillates twice as fast (see Fig. 2).

The faster of the two square waves determines when the motor runs, and the slower one determines its direction. Here’s how it’s done: First, the faster square wave goes through a capacitor, resistor, and diode, which convert it into a narrow negative-going pulse that occurs once per hour. Then the 555, connected as a monostable, stretches the short pulse so that it is 10 seconds long (the length of time the motor should run). Logic gates then steer that pulse to one of two relays so that the motor runs either forward or backward, depending on which state the slow square wave is in at the time. Because the forward and reverse pulses are generated by the same 555 circuit, they are the same length—important so that the reverse cycle will exactly undo the motion of the forward cycle. Wiring the relays to the motor is left up to you. Good luck with your eggs.

**TONE DECODER**

I am hoping that you or one of your readers may have a cross reference and/or pin assignment for an SSI 20C90 DTMF chip.—J. Lubben, Deer Park, TX.

DTMF (dual tone multi frequency) signals are the tones used for telephone dialing; they are also used for other purposes, such as control of ham radio repeaters. Each tone consists of two sinewaves transmitted simultaneously, one indicating the row on the keypad and one indi-

---

**FIG. 1—CIRCUIT CONTROLS FORWARD AND REVERSE MOTORS to rock eggs in incubator. Every hour, one motor runs for 10 seconds.**

**FIG. 2—WAVEFORMS in the circuit of Fig. 1 (not to scale).**
**FIG. 3—**EACH DTMF SIGNAL consists of two sinewaves transmitted simultaneously, one indicating the row on the keypad and one indicating the column.

cating the column, as shown in Fig. 3. For example, the digit 5 is transmitted as 770 Hz and 1336 Hz. The codes in the rightmost column (A, B, C, and D) are not normally available on consumer equipment.

SSI (Silicon Systems, Inc.) makes ICs that recognize and decode DTMF tones. Several SSI chips (though not this particular one) are described in The ARRL Handbook for Radio Amateurs, published by the American Radio Relay League, Newington, CT 06111—a book every electronic tinkerer should have. For data on the 20C90, you can write to SSI at 14351 Myford Road, Tustin, CA 92680.

**ELECTRONIC CLOCKWORK?**

In 1977 I assembled a 6-digit LED clock kit. Now, 17 years later, the clock has failed, and I can’t get a replacement for its CT7001 clock chip. Could you direct me to plans for a similar clock kit that is still available?—P. Smith, Thousand Oaks, CA.

Certainly. LED clock kits and parts are available from Jameco, 1355 Shoreway Road, Belmont, CA 94002-4100. Although their catalog does not list a CT7001, they’ll know of a replacement if one exists.

**METER SHUNTS**

What type of shunt do I need to measure 50 amperes on a 50-microampere meter, and where can I get one?—Steve Baumfalk, Norfolk, NE.

A shunt is a small resistor connected across a current meter to make it read a higher range of current than it normally could. For example, a 1-milliampere meter can read 100 milliampere full scale with the proper shunt (see Fig. 4).

To calculate the resistance of the shunt, you have to know the resistance of the meter. You can measure this with an ohmmeter, but make sure the ohmmeter doesn’t send too much current through the meter movement that you’re testing. For best results, use a digital multimeter (DMM) set to its 20-kiloohm or higher range, and switch to lower ranges only if necessary. You’ll find that the resistance of your 50-microampere meter is probably a few thousand ohms. Then you can find the shunt resistance:

\[ R_{shunt} = \frac{(R_{meter} \times I_{meter})}{(I_{total} - I_{meter})} \]

The current can be in amperes, milliamperes, or microamperes, as long as you use the same units in all three places in the formula. For example, if you had a 1-milliampere meter with a resistance of 1000 ohms, and you wanted to make it read 100 milliampere full-scale, you’d plug in the following values:

\[ R_{shunt} = \frac{(1000 \times 1 \text{ mA})}{(100 \text{ mA} - 1 \text{ mA})} = 1000/99 = 10.1 \text{ ohms} \]

A 10-ohm resistor will do just fine; in general, it’s sufficient to get within a few percent of the correct value.

Now back to your problem. Yours is a special case because you want a million-to-one change of scale (50 amps to 50 microamps). Suppose the resistance of your meter turns out to be 6000 ohms. Then you’ll calculate as follows:

\[ R_{shunt} = \frac{(1000 \times 50 \mu A)}{(50,000,000 \mu A - 50 \mu A)} = \frac{50,000}{49,999,950} = 0.001 \text{ ohm} \]

They don’t make resistors that... Continued on page 93
MILLIOHM TESTER MODIFICATIONS

I read the article "Build this Milliohm Tester" (Electronics Now, February 1995) and I found some possible problems with the circuit and would like to suggest ways to simplify it.

Approximating a current source with a voltage source in series with a resistor will allow the current through the resistor under test to vary as a function of the unknown resistor's value. Although that reference current error will be small for small values of $R_x$, I would suggest a three-terminal voltage regulator as a current source, as shown in Fig. 1.

IC1 is an ECG956 (or equivalent) positive adjustable voltage regulator that has a 1.2 voltage reference between its OUT and ADJ terminals. A 12-ohm resistance (R1 and R2) connected between IC1's OUT and ADJ terminals sets the regulator's output current to 100 milliamperes. To calibrate the circuit, connect a digital ammeter in place of $R_x$ and adjust R2 to get a current of 100 milliamperes.

I have another criticism of the article's circuit: Never connect the current source and voltage measurement leads together before connecting any device under test in any kind of four-wire resistance measurement. If you do, you'll be measuring the resistances of the contacts between the current leads as well as the resistance under test. This is shown in Fig. 2.

Instead, connect the current source and voltage measurement leads separately to the leads of the resistor under test, as shown in Fig. 1. That avoids measuring the voltage drop across the current lead's contact resistance, as shown in Fig. 3. (Contact resistance of the voltmeter probes is not measured because a digital multimeter draws no current.)

Note also that the circuit shown in Fig. 1 requires fewer parts than that in the published article. Moreover, a power switch is not needed because the Fig. 1 circuit draws no current when there is no $R_x$ connected.

GARY TONG
White Deer, PA

SIGNAL THEFT

Thank you for publishing a fine electronics magazine. I enjoy the wide editorial coverage of the electronics industry.

I'm writing in response to the "Signal Theft" article (January 1995). Scrambling and descrambling techniques are of great interest to me. Although the article was good, I believe that there are many sides to the issue.

First, consider cable TV as a utility: it is a monopolistic one at that. I pay my local cable-TV provider to deliver non-premium service to a terminal on the back of my house. Their only obligation beyond that is to deliver a clear signal.

Second, look at the other utilities that service my house: electric, water, and telephone. The electricity and water are metered and I pay for the quantity I use. However, once all three of these services are installed in my house, I can do whatever I want with them as long as I don't interfere with their delivery. I can even choose not to use any of them and seek alternative sources.

For example, I can use the electricity as is, transform it up or down, rectify it or connect a wire so my neighbor can use it. Similarly, I can use the water just as it enters the house or I can heat it, cool it, freeze...
it, or give it away. As for the telephone service, I can speak over the phone or send data over it with a modem or fax. I can even add extra phones or answering machines.

The point is, if I have paid for a service to be delivered to my house, I believe that I should be able to do whatever I please with that service in the confines of my home, as long as it doesn’t interfere with the service’s distribution.

I don’t think of cable-TV signals as different from these other services. If the cable company does not take steps to limit or control the incoming signal with its equipment, I should be able to do whatever I want with the signal in my home. Yes, even descramble it if I had the equipment and were inclined to do so.

Satellite program services have taken a similar approach; they have added some sophisticated techniques to their VideoCypher scrambling method. No “pirates” have been successful in breaking the VCRS board to receive the television audio from it without subscribing, and satellite piracy has been virtually eliminated. If cable-TV distributors are to achieve the same kind of control, extensive equipment upgrades will be required.

I do not think that we will see that happen as the competitive threat of the small-dish TVRO industry continues to grow. Programming bargains are becoming more widely available as the competition heats up. That will benefit us TVRO owners. (Yes, I have both cable and a satellite dish.)

The cable TV companies will receive their comeuppance for their lousy service, poor quality signal, and indiscriminate and frequent rate increases when the TVRO industry increases its offerings.

The operative word in my examples is ownership. Once a service enters my home, ownership is transferred to me so that I can use that service as I please. That includes altering the state of the service or product to my preferences. After all, who would want to take a cold shower in the dark and have the only phone in the house ringing in another room?

J. DARRELL GAMMON
Cary, NC

---

**TV-SERVICE TIP**

I service television sets for a living, and I've found a way to check for open electrolytic capacitors.

My oscilloscope has a 1-kHz squarewave output jack for calibration. Because it has an output impedance of about 1500 ohms, a capacitor connected between it and ground will cause integrate the signal, depending on the value of the capacitor.

I connect my oscilloscope probe to the jack and use several test leads, one from the jack and one from ground to find defective electrolytic capacitors. Any capacitor with a value above about 10μF will show up as a straight line trace (as will a short circuit, so be careful).

A good 1- to 10-μF capacitor will show up as a triangle waveform. An open capacitor will, however, not show any pattern, just add noise to the square wave, or give a reduced amplitude squarewave, depending on the resistance in parallel with the capacitor.

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<tr>
<td>OS-3060: 60 MHz, 20 MS/s</td>
<td>OS-9960D: 60MHz, Delayed Sweep</td>
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<td>OS-8100A: 100MHz, Delayed Sweep</td>
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<td>OS-90400: 20 MHz, Delayed Sweep</td>
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<td>OS-904RD: 40 MHz, Delayed Sweep</td>
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<tr>
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<td>OS-904DG: 20 MHz with 1MHz</td>
</tr>
</tbody>
</table>

Don't forget the other sensibly priced instruments available from GoldStar (Sweep Function Generators, Frequency and Universal Counters, Bench Power Supplies, and Bench and Handheld Digital Multimeters).

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The Sensible Source
13013 East 166th St., Cerritos, CA 90701 310-404-0101 fax: 310-921-6227

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May 1996, Electronics Now

www.americanradiohistory.com
While this method is not infallible, it can save you the trouble of removing capacitors from a circuit and testing them individually.

ARDELL FAUL
Spokane, WA

IN DEFENSE OF CSICOP
The letter from Benson Boss (Electronics Now, January 1995) condemning the Committee for the Scientific Investigation of Claims of the Paranormal (CSICOP) requires an answer. I will take on his points one by one:

1. He says that CSICOP condemns before investigating. Can he give me an example of that? CSICOP has investigated countless claims of paranormal events. In many cases, the claims have absolutely nothing but anecdotal evidence to support them.

Plenty of television talk shows provide a large audience for people who want to make fantastic claims. I certainly don't want CSICOP to join that parade. Just remember that the second and third words in CSICOP's title are "scientific investigation."

Mr. Boss claims that the committee picks on weak, absurd, and vulnerable reports of the paranormal. That probably represents most paranormal claims. Does he know about any paranormal event that CSICOP refuses to explore because that event could possibly be real? I'm sure CSICOP will pay particular attention to any paranormal claim that seems to be truly remarkable.

Mr. Boss condemns CSICOP for demanding physical evidence to substantiate claims. No one who believes in the scientific method should ever settle for less. Anyone can make up a fantastic story. No organization could possibly investigate every idiotic claim made in a world that does not seem to have a shortage of crackpots.

Finally, Mr. Boss believes that it is professors, intellectuals, and scientists (the sort of people who make up CSICOP) who prevent the introduction of any fundamentally new ideas in politics, religion, medicine, and science. Well, just who has made the major contributions in those areas?

The readers of Electronics Now are interested in electronics. There is no doubt that the incredible advances being made in that field are being made by just the kind of people Mr. Boss thinks are too narrow-minded to achieve such accomplishments.

Everyone interested in learning about CSICOP should read its journal, Skeptical Inquirer.

RICHARD W. STICKA
Yorkville, IL

Continued on page 93
Look beyond our Scope.

Tektronix gives you an entire bench of affordable test instruments.

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CIRCLE 196 ON FREE INFORMATION CARD
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The soldering iron is perhaps the most important tool for assembly and repair work in electronics. The basic soldering iron can tackle nearly any job involving common leaded components—not only assembly and installation work, but disassembly and repair work as well.

In skilled hands, no work with leaded components is too delicate for an ordinary soldering iron. But experience is the only way to learn how long to hold an iron in place and how much solder is sufficient.

Disassembly work can also be done with a soldering iron and either a plunger-type "solder sucker" or a piece of desolder braid. Most hobbyists are familiar with the manually operated plunger-type solder suckers that must be cocked before use. After a solder joint is melted with an iron, the sucker is placed over the joint, and a trigger is pressed that releases the spring-loaded plunger and, if everything goes right, the solder is sucked out of the joint.

Because solder suckers are difficult to operate effectively, many people prefer to use desoldering braid. Desoldering braid is placed over a solder joint, and is heated along with the solder. As the solder melts, the braid soaks it up. After the solder has been removed from all of an IC's pins, the part can usually be removed from the board fairly easily.

Unlike through-hole components, surface-mounted components usually require specialized tools. Some surface-mount work can be done with a regular soldering iron, but not much. For example, disassembly or repair work on surface-mount components is next to impossible with a regular iron, because surface-mount components must be removed by simultaneously melting all solder joints and lifting the part off the board. There is no way to effectively heat all of an IC's pins at once with an ordinary soldering iron.

Surface-mount assembly and repair work requires special tools: tools to dispense special solder, others to melt it, and yet others to remove a part already soldered in place.

The SMD-250

The SMD-250 from Automated Production Equipment Corporation (A.P.E., 142 Peconic Avenue, Medford, NY 11763, 516-654-1197) could be the last piece of soldering equipment you'll ever need. The SMD-250 is a professional-quality tool that includes all of the features normally required for working with both through-hole and surface-mount components.

The unit is somewhat like an erector set in that many different tips and attachments can be interchanged to perform any soldering or desoldering task. All tips are sensor-driven so that the unit can display the actual tip temperature.

The SMD-250’s thermal quad-pack tweezer with interchangeable tips allows the quick removal of all kinds of surface-mount devices. The tweezer handle is basically two gold-plated irons joined at a hinge that allows a surface mount device to be grabbed, heated, and removed from the board with one hand. Tips for the tweezer handle range from simple chopstick-like ones that can grasp a surface-mount capacitor or resistor, to square-shaped tips of different sizes that can slip over a PLCC (plastic leaded chip carrier). The tips tighten when the handle is squeezed, and heat all the pins at once—the part then lifts right off the board. Precise temperature control targets the heat to the leads without damaging the part or the board.

A static-dissipative solder extractor can remove solder from leaded components. The solder extractor is basically a soldering iron with a hollow tip. The tip is pressed over the end of a lead on the solder side of a PC board. Once the solder melts, the user can press a trigger that activates a vacuum pump within the SMD-250. That sucks the solder out of the joint, freeing the lead. The procedure must be repeated for each pin of a conventional IC before the part can be removed. The solder extractor can be used to remove any type of leaded component from a PC board. The sensitive tip responds to changes in temperature quickly, even when it is used on multilayer boards.

The SMD-250 also contains a high-efficiency lightweight soldering iron for use with both through-hole and surface-mount applications. The iron is temperature-controlled. A variety of interchangeable tips are included with the iron.

The SMD-250 also has a built-in epoxy/solder paste dispenser that can apply consistent deposits of the paste. Paste is pumped out of a dis-

Continued on page 92
New device turns any electrical outlet into a phone jack

Engineering breakthrough gives you unlimited phone extensions without wires or expensive installation fees

You don’t have to have a teenager to appreciate having extra phone jacks. Almost everyone wishes they had more phone jacks around the house.

When I decided to put an office in my home, I called the phone company to find out how much it would cost to add extra phone jacks. Would you believe it was $158?

No more excuses.

Today, there are a thousand reasons to get an extra phone jack and a thousand excuses not to get one. Now an engineering breakthrough allows you to add a jack anywhere you have an electrical outlet. Without the hassle. Without the expense. And without the rules of wires.

Like plugging in an appliance. Now you can add extensions with a remarkable new device called the Wireless Phone Jack. It allows you to convert your phone signal into an FM signal and then broadcast it over your home’s existing electrical wiring.

Just plug the transmitter into a phone jack and an electrical outlet. You can then insert a receiver into any outlet anywhere in your house. You’ll be able to move your phone to rooms or areas that have never had jacks before.

Clear reception at any distance. The Wireless Phone Jack uses your home’s existing electrical wiring to transmit signals. This gives you a quality sound that far exceeds cordless phones. It even exceeds the quality of previous devices. In fact, the Wireless Phone Jack has ten times the power of its predecessor.

Your range extends as far as you have electrical outlets: five feet or five hundred feet. If you have an outlet, you can turn it into a phone jack—no matter how far away it is. The Wireless Phone Jack’s advanced companding noise reduction features guarantee crystal-clear reception throughout even the largest home.

Privacy guarantee. You can use The Wireless Phone Jack in any electrical outlet in or around your home, even if it’s on a different circuit than the transmitter. Each Wireless Phone Jack uses one of 5,000,000 different security codes. You can be assured that only your receiver will be able to pick up transmissions from your transmitter.

Is the Wireless Phone Jack right for you?
The Wireless Phone Jack works with any single-line phone device. Almost anyone could use it, especially if...

- Few jacks. You want more phone extensions without the hassle and expense of calling the phone company.
- Bad location. You have jacks, but not where you need them most, like in the kitchen, garage, home office or outside on the deck.
- Renting. You want to add extensions, but you don’t want to pay each time you move.
- Other phones. You have an answering machine, modem or fax machine you want to move to a more convenient place.

The Wireless Phone Jack System consists of a transmitter (right) and a receiver (left). One transmitter will operate an unlimited number of receivers.

Unlimited extensions—no monthly charge. Most phone lines can only handle up to five extensions with regular phone jacks. Not with the Wireless Phone Jack. All you need is one transmitter, and you can add as many receivers as you want. Six, ten, there’s no limit. And with the Wireless Phone Jack, you’ll never get a monthly charge for the extra receivers.

Works with any phone device.

This breakthrough technology will fulfill all of your single-line phone needs. It has a specialized digital interface for use with your answering machine or modem. You can even use it with your answering machine just by plugging it into the Wireless Phone Jack receiver.

Special factory-direct offer. To introduce this new technology, we are offering a special factory-direct package. For a limited time, the transmitter is only $49. One transmitter works an unlimited number of receivers priced at $49 for the first one and $39 for each additional receiver. Plus, with any Wireless Phone Jack purchase, we’ll throw you a phone card with 30 minutes of long distance (a $30 value) for only $9.95.

Try it risk-free. The Wireless Phone Jack is backed by Comtrad’s exclusive 30-day risk-free home trial. If you’re not completely satisfied, return it for a full “No Questions Asked” refund. It is also backed by a one-year manufacturer’s limited warranty. Most orders are processed within 72 hours and shipped UPS.

To order, call toll-free 24 hours a day.

May, 1985, Electronics Now

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PERSONAL LAB SCOPES.
The TDS 400A series of three digitizing storage oscilloscopes from Tektronix offer operating bandwidths from 200 to 400 MHz and sampling rates from 2.5 samples per second to 100 megasamples per second. The oscilloscopes are capable of making the electrical and physical measurements required for a range of applications from biophysical research, medical research, and mechanical analysis to high-voltage equipment.

Signal conditioning with 1.5% accuracy is offered. An extended record length of 120 kilobits per channel allows researchers to capture hours of complex, slow-varying waveforms. When teamed with the ADA400A differential preamplifier, the instruments' 10-microvolt sensitivity can analyze extremely small amplitude signals. A HiRes mode extends vertical dynamic resolution to 12 bits, even on its single-shot signals.

Both TDS400A instruments feature an easy-to-use graphical user interface (GUI) and waveform zoom functions for efficient handling, viewing, and management of complex waveform data. The GUI and 25 automatic measurements are standard. A Fast Fourier Transform (FFT)/math option permits the harmonic analysis of signals in the frequency domain. An optional floppy-disk drive permits data and waveforms to be saved for further processing to document the results of acquired measurements.

Specialized signal-conditioning accessories supplement the personal lab scopes' capabilities. The ADA400A differential preamplifier makes 10-microvolt sensitivity possible and the P5200 high-voltage differential probe permits a TDS 400A to make safe and accurate measurements at voltage levels up to 1300 volts.

The TDS 410A two-channel model has a base price of $4950. There are two four-channel models: the 200-MHz TDS 420A has a base price of $6295, and the 400-MHz TDS 460A has a base price of $7685. The ADA 400A differential input preamplifier is priced at $895, and the P5200 high-voltage differential probe is priced at $399.

TEKTRONIX MEASUREMENT BUSINESS

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PHOTovoltaic RELay. The PVT412 Series of photovoltaic relays from International Rectifier are single-pole, normally open, solid-state relays that can replace electromechanical relays in many applications. Each includes a power MOSFET (HEXFET) output switch, driven by an integrated circuit photovoltaic generator. The output switch is controlled by radiation from a GaAlAs light-emitting diode, which is optically isolated from the photovoltaic generator.

The relays, intended for telecommunications applications, are designed for off-hook switching, dial pulising, ringer injection, and general switching. For example, the PVT412L includes an active, current-limiting circuit conforming to FCC Part 68 and other regulatory agency current-surge requirements when overvoltage protection is provided. The PVT412 does not include current-limiting circuitry, but offers lower on-state resistance. The relays permit ±400 volt AC peak or DC switching at up to 140 milliamperes in AC mode and 210 milliamperes in DC mode.

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Series PVT412 relays are packaged in six-pin, molded DIP packages with either thru-hole or "gull-wing" surface-mount terminals. They are available in standard (50-count) plastic shipping tubes or on tape-and-reel, priced at $1.40 each in 25,000 quantities.

International Rectifier
233 Kansas Street
El Segundo, CA 90245
Phone: 831-322-3331
Fax: 310-322-3332

10-BIT WIDE BIDIRECTIONAL OPTICAL LINK. The Optobus optical link from Motorola is a 10-bit wide bidirectional data interconnect assembly that will link computer systems over distances of up to 30 meters. The optical link
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2. **Composite Video/Audio Generator**
   - Information on the PocketGen generator, including its features and capabilities.

3. **GUI Designer**
   - Details on DOS Buttons, including their design and functionality.

4. **Electromagnetic Field Meter**
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The TTL-compatible sync output from the internal oscillator maintains a 50% duty cycle—regardless of the duty cycle of the other waveforms—to synchronize other devices in the system. An internal phase detector allows the oscillator to be synchronized to an external TTL clock.

The MAX038 is available in a 20-pin DIP or wide-small outline package with two temperature ranges: 0 to 70°C and -40°C to +85°C. Prices start at $9.50 each in quantities of 1000.

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CIRCLE 26 ON FREE INFORMATION CARD
HIGH-SPEED, LOW-POWER OP-AMP. The OPA658 is a new ultra-wideband, low-power, current-feedback operational amplifier from Burr-Brown. It features a high slew rate and low differential gain/phase error. Its low (50-milliwat) power dissipation combined with its high (900-MHz) bandwidth make the device suitable for video, medical imaging, communications, and digital-to-analog conversion applications.

The current feedback of the OPA658 allows large signal bandwidth at high gains. Internally compensated for unity-gain stability, it operates from a ±5-volt power supply. It is packaged in eight-pin DIP and SOIC cases.

The OPA658 operational amplifier is priced at $2.25 each in quantities of 1000.

Burr-Brown Corporation
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Phone: 800-546-6132

DUAL TIME-BASE OSCILLOSCOPE. The Model 2260 oscilloscope from B + K Precision has a 60-MHz bandwidth and 1-milli- volt per division vertical sensitivity. V-mode triggering permits viewing two signals unrelated in frequency. Other features are main and delayed time bases and a built-in component tester for checking resistors, capacitors, coils, diodes, and other semiconductor devices.

The oscilloscope’s digital readout displays volts per division (either channel), seconds per division, and important operating mode information. Cursors can be set for measuring voltage and time differences and frequency.

There are 23 user-selectable calibrated sweep time ranges on the main timebase and 19 user-selectable ranges on the delayed sweep timebase. Each sweep time range is fully adjustable between calibrated ranges. A times 10 magnifier allows closer examination of waveforms without disturbing the oscilloscope’s display calibration.

The 2260 dual time-base oscilloscope with two 10:1 probes, instruction manual, and schematic diagram is priced at $1399.00.

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CIRCLE 28 ON FREE INFORMATION CARD

CIRCLE 27 ON FREE INFORMATION CARD

CIRCLE 99 ON FREE INFORMATION CARD
Windows 95 Revealed; by Jack Nimersheim. Random House Electronic Publishing, 201 East 50th Street, New York, NY 10022; Phone: 800-733-3000; CompuServe: GO RANDOM; $19.00

Microsoft's Windows 95 differs significantly from its predecessor Windows 3.1. It has a radically new interface design, and it handles DOS differently. Nevertheless, many new features to help Windows users work more effectively with their personal computers.

Nimersheim's book cuts through the Windows 95 promo about such subjects as the 32-bit environment and plug-and-play. It will help the reader to decide whether or not to upgrade to Windows 95 because of its comprehensive information on this new operating system.

The topics covered include how to: navigate and configure the user interface; use the new folders feature to hold documents and applications; set up peripherals, such as printers and modems; and install popular software programs in computers.

The book also explains how to use the Explorer, the improved version of Windows 3.1's File Manager. It explains how to access DOS (and why it's still necessary). And the reader will learn how to access frequently used files and programs rapidly with short-cuts and time-saving tips.

Miniature Satellite Dishes: The New Digital Television; by Dr. Frank Baylin. Baylin Publications, 1905 Mariposa, Boulder, CO 80302; Phone: 303-449-4551; Fax: 303-939-8720; $20.00 plus $4.00 S&H.

The introduction of high-power direct-broadcast satellites (DBS) has made possible reception with miniature parabolic-dish antennas only 18 inches in diameter. This book gives the fundamentals of both large- and small-dish digital satellite television systems, and it provides a technical background in both DBS and large-dish television receive only (TVRO) systems.


Analog Devices' latest fixed- and floating-point DSPs (digital signal processors) and 16-bit codecs are described in this brochure. Also included are chipset solutions for sound, fax/modem, and combination sound/modem designs.

An overview of DSP architectures includes the new SHARC (Super Harvard ARChtitecture Computer) DSP with a 4-megabit on-chip SRAM and "glueless" interface for multiprocessors. A second member of the SHARC family offers 2 megabits of memory.

The brochure includes an overview of the company's software and hardware tools for application development. They include GNU C compilers and C debuggers; FFT benchmarks are provided to measure performance for routing DSP functions. Mixed-signal processors with DSP, codec, and all data and program memory on a single IC are discussed.

Mastering Laser Printer Repair; by Don Thompson. Diversified TechniGraphics, Inc., 6 Morgan, Suite 112, Irvine, CA 92718; Phone: 1-800-457-5776 or 714-855-3838; Fax: 714-855-3959; $395 plus $10.00 S&H (U.S.).

This book will help technicians at all experience levels diagnose and fix laser printers. It covers such popular products based on Canon printer engines as Hewlett-Packard LaserJets and Apple LaserWriters.
Thompson's book begins with an overview of laser printers and discusses their principles and technology. It then explains why servicing them can be profitable, and how to start and expand a laser-printer service company.

With the Canon SX engine as a model, the other printers are compared. The book discusses faults that are common to the four most popular Canon printer engines. The frequency of occurrence of those faults is explained with probability charts.

One chapter covers print defects. Each page gives an example of a defect accompanied by explanations of its cause and cure. Preventative maintenance procedures are discussed and service procedures developed by experienced professionals are presented. The basic electrical and mechanical troubleshooting techniques are given.

The Robotics Practitioner: The Journal for Robot Builders. Footfalls Ltd., 483 South Kirkwood Road, Suite 130, Kirkwood, MO 63122; E-mail: TRPSAKFootfalls.com; special first-year (four-issue) subscription rate for Electronics Now readers: $29.00

This new quarterly magazine will cover the design, development, and performance of robots, with its focus on the robot hobbyist, students, educators and inventors.

The contributed articles will be written by robot builders about their projects. They will cover the wide variety of software and hardware issues raised in robotics technology. Construction articles will take readers step-by-step through the construction of working robots designed to be built from readily available components.

Regular columns will list robot clubs, provide a calendar of robot events, and give electronic addresses for robot builders' bulletin boards.

Looking Good with QuarkXPress: The Designer's Companion for Mac & Windows; by Joe Grossman. Ventana Press, P. O. Box 2468, Chapel Hill, NC 27515; Phone: 919-942-0220; FAX: 919-942-1140; $34.95, including a CD-ROM.

This book on QuarkXPress is a guide for those who use or want to use that software in the design and production of brochures, newsletters, advertising matter and other publications. The latest versions QuarkXPress have concepts, and the design development process.

The reader will learn how to use dialog boxes and palettes to create page designs, headlines, photo arrangements, and color effects. Actual XPress creations, including 40 pages of color examples, are analyzed.

The companion CD-ROM disk contains 45 design templates that serve as models for the readers' page designs. Included are backgrounds, special picture boxes, fonts, and clip art.

Digital Image Processing: Principles and Applications; by Gregory A. Baxes. John Wiley & Sons, Inc., 605 Third Avenue, New York, NY 10158-0012; Phone: 1-800-CALL-WILEY; $39.95, including an instructional floppy disk.

This book discusses the principals and applications of digital image processing at a level that will be comprehensible to a wide range of readers. Baxes has written in clear, jargon-free language to attract those readers who need to know but may have neither the time nor opportunity to take a formal course in the subject.

Step-by-step lessons are given in digital image processing principles, techniques, and technologies. The author provides detailed explanations of the most commonly used digital image-processing operations.

The book also includes a comprehensive listing of available hardware, and an explanation of the best methods for acquiring, displaying, and processing digital images. The text is backed-up by a digital image-processing program on a floppy disk that is included with the book.

PC Instrumentation and Data Acquisition Catalog. Global Specialties, 70 Fulton Terrace, New Haven, CT 06512; Phone: 800-572-1028; Fax: 203-468-0060; 16 pages; free.

This is Global Specialties' latest catalog on personal computer instrumentation and data acquisition products. It includes virtual instruments on a card and analog and digital I/O cards for IBM-PC or compatible personal computers.

The plug-in boards include A/D combination cards, opto-isolated Darlington output cards, a 48-channel PIO card, a thermocouple input card, and two virtual instrument boards.

The virtual instruments include those for simulating a digital multimeter with chart recording and data-logging functions, and a combination function generator, pulse generator, waveform generator, and universal counter-timer. Each virtual instrument includes the card and a software graphics package.
Countersurveillance

Never before has so much professional information on the art of detecting and eliminating electronic snooping devices—and how to defend against experienced information thieves—been placed in one VHS video. If you are a Fortune 500 CEO, an executive in any hi-tech industry, or a novice seeking entry into an honorable, rewarding field of work in countersurveillance, you must view this video presentation again and again.

Wake up! You may be the victim of stolen words—precious ideas that would have made you very wealthy! Yes, professionals, even rank amateurs, may be listening to your most private conversations.

Wake up! If you are not the victim, then you are surrounded by countless victims who need your help if you know how to discover telephone taps, locate bugs, or “sweep” a room clean.

There is a thriving professional service steeped in high-tech techniques that you can become a part of! But first, you must know and understand Countersurveillance Technology. Your very first insight into this highly rewarding field is made possible by a video VHS presentation that you cannot view on broadcast television, satellite, or cable. It presents an informative program prepared by professionals in the field who know their industry, its techniques, kinks and loopholes. Men who can tell you more in 45 minutes in a straightforward, exclusive talk than was ever attempted before.

Foiling Information Thieves

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

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

Stolen Information

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

The professional discussions seen on the TV screen in your home reveals how to detect and disable wiretaps, midget radio-frequency transmitters, and other bugs, plus when to use disinformation to confuse the unwanted listener, and the technique of voice scrambling telephone communications. In fact, do you know how to look for a bug, where to look for a bug, and what to do when you find it?

Bugs of a very small size are easy to build and can be placed quickly in a matter of seconds, in any object or room. Today you may have used a telephone handset that was bugged. It probably contained three bugs. One was a phony bug to fool you into believing you found a bug and secured the telephone. The second bug placates the investigator when he finds the real thing! And the third bug is found only by the professional, who continued to search just in case there were more bugs.

The professional is not without his tools. Special equipment has been designed so that the professional can sweep a room so that he can detect voice-activated (VOX) and remote-activated bugs. Some of this equipment can be operated by novices, others require a trained countersurveillance professional.

The professionals viewed on your television screen reveal information on the latest technological advances like laser-beam snoopers that are installed hundreds of feet away from the room they snoop on. The professionals disclose that computers yield information too easily. This advertisement was not written by a countersurveillance professional, but by a beginner whose only experience came from viewing the video tape in the privacy of his home. After you review the video carefully and understand its contents, you have taken the first important step in either acquiring professional help with your surveillance problems, or you may very well consider a career as a countersurveillance professional.

The Dollars You Save

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

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G rowing up can be bittersweet. On one hand, you get to learn the truth concerning many things you were curious about. On the other, you do learn the truth.

Borland is the company that never grew up. Throughout the first decade of its existence, Borland prided itself on being different. It shunned traditional corporate culture. It emphasized product performance and originality. Based on an underlying faith in excellence, it thumbed its nose at hard-nosed business practices, preferring instead what it called a "barbarian" style of marketing.

Its barbarian style worked, for awhile. Throughout the 80's, when the computer industry was much more fragmented, when products with original ideas sprouted like weeds overnight—and often disappeared just as quickly—Borland was a mainstay in that environment. Turbo Pascal, SideKick, Turbo C... then what?

There were brief flings with various products, including a Prolog development system, a text editing/formatting system, a massive upgrade of SideKick that substituted mere help for magic, and an OS/2 version that went nowhere. (For you youngsters: SideKick was the original TSR and the original PIM [personal information manager]; but Borland never even tried to make SideKick desirable to the PIM market. Yes, Borland did eventually—in the fall of '94) release a version of SideKick for Windows, but it was much too little, way too late. In fact, SideKick for Windows was one of the first products jettisoned in the company's recent reorganization.)

Then Borland bought Ashton-Tate, to gain control of dBase database software. dBase? Borland had already bought Paradox, considered technically superior to dBase. dBase had been in technical trouble at Ashton-Tate, and Borland quickly found out that resolving those difficulties was going to be difficult and time-consuming. The protracted period during which Borland fought to overcome those difficulties gave Microsoft a tremendous head-start in the just-emerging Windows market. Borland was taken off-guard by the success of Microsoft's Access database for Windows. Despite years of development, Microsoft had never even introduced its DOS-based database, known internally as Cirrus, which was eventually re-architected for Windows and released as Access. (The header of one appendix of the user manual for Access 1.0 actually refers to the product as Cirrus.)

Throughout that period, Borland was busy building fancy new office space and providing a musical outlet for saxophone-playing founder and charismatic chairman of the board, Philippe Kahn.

Hard-nosed business practices eventually caught up with Kahn. In early January of this year, he resigned his roles as President and CEO of Borland. Although he retains chairmanship, Gary Wetsel has assumed the roles of President and CEO. One of Wetsel's first actions was to lay off 40% of the company. That came on the heels of a decision by the board to divest Borland of its consumer product line, which consisted only of SideKick for Windows and a nice Windows shell originally written by Hewlett Packard called DashBoard.

The new Borland intends to focus on programming tools, including its C/C++ compilers, dBase and Paradox, and a new entry currently known as Delphi, expected for release around the time you read this. I find the C/C++ market rather ho-hum, but Delphi sounds hot.

**The oracle and the barbarian**

In many ways, Delphi represents Borland's last best hope for survival. Delphi reaches back to Borland's earliest roots in Pascal, but in an up-to-date, object-oriented visual development environment. Delphi is intended to be a Visual Basic (VB)
killer. Delphi is intended to make up for many of VB's deficiencies.

Whereas VB is based on relatively slow technology that interprets an intermediate "p-code" at run-time, Delphi produces fully compiled applications. One reason for VB's immense popularity is its extensibility via what are called VBXs (Visual Basic Extensions). An entire subindustry now exists to supply VBXs of all sizes, shapes, and colors. Ironically, though, VB itself cannot be used to produce VBXs; a Windows C compiler is required. Delphi, by contrast, can create its own custom extensions. Delphi can also run VBXs.

Visual Basic, in its attempt to simplify Windows programming, restricts direct programmer access to numerous properties, functions, and messages; Delphi will by contrast make these features visible. Another feature worth mentioning is run-time support. Visual Basic requires a 400K dynamic link library (DLL), whereas Delphi can produce complete applications with everything bound into a single file.

Delphi is based on Pascal. There is no internationally sanctioned standard for Pascal; over the years, whatever Borland has done has defined a de facto, albeit single-sourced, standard. Delphi will do nothing to change that. In addition, from what I've heard so far, it appears that Delphi will have no cross-platform support. On the other hand, the Visual Basic language conforms to no standard either; nor is it available on any other platform.

Another issue is that there are lots of Basic programmers out there, and lots of C/C++ programmers. But Pascal programmers? Is Pascal still commercially viable? I love Pascal as a language. I find it infinitely more elegant than either Basic or C. But I know that's a minority opinion.

In the meantime, Microsoft has been working on version 4.0 of Visual Basic. The product was originally targeted for release early this year, but Microsoft seems to be holding off to coordinate its release with Chicago. That may give Borland a six-month lead, or it may force buyers to hold off for six months.

Can Borland survive? Can Delphi save Borland? I don't know, but I would hate for the industry to lose Borland—it needs more than one vendor of programming tools.

Growing up can be hard. But the mistakes of youth can make us stronger adults. Let's hope Borland has learned its lesson. We need barbarians to keep the big guys honest.

Product cameos
I used to review lots of products. Due in part to evolution of my interests, but also due in part to a slowdown in innovation in the computer industry, product reviews have become less and less a part of what I do.

Nonetheless, I am always on the lookout for new and innovative products, especially those produced by small, out-of-the-mainstream companies. If you know of computer products in this category that you believe other readers would find interesting, send me E-mail with a brief description of the product, what you find intriguing about it, and contact information. I'll see what I can do.

In that spirit, I'd like to discuss briefly one such product, NamePro, along with one very much in-the-mainstream product, Microsoft Office Professional & Bookshelf.

NamePro. How do you name a new product? There are two major tasks, one creative, the other administrative. The creative part involves coming up with a name that concisely expresses something about the nature of your product. The administrative part involves verifying that the name is not already in use.

NamePro can help in both regards. The creative part consists of several databases of words, along with an interactive Windows-based component that allows you to combine them in various ways, based on the connotation you'd like the name to have. The administrative part consists of a database of existing trademarked names against which you can compare candidate names.

For example, if you wanted to start a company dealing with networks and databases, you might find the following prebuilt names in NamePro's database: The Promised LAN, DataZoom, and DataWhiz. Then you could load a word-part database dealing with company names, and automatically combine them, in all permutations, with the prebuilt names, as shown in Fig. 1.

By itself, NamePro might or might not lead you to the perfect name. But its numerous databases and combinations can help you get into the right frame of mind.

Microsoft Office Professional & Bookshelf. Someday we will look back at this massive cantankerous lumbering collection of applications as, in the evolutionary sense, a dinosaur. But right now, it's the best dinosaur we've got, particularly Word for Windows and Access. And more and more new PCs come with this package preinstalled. I was curious to see how the integrated installation and documentation function. Let's say I wasn't overly impressed.

This "Office Suite with Integrated CD-ROM Library" comes on a pair of CD-ROMs. One contains all the programs (primarily Word, Excel, PowerPoint, and Access; a license (but not the code) for Microsoft Mail; and a set of mini-applications, some of which (e.g., a scanning utility and an organization chart utility) appear to be brand new but unadvertised. The other CD contains an extensive set of on-line documentation and Bookshelf, a collection of reference works, including dictionary, thesaurus, encyclopedia, quotations, almanac, and more. Interesting points about the package:

- The basic package does not include printed documentation; if you want it, you must purchase a set of manuals separately for about $130.
- A complete installation of everything (less the Bookshelf database and on-line documentation) requires only about 90 megabytes of disk space.
- The installation routine is buggy, as it repeatedly reports errors after installing some icons into Program Manager.
- An installation frustration is that it asks where you want to install files, and then proceeds to stick a nice little 12-megabyte chunk where it wants.
- The overall installation process is
awkward. You can’t just set of bunch of options on a screen or two and go away. Instead, you’re presented with dialog after dialog, redundant checks for available disk space, and other time wasters.

Once you get through the installation, everything pretty much works as advertised. The package also includes a couple of “always-on-top” button bars (to which you can add your own buttons) that keep you never more than a click away from any of the Office applications and Bookshelf references.

E-mail

My column on Conceptual Documentation is still generating responses. G. Lundy thoughtfully writes, “As an engineer who dream of being an engineer, not a technical writer, I drifted into the technical writing field, where I have seemingly been enslaved for the past ten years . . . Each of six writers here is a degreed engineer (EE, ME, CS, other).

The common problem faced is not just a standard methodology for writing, but getting project managers to fit within the scope of their respective projects the need to plan document development in parallel with engineering. Far too often the document is the last thing to be scheduled. This leads to writing garbage-in—garbage-out-type technobabble, and rushing to put out anything that can meet the terms of the contract.” Yup. I hear you. I’ve been there.

Also, for you die-hards out there, Chris Courson operates a free BBS that supports 8-bit computers and public domain software. The number is (813) 238-8076.

As always, comments are welcome. Send them to my Internet address jkh@acm.org.

WHAT'S NEWS

continued from page 4

that a U.S.-based company topped the list.

Most of the IBM patents were in the field of information processing, but IBM continued to hold its lead in patenting software-related inventions. The patents issued include one for a method for encrypting and decrypting software on a CD-ROM.

Patents also were issued for processes that make possible for the speedy and efficient transmission of multimedia data—audio, video, graphics, and text—over a network. The patented technology, called asynchronous transfer mode or ATM, allows computers to send and receive a combination of multimedia information simultaneously over a network.

Related patents covered methods for bundling different packets of information and “traffic cop” techniques for directing the information around a network without overloading it.

Another patent was issued for a high-quality semiconductor material production method that combines silicon with germanium. The material is intended to allow IBM to build super-fast transistors. Those transistors, which can be produced on existing wafer fabrication lines, could lead to improved consumer electronics products, better medical equipment, and higher-speed computers.
What Do These Prestigious Companies Have In Common?

**Aerovox**
DC Film and RF Suppression Capacitors, Aluminum Electrolytic and AC Oil Capacitors, EMI Filters

**AMP**
Electrical/Electronic Connectors, IC Sockets, PCB Switches

**MURATA**
Fixed Ceramic Capacitors, Variable Capacitors and Resonators, Crystal Oscillators, Ceramic Filters, Resistors, EMI Filters, Hybrid Circuits and more.

**Panasonic**
Industrial Company
Resistors, Resistor Networks, Ceramic, Film, Electrolytic, Double Layer Capacitors, Potentiometers, Switches, Inductors, Filters, Resonators, Varistors, Thermistors

**Philips Components**
Resistors, Ferrite Components
Aluminum Electrolytic, Film & Ceramic Capacitors

**Quam**
Loudspeakers and Commercial Sound Products

**ROHM**
Resistors, Ceramic Capacitors, Transistors/Diodes, Opto Components and IC's

**Selesta**
Switches, Relays, Terminals, Indicators/Print Lights, LED Indicators, Test Clips, Test Leads, Cable Ties and Heat Shrinkable Tubing

**Sprague**
Tantalum Capacitors, Wet & Foil Capacitors, Resistor Networks, Resistor Capacitor Networks, Filters

**Switchcraft**
Switches, Connectors, Jacks, Plugs, Jackfields & Audio Accessories, Cable Assemblies

Leadership in electronics is not just a matter of designing products better and manufacturing them better, but also of marketing them better. And the sponsors of this message understand that better service to customers requires effectively involving distributors as part of their marketing teams.

Distributor involvement means lower prices, quicker deliveries, better service over-all. The Buyer wins...the Seller wins.

Distributors help achieve marketing leadership. So does the manufacturer's involvement in the Components Group of the Electronic Industries Association. EIA fosters better industry relations, coherent industry standards, and the sharing of ideas, which helps one another and serves customers better.

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Washington, D.C. 20006
Phone: (202) 457-4930
Fax: (202) 457-4985

Committed to the competitiveness of the American electronics producer.

*American Radio History* magazine, May 1995, page 30
Do you want to save money and the environment? Then think green!

TJ BYERS

EVERYONE WANTS TO SAVE MONEY, AND MOST people want to improve the well-being of our planet. Well, you can do both by simply using such energy-saving computer products as "green" PCs and other Energy Star peripherals.

Recent studies conducted by the Environmental Protection Agency (EPA) conclude that personal computer systems account for more than five percent of all electrical power consumption in the U.S. That consumption is increasing rapidly because home and office computer equipment has become the fastest-growing segment of the consumer-electronics market. That booming growth not only threatens to increase energy costs, but also to damage the environment as power companies scramble to meet the need by building new facilities.

In an effort to stem this rising tide, Phoenix Technologies and Intel conceived of the concept of the "green" PC: one that draws little or no power when it is idle. The green concept was later expanded to include PC peripherals and energy-smart software. These energy-saving products cut energy consumption by switching the device to a low-power state when it is idle or not in use. As an added benefit, powering down these devices can often extend their life.

Even if you are not concerned about saving money or the planet, it's virtually impossible to avoid the green movement. Many PCs and peripherals sold today—which include everything from monitors to printers to modems—include energy-saving features.
Energy Star

In late 1992, the EPA proposed a set of power-management guidelines for energy-efficient computer equipment. The program, called Energy Star, is not a government mandate; therefore participation is not a requirement for computer and peripheral manufacturers.

Energy Star guidelines recognize two levels of operation: a full power mode and an inactive, or sleep, mode. To garner an Energy Star rating, a device cannot draw more than 30 watts of power when it is idle. However, Energy Star guidelines say nothing about the length of time the device has to be inactive before it powers down, or how the power-down is accomplished. All of those details are left up to the individual manufacturer.

Computer products that comply with the Energy Star guidelines are distinguished by an Energy Star logo (see Fig. 1) that the vendor can proudly display in advertisements, publications, and on the product itself. To encourage participation in the program, President Clinton issued an Executive Order on April 21, 1993, Earth Day, that directs all government agencies to purchase only equipment that meets the Energy Star guidelines.

NUTEK/TCO

Of course, Energy Star isn't the last word in energy conservation, and many consider the guidelines to be much too lenient. A stricter version comes from Sweden's Department of Energy Efficiency, NUTEK, which has teamed up with TCO, a trade union, to create an energy-saving standard known simply as NUTEK/TCO for use throughout Europe.

The NUTEK/TCO recommendation defines three power levels of operation:.full power, automatic standby, and automatic power down (see Table 1). The automatic standby mode, the first step down from full power, limits power consumption to 30 watts (which matches Energy Star's recommendation) but suggests a 15-watt ceiling. The automatic power-down mode, for which there isn't an Energy Star equivalent, specifies 8 watts as the highest acceptable energy consumption level, with a desired figure of 5 watts or less. NUTEK/TCO's ultimate goal for power-down is 1-watt total power consumption, which would occur when everything but the power-controller circuit is turned off.

Both shut-down modes are activated by a timer. If no user or communications (modem or network) activity is detected within a period of five minutes to one hour (the length of the period determined by the user) the energy-saving gears are set into motion. Note, though, that the timers run concurrently. For example, if the standby mode is set to kick in at 30 minutes and the power down mode is set for 40 minutes, the device will reduce power to standby status in 30 minutes and go into the power down mode 10 minutes after that.

Green PCs

Although the concept of powering down idle devices seems simple enough, the process itself can get quite complex. In a green PC, the microprocessor or CPU, its associated chip set, and the BIOS (basic input/output system) are all involved. Basically, it's the job of the BIOS and chip set to monitor system activity and determine when it's appropriate to shut down the various subsystems. The priority of device

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**FIG. 1—ENERGY STAR IS A SELF-POLICING PROGRAM** that lets the vendors test their own products for compliance. The EPA grants the Energy Star logo shown on the Mag Innovation screen above to PCs, monitors, and printers that use 30 watts or less when idle.

**TABLE 1—ENERGY-SAVING RECOMMENDATIONS**

<table>
<thead>
<tr>
<th></th>
<th>Normal</th>
<th>Standby</th>
<th>Suspend</th>
<th>Off</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy Star</td>
<td>100%</td>
<td>Not defined</td>
<td>&lt;30 watts</td>
<td>Not defined</td>
</tr>
<tr>
<td>NUTEK/TCO</td>
<td>100%</td>
<td>&lt;30 watts;</td>
<td>&lt;8 watts;</td>
<td>&lt;1 watt</td>
</tr>
<tr>
<td></td>
<td></td>
<td>&lt;15 watts</td>
<td>&lt;5 watts</td>
<td>ultimate goal</td>
</tr>
<tr>
<td></td>
<td></td>
<td>recommended</td>
<td>recommended</td>
<td></td>
</tr>
</tbody>
</table>
shutdown depends on its power consumption and typical use cycle (see Fig. 2).

**Processors**

The microprocessor is a major power consumer. Pentium processors can draw up to 15 watts under full load, and the 80486DX2 can easily consume 5 watts, even while doing absolutely nothing. The amount of power a microprocessor consumes is directly proportional to its operating frequency, as described by the equation:

\[
P = CV^2f
\]

where \(C\) is the device's capacitance, \(V\) is the voltage difference between its high and low logic levels (1.6 volts for 5-volt logic, and 0.6 volts for 3.3-volt logic), and \(f\) is the clock frequency (see Table 2).

An obvious way to reduce power consumption is to slow down the microprocessor’s clock speed. The speed of the clock can be dropped to 8 MHz during periods of inactivity for most 486 processors without adversely affecting system performance. Slowing the clock was a popular method of energy conservation a couple of years ago, but it has largely given way to suspend- and stop-clock power reduction. However, the microprocessor must be a static device for the stop-clock mode to work: that is, it must be able to retain its data even with the clock stalled. All Pentium and all 486 microprocessors (except those made by AMD) are static devices.

In most microprocessors, the suspend state is accomplished by stopping the clock to the bulk of the circuits, while keeping the memory, cache control, and external-bus control alive. A halt instruction causes all 486 and Pentium processors (except AMD’s 5-volt 486 series) to enter their suspend states.

In the suspend mode, the microprocessor still responds to interprocessor and external snoop requests. For example, an interrupt request (INTR), non-maskable interrupt (NMI), or signal-managing interrupt (SMI) will terminate the suspend mode and bring the microprocessor back to full power.

In the clock-stop mode, clock signals to all microprocessor logic, except that needed to awaken the processor, are stopped. In this mode, power consumption is typically less than 1/10th watt; the clock is restored when the “clock-stop” reset line is strobed.

The mechanism normally used to control power management is system-management mode (SMM), a set of special instructions that was first available on Intel’s SL processors. The SMM software, which is stored in a separate memory space called system-management RAM (SM-RAM), controls microprocessor power without requiring that the existing operating system be rewritten or modified.

Storing the system-management code at a specific memory address allows the SMM to operate without interrupting normal microprocessor operation or system memory. System-management code is entered via the signal-management hardware interrupt. An SMI signal is generated by any one of the many system interrupts that monitor for system activity or inactivity. When an SMI is detected, the processor saves its state to a fixed location within the SM-RAM, and then runs the SMM code. The code’s message determines the level and depth of power management. Normal microprocessor operations are restored by entering an SMM instruction called Resume Normal Mode (RSM).

**Green chip sets and BIOS**

If you think of the microprocessor as the muscle of a power-management system, then the chip set represents the nervous system, and the BIOS is the brains. The chip set is a collection of signaling devices that link the microprocessor to its peripherals. A green chip set must also provide the signals necessary for a power-down and reactivates the microprocessor and peripherals. At the simplest level, a green chip set provides

---

**TABLE 2—MICROPROCESSOR POWER CONSUMPTION**

<table>
<thead>
<tr>
<th>Processor</th>
<th>Frequency</th>
<th>Power (W) active</th>
<th>Power (W) suspend</th>
<th>Power (W) stop clock</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intel Pentium</td>
<td>100</td>
<td>10.1</td>
<td>1.55</td>
<td>0.090</td>
</tr>
<tr>
<td>Cyrix Cx486DX2</td>
<td>66</td>
<td>6.6</td>
<td>0.17</td>
<td>0.005</td>
</tr>
<tr>
<td>AMD 486DXL2</td>
<td>80</td>
<td>7.5</td>
<td>1.17(1)</td>
<td>n/a(2)</td>
</tr>
<tr>
<td>Intel 486DX2</td>
<td>50</td>
<td>5.7</td>
<td>0.45</td>
<td>0.100</td>
</tr>
<tr>
<td>AMD 486DX2-V</td>
<td>80</td>
<td>5.2</td>
<td>0.15</td>
<td>0.040</td>
</tr>
<tr>
<td>Intel 486DX</td>
<td>33</td>
<td>4.5</td>
<td>0.50</td>
<td>0.010</td>
</tr>
<tr>
<td>Cyrix Cx486DX2-V</td>
<td>66</td>
<td>4.4</td>
<td>0.13</td>
<td>0.038</td>
</tr>
<tr>
<td>Intel 486DX4</td>
<td>100</td>
<td>4.3</td>
<td>0.33</td>
<td>0.003</td>
</tr>
<tr>
<td>Intel 486SX</td>
<td>33</td>
<td>3.2</td>
<td>0.40</td>
<td>0.010</td>
</tr>
<tr>
<td>Cyrix Cx486DX2-V</td>
<td>50</td>
<td>2.9</td>
<td>0.09</td>
<td>0.034</td>
</tr>
</tbody>
</table>

---

**FIG. 2—WHILE IT'S ADVANTAGEOUS TO SHUT DOWN power hogs as quickly as possible, it's not always practical. As much power savings can be gained by paying close attention to spinning the hard disk up and down as to blanking the monitor.**
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TABLE 3—VESPA MONITOR POWER STATES

<table>
<thead>
<tr>
<th>H-sync</th>
<th>Normal</th>
<th>Standby</th>
<th>Suspend</th>
<th>Off</th>
</tr>
</thead>
<tbody>
<tr>
<td>On</td>
<td>Off</td>
<td>On</td>
<td>Off</td>
<td>Off</td>
</tr>
<tr>
<td>V-sync</td>
<td>On</td>
<td>Off</td>
<td>On</td>
<td>Off</td>
</tr>
<tr>
<td>Power level</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mitsubishi Diamond</td>
<td>100%</td>
<td>80%</td>
<td>&lt;30 watts</td>
<td>&lt;8 watts</td>
</tr>
<tr>
<td>Scan 17FS—power usage</td>
<td>106 watts</td>
<td>78 watts</td>
<td>10 watts</td>
<td>5 watts</td>
</tr>
</tbody>
</table>

SMI, stop-clock, and suspend power-management signals to the microprocessor. But virtually all green chip sets also include SMI support for Intel's SMI power-management scheme, and most support AMD's and Cyrix's power management routines.

All chip sets have one or more timers to monitor system activity and provide signal-management (or equivalent) interrupts as subsystems and peripherals time out. These interrupts trigger on the activity or inactivity of video, floppy- and hard-disk drives, I/O ports, keyboard, DMA (direct memory access), and system memory. The BIOS dictates when a timer will time out and generate an interrupt signal.

For example, consider the typical duty cycle of a hard-disk drive—the second largest energy consumer in a desktop PC. When the computer system is booted (started), the BIOS loads the hard-disk drive timer with a time-out value. That value may be user supplied or a system default, and typically ranges from 2 to 15 minutes. The chip set monitors the hard disk's activity, and resets the timer every time a read/write operation is performed. If a read or write isn't detected within the specified period, the timer times out, and the chip set generates an SMI, forcing the microprocessor to run the SMM code that shuts off power to the hard disk.

Advanced Power Management

So far, only power management at the hardware level—where hardware timers determine the sequence of power-down events—has been discussed. However, greater power saving can be achieved if the software, which can determine exactly what components are needed and when, takes an active role in defining the power-management profile.

Advanced Power Management (APM) is a layered approach to software power management. It allows applications, operating systems, and the system BIOS to work together to reduce power consumption. As the program runs, it constantly feeds the BIOS with updated information, dynamically changing the system's power-management parameters to match those of the application. The BIOS, in turn, programs the chip set in real-time as it writes special SMM code to the SMAR that's in step with changing software demands. When necessary or requested, the chip set generates an SMI to the microprocessor, causing it to enter SMM. Originally designed for use in notebook computers, the APM standard is finding widespread acceptance in green desktop computing. (See Advanced Power Management: Power-Saving Protocol for Mobile PCs for details.)

Monitors

It used to be that the motherboard was the biggest consumer of electric power in a computer system. That's no longer true because computer users are replacing their small-screen 14-inch monitors with large-screen 17-inch displays—which can consume 100 watts and more. That's about 50% more power than used by a typical 486SX multimedia PC system. That's why a lot of effort has gone into reducing monitor power consumption.

Buying a green monitor is only half the battle, however. Few monitors are smart enough to know when they're needed and when they're not. They have to be told when to be awake and when to go to sleep. There are no set rules on how to do this—each monitor manufacturer can create its own power-management scheme. At present, the two methods most commonly implemented are the Video Electronics Standards Association...
The VESA standard and video-blanking signaling.

The VESA Standard

The most popular method is the VESA standard, which incorporates a four-step program called display-power management signaling (DPMS). DPMS sends a binary code to the monitor via the horizontal and vertical sync signals. The monitor, in turn, decodes the message and shifts its circuits into the appropriate power-saving mode (see Table 3).

Step one is the full-power, normal mode where the monitor is active and receiving both horizontal and vertical sync signals. The next step is called standby, which is activated by disabling the horizontal sync while maintaining the vertical sync. At this level, the power is reduced by a mere 20%, which and is usually achieved by simply blanking the screen.

The third step is the suspend mode, in which the horizontal sync becomes active and the vertical sync shuts off. VESA specifies that the monitor consume no more than 30 watts at this level. While each vendor does it differently, the typical game plan is to turn off the high voltage (flyback circuit) and video drivers, while maintaining full power to the filaments. Recovery time to full screen brightness is typically 5 seconds or less.

The final stage is the off mode where both the horizontal and vertical sync are disabled. This tells the monitor to shut off all circuits—including the CRT’s filament. The only thing kept alive is a watchdog circuit that looks for any sync activity which will awaken the display. Although DPMS dictates that the off-power consumption cannot exceed 8 watts, many DPMS-compliant monitors con-

Advanced Power Management: Power-Saving Protocol for Mobile PCs

Advanced Power Management (APM) is a layered approach to software power management that allows applications, operating systems, and the system BIOS to work together toward the goal of reducing power consumption. APM distinguishes between the BIOS default standby settings and APM-aware software can change the timer values as the application changes phases, resulting in more precise power management. The system can recover from standby mode by a hardware interrupt (as happens when the device asks permission for microprocessor or memory access) or a CPU call to the device. All data and operational parameters are preserved when the system is in the standby mode.

Suspend The suspend state is a special low-power condition that applies only to the system itself, and not its individual parts. The suspend mode is the lowest level of power consumption that guarantees to preserve operational data and parameters. The suspend state can be triggered by either the system BIOS or the application software. When the system is in the suspend mode, computation will not be performed until normal activity is resumed.

Off In the off state, the system or device is powered down and inactive. Data and operational parameters may or may not be preserved, depending on the BIOS.
sume less than 5 watts. In the off mode, recovery time is the same as it would be from a cold start, which can take up to 20 seconds and longer.

For display power management signaling to be effective, both the monitor and the video controller card must be DPMS-aware. The video controller must be able to interpret instructions from the DPMS software and process them to turn the sync signals on and off properly. While most of today's video controllers are DPMS compatible, there is a large base of existing video controllers, both on adapter cards and built into the motherboard, that aren't.

Fortunately, there are several TSR (terminate and stay resident) programs that allow video controllers built before the DPMS standard was accepted to signal a DPMS-compatible monitor properly (see Fig. 3). The programs work by accessing an unassigned video BIOS call that controls the horizontal sync and vertical sync signals.

**Video-blanking signaling**

Not all PCs are capable of DPMS signaling. Therefore, some monitors instead incorporate the video-blanking signaling method. The power-saving mode is triggered by a blank screen created by a screen saver, such as those in After Dark or Windows.

A blank screen is an all-black screen which has both the horizontal and vertical sync signals, but no red, green, or blue video information. By itself, a blank screen will reduce power consumption by 20% to 25% because the electron guns don't have to supply current to the screen.

When a video-blanking monitor detects a blanked screen and enters its power-saving modes, it takes control of the power-management process without help or instruction from the video controller. The power-down modes are controlled by an EEPROM built into the monitor. Typically, the power-down routine is similar to that established by VESA, but some monitors provide only the two-step power-down sequence suggested by Energy Star. The amount of time the monitor waits before acting on a blanked screen and the time intervals between the different power modes is usually user-programmable.

**Printers**

The laser printer has no peer as an energy hog. At full speed, a laser printer can easily consume 500 watts of power or more. Even in the idle state, some printers can waste 100 watts just keeping warm. That's why more and more printers feature a low-energy sleep mode that kicks in after a set period of inactivity. This mode trims the cost of running the printer. It also reduces wear and tear on the machine and cuts your office cooling costs.

Like systems and monitors, Energy Star printers must consume 30 watts or less when idle. And again like systems and monitors, not all Energy Star printers are created equal. The LaserJet 4L, for example, consumes five watts when asleep, yet it can respond instantly to a print request. Some other printer models consume 20 watts or more when asleep, and can take as long as 10 minutes to wake up and begin printing.

The HP LaserJet 4L is a good example of the type of laser printer that is common in home offices. It's light on price, about $8599 on the street, and light on

---

**TABLE A—RETROFIT HARDWARE**

<table>
<thead>
<tr>
<th>Price</th>
<th>Manufacturer</th>
<th>Green Keeper</th>
<th>LaserMiser</th>
<th>Monitor Manager</th>
<th>MonitorMiser</th>
<th>PC Ener-g Saver</th>
<th>Wattless VDU Power Saver</th>
</tr>
</thead>
<tbody>
<tr>
<td>$69.95</td>
<td>B&amp;B Electronics</td>
<td>EMPAC Int'l</td>
<td>Alpha Micro Technology</td>
<td>EMPAC Int'l</td>
<td>NEI</td>
<td>Ergonomics</td>
<td></td>
</tr>
<tr>
<td>90-130</td>
<td>90-140</td>
<td>110-240</td>
<td>100-240</td>
<td>90-130</td>
<td>100-250</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>10</td>
<td>4</td>
<td>5</td>
<td>8</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>20</td>
<td>20</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>410</td>
<td>3000</td>
<td>100</td>
<td>500</td>
<td>320</td>
<td>n/a</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Y</td>
<td>N</td>
<td>Y</td>
<td>N</td>
<td>Y</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Y</td>
<td>3 yrs</td>
<td>3 yrs</td>
<td>90 days</td>
<td>3 yrs</td>
<td>5 yrs</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

---

[FIG. 5—MONITORMISER AND LASERMISER from EMPAC are companion energy savers that need no software to work. Both have DIP switches for setting their programming values. MonitorMiser uses a simple keyboard-sensing circuit to monitor PC activity. LaserMiser uses a microprocessor that analyzes and remembers your printing habits to power down a laser printer based on consumption.]
power consumption. In the print mode, it soaks up a fairly decent 120 watts of power—about as much as a large-screen monitor. But give it 15 minutes of rest, and it goes to sleep to the tune of just 5 watts. Power-up is described as “instantaneous,” in that the fuser drum reaches its operating temperature well before most software can time out and display a print-error message.

A bigger, faster brother of the HP LaserJet 4 is the LaserJet 4 Plus, which has a throughput of 12 pages per minute (ppm). At full speed, it consumes a healthy 180 watts—twice the energy of a 15-inch monitor. Fortunately, it slows down to a cool 10 watts in the power-saving mode. The power-down interval is user-programmable in steps of 5, 15, 30, and 60 minutes. However, the LaserJet 4 Plus has a large transfer drum that can take up to 30 seconds to warm up to operating temperature. During this period, the 4-Plus built-in 2-megabyte RAM buffers the data to emulate normal operation. Thus, the software application that is sending print data doesn’t realize that the printer is just warming up and not ready to print.

**Green retrofits: a buyer’s guide**

Yes, it’s great news that new computer equipment is finally energy efficient. But what about the millions of existing devices—older PCs, monitors, and printers—out there that were made before Energy Star that continue to suck up power and greenbacks at an alarming rate? Fortunately, there is a good selection of add-on products that can turn your system into a lean, green machine. These power controllers generally are connected in the line between the AC outlet and the monitor or printer. They interrupt the flow of current (which is the same thing as flipping the on/off switch) when the device is idle. All perform as promised, shutting down equipment to save power, but each goes about it in different ways. Some are specifically designed for monitors, while others target printers; some do both. Here’s a look at six such energy savers.

**Wattless VDU Power Saver**

Wattless is a small unit designed to power-down the video display by monitoring keyboard and/or mouse activity (see Fig. 4). It is supplied with cables that you hook to your PC, monitor, mouse, and keyboard. Thanks to a design that needs no software, the Wattless is the fastest and easiest of all power savers to install. A single slide switch located on the side of the case lets you choose a sleep time of 15, 30, or 60 minutes. If the Wattless doesn’t detect any keyboard or mouse activity before the defined time expires, it shuts off power to its single AC outlet.

Unlike other power-saver controllers, which use a mechanical relay to switch the AC power on and off, the Wattless has a semiconductor relay built around a triac. The advantages are an inrush surge current of 90 amperes and zero-crossing switching that all but eliminates radio-frequency interference (RFI). However, the solid-state relay’s continuous current rating of three amperes is too low to handle a large-screen monitor and laser printer, too. A nice safety feature is a lamp on the side of the case that warns you if you have the polarity of the monitor’s power cord reversed. The Wattless is priced at $57, but is less with substantial discounts for volume buyers.

**MonitorMiser**

Like the Wattless, MonitorMiser is a hardware-programmable monitor controller that’s extremely easy to install. The MonitorMiser sits in-line between the keyboard, PC, monitor, and AC outlet, and requires no tools or software to install. Power-down times of 10, 18, 26, or 42 minutes can be switch-selected. Power is restored to the monitor within moments of touching any key on the keyboard. While the MonitorMiser doesn’t connect directly to the mouse or mouse port, it can detect mouse activity for the PS/2 mouse that is supplied with most Compaq computer systems and many PC clones. However, it can’t trigger off a serial mouse. The unit can supply five amperes of continuous current, enough for the largest monitor plus a desktop laser printer. It is fuse-protected and priced at $49.95.
LaserMiser

The companion to the MonitorMiser is the LaserMiser. The LaserMiser is a microprocessor-based energy-saving controller that saves electrical power by automatically switching laser printers on and off. By monitoring and analyzing the data stream passed from the PC to the printer, the LaserMiser learns your consumption patterns and uses it to shut down the printer intelligently. For example, if you typically print intensively for 15 minutes and don't print for several hours afterward, LaserMiser will remember this pattern and shut down the printer immediately after hard-copy printing is complete. If you tend to do a lot of randomly-timed screen printouts, on the other hand, LaserMiser remembers this pattern too, and waits a few minutes before powering down the printer. When the printer is off or powering up, the LaserMiser buffers data in its built-in RAM.

The LaserMiser is installed between a parallel port and a compatible laser printer, including stand-alone printers and networked print servers. Serial connections to the PC are made through an external adapter. LaserMiser requires no special tools or software to install. All time-out settings and options are entered with four DIP switches located on the front panel (see Fig. 5). Although pricey at $149, LaserMiser is a master at curbing the high cost of keeping a laser printer on call 24 hours a day, 365 days a year.

MonitorManager

If it's lowest cost you're looking for, there's no beating Alpha Micro Technologies' S25 MonitorManager. Low cost doesn't mean low performance, here. Unlike many power savers, the MonitorManager works with or without a software driver—you decide. With the supplied software installed, the MonitorManager shuts down your monitor in two stages. If there is no keyboard activity within a defined time period of 1 to 9 minutes (5 minutes is default), MonitorManager first activates a screen saver. Three minutes after that, it shuts off power to the monitor. Without a software driver, MonitorManager shuts off AC power after 3 minutes.

Should you opt not to use MonitorManager's software driver, the unit will only monitor for keyboard activity. With the driver installed, it will trigger on both the mouse and the keyboard. Current output to the single AC outlet is 4 amperes, enough to handle a monitor and inkjet or dot-matrix printer, but insufficient for controlling a large-screen monitor plus office-quality laser printer.
Save your dollars—and your monitor—with

THE

POWER PINCHER

whether electric power is generated by nuclear, hydroelectric, natural-gas, or coal-powered generators, one thing is for certain: it costs more today than it did yesterday. You can bet that it will cost more tomorrow than it does today.

If the thought of wasted electricity bothers you, you'll want to build the Power Pincher. It's a simple device that can monitor keyboard activity on an IBM-compatible personal computer. If no keys are pressed after a predetermined amount of time, the Power Pincher will cut off power to your monitor. Many new monitors and computer systems have this kind of power-down feature built right in. (See "Green PCs" on page 31 of this issue.) Power Pincher will give the same capability to an older system.

The complete Power Pincher circuit details, including foil patterns for the PC board, are presented here. In addition, a complete kit of parts is available at reasonable cost. (See the Parts List.) Power Pincher can actually pay for itself in less than a year, and it might prolong the life of your monitor, too.

How it works

Figure 1 is a block diagram of the circuit, in which a low-frequency oscillator continually drives the input of a multistage binary counter. Whenever the count reaches the setting selected by DIP switch S1, the circuit turns triac Q3 off, thereby interrupting the flow of 120-volt AC current to the monitor.

A keyboard-monitoring circuit keeps the video monitor powered up during active use by resetting the counter every time a key is pressed. As long as a key-press occurs before the time delay expires, the counter keeps resetting. Hence it never times out, and the monitor continues to receive power.

When the computer turns on, a routine in its basic input/output system (BIOS) polls the keyboard. The keyboard, in turn, sends a series of data pulses back to the microprocessor to indicate its status. The data line is normally high (+5 volts), and the pulses are low-going transitions. The first stage of the Power Pincher inverts the sense of the logic to normally low with high-going transitions.

Circuit description

The full Power Pincher circuit schematic is shown in Fig. 2. It consists of an input buffer (IC1-d), a peak detector (IC2 and Q1), a buffer stage (IC1-b and IC1-c), a programmable 24-stage bin-
ary ripple counter (IC4), a triac (Q3), and an optoisolated driver (IC3).

The circuit monitors PC keyboard activity through five-pin DIN connector J1. When the user presses a key, the keyboard sends a series of negative-going pulses on pin 3. Capacitor C2 couples the signal to NAND gate IC1-d, which buffers it for use by op-amp IC2. In conjunction with Q1 and C3, the op-amp essentially functions as an integrator, which stretches the continually varying periods of the input pulses to a relatively constant period with a higher average DC value.

Inverters IC1-c and IC1-b buffer the peak detector's output to trigger IC4, an MC14536B programmable timer. Understanding the timer's operation is key to understanding the circuit; its block diagram is shown in Fig. 3.

The MC14536B

The MC14536B has two sets of dividers: an eight-stage block and a 16-stage block. The eight-stage block can be bypassed by setting pin 6 (8-BYPASS) high. The four binary inputs (A–D, pins 9 to 12) allow the user to specify which of the 16 counter stages then provides a monostable output via pin 13. (Table 1 shows the switch settings and corresponding output stages.) When the specified count oc-
curs, pin 13 goes high, where it remains until the IC's reset input (pin 2) goes from high to low, which in turn restarts the count cycle.

Input to the device can come from two sources: an external clock or an RC oscillator configured using the first few inverters in the MC14536B. The Power Pincher circuit uses the latter configuration. Returning to Fig. 2, the output frequency of the oscillator is given by the following equation:

\[ f_o = \frac{1}{(2.3 \times R4 \times C4)} \]

where \( f_o \) is in hertz, \( R4 \) is in ohms, and \( C4 \) is in farads. With the values specified, the circuit provides a base frequency of about 4.4 Hz. The 4.4-Hz signal can then be divided down as many as 24 times, theoretically giving delays as long as about 16 hours. Table 2 shows approximate delay times for the first 16 stages.

The time delays produced by the circuit depend on the accuracy of \( R3, R4, \) and \( C4 \). For that reason, all times given in this article are approximate. If an accurate delay time is important to you, you could tweak the value of one or more of the timing components while monitoring the circuit's output frequency at pin 5 of IC4.

On power-up, the monostable output (decode out, pin 13) goes high. The Power Pincher circuit ties that output to the inhibit input (pin 14), which puts the device in a low-current standby mode. The rising edge of the reset pulse then causes the output to go low, thereby disabling the inhibit function.

The monostable output of the MC14536B drives PNP transistor \( Q2 \). As long as pin 13 is low, \( Q2 \) conducts and, in turn, drives optoisolator IC4. That device contains a complete triac driver. When the triac is on, AC current is available to power a monitor. On the other hand, when pin 13 goes high, \( Q3 \) goes off, so does the optoisolator, so does the triac, and so does the monitor.

In addition to monitoring the keyboard's data line, Power Pincher taps power and ground through the keyboard connector, hence no dedicated power supply is needed. A fuse (F1) in series with the +5-volt supply line provides protection for the host PC. Another fuse, F2, protects the monitor from line surges.

**Construction**

Construction of the Power Pincher is straightforward. No special construction procedures are required, but building the circuit on a PC board is recommended. Foil patterns are

---

**FIG. 3—BLOCK DIAGRAM OF THE MC14536B. Tie pin 6 high to bypass the first eight stages of the counter.**

**TABLE 1—MC14536B OUTPUTS AND SWITCH SETTINGs**

<table>
<thead>
<tr>
<th>DCBA</th>
<th>8-Bypass</th>
<th>Output</th>
<th>8-Bypass</th>
<th>Output</th>
</tr>
</thead>
<tbody>
<tr>
<td>0000</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>9</td>
</tr>
<tr>
<td>0001</td>
<td>1</td>
<td>2</td>
<td>0</td>
<td>10</td>
</tr>
<tr>
<td>0010</td>
<td>1</td>
<td>3</td>
<td>0</td>
<td>11</td>
</tr>
<tr>
<td>0011</td>
<td>1</td>
<td>4</td>
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<td>12</td>
</tr>
<tr>
<td>0100</td>
<td>1</td>
<td>5</td>
<td>0</td>
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</tr>
<tr>
<td>0101</td>
<td>1</td>
<td>6</td>
<td>0</td>
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<td>0110</td>
<td>1</td>
<td>7</td>
<td>0</td>
<td>15</td>
</tr>
<tr>
<td>0111</td>
<td>1</td>
<td>8</td>
<td>0</td>
<td>16</td>
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<td>0</td>
<td>18</td>
</tr>
<tr>
<td>1010</td>
<td>1</td>
<td>11</td>
<td>0</td>
<td>19</td>
</tr>
<tr>
<td>1011</td>
<td>1</td>
<td>12*</td>
<td>0</td>
<td>20</td>
</tr>
<tr>
<td>1100</td>
<td>1</td>
<td>13*</td>
<td>0</td>
<td>21</td>
</tr>
<tr>
<td>1101</td>
<td>1</td>
<td>14*</td>
<td>0</td>
<td>22</td>
</tr>
<tr>
<td>1110</td>
<td>1</td>
<td>15*</td>
<td>0</td>
<td>23</td>
</tr>
<tr>
<td>1111</td>
<td>1</td>
<td>16</td>
<td>0</td>
<td>24</td>
</tr>
</tbody>
</table>

* = Recommended Settings
FIG. 4—MOUNT ALL COMPONENTS as shown here. Note that DIP switch S1 mounts on the foil side of the board.

shown here; you may also purchase a board from the source mentioned in the Parts List.

Start by mounting and soldering the lowest profile components first, gradually working your way up to the DIN connector J1 and the fuse holder for F2. The board provides two pad spacings to allow for standard fuse sizes. IC sockets are optional; unless you use premium-quality sockets, their installation is not recommended.

Make sure you mount Q3 in a vertical position; do not allow it to be bent over and accidentally apply 120 volts AC to the digital circuit! Unless you are pumping more than five amps through the tria, you won’t need to use a heat sink. For the prototype, as shown in Fig. 4, board-mounted, noninsulated spade connectors were used to connect the black wires from the two power cables to the board.

Alternatively, you could solder the power wires directly to the board.

One line cord is terminated with a three-prong plug, the other with a three-pin socket, to mate with typical monitor power connectors. You might have to customize the P3 connector to match your monitor. Connect the ground (green) and neutral (white) wires of the two cables directly, or with insulated spades. Then connect the black wires to the PC board.

In the prototype, the keyboard was attached to a five-pin header block and matching connector. You could also solder those wires directly to the board.

You may have noticed a three-pin jumper in the photo. The jumper in the prototype ensured compatibility with older XT-class PCs. Because of the rarity of that type of machine these days, the jumper was eliminated from the final design.

One final construction note: Be sure to mount the DIP switch on the foil side of the board so that it can protrude through the hole in the case supplied with the Power Pincher kit.

PARTS LIST

<table>
<thead>
<tr>
<th>Resistor Values: 0.1% unless otherwise noted.</th>
</tr>
</thead>
<tbody>
<tr>
<td>R1—1000 ohms</td>
</tr>
<tr>
<td>R2—1 megohm</td>
</tr>
<tr>
<td>R3, R4—100,000 ohms</td>
</tr>
<tr>
<td>R5—220 ohms</td>
</tr>
<tr>
<td>R6—1200 ohms</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Capacitors</th>
</tr>
</thead>
<tbody>
<tr>
<td>C1, C3—0.1 µF, 50 volts</td>
</tr>
<tr>
<td>C2—100 µF, 50 volts</td>
</tr>
<tr>
<td>C4—1 µF, ceramic</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Semiconductors</th>
</tr>
</thead>
<tbody>
<tr>
<td>IC1—CB4011B quad NAND gate</td>
</tr>
<tr>
<td>IC2—741 op-amp</td>
</tr>
<tr>
<td>IC3—MOC3010 optoisolated triac driver, Motorola or equivalent</td>
</tr>
<tr>
<td>IC4—MC14536B 24-stage binary counter, Motorola or equivalent</td>
</tr>
<tr>
<td>Q1—2N3904 NPN</td>
</tr>
<tr>
<td>Q2—2N4403 PNP</td>
</tr>
<tr>
<td>Q3—T14PT3101 triac, Texas Instruments or equivalent</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Other components</th>
</tr>
</thead>
<tbody>
<tr>
<td>S1—4-pole SPDT DIP switch</td>
</tr>
<tr>
<td>F1—115 VAC, 250 mA, (Pico Fuse 251.250 or equiv.)</td>
</tr>
</tbody>
</table>

F2—4A slow blow fuse

J1—5-pin DIN jack for IBM compatible keyboard

P1—IBM keyboard cable with 5-pin DIN connector on one end

P2—AC line cord with male end

P3—AC line cord with female end (or as required to match your monitor)

Other—Fuse holder (2), 5-pin header with 0.1" spacing and mating connector, insulated male Panduit spade (2), insulated female Panduit spade (2), noninsulated male Panduit spade (2), strain reliefs (3), case (Unibox 01 or equiv.), PC board, mini DIN adapter, wire, solder, etc.

ORDERING INFORMATION

The following items are available from Eikim Electronics, 4142 Old Almonte Road, RR #4, Almonte, Ontario, Canada, K0A 1A0. (613) 256-0224. Kit of all parts listed above ($45). Check or money order. Commercial orders welcome; quantity discounts available for assembled and tested units.
POWER PINCHER COMPONENT SIDE FOIL PATTERN.

SOLDER SIDE FOIL PATTERN.

**Why bother?**

Consumers, the government, and industry, are all being forced to take a long, hard look at energy consumption patterns. Take your average computer monitor for example. If left running continuously for 24 hours a day, seven days a week, the yearly cost to run that monitor would be about $145.

The chances are, however, that the monitor is used only sporadically throughout that period. If you assume that the monitor consumed energy only when it is really needed—about 15 hours per week—the cost would be reduced to only about $15 yearly. On an individual basis, that's quite a cost reduction. When you scale those numbers to cover corporate and government use, savings mount up even more dramatically. For example, 100 continuously running monitors translates into $13,000 of wasted power, and 1000 monitors wastes $130,000 worth of electricity. Furthermore, those calculations include only direct operating costs, and ignore additional costs of air conditioning required to offset heat generated by the monitors. The U.S. Government considers wasted power to be of such concern that it has legislated that all computer monitors sold in the U.S. after 1998 must have an automatic power-off feature. The Power Pincher can retrofit any PC clone computer to achieve those goals.

An additional benefit is that use of the Power Pincher can actually extend monitor life by decreasing the usage rate of CRT phosphors.

**Checkout and calibration**

After building the circuit, make sure that every component is mounted in the right place and with the correct orientation. Also check that all of your solder joints are perfect before you try to verify the Power Pincher's operation. Before you plug in the line cord, put the circuit into an insulated case. Because the circuit has 120 volts AC present at various points, it is easy to destroy the Power Pincher, your computer, or injure yourself if you are not careful.

Turn your computer off and plug its keyboard into J1. Then insert P1 into the keyboard port on your PC. (The kit of parts includes an adapter for the mini-DIN PS/2 style plug; use it if necessary). Next, unplug the monitor's line cord, plug the Power Pincher's female end into the back of the monitor, and the male end into the wall outlet. Leave your monitor switch in the on position.

Using Table 2 as a guide, set S1 for a short delay, say, 8 or 16 seconds. Then turn on the computer. The monitor should come

---

**Table 2—Delays Produced by Stage**

<table>
<thead>
<tr>
<th>Stage</th>
<th>Hz</th>
<th>Seconds</th>
<th>Minutes</th>
<th>Hours</th>
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<tr>
<td>1</td>
<td>4.4</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>2</td>
<td>2.2</td>
<td>0</td>
<td>0</td>
<td>0</td>
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<tr>
<td>3</td>
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<tr>
<td>4</td>
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<tr>
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<td>14</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
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<td>0.034375</td>
<td>29</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>9</td>
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<td>0</td>
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<tr>
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<td>0.008593</td>
<td>116</td>
<td>2</td>
<td>0</td>
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<tr>
<td>11</td>
<td>0.004296</td>
<td>232</td>
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<td>16</td>
<td>0.000134</td>
<td>7447</td>
<td>128</td>
<td>2</td>
</tr>
</tbody>
</table>

---

**Power Pincher Side Foil Pattern**

**Solder Side Foil Pattern**

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**Checkout and calibration**

After building the circuit, make sure that every component is mounted in the right place and with the correct orientation. Also check that all of your solder joints are perfect before you try to verify the Power Pincher's operation. Before you plug in the line cord, put the circuit into an insulated case. Because the circuit has 120 volts AC present at various points, it is easy to destroy the Power Pincher, your computer, or injure yourself if you are not careful.

Turn your computer off and plug its keyboard into J1. Then insert P1 into the keyboard port on your PC. (The kit of parts includes an adapter for the mini-DIN PS/2 style plug; use it if necessary). Next, unplug the monitor's line cord, plug the Power Pincher's female end into the back of the monitor, and the male end into the wall outlet. Leave your monitor switch in the on position.

Using Table 2 as a guide, set S1 for a short delay, say, 8 or 16 seconds. Then turn on the computer. The monitor should come
on shortly after your keyboard is polled, and turn off shortly thereafter. Press a key: the monitor should come back on and begin a new delay. Repeat the process several times to verify that the Power Pincher is operating properly. Then set S1 for the desired delay. The author found the eight-minute setting most suitable.

**Further notes**

One concern that many people have about this kind of circuit is the effect of increased power cycling on a monitor's working life. Hence we contacted several major monitor manufacturers to get their recommendations.

The consensus is that all UL/Csa listed monitors have built-in circuitry to dampen the effects of surges that occur when power is applied or removed. In general, monitors are rated to withstand 100,000 on/off sequences. If you assume that a monitor turns on and off a total of 10 times per day, five days per week, 50 weeks per year, that amounts to a 40-year life span. Thus the monitor will likely be obsolete before it is damaged from power cycling.

Another interesting fact surfaced: The Power Pincher will probably extend the useful life of the average monitor. The reason is that monitors become less efficient (they lose crispness, brightness, and focus) as the CRT phosphor is depleted. In simple terms, the longer electrons continue hitting the phosphor, the faster it will be affected. Screen-saver software can protect against image burn-in, but it does nothing to stop wear and tear on the phosphor. Thus, the only way to extend CRT lifespan is to remove power. In fact, a study done for the Canadian government revealed that useful monitor life could be increased from three to at least five years through the use of automatic power-down devices.

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**GREEN PC'S**

*continued from page 42*

**Green Keeper**

The most ambitious stand-alone power controller is Green Keeper from B&B Electronics. Green Keeper is completely software driven (there are no hardware defaults), which adds extra steps and time to the installation process. The software communicates with the Green Keeper unit via the keyboard cable to turn off the monitor after a user specified time. The software lets you create up to nine different shutdown scenarios. For example, you can program it to shut down after 15 minutes of inactivity between 8 AM and 12 noon. During your lunch break, a second event timer would kick in to turn your monitor off after just one minute of inactivity. After that, a third timer would reset the time-out value back to 15 minutes for the rest of your workday. You can also set different time outs on different days (see Fig. 6).

In addition to monitoring the keyboard and mouse for activity, Green Keeper keeps an eye on your printer's activities. This prevents it from shutting down during times when the printer is active and the keyboard and mouse aren't. Green Keeper's 10-ampere load rating is robust enough to control a monitor, laser printer, and a desk lamp when used with a power strip. Its price is $869.95, with price breaks on quantity purchases.

**PC Ener-g Saver**

Like the Green Keeper, NEI's PC Ener-g Saver is a software-driven stand-alone power controller that monitors keyboard, mouse, and printer activity. However, PC Ener-g Saver takes power control one step further by providing separately switched outlets for the monitor and printer. The outlets are controlled by independent timers; this means that the printer can be shut off while the monitor is powered up, and visa versa. Users can select printer ports and printer warm-up time, and schedule the monitor and printer to turn off at the end of the day. PC Ener-g Saver also features a management report that audits energy use and costs. Total switching current is eight amperes, and the unit is fuse-protected. It's moderately priced at $879.95. Like the other products mentioned here, PC Ener-g Saver will save you money in the long run.
Add text overlays to your home video with this handy device.

TEXT OVERLAYS CAN MAKE ANY VIDEO RECORDING MORE VALUABLE AND INFORMATIVE. NOW YOU CAN BUILD A VIDEO TITLER TO CREATE YOUR OWN TEXT OVERLAYS OR TITLES AND ADD THEM TO YOUR HOME RECORDINGS. THE VIDEO TITLER IS A SMALL, HANDHELD DEVICE THAT CAN OVERLAY BLACK OR WHITE TEXT ON ANY COMPOSITE VIDEO SOURCE. THE OVERLAY AREA CONSISTS OF 12 ROWS OF 24 CHARACTERS PER ROW OR 6 ROWS OF 12 CHARACTERS PER ROW OF DOUBLE-SIZE CHARACTERS. A MAXIMUM OF 110 NORMAL-SIZE CHARACTERS, INCLUDING LINE FEEDS, CAN APPEAR ON THE DISPLAY AT ANY ONE TIME, AND A MAXIMUM OF 72 DOUBLE-SIZE CHARACTERS CAN APPEAR.

To input text, any one of three interfaces can be used, all connected through a female DB9 connector. First, an IBM PC/AT type keyboard can be attached, allowing a user to type in overlays. Second, commands can be input from an interactive RS-232 interface. Last, an RS-485 network-type interface is provided. The RS-485 interface conforms to the HCSII protocol used in the Circuit Cellar Home Control System Network.

Overlay text is stored and recalled from a 1024-bit EEPROM with non-volatile data storage. Character intensity and outline can be individually adjusted via software-controlled potentiometers (EEPOTs). The device is small in size, measuring only about 3 3/4 inches long, 2 5/8 inches wide, and 1 inch high.

The 87C055
The 87C055 microcontroller for television and video from Philips Semiconductor is the heart of the Video Titler. It is a derivative of the industry-standard 80C51 microcontroller. The 87C055's features include:

- 16K x 8 one-time-programmable (OTP) EPROM
- 256 x 8 RAM
- On-screen display (OSD) controller IC
- 128 x 10 display RAM
- 60 x 18 x 14 character generator OTP EPROM
- Eight 6-bit pulse width modulators ICs
- One 14-bit pulse width modulator IC
- Two 16-bit timer/counters
- D/A converter/comparator with 3-input multiplexer
- Four high-current open-drain outputs
- Twelve high-voltage (+12V) open-drain outputs

Many of those resources are not used in the video titler circuit, but they could be useful to readers who can write their own software.

DAN MICHELSON

May, 1995, Electronics Now

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FIG. 1—SCHEMATIC OF THE VIDEO TITLER CIRCUIT. The power-on reset function is generated by IC7, a Maxim MAX699. That device supplies a reset pulse of 140–500 milliseconds at power-up.

Circuit description

Figure 1 shows the schematic of the video titler circuit. The power-on reset function is generated by IC7, a Maxim MAX699 reset and watchdog pulse generator. That device supplies a reset pulse of 140–500 milliseconds at power-up. The watch-
dog function is enabled by tying the w0i input at pin 6 to a logic high or low: if the pin is left floating, the function is disabled. Therefore, if jumper JU1 is inserted, the watchdog function is enabled. This pin must be toggled a minimum of once a second, or the watchdog will time out and generate a reset to the processor. The reset from IC7 is inverted by transistor Q1 because microprocessor IC1 requires an active-high reset.

The overlay text must be synchronized, or genlocked to the input video. Genlocking is simply the synchronization of two video sources by locking horizontal and vertical timing together. This is accomplished with some external parts as well as the OSD controller in IC1. First, the horizontal and vertical sync from the composite video input is detected by IC2, which is set for NTSC specification horizontal and vertical synchronization timing via resistor R4.

The detected horizontal and vertical sync is fed to IC1. The OSD controller in IC1 uses these signals to internally synchronize the overlay text to the incoming video. The frequency of the dot clock is controlled by components L1, C5, and C6. Text is overlayed by video multiplexer IC5 which is controlled by IC1. This device has onboard input clamps and a 75-ohm output driver. The video input can be terminated to 75 ohms by shorting jumper JU2.

The overlay character outline and intensity are controlled via solid-state potentiometers IC3 and IC4 respectively. The solid-state potentiometers allow the microcontroller to control the position of their wipers and store the settings in an onboard EEPROM. This provides a self-contained, non-volatile, software-controlled potentiometer. The microcontroller's OSD logic controls the multiplexer timing from the BF (IC1, pin 30) and VIDCTL (IC1 pin 25) signals. The BF signal switches the video multiplexer between character and character-outline video, and VIDCTL switches the multiplexer between the input video and the overlay video from IC1. The DC levels from IC3 and IC4 set the character and outline intensity, and these levels are fed to video multiplexer IC5. The output of IC5's internal multiplexer is fed to an internal 75-ohm output driver and then output at pin 7.

The video titler can store and recall text from EEPROM IC6, which has enough capacity to store one overlay screen and other required data such as network address, horizontal and vertical overlay fine position, and type of interface.

The RS-232 interface is provided by a MAX202 transceiver which contains two line drivers and two receivers. The device also contains a charge pump that allows it to generate +10-volt and −10-volt sources for the RS-232 interface from a single +5-volt supply. The RS-485 interface is provided by an LTC485 transceiver that provides both transmit and receive functions. The keyboard interface is basically a direct connection to the microprocessor. All three interfaces are attached through DB9 connector J3.

Construction

For best results, this project should be assembled on a printed circuit board. The microcontroller has pins on 0.070-inch centers. That makes the use of standard perforated construction board with 0.1-inch centers very difficult. You can make your own PC board from the foil patterns provided here, or you can buy one from the source given in the Parts List. A programmed microprocessor (IC1) is also available.

The binary code for IC1 is available as part of a ZIP file called VIDTITE.ZIP on the Gernsback BBS (516-293-2283, v.32, v.42bis) for those with access to a programmer. Because this is a one-time programmable (OTP) device, you get only one shot at programming it. Unless you have an emulator for the processor to debug your own code, the code from the BBS should be used. The code provides a flexible user interface.

The parts placement diagram is shown in Fig. 2. Insert all resistors, capacitors, and induc-
FIG. 2—PARTS PLACEMENT DIAGRAM. Capacitor C24 is a tight fit, and must be offset slightly. One of the pins on jack J4 must be clipped off before mounting, and IC10 should be mounted flat against the board.

FIG. 3—THE COMPLETED BOARD. The leads should be trimmed to the length of the IC socket pins to allow the board to sit flat at the proper height in the enclosure.

tors first. Note that C24 is a tight fit, and must be offset slightly. Mount the parts as close to the circuit board as possible. Next, mount all of the IC sockets. Finish by mounting the rest of the parts. Note that one of the pins on jack J4 must be clipped off before mounting. Voltage regulator IC10 should be mounted flat against the board with its leads bent at 90 degrees. Figure 3 shows the completed board.

When all components have been soldered in place, the leads should be trimmed to the length of the IC socket pins to allow the board to sit flat at the proper height in the enclosure. If a stock enclosure is purchased instead of the pre-drilled one available with the kit, it must be modified before the input and output jacks can be installed.

For simplicity, the reader may wish to make the cutout for the DB9 rectangular rather than the DB9 shape. The pre-drilled enclosure from has the DB9 shaped cutout. Before installing the ICs, check power at each socket. When everything checks out, the ICs can be installed.

Cables

There are three possible interfaces and therefore three different cables. All three terminate in a female DB9 connector, J3. Figure 4 shows how to wire the three different cables.

Serial RS-232—The RS-232 serial cable is simply a one-to-one male-female DB9 cable that ties pins 2, 3, and 5 together. Only pins 2, 3, and 5 must be connected. Any RS-232 signals driven into other pins can cause damage. (See Fig. 4-a.)

PC/AT keyboard—Rather than make this cable from scratch, a readily available PC/AT keyboard extension cable be purchased and modified. Just about any computer supply store stocks these cables. By cutting off the male end (the one that does not mate with the keyboard) and installing a DB9 male connector, this cable can be assembled quickly. After cutting off the connector, the wires will have to be tested for con-
Other components
L1—22 µH inductor, 5%
J1, J2—right-angle female F connector
J3—DB9 right angle female J4—2 mm right angle power jack
XTAL—12 MHz crystal
T1—9-volt DC, 200 mA adapter
JU1–JU3—2 pin, 0.1-inch header
JU4—3 pin, 0.1-inch header
HDR1—10-pin, 5-position, 0.1-inch header

Miscellaneous: Seven 8-pin DIP sockets, one 16-pin DIP socket, one
42-pin shrink DIP socket for IC1, six shorting jumpers for I0–I2 and
STP1–STP3, Enclosure (Pactec Model HM drilled for fit), PC board,
two male “F” connector to RCA female phono jack adapter, RCA
video cables.

Note: The following items are available from MEC, 1036 Marshall
Drive, Des Plaines, IL 60016:
• Printed Circuit Board and full assembly documentation (VTKIT
1) $25.00
• Programmed 87C055 Microprocessor, Printed Circuit Board,
and full assembly documentation (VTKIT 2) $65.00
• Partial kit (contains PC board, programmed microprocessor, all
parts that mount on the PC board, and full assembly documen-
tation (VTKIT 3) $159.00
• Complete kit (contains PC board, programmed microprocessor,
all parts that mount on the PC board, pre-drilled enclosure, wall
transformer, and full assembly documentation (VTKIT 4) $179.00
Check or Money orders only. Illinois residents add 8.25% sales
tax. Add $4.00 to all orders for shipping and handling.

continuity to determine which pin goes to which wire. (See Fig.
4-b.)

RS-485—RS-485 generally involves connecting network
wires to a terminal block. Since
the board space did not make
this practical, the RS-485 con-
nexions were assigned two pins
on the female DB9 connector J3. The reader can connect
these in any manner that
makes sense in the chosen net-
work environment. (See Fig.
4-c.) Details on RS-485 opera-
tion are contained in the ZIP file
available on the Gernsback BBS
(516-293-2283, v.32. v.42bis).

The first power-up
On first power-up, the soft-
ware will initialize the EEPROM
(IC6) checksum, set the
EEPROMs (IC3 and IC4) to default
intensities, and overlay the
video titler character set on the
display. Connect a noise-free com-
posite video source such as that
from a video camera to the video
input connector J1. Next, con-
nect video output J2 to a com-
posite video monitor or the
video input of a VCR whose out-
put is connected to a TV. Install
jumpers for JU1–JU4 and HDR1
as needed for the type of inter-
face you are using (see Fig. 5).
For the first power-up, a serial
RS-232 or keyboard interface
should be used.

The cable for the chosen in-
terface should be attached to J3
and connected to the keyboard
or RS-232 serial device (a
“dumb” terminal or PC running
a terminal-emulation program).
Plug the wall-mount adapter
into an outlet and insert its DC

FIG. 4—THERE IS A DIFFERENT CABLE for each interface. The RS-232 serial cable is
shown in a, the PC/AT keyboard cable is shown in b, and the RS-485 cable is shown in
c.
### TABLE 1 – CONTROL-KEY FUNCTIONS

<table>
<thead>
<tr>
<th>Function</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>F1</strong> Enter Edit Mode</td>
<td>Automatically clears the screen and places the cursor at line 1, column 1. Once in the Edit mode, overlay text can be entered.</td>
</tr>
<tr>
<td><strong>F2</strong> Exit Edit Mode With No Overlay Save</td>
<td>Exits the Edit mode and no further editing of characters on the screen can occur. No Overlay data is saved.</td>
</tr>
<tr>
<td><strong>F3</strong> Exit Edit Mode and Save Overlay</td>
<td>Exits the Edit mode and saves the current overlay data. This includes the fine horizontal and vertical position.</td>
</tr>
<tr>
<td><strong>F4</strong> Recall Overlay</td>
<td>Recalls the stored overlay data and puts it on the screen. This function is not available in Edit mode.</td>
</tr>
<tr>
<td><strong>F5</strong> Clear Overlay</td>
<td>Removes all overlay data from the screen.</td>
</tr>
<tr>
<td><strong>F6</strong> Increment Character Intensity</td>
<td>Increments the intensity of the overlay character video. The increments are small, so many keystrokes may be required. Each new setting is stored.</td>
</tr>
<tr>
<td><strong>F7</strong> Decrement Character Intensity</td>
<td>Decrement the intensity of the overlay character video. If the current overlay is turned off, then repainted from the top to the bottom of the screen. This has the same effect as turning on the overlay display (F11). The presentation is the only difference.</td>
</tr>
<tr>
<td><strong>F8</strong> Increment Character Outline Intensity</td>
<td>Increment the outline intensity of the overlay character video. If the current overlay is turned off, then repainted from the top to the bottom of the screen. This has the same effect as turning on the overlay display (F11).</td>
</tr>
<tr>
<td><strong>F9</strong> Decrement Character Outline Intensity</td>
<td>Decrement the outline intensity of the overlay character video. If the current overlay is turned off, then repainted from the top to the bottom of the screen. This has the same effect as turning on the overlay display (F11).</td>
</tr>
<tr>
<td><strong>F10</strong> Turn Overlay Display Off</td>
<td>The overlay display will be turned off. The characters in the overlay area will be displayed as normal characters.</td>
</tr>
<tr>
<td><strong>F11</strong> Turn Overlay Display On</td>
<td>The overlay display will be turned on. The characters in the overlay area will be displayed as outlined characters.</td>
</tr>
<tr>
<td><strong>F12</strong> Display Character Set</td>
<td>This function is not available in Edit mode.</td>
</tr>
<tr>
<td><strong>SHIFT + F1</strong> Wipe On Effect From Top to Bottom</td>
<td>The current overlay is turned off, and then repainted from the top to the bottom of the screen. This has the same effect as turning on the overlay display (F11). The presentation is the only difference.</td>
</tr>
<tr>
<td><strong>SHIFT + F2</strong> Wipe On Effect From Bottom to Top</td>
<td>The current overlay is turned off, and then repainted from the bottom to the top of the screen. This has the same effect as turning on the overlay display (F11).</td>
</tr>
<tr>
<td><strong>SHIFT + F3</strong> Wipe Off Effect From Top to Bottom</td>
<td>The screen will redisplay the current overlay if it is off, then it will begin removing the overlay from the top to the bottom of the screen. This has the same effect as turning off the overlay display (F10).</td>
</tr>
<tr>
<td><strong>SHIFT + F4</strong> Wipe Off Effect From Bottom to Top</td>
<td>The screen will redisplay the current overlay if it is off, then it will begin removing the overlay from the bottom to the top of the screen.</td>
</tr>
<tr>
<td><strong>SHIFT + F5</strong> Set Double Size Character Height/Width</td>
<td>Characters are set to double height/width, allowing 6 rows of 12 characters per row. If the screen already has more than 6 rows or 12 characters in a row, this key sequence will cause distortion on the display. (This is a limitation of the video controller.) The screen must either be in a 12-character-per-row, 6-line format, or must be cleared before using this key sequence.</td>
</tr>
<tr>
<td><strong>SHIFT + F6</strong> Set Normal Size Character Height/Width</td>
<td>Sets characters to the normal size, allowing 12 rows of 24 characters per row. This function is not available in Edit mode.</td>
</tr>
<tr>
<td><strong>SHIFT + F7</strong> Overlay Display Blink On</td>
<td>The overlay display will begin blinking.</td>
</tr>
<tr>
<td><strong>SHIFT + F8</strong> Overlay Display Blink Off</td>
<td>The overlay display will stop blinking if it is currently doing so. The overlay display will be left in the on state.</td>
</tr>
<tr>
<td><strong>ENTER</strong> Go to New Line</td>
<td>Move to the first column of the next line on the display. If Edit mode is not active, this key is ignored.</td>
</tr>
<tr>
<td><strong>(Back Space)</strong> Move Cursor Left and Erase</td>
<td>If the cursor is in column 1 when the keystroke is received, it will move up to the end of the preceding line. If Edit mode is not active, this key is ignored.</td>
</tr>
<tr>
<td><strong>Move Overlay Screen Position Left</strong></td>
<td>Moves the entire overlay screen to the left by 4 character dots. This is used for fine horizontal positioning of the overlay characters.</td>
</tr>
<tr>
<td><strong>Move Overlay Screen Position Right</strong></td>
<td>Moves the entire overlay screen to the right by 4 character dots.</td>
</tr>
<tr>
<td><strong>Move Overlay Screen Position Up</strong></td>
<td>Moves the entire overlay screen up by 4 horizontal lines. This is used for fine vertical positioning of the overlay characters.</td>
</tr>
<tr>
<td><strong>Move Overlay Screen Position Down</strong></td>
<td>Moves the entire screen down by 4 horizontal lines.</td>
</tr>
</tbody>
</table>
power connector into J4. The display should initialize to the power-up default overlay screen which displays the titler's character set.

The character set is programmed into the 87C055 microprocessor's EPROM. The set contains alpha-numeric as well as some special characters. The characters can range from white with a black outline to black with a white outline. The characters are not reprogrammable. Once the characters are programmed in the EPROM of the microcontroller, they are fixed.

If a keyboard was chosen as the interface, it should be functional at this point. If a serial RS-232 interface was chosen, a banner should appear on the display of the connected terminal or PC.

Interfaces

With an IBM PC/AT keyboard attached, the user can simply type-in overlays and manipulate them in various ways. An interactive RS-232 interface provides a prompt that allows the entry of commands.

When using the keyboard interface, in addition to the standard alphanumeric keys, certain function keys are recognized. The function keys are outlined in Table 1. If you press the F1 key, the video titler will respond by clearing any overlay present and put a cursor in the upper left corner of the display in row 1, column 1. At this point, any of the character set keys shown in Table 2 can be typed.

When column 24 of any line is reached, the next character will roll to the next line in the column 1 position. When the cursor is at column 1, the backspace key will move the cursor back to column 24 of the previous line.

RS-232 serial interface

The RS-232 interface can be used in a Network or Interactive mode. It is, however, mainly meant to be used with the Interactive mode.

In the Interactive mode (NO), a "dumb" terminal can be at-

<table>
<thead>
<tr>
<th>HDR1</th>
<th>JU4</th>
<th>Interface</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>In</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Out</td>
<td>In</td>
<td>Out</td>
</tr>
<tr>
<td>Out</td>
<td>Out</td>
<td>In</td>
</tr>
</tbody>
</table>

\(X = \text{DON'T CARE}\)

**INTERFACE SELECTION**

**WATCHDOG GENERATION**

<table>
<thead>
<tr>
<th>JU1</th>
<th>Function</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>In</td>
<td>Watchdog</td>
<td>Timer</td>
</tr>
<tr>
<td>Out</td>
<td>Watchdog</td>
<td>Enabled</td>
</tr>
</tbody>
</table>

**VIDEO INPUT TERMINATION**

<table>
<thead>
<tr>
<th>JU2</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>In</td>
<td>Video Input Terminated To 75 Ohms</td>
</tr>
<tr>
<td>Quit</td>
<td>No Video Input Termination</td>
</tr>
</tbody>
</table>

**RS485 TERMINATION**

<table>
<thead>
<tr>
<th>JU3</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>In</td>
<td>RS485 Terminated To 100 Ohms</td>
</tr>
<tr>
<td>Out</td>
<td>RS485 Not Terminated</td>
</tr>
</tbody>
</table>

**FIG. 5—JUMPERS MUST BE INSTALLED** for JU1–JU4 and HDR1 according to the type of interface you are using.

1) Put the Titler in Edit mode
2) Send: "THIS IS A TEST"
3) Exit the edit mode.

**FIG. 6—THE INTERACTIVE MODE** is the easiest way to set up the Titler. Some examples in the RS-232 Interactive mode are shown here.
<table>
<thead>
<tr>
<th>Hex Value</th>
<th>ASCII Char.</th>
<th>Titler Function</th>
<th>Hex Value</th>
<th>ASCII Titler</th>
<th>Char. Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>00</td>
<td>NUL</td>
<td>Not Used</td>
<td>0D</td>
<td>CR</td>
<td>Reserved in Serial</td>
</tr>
<tr>
<td>01</td>
<td>SOH</td>
<td>Not Used</td>
<td>0E</td>
<td>SO</td>
<td>Not Used</td>
</tr>
<tr>
<td>02</td>
<td>STX</td>
<td>Not Used</td>
<td>0F</td>
<td>SI</td>
<td>Not Used</td>
</tr>
<tr>
<td>03</td>
<td>ETX</td>
<td>Not Used</td>
<td>10</td>
<td>DLE</td>
<td>Not Used</td>
</tr>
<tr>
<td>04</td>
<td>EOT</td>
<td>Not Used</td>
<td>11</td>
<td>DC1</td>
<td>Not Used</td>
</tr>
<tr>
<td>05</td>
<td>ENQ</td>
<td>Not Used</td>
<td>12</td>
<td>DC2</td>
<td>Not Used</td>
</tr>
<tr>
<td>06</td>
<td>ACK</td>
<td>Not Used</td>
<td>13</td>
<td>DC3</td>
<td>Not Used</td>
</tr>
<tr>
<td>07</td>
<td>BEL</td>
<td>Not Used</td>
<td>14</td>
<td>DC4</td>
<td>Not Used</td>
</tr>
<tr>
<td>08</td>
<td>BS</td>
<td>Not Used</td>
<td>15</td>
<td>NAK</td>
<td>Not Used</td>
</tr>
<tr>
<td>09</td>
<td>HT</td>
<td>Not Used</td>
<td>16</td>
<td>SYN</td>
<td>Not Used</td>
</tr>
<tr>
<td>0A</td>
<td>LF</td>
<td>Not Used</td>
<td>17</td>
<td>ETB</td>
<td>Not Used</td>
</tr>
<tr>
<td>0B</td>
<td>VT</td>
<td>Not Used</td>
<td>18</td>
<td>CAN</td>
<td>Not Used</td>
</tr>
<tr>
<td>0C</td>
<td>FF</td>
<td>Not Used</td>
<td>19</td>
<td>EM</td>
<td>Not Used</td>
</tr>
<tr>
<td>0D</td>
<td>CR</td>
<td>Reserved in Serial</td>
<td>20</td>
<td>SP</td>
<td>Space</td>
</tr>
<tr>
<td>0E</td>
<td>SO</td>
<td>Not Used</td>
<td>21</td>
<td>!</td>
<td>Reserved in Serial</td>
</tr>
<tr>
<td>0F</td>
<td>SI</td>
<td>Not Used</td>
<td>22</td>
<td>#</td>
<td>Reserved in Serial</td>
</tr>
<tr>
<td>10</td>
<td>DLE</td>
<td>Not Used</td>
<td>23</td>
<td>$</td>
<td>Not Used</td>
</tr>
<tr>
<td>11</td>
<td>DC1</td>
<td>Not Used</td>
<td>24</td>
<td>%</td>
<td>Not Used</td>
</tr>
<tr>
<td>12</td>
<td>DC2</td>
<td>Not Used</td>
<td>25</td>
<td>&amp;</td>
<td>Not Used</td>
</tr>
<tr>
<td>13</td>
<td>DC3</td>
<td>Not Used</td>
<td>26</td>
<td>(</td>
<td>Not Used</td>
</tr>
<tr>
<td>14</td>
<td>DC4</td>
<td>Not Used</td>
<td>27</td>
<td>)</td>
<td>Not Used</td>
</tr>
<tr>
<td>15</td>
<td>NAK</td>
<td>Not Used</td>
<td>28</td>
<td>!</td>
<td>Not Used</td>
</tr>
<tr>
<td>16</td>
<td>SYN</td>
<td>Not Used</td>
<td>29</td>
<td>#</td>
<td>Not Used</td>
</tr>
<tr>
<td>17</td>
<td>ETB</td>
<td>Not Used</td>
<td>2A</td>
<td>+</td>
<td>Not Used</td>
</tr>
<tr>
<td>18</td>
<td>CAN</td>
<td>Not Used</td>
<td>2B</td>
<td>-</td>
<td>Not Used</td>
</tr>
<tr>
<td>19</td>
<td>EM</td>
<td>Not Used</td>
<td>2C</td>
<td>.</td>
<td>Not Used</td>
</tr>
<tr>
<td>1A</td>
<td>SUB</td>
<td>Not Used</td>
<td>2D</td>
<td>,</td>
<td>Not Used</td>
</tr>
<tr>
<td>1B</td>
<td>ESC</td>
<td>Not Used</td>
<td>2E</td>
<td>/</td>
<td>Not Used</td>
</tr>
<tr>
<td>1C</td>
<td>FS</td>
<td>Not Used</td>
<td>2F</td>
<td>0</td>
<td>Not Used</td>
</tr>
<tr>
<td>1D</td>
<td>GS</td>
<td>Not Used</td>
<td>30</td>
<td>1</td>
<td>Not Used</td>
</tr>
<tr>
<td>1E</td>
<td>RS</td>
<td>Not Used</td>
<td>31</td>
<td>2</td>
<td>Not Used</td>
</tr>
<tr>
<td>1F</td>
<td>US</td>
<td>Not Used</td>
<td>32</td>
<td>3</td>
<td>Not Used</td>
</tr>
<tr>
<td>20</td>
<td>SP</td>
<td>Space</td>
<td>33</td>
<td>4</td>
<td>Not Used</td>
</tr>
<tr>
<td>21</td>
<td>!</td>
<td>Reserved in Serial</td>
<td>34</td>
<td>5</td>
<td>Not Used</td>
</tr>
<tr>
<td>22</td>
<td>#</td>
<td>Reserved in Serial</td>
<td>35</td>
<td>6</td>
<td>Not Used</td>
</tr>
<tr>
<td>23</td>
<td>$</td>
<td>Not Used</td>
<td>36</td>
<td>7</td>
<td>Not Used</td>
</tr>
<tr>
<td>24</td>
<td>%</td>
<td>Not Used</td>
<td>37</td>
<td>8</td>
<td>Not Used</td>
</tr>
<tr>
<td>25</td>
<td>&amp;</td>
<td>Not Used</td>
<td>38</td>
<td>9</td>
<td>Not Used</td>
</tr>
<tr>
<td>26</td>
<td>(</td>
<td>Not Used</td>
<td>39</td>
<td>;</td>
<td>Not Used</td>
</tr>
<tr>
<td>27</td>
<td>)</td>
<td>Not Used</td>
<td>3A</td>
<td>:</td>
<td>Not Used</td>
</tr>
<tr>
<td>28</td>
<td>!</td>
<td>Not Used</td>
<td>3B</td>
<td>&lt;</td>
<td>Not Used</td>
</tr>
<tr>
<td>29</td>
<td>#</td>
<td>Not Used</td>
<td>3C</td>
<td>&gt;</td>
<td>Not Used</td>
</tr>
<tr>
<td>2A</td>
<td>+</td>
<td>Not Used</td>
<td>3D</td>
<td>?</td>
<td>Not Used</td>
</tr>
<tr>
<td>2B</td>
<td>-</td>
<td>Not Used</td>
<td>3E</td>
<td>=</td>
<td>Not Used</td>
</tr>
<tr>
<td>2C</td>
<td>.</td>
<td>Not Used</td>
<td>3F</td>
<td>?</td>
<td>Not Used</td>
</tr>
</tbody>
</table>

The pins on Header 1 (HDR1) marked S1-S4 are for connecting jumpers or external switches to activate certain functions. If external switches are going to be used, they should be of the normally open SPST-type. The switch inputs are read via the "Q" command from the serial interface. Only switch closures since the last Q command are reported.

The Interactive mode can be selected at power-up by closing the S2 contacts. It can also be selected from the Network mode by generating command NO. The interface can then be changed to RS-232 via jumpers and a "dumb" terminal can be attached.

When used in the Network mode, the address and optional checksum portion of the command string is required. If the Interactive mode is selected, the address and optional checksum are omitted. When the Interactive mode is selected, a sign-on screen will be sent to the terminal along with a prompt that indicates the Network address. The address defaults to TERMO at the first power-up. The Interactive mode is the easiest way to set up the Titler. Some examples in the RS-232 Interactive mode are shown in Fig. 6.

**Power-up overrides**

At power-up, certain override functions can be performed by closing S1 and S2. If S1 is closed at power-up, the titler will force all parameters to their defaults. This will put the video titler's default character set on the display, set the address of the unit to TERMO, and the mode of the unit will be interactive. This is a good way of forcing a start from a defined point if everything else you try fails. If S2 is closed at power-up, the titler will assume Interactive mode of operation. This is equivalent to entering the "NO" command from the Network mode.
POWER SEMICONDUCTORS

POWER SEMICONDUCTORS ARE semiconductor devices that have been designed to handle or switch power. They include bipolar and field-effect transistors, thyristors, solid-state relays and a fairly new class of device called the power ICs.

There is no industry-accepted definition that will apply to all power semiconductors. However, most should be capable of passing at least 1 ampere of current or handling 1 watt of power during normal operation without being damaged or destroyed.

Some semiconductor devices are rated for handling voltages and currents that are far beyond those normally encountered in electronics. They are more properly classed as electrical power and distribution components, but there is no agreement on the boundaries between those classifications. They are best determined by their applications.

Many people think of power semiconductors as components found only in automotive, industrial, and military circuits, but they are now found in many consumer appliances, entertainment products, and business machines. Not so long ago it was easy to distinguish a power semiconductor device from a small-signal device—they were in metal cases.

Today, a surprisingly large number of mid- and low-range power devices are packaged in plastic cases because of the development of improved, low-cost plastic cases that will withstand thermal stress. Some have metal tabs that function both as heatsinks and mounting surfaces.

Power transistors

Three types of discrete transistors qualify as power transistors: power bipolar junction transistors (BJT), power bipolar Darlington transistors, and power MOSFETs.

Power bipolar transistors

Power bipolar junction transistors (BJT), like their small-signal counterparts, are three-layer, three-terminal devices formed by adding a second junction to a two-layer diode chip. Figure 1 is the schematic symbol for an NPN BJT; it is the same symbol as that for a small-signal BJT. Power BJTs also have emitter, base, and collector terminals. In normal operation, the emitter-to-base junction is biased in the forward direction, while the collector-to-base junction is reverse-biased.

Electrons flow from the emitter to the collector in all BJTs (opposite the flow of conventional current). However, the outward-pointing arrowhead in Fig. 1 shows the direction of conventional current. Figure 2 is the schematic symbol for a power PNP BJT. Here electron flow and conventional current are reversed. This can be seen from the inward direction of the arrowhead. (For more information on all BJTs refer to the September 1993 Electronics Now, page 57.)

Both kinds of power BJTs are...
made as two parallel PN junctions with controlled spacing between their junctions and controlled impurity levels on both sides of each junction. This is shown in Fig. 3, the functional diagram for an NPN showing the polarities for conventional operation.

In power BJTs, structure refers to the junction depth, the concentration and profile of the impurities (doping), and the spacing of the various levels of the device. Figure 4 is a cross-section view of an NPN BJT formed as a vertical silicon structure. The collector terminal is at the base of the chip, but both the base and emitter terminals are on the top.

The term geometry refers to the topography of the transistor, that is, the way the various doped parts of the transistor are formed on the silicon chip or die.

The applications for power BJTs are influenced by their structure, geometry, and packaging. When selecting a power BJT, the circuit designer must consider gain, frequency, voltage, current, and the heat dissipation characteristics of the device.

**BJT structures**

Various power transistor structures have been developed to provide different electrical and thermal characteristics at different price levels. Each has advantages and disadvantages or compromises. BJT structures can be classified in terms of the number of diffused layers, the use of an epitaxial base, or combinations of these.

Some power BJTs have a mesa structure and others have a planar structure. In text-

3. Triple-diffused (mesa and planar)
4. Epitaxial-base (mesa)
5. Multiple-epitaxial base (mesa)

A discussion of these structures and how they are formed is beyond the scope of this article. However, each of these structures has its own set of characteristics that make them suitable for handling high voltages, current, and power. Some structures are best suited for power switching while others function better as large-signal amplifiers including radio frequency (RF) amplification.

There also economic considerations. Some structures cost more to manufacture than others and this is reflected in their pricing. If a metal case is required, or a wider operating temperature is needed, expect to pay more for the device.

Power BJTs are specified in terms of the following parameters:
1. Voltage rating, collector-to-emitter.
2. Current rating of the collector.
3. Power rating.
4. Switching speed.
5. Direct-current gain.
7. Rise and fall times.
8. Safe operating area (SOA).
9. Thermal properties.

**Power switching BJTs**

The popularity of the switching or switchmode power supply has created a heavy demand...
Darlington power transistor
Figure 5 is the schematic symbol for a Darlington power transistor. A Darlington power transistor consists of two bipolar power transistors on a single chip that are DC coupled internally as emitter followers. Because they are packaged in discrete cases with three pins, they look like conventional power BJTs. Power Darlington transistors offer higher input resistance and current gain than individual BJTs.

Power MOSFETs
Power MOSFETs are metal-oxide semiconductor field-effect transistors made to handle higher current and power than small-signal MOSFETs. Like small-signal MOSFETs, power MOSFETs are voltage-controlled devices; they have the same three electrodes: source, gate, and drain.

Figure 6 is the schematic symbol for an N-channel, enhancement-mode power MOSFET. This symbol differs from the small-signal MOSFET symbol in that it has a diode connected between its source and drain. However, as in the small-signal MOSFET symbol, the direction of the arrow indicates the direction of conventional current flow. The broken lines representing the source to drain channel indicate that it is an enhancement-mode device. This means that it is a "normally off" device. Electrons flow from the source to the drain in an NPN MOSFET when the channel is enhanced or correctly biased.

Figure 7 is the schematic symbol for a P-channel, enhancement-mode power MOSFET. Again, as in the NPN transistors, the flow of electrons and the flow of conventional current are reversed. This can be seen from the direction of the arrowhead representing conventional current flow. (For more information on MOSFETs, both enhancement- and depletion mode, see the May 1993 Electronics Now, page 59.)

Figure 8 is a functional diagram for a N-channel, enhancement-mode MOSFET that is better for explaining the operation of the device. Voltage applied across the gate and source causes current to flow to the drain. The gate, as in all MOSFETs, is isolated from the source by a layer of insulating silicon oxide. With no voltage between the gate and source electrodes, the impedance between the gate and source is high and no current flows.

Figure 9 is a simplified section view of the structure of a typical power MOSFET. Unlike the planar structure of small-signal MOSFETs, most power MOSFETs today are made as vertical structures. The drain is the substrate body and its terminal is a metallized layer on the bottom. The gate and source are deposited on top of the drain structure like icing on a cake.

Most power MOSFETs today are made by the double-diffused vertical DMOS process. (It is a MOS manufacturing process involving two-stage diffusion of impurities through a single mask opening.) This geometry
Power MOSFET geometry.

To gain more uniform current distribution throughout the power MOSFET chip, manufacturers have developed various mesh or honeycomb gate and source structures for the upper surfaces of the chip. They define the multiple gates and sources. Figure 10 is a cutaway view of a typical power MOSFET made by the DMOS process.

The source cells consist of closed rectangular or hexagonal channels which separate a source region from the substrate drain body. The source cells are formed by an deposition process and some power MOSFETs have a density of more than a half-million cells per square inch.

Channels are formed by double diffusion at the periphery of each source cell, as shown in Figs. 9 and 10. An insulating layer of silicon dioxide is then deposited over all of the channels. A polysilicon gate pattern is deposited on top of both the insulating oxide and channel.

The silicon gate is then insulated from the source by another silicon oxide layer. All of the source cells are then connected in parallel by a continuous deposition of aluminum that forms the source terminal.

MOSFET conduction occurs when a voltage is applied between the gate and source terminals: it modulates the conductivity between the source and drain. Electrons flow from a source cell through the channel around the outside of the cell and then into the drain body.

The lower metallized surface of the drain substrate forms a conductive electrical and thermal contact with the header or mounting surface within in the device case.

International Rectifier Corp. (IRC) developed power MOSFETs with hexagonal gate cells that HEXFETs to highlight the manufacturing process. However, Motorola Semiconductor developed rectangular gate cells, but its MOSFETs are called TMOS, a name that suggests the T-shaped flow of current in the device. This is seen in Fig. 10. Other manufacturers refer to their power MOSFETs by their own proprietary names.

Typical applications for power MOSFETs are in high-frequenc-
like conventional PN rectifiers in the presence of current passing in the reverse direction and as combination switch/rectifiers in the presence of current in the forward direction.

**Controlled rectifier**

The silicon controlled rectifier (SCR) is a four-layer PNPN thyristor that switches load currents in one direction only. This makes it useful for switching DC as well as half-wave and full-wave AC power. Figure 11-a shows the schematic symbol for the SCR and Fig. 11-b is a section view of its layered structure. The SCR has three junctions and three terminals: anode, cathode, and gate.

The SCR is fundamentally a rectifier diode with a control element called the gate. The anode-to-cathode voltage at which the SCR starts to conduct is determined by the current flowing in the gate electrode. The gate bias can hold the SCR off, or it can permit conduction to begin at any point in the forward half cycle of AC across the anode and cathode terminals.

The SCR anode voltage must be positive for conventional forward-biased operation. The SCR is turned on by placing a positive voltage on the gate electrode. Once it is turned on, the SCR remains on—even if its gate voltage is cut-off or made negative.

The anode-to-cathode voltage must be reduced to the threshold level or the forward current must be reversed. Also, if the SCR is switching AC, the AC must cross the zero level.

In most applications, the SCR switches currents in only one direction. SCRs can also function as controlled rectifiers in high-power bridges. Heavy-duty SCRs can handle hundreds of amperes and peak voltages as high as 1500 volts with triggering currents of a few milliamperes.

Most SCRs specified for electronics circuits are rated for 40 amperes or less. Those with higher ratings typically serve in electrical power generation, distribution, and control applications.

The gate turn-off rectifier (GTO) is a variation on the SCR. It can be turned off with a negative bias applied to its gate terminal.

**Bidirectional thyristors**

A triac is a bidirectional thyristor that can be turned on for load current in either direction. Figure 12-a is the schematic symbol for a triac and Fig. 12-b is a diagram of the triac's five-layer, four junction NPNPN structure. It acts like two inverse-parallel connected SCRs. A single-gate electrode turns the device on for current in both directions.

A triac is also called a gated symmetrical switch. Because triacs are bidirectional, they are widely specified for switching AC. Unlike an SCR, a triac need not be preceded by a bridge rectifier to switch full-wave AC. The electrodes of the triac are the main terminals 1 and 2, and the gate.

When a positive voltage is applied across the main terminals, a positive pulse at the gate will trigger the device into forward conduction; when a negative voltage is applied, a negative gate pulse will trigger the device into reverse conduction. Once a triac is turned
on, the gate loses control and the device remains in its on-state until the AC voltage across its terminals falls to the triac's sustaining value or passes through the zero value.

Some triacs can switch up to 1500 volts and others can switch currents up to about 40 amperes. The restriction on current is imposed because a single silicon triac chip carries current in opposite directions. If the current is excessive, it will cause the chip to break down and be destroyed.

A diac is a variation of the triac without a gate terminal. Figure 13 is the schematic symbol for a diac. The device is switched on by raising the applied voltage to the breakover voltage.

Triacs are found in consumer products including power switches, lamp dimmers, appliance motor speed controls, microwave ovens, and space heaters. In addition, they are widely used as power switches in industrial and commercial solid-state relays and AC output modules.

Thyristor packaging

Thyristors are packaged in the same kinds of cases as power transistors. Thyristors rated for more than 1 ampere are typically packaged in TO-220 plastic cases and those rated for 15 to 40 amperes are typically packaged in one of the popular metal cases.

Optocouplers

An optocoupler, also known as an optoisolator, is a semiconductor device consisting of a photoemitter, a short optical transmission path and a photodetector in the same package, typically a DIP. Optocouplers are capable of converting an electrical input signal to modulated light and restoring it to an electrical signal.

The only optocouplers discussed here are those with thyristor drivers. (For more complete information on optocouplers, see the August 1992 Electronics Now, page 44.)

All optocouplers provide electrical isolation between the input and output circuits and are able to protect the output circuit against damaging or destructive voltage transients or surge currents in the input circuit.

The photoemitters in power optocouplers are infrared-emitting diodes (IRED) and the photodetectors can be photoSCRs or phototriacs. As in other couplers, these optothyristors are matched to the output of the IRED. The photoSCR can switch direct current and the phototriac can switch alternating current.

Figure 14 is the schematic for an optocoupler with a triac driver and Fig. 15 is the schematic for an optocoupler with a zero crossing triac driver. When not receiving an electrical input, the IRED and photothyristor are normally "off." The input signal across the IRED terminals causes it to emit infrared energy that is transmitted through a short glass or plastic waveguide to the photothyristor.

Light energy incident on the photoSCR or phototriac causes it to generate an electrical output. Both optothyristors respond to input signals that might be short pulses. The internal zero-crossing circuit switches the triac only at zero crossings of the AC.

Optocoupler packaging.

All optocouplers are packaged in opaque cases to prevent the entry of extraneous light that could interfere with signal transmission. The most popular commercial/industrial optocouplers are packaged in standard six-pin dual-in-line (DIP) packages, but there is increasing demand for surface-mountable, gull-wing lead cases.

The accepted industry standard for electrical isolation ($V_{ISO}$) is about 5000 volts AC peak, but Motorola offer optoisolators with ratings of 7500 volts. Most manufacturers seek the UL recognition as well as approval by CSA, VDE, DIN and other regulatory agencies for their products because they can switch AC line power.

Solid-state relays

A solid-state relay (SSR) is an electronic circuit that includes a signal-level trigger circuit coupled to a power semiconductor switch, either a transistor or thyristor. The term SSR is widely understood to mean a factory-made and tested product rather than a solid-state relay function built from separate components on a PC board by the user.

The SSR differs significantly in both structure and operation from the coil-and-contact electromagnetic relay (EMR). However, both provide power gain. The input circuit of an SSR might be an optocoupler,reed relay, or transformer. It is analogous to the "coil" of an EMR, and it is electrically isolated from the power semiconductor switch that acts as the "contact." SSRs require only relatively low energy control circuits to switch the output power.

SSRs for switching alternating current require either two
inverse-parallel (back-to-back) silicon controlled rectifiers (SCR) or an electrically equivalent triac. However, if direct current is to be switched, the switching device is either a bipolar or MOSFET transistor.

The classification of an SSR is based on its input circuit or method for achieving input-output (I/O) isolation. True SSRs achieve electrical isolation between the input and output circuits with optocouplers. Figure 16 is the block diagram of an optically-coupled, solid-state relay with zero-voltage triggering of a triac for switching an AC load. However, hybrid solid-state relays for have reed relays or transformers for isolation.

Solid-state relays have many advantages over electromechanical relays. These advantages include:
1. Longer life and higher reliability
2. Ease in matching logic-level circuits
3. Higher-speed switching
4. High resistance to shock and vibration

5. Absence of mechanical contacts.

The absence of mechanical contacts eliminates: contact bounce, arcing due to contact opening, electromagnetic interference (EMI), and fire or explosion hazards that would be caused by contact arcing in the presence of explosive or flammable gases, liquids or solids.

However, electromechanical relays are more cost effective in many applications that do not call for high-speed switching or operation in a hazardous environment. Many small sensitive electromechanical relays can be switched at TTL logic level.

Solid-state relays can be classified in five general groups:
1. AC power relays capable of switching 24 to 530 volts AC at 2 to 75 amperes with DC input (typically 3 to 32 volts) or AC input (typically 90 to 280 volts) with triacs or dual, back-to-back SCRs.
2. DC power relays, capable of switching 100 to 500 volts at 7 to 40 amperes under DC control with power transistors.
3. AC low-power relays, for PCB -board mounting, capable of switching 60 to 240 volts at 0.3 to 4 amperes with triacs.
4. DC low-power relays, for PCB -board mounting, capable of switching up to 60 volts at 3 amperes with power transistors.
5. Input-output modules, specialized miniature low-power AC and DC relays for PCB-board mounting. They are widely used for interfacing computer systems and industrial controls with external sensors and actuators.

AC solid-state relays

The most popular AC power relays with ratings of 2 to 75 amperes are packaged in four-terminal, rectangular flatpacks suitable for panel or heatsink mounting. They have three functional sections as shown in Fig. 16: an optocoupler, a zero-voltage detector and a triac.

The zero-voltage detector assures that the thyristor will be triggered only when the AC voltage crosses the zero reference (in either the negative or positive direction) to minimize the effect of surge currents at the time the thyristor is switched.

Surge currents can result from switching tungsten-filament incandescent lamps and capacitive loads. For example, the cold resistance of a tungsten lamp is less than 10% of its illuminated resistance.

If the SSR is turned on when the voltage is not at a zero crossing, the high instantaneous load current drawn by the lamp could destroy the SSR. The thyristor, once triggered, will not stop conducting until the load current it is conducting falls to zero.

A resistor and capacitor in series, called a snubber, bypasses voltage transients that occur with inductive loads when current and voltage are out of phase. Triacs are the thyristor of choice in general purpose AC relays for ratings up to 10 amperes at 120 to 240 volts. Dual SCRs are capable of switching AC power loads in excess of 40 kilowatts.

Important specifications for AC SSRs include:
1. Isolation voltage.
2. Operating temperature range.
3. Control signal range.
4. Must-operate voltage.
5. Must-release voltage.
6) Input current.

UL recognition and CSA approval are commonly obtained for all factory-made power SSRs for use in the United States and Canada. But there is an increasing demand for SSRs made by North American manufacturers that meet the European VDE and DIN standards so that they
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will meet European requirements as components or when installed in American-made equipment.

**SS relay packaging.**

The standard industry-accepted package for for AC SSRs worldwide rated 2 to 40 amperes is a rectangular flatpack that measures 2 3/4 x 1 3/4 x 0.9-inches. Its four screw terminals permit the relay to installed (or replaced) in the field by forming hooks in the ends of the connecting wires and clamping the wires tightly with the screws.

SSR for switching direct current include optocouplers for isolation and power MOSFET drivers. The are also packaged in the flatpack cases but there is no real standardization of DC SSR package style.

**Power integrated circuits**

A power integrated circuit is a monolithic IC with signal-level analog circuitry or digital logic circuitry on the same chip with one or more power transistors. These ICs are capable of handling 2 amperes or 2 watts. The first commercial power ICs were drivers for high-voltage neon gas-discharge seven-segment displays. They combined bipolar digital logic with a bipolar power transistor on the same chip.

Later power ICs were made with mixed bipolar and metaloxide semiconductor (MOS) technologies, and analog circuitry was added. CMOS logic was combined with bipolar transistors in a fabrication process called BIMOS technology. Then CMOS logic was combined with DMOS MOSFETs in a technology called CMOS/DMOS.

BIMOS technology is suitable for medium voltage and current devices. Motor controller, solenoid switcher, pulse-width modulators, and voltage regulator ICs have been made with this technology.

By contrast, CMOS/DMOS technology is suitable for applications involving either low-voltage, high-current, fast-switching or high-voltage, low-current, fast-switching ICs. Display drivers have been fabricated with CMOS/DMOS technology.

Three different techniques are used to isolate the control circuitry from the power device on the monolithic IC chip to prevent interference and electrical breakdown of the device. These are:

1. **Self-isolation.** An extension of CMOS technology. The reverse-biased junction is located between the source and the drain region. This technique is usually limited to devices drawing less than 2 amperes, but voltage can be as high as 500 volts.

2. **Dielectric isolation (DI).** Employed single-crystal islands or "tubs" grown on a polysilicon substrate for locating the IC functions. Because current must be brought out of the top of the circuits within the tub, the voltage levels are limited. It is said to produce the lowest parasitic capacitance and permit full isolation on the chip.

3. **Junction isolation (JI).** Permits the formation of both lateral and vertical ICs. An epitaxial layer is formed on the substrate and deep junctions are diffused to obtain isolated areas. Current flow is similar to that in discrete power devices.

**Power IC packaging**

Power ICs are being packaged in many of the same style cases as conventional ICs. However, more attention is being given to keeping junction temperatures below set limits. These include DIP cases with 8 to 28 pins and small outline (SO) cases where dissipated power is less than 2 watts.

More complex parts are being packaged in single-in-line (SIP) cases with from 11 to 23 leads. Plastic TO-220-style cases are used for power ICs that dissipate from 5 to 10 watts. Some power ICs are being packaged in plastic leaded chip carriers (PLCCs).

Power semiconductors are used in a wide variety of practical power control circuits, from simple switches to thermostatically controlled heaters.
Measure the voltage values of waveforms accurately and easily on your oscilloscope with the Voltage Cursor Adapter.

Have you ever had trouble measuring the voltage value of a waveform on an oscilloscope screen? Are you tired of counting graticule squares and "guesstimating" those values? If so, you need the Voltage Cursor Adapter. It superimposes horizontal cursor lines on the top and bottom of the waveform—a kind of electronic calipers—to permit direct readout of the voltage value. The cursor lines extend across the entire screen.

The lower cursor (think of it as the floor) is the zero-volt cursor and the upper cursor (think of it as the ceiling) is the precision DC reference voltage. The cursors can be placed on any parts of the waveform that you want to measure, and the voltage can be read directly from a turns counter coupled to a precision potentiometer.

Figure 1 is the schematic diagram for the voltage cursor adaptor. The required 15 to 25-volt power to the circuit can be supplied either by batteries or a wall-mounted AC to 15-volt DC adapter. The author's prototype has a jack that will accept a plug from either the adapter or a battery pack consisting of two 9-volt batteries taped together.

The MC78L12 voltage regulator (IC1) supplies regulated 12-volts DC to the rest of the circuit. The ICM7555 timer (IC2), a CMOS version of the industry-standard 555, drives the CD4066B, a CMOS bilateral switch (IC3). This drive frequency can either be a normal

![Skip Campisi](image)
frequency (NORM) of 100 Hz or a low-frequency (L.O.F) of 10 kHz, depending on the setting of switch S1. Set S1 to L.O.F for inputs below 500 Hz.

The DC reference voltage supplied to pin 3 of IC3 is set by R3, a 10-turn, 5000-ohm precision potentiometer. The voltage can be read directly from a turns counter dial coupled directly to the potentiometer’s wiper. The accuracy of this reading can be 1% or better. Trimmer potentiometer R1 permits the voltage to R3 to be calibrated to precisely 10 volts.

The circuit is calibrated by setting the digital reading on the turns counter of R3 to the full clockwise position and adjusting R1 for a reading of 10 volts at the wiper of R3 with a digital voltmeter.

Bilateral switch IC3 converts the DC reference to a square-wave with exactly the same wiper amplitude. The square-wave output appears on the common pins 4, 9, and 10 of IC3 and coaxial plug PL1.

Building the adapter

The circuitry is simple enough to be built on an approximately 2 × 3-inch stock predrilled perforated board by point-to-point wiring methods. The prototype circuit was built on a multipurpose board from

Radio Shack.} There is nothing critical about component selection or placement. Figure 2 is a guide for positioning components on the circuit board.

The prototype was mounted in a two-part aluminum case that measured approximately 4 by 2 by 1 1/8 inches. If you intend to put the circuit in similar project case, use the blank circuit board as a pattern and mark the hole locations on that part of the case with the ends folded up.

It is recommended that both

FIG. 1—SCHEMATIC DIAGRAM for the voltage cursor adapter. Power can be supplied by batteries or an AC adapter.

FIG. 2—USE THIS AS A GUIDE for positioning the parts on the perforated construction board.

PARTS LIST

Resistors: all fixed are 1/4-watt, 5%
R1—1000-ohm multturn trimmer potentiometer, Bourns 3005P 101 or equiv.
R2—510 ohms
R3—5000-ohm, 1/8in. precision potentiometer, ten-turn with matching multturn dial, Clarostat 73JB with a 15-turn dial or equiv. (See text)
R4—10,000 ohms
R5—62,000 ohms

Capacitors
C1—47µF, aluminum electrolytic, 35 VDC
C2, C3, C6, C7—0.1µF, ceramic
C6—0.1µF, polyester
C4—0.01µF, ceramic
C5—0.001µF, polyester
C8—1.0µF, solid tantalum dipped

Semiconductors
IC1—MC78L12 12-volt voltage regulator, Motorola or equiv.
IC2—ICM7555 CMOS timer, Harris or equiv.
IC3—CD4066B CMOS quadrilateral switch, Harris or equiv.

Other components
S1—SPDT switch, miniature, panel-mounted. 3A
J1—coaxial jack, panel-mounted (to mate with power plug)
PL1—panel-mounted phone plug 1/4-inch dia.

Miscellaneous: multipurpose perforated board 127/32 × 227/32 (Radio Shack 276-150 or equiv.); project case, aluminum, 4 × 2 3/4 × 1 1/8in. (Radio Shack 270-239 or equiv.); one 8-pin DIP socket and one 14-pin DIP socket; four standoffs with screws, 1/8 × 1 1/2 in.; two 9-volt batteries with two snap connectors and attached plug or wall-mounted line AC to 15-VDC adapter, 50 mA; insulated hookup wire; solder; screws.
IC2 and IC3 be inserted in sockets. Insert and solder an 8-pin socket for IC2 and a 14-pin socket for IC3, as shown in Fig. 2. Insert and solder all other onboard ledged components in the positions shown, but do not trim any leads at this time.

Set the circuit board aside. Refer to Fig. 3, the mechanical assembly diagram, and drill the holes that you marked on the case half for mounting the 3/4-inch standoffs. Then drill the holes for mounting jacks J1 and J2. precision potentiometer R3 with counter and switch S1 in the case end surfaces.

Mount the jacks, potentiometer and switch on the case half. Cut 3- to 4-inch lengths of No. 22 AWG stranded, insulated, hookup wires for making all connections to the board-mounted components, as shown in Fig. 2. Note: A lower cost counter can be substituted for the digital readout dial used in the author's prototype.

Solder one end of the wires from the jacks, potentiometer and switch and the other ends to the assigned terminal pads on the circuit board, leaving enough slack in the hookup wires to permit inverting the board and fastening it to the case half.

Carefully check all solder joints to be sure they are free of inadvertent bridges or cold soldering. Check IC1 to be sure that the three pins are identified and soldered correctly. Insert IC2 and IC3 in their sockets, observing the correct pin locations. After the Voltage Cursor Adapter is completely assembled it is ready for testing.

Connect the times 10 probe from the channel B input of your oscilloscope to the output jack of the Voltage Cursor Adapter.

Measuring waveform voltage
Display the signal whose voltage you want to measure by plugging a lead from the signal source into the channel A vertical amplifier jack of your oscilloscope. Set the triggering on channel A. The output is variable from 0 to 10 volts.

Set your oscilloscope's attenuators to accommodate the 0 to 10-volt range. Using the CHOPPED/ALTERNATE mode, position in the zero cursor with the channel B vertical position control. Then adjust potentiometer R3 to position the reference voltage cursor at the correct level on the signal waveform you want to measure.
MAGNETIC TAPE AND FLOPPY-DISKETTE STORAGE are based on reliable technologies that have been proven over many years for storing analog audio and video as well as digital computer data. However there are a few actions that you can take to improve the quality, lifetime, and interchangeability of your magnetic recordings.

Bulk-erase your media. When a magnetic head overwrites new data on previously recorded media, it will write precisely at the same track location or recording depth. Therefore a portion of the previously recorded signal will remain on the media as a noise signal.

Bulk erasing is the best way to completely erase most magnetic media. Handheld bulk erasers are low-cost, widely available devices that can improve the quality of your recordings. Unlike an overwriteable magnetic head, a bulk eraser can erase the media at all recording depths, without regard to track alignment.

Limit interchange. The best quality is obtained when formatting, recording, appending and retrieval all take place on the same unit.

Every tape or disk drive will have slight variations in track locations, head-azimuth adjustments, media speed and other critical tolerances. Although each variation may be within specification, the combination of variations can cause immediate problems or reduce the storage life of the data.

Pre-formatted media adds an additional stage of interchange (because, by definition, they are recorded on a different machine). That can be compensated for by reformatting the media in the same recording unit that will be used to read, write and append data.

Select high quality media. Magnetic media contains lubricants to reduce friction, and abrasives to prevent head clog. Too much lubricant can clog the magnetic head or gum up moving parts. Too much abrasive will wear out a head prematurely. It is essential to follow manufacturer's media recommendations to avoid "sandpapering" your magnetic head.

Brand new tapes are much more abrasive than tapes that have been "burnished" by several passes across a recording head. Using a drive primarily to record brand new media will reduce its magnetic-head life below the nominal specification.

Control media storage environment. Media storage should be at the media vendor's environmental specification. Long-term storage, especially at high temperature, can result in the spreading apart of magnetic transitions, or print-through, a condition where data is unintentionally transferred between adjacent layers of tape packed on a spool.

Annual retension passes on tapes in long term storage will help prevent print through. Multiple passes across a recording head can correct a print through condition by scraping away the surface layers of the tape. Do not store media near magnetized screwdrivers, magnets, motors, audio speakers, power supplies or other equipment producing strong magnetic fields.

Retension tapes. Tape media should be occasionally retensioned by performing one complete end to end pass to prevent loose or uneven packing of tape around the cartridge hub. This should be done after each insertion into the drive, after prolonged operation over a limited area of tape, after each hour of start-stop or shuffle operations, and after exposure to a temperature change.

Tape cartridges that develop loose packs in storage should be tightened manually, if possible, before the cartridge is inserted into a drive.

Maintain equipment properly. Do not place a magnet or Continued on page 92
The PROCAR SECURITY SYSTEM

This is the third part of a series of articles about building ProCar, an automobile alarm, anti-theft, and anti-carjacking system.

DAVID T. MIGA

THE SECOND PART OF THIS ARTICLE (Electronics Now, March 1995, page 65) picked up on the discussion of ProCar's Power Module and went on to describe the assembly of the Main Alarm, Voice/Options, and Power Module circuits. The Logic Module consists of the Main Alarm and Voice/Options circuits.

The wiring of the Power Module board and its assembly to the aluminum case and interboard wiring were discussed. In addition, the formation of the wiring harnesses and the packaging of the Logic Module were explained.

Wiring harness assembly

ProCar has two wiring harnesses: A main 15-wire harness connects plug PL1 from the Logic Module to the battery, radio, door lock motor, stereo amplifier, siren, door switches, and other functions, as shown in Fig. 17. A three-wire cable from the logic module is terminated by indicator LED1, the system's only visual indicator. Four wires from the logic module connect to the optional remote radio-frequency receiver, and an antenna wire extends from the radio-frequency module.
Logic Module connections

Refer to Table 2, Logic Module Pin Functions and Fig. 17 showing the wiring from the Logic Module. (Also see Fig. 13, Logic Module Wiring Harness, March 1995 Electronics Now, page 77.) The following comments are specific to colored wire connections to the pins from socket SO1:

- Red to pin 1 (+12 V): Verify that the supply can produce at least 10 amperes. (Connect this positive wire to the 12-volt battery last.
- Black to pin 2 (Negative ground)
- Orange to pin 3 (Ignition accessory): Connect to the radio accessory power “ignition on” wire.

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Pin</th>
<th>Color</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>+12</td>
<td>1</td>
<td>red</td>
<td>+12V</td>
</tr>
<tr>
<td>GND</td>
<td>2</td>
<td>black</td>
<td>GROUND</td>
</tr>
<tr>
<td>A</td>
<td>3</td>
<td>orange</td>
<td>Ignition</td>
</tr>
<tr>
<td>D</td>
<td>4</td>
<td>—</td>
<td>Open</td>
</tr>
<tr>
<td>D</td>
<td>5</td>
<td>yellow</td>
<td>+Disarm from OEM keyless entry</td>
</tr>
<tr>
<td>S</td>
<td>6</td>
<td>blue</td>
<td>Secret switch</td>
</tr>
<tr>
<td>R+</td>
<td>7</td>
<td>red</td>
<td>Speaker relay +</td>
</tr>
<tr>
<td>SP</td>
<td>8</td>
<td>green</td>
<td>Speaker –</td>
</tr>
<tr>
<td>SP</td>
<td>9</td>
<td>white</td>
<td>Speaker +</td>
</tr>
<tr>
<td>I</td>
<td>10</td>
<td>white</td>
<td>Internal siren</td>
</tr>
<tr>
<td>DRI</td>
<td>11</td>
<td>brown</td>
<td>Driver door</td>
</tr>
<tr>
<td>PAS</td>
<td>12</td>
<td>gray</td>
<td>Passenger doors</td>
</tr>
<tr>
<td>T</td>
<td>13</td>
<td>red</td>
<td>Trigger</td>
</tr>
<tr>
<td>R</td>
<td>14</td>
<td>green</td>
<td>Armed</td>
</tr>
<tr>
<td>H</td>
<td>15</td>
<td>black</td>
<td>Hood/sensor</td>
</tr>
</tbody>
</table>

Two wires connect the car’s stereo amplifier to the relay: a yellow positive amplifier and a blue negative amplifier output.

If you do not want to include the car’s speaker system, install a dedicated speaker wired to green negative and white positive wires.

- White to pin 10 (Internal siren): This is a positive wire to the piezoelectric siren. Ground the siren’s negative lead.
- Brown to pin 11 (Driver door): Open the Logic Module and select the positive or negative door switches at their headers, (see the specific directions for doing this further on in this article).
- Gray to pin 12 (Passenger Doors): This wire is accessible in the driver’s side door. Select positive or negative door switching. (See specific directions further on in this article.)
Red to pin 13 (Trigger), green to pin 14 (Armed) and black to pin 15 (Hood sensor): Pass the cable containing these three wires through the car’s firewall to the Power Module. The connections of these wires are:
- Red: positive output to Power Module for external siren power. (This wire can power other sirens or relays if their current drain is less than 1 ampere.)
- Green: becomes positive when the system is armed to cut out the engine. This wire also signals the optional automatic door-locking and unlocking relays.
- Black: hood switch and motion sensor from the Power Module. Connect special sensors, such as microwave field sensors to this wire. (Standard grounded switching.) There is no limit to the number of switches that can be connected to this wire.

Cut appropriate six-foot lengths of red and black No. 16 AWG stranded, insulated, hookup wire. The red wire will connect from pin 1 of the socket SO1 to the battery and ignition switch, and the black wire will connect pin 2 of SO1 to the negative side of the battery and ground.

Cut approximately six-foot lengths of the appropriately colored No. 18 AWG stranded, insulated hookup wire for pin 3 (to ignition accessory); pin 5 (+ Disarm) to the door-lock motor; pin 6 (to secret switch); pin 10 (to the internal piezoelectric siren); pin 11 (to driver’s side door switch); and pin 12 (to the passenger door switches). Crimp the ends of the wires to AMP A1441 socket sleeves and insert them in the 15-pin socket SO1 (AMP A14630).

Cut a 10-foot length of three-conductor cable that will pass through the car’s firewall to the Power Module to be located in the engine compartment. Crimp and connect the wires to SO1 socket pins 13 through 15. The wire from pin 13 also goes to additional...
piezoelectric sirens; the wire from pin 14 also goes to the optional auto lock/unlock module and the wire to pin 15 also goes to the hood pin switch.

Wire the speaker relay RY1 to an approximate 1-foot length of four-wire shielded cable containing black, red, green, and white wires as follows: pin 2, black, ground; pin 7, red, speaker relay +; pin 8, green, speaker −; pin 9, white, speaker +.

Wire a four-wire shielded cable from the speaker relay to the car's left front speaker and stereo amplifier. Connect the green wire to the speaker −; white wire to the speaker +; blue wire to the amplifier − output; and yellow wire to the amplifier + output. Enclose the relay in a rubber or shrinkable-plastic tube to keep out moisture and dust from the exposed pins as well as to avoid unintentional short circuits.

Installation
Mount the Logic Module high up under the car's dashboard behind the center console with appropriate fasteners.

When you wire the Logic Module harness to its intended speakers, switches and other destinations, the red battery power wire (pin 1, +12V) must be the last one connected because ProCar will auto-arm when a positive voltage is on the red wire.

Mount the three-color LED on the end of the cable through any flat surface on the automobile's
dashboard that is less than \( \frac{3}{16} \) inch thick. Drill a \( \frac{3}{16} \) -inch hole, then carefully ream it so that the reflector of LED1 fits securely in position.

**Power Module wiring**

The Power Module contains the circuits for flashing lights, sounding the siren, powering the fuel-injection system and performing other functions. It has a 15 pin socket SO2 (See Fig. 19 and Table 3 and Fig. 10 [March 1995 Electronics Now]). Select the wire sizes following the guidelines given for the Logic Module harness. The wires to the mating plug are as follows:

- **Brown to pin 2 (Engine sensor defeat—ESD):** This defeat wire intermittently grounds the output from the airflow sensors (APS) or throttle-position sensors (TPS) through a protective resistor. It simulates engine problems to a carjackers.
- **Red to pin 3 (Trigger), green to pin 4 (Armed) and black to pin 5 (Hood/shakes):** the three wires form a cable. Connect the black wire from pin 5 to the motion sensor and the hood pin switch. There is no restriction on the number or type of motion sensors or pin switches that can be connected to that black wire.
- **White pin 6 (Light/flasher) is a positive output wire to the parking lights. Its maximum load of 15 amperes is protected by a 10-ampere automatic-reset circuit breaker CB1.
- **Silver to pin 7 (Speaker) and gold to pin 8 (Speaker):** This pair of wires can connect up to four four-ohm horn speakers to the siren module. Both wires should “float” electrically.
- **Green to pin 9 (Coil negative):** This wire intermittently short-circuits the points or ignition module and negative side of the coil to ground when the siren is activated.
- **Orange to pin 10 (Engine power, input 1) and orange to pin 11 (Engine power, input 2):** Connect both orange wires. (The second wire is a backup wire.) The paired wires are connected to the wire that normally provides power to the fuel injectors or ignition coil.
- **Yellow to pin 12 (Engine power, output 1) and yellow pin 14 (Engine power, output 2):** The Power Module routes (or interrupts) the power input on pins 10 and 11 to pins 12 and 15. The output of pins 12 and 15 is fed to either the fuel injectors or the positive side of the coil. The paired yellow and orange wires will supply up to 20 amperes.

**Note:** The connection at the junction between the pairs of orange and yellow wires is broken as soon as ProCar is armed. This does not occur for the green (Coil negative) or brown (Engine sensor defeat) wires which are only activated simultaneously with the siren.
- **Black to pin 13 (Ground) and black to pin 14 (ground):** Ground both of these wires.

**Power Module installation**

The Power Module contains circuitry for flashing the lights, powering the external siren speakers, the fuel system, ignition shut-off, and engine shutdown circuits. Mount the module in the engine compartment high enough up to be in a dry location and away from the exhaust manifold so that air can circulate freely around it.

**Light flasher**

After mounting the power module, connect the wire from the vehicle’s parking light on the same side of the vehicle as the power module. (Identify this parking light power wire by turning on the parking lights and finding the live wire.) Caution: Do not use the headlight wires.

Connect the power wire to the white wire from pin 6 (Light/flasher) of the power module. If ProCar lights the driver’s side parking lamps when activated, install 10-ampere diodes to isolate the driver’s side and passenger light circuits, as shown in Fig. 19.

**Ignition cutoff**

The green wire from pin 9 (Coil negative) of the Power Module will intermittently short circuit the negative side of the ignition coil to ground through an internal ballast resistor only when the siren is activated. This will simulate intermittent engine trouble. The wire was intended for typical, single-coil ignition systems, but it can be wired to one of the coils of a multicoil system. Caution: If the green pin 9 wire is used, do not connect the brown engine sensor defeat (ESD) wire from pin 2.

**TABLE 3—POWER MODULE PIN FUNCTIONS**

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Pin</th>
<th>Color</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>+</td>
<td>1</td>
<td>red</td>
<td>+12V</td>
</tr>
<tr>
<td>E</td>
<td>2</td>
<td>brown</td>
<td>Engine sensor defeat (ESD)</td>
</tr>
<tr>
<td>T</td>
<td>3*</td>
<td>red</td>
<td>Trigger</td>
</tr>
<tr>
<td>R</td>
<td>4*</td>
<td>green</td>
<td>Armed</td>
</tr>
<tr>
<td>H</td>
<td>5*</td>
<td>black</td>
<td>Hood/speaker</td>
</tr>
<tr>
<td>L</td>
<td>6</td>
<td>white</td>
<td>Light/flasher</td>
</tr>
<tr>
<td>S</td>
<td>7*</td>
<td>silver</td>
<td>Speaker</td>
</tr>
<tr>
<td>S</td>
<td>8*</td>
<td>gold</td>
<td>Speaker</td>
</tr>
<tr>
<td>P</td>
<td>9</td>
<td>green</td>
<td>Coil negative</td>
</tr>
<tr>
<td>I</td>
<td>10*</td>
<td>orange</td>
<td>Engine power (Input 1)</td>
</tr>
<tr>
<td>I</td>
<td>11*</td>
<td>orange</td>
<td>Engine power (Input 2)</td>
</tr>
<tr>
<td>C</td>
<td>12*</td>
<td>yellow</td>
<td>Engine power (Output 1)</td>
</tr>
<tr>
<td>G</td>
<td>13*</td>
<td>black</td>
<td>Ground</td>
</tr>
<tr>
<td>G</td>
<td>14*</td>
<td>black</td>
<td>Ground</td>
</tr>
<tr>
<td>C</td>
<td>15*</td>
<td>yellow</td>
<td>Engine Power (Output 2)</td>
</tr>
</tbody>
</table>

*Denotes functional pairs or cable

May 1995 Electronics Now

www.americanradiohistory.com
Locate the coil if the car has a coil and a distributor. Expect to see two or more small wires leading to the coil. Ignore the high-voltage distributor wire. Start the car and measure the voltage at the terminations of the small wires.

The voltage on one wire will be +12 volts. The second wire (or wires) are switching wires to the ignition amplifier module (or the points on older model cars). A voltage lower than +12 volts that varies with engine revolutions per minute should appear on those wires.

If you make the measurement with an oscilloscope, expect to see a voltage squarewave as the coil discharges. If this is seen, the correct wire to join to the green wire from pin 9 of the Power Module has been correctly identified.

Disabling sensors

Some late model cars do not have an ignition coil system. The brown (Engine sensor defeat—ESD) wire from pin 2 of the Power Module can be wired to many different kinds of sensors on a fuel-injected engine to cause the engine to stutter and stall without damaging it. Two examples are the airflow sensor (AFS) or throttle-position sensor (TPS).

The output voltages of those sensors vary with engine acceleration. Each sensor has two or three wires. The voltage on one wire will vary directly with engine revolutions per minute. Connect that wire to the brown engine sensor defeat (ESD) wire, pin 2 from the Power Module.

Caution: The car's engine electronics will not be damaged if only the wire carrying the changing voltage is connected to the brown ESD) wire. If the brown wire is connected, do not connect the green (Coil negative) wire from pin 9.

Power cutoff circuit

If the engines of cars with automatic transmissions are shut off, the power steering and braking functions will be disabled. Therefore, the orange engine power input 1 wire from pin 10 and the yellow engine power input 2 wire from pin 11 should not be connected to shut off the fuel system. Instead, the green coil negative wire from pin 9 or the brown ESD wires will ground pulsed signals. Those signals stall the car intermittently and slow it down, rendering it virtually undrivable. However, the pulse signals will not cause the driver to lose control of the car.

The direct link between the engine and transmission on cars with standard transmissions will allow the engine crankshaft to turn as the car decelerates. Although the ignition is shut off, the car's brakes and steering function will remain unaffected.

Power cutoff to fuel

Cars with fuel-injection have an electric fuel pump, fuel injectors, and a fuel-control relay. The two orange engine power input 1 and 2 wires from pins 10 and 11 and the two yellow engine power output 1 and 2 wires from pins 12 and 15 of the Power Module can be connected to act as a normally closed switch. The "switch" opens when Logic Module directs the Power Module to shut down the engine.

ProCar includes two identical switches, wired in parallel for fail-safe operation. Be sure to install both pairs of orange and yellow wires.

The best way to cut off fuel is to wire ProCar to the fuel relay if you car has one. The fuel relay is usually in the engine compartment and it draws low current. As another person turns the ignition key on and off, listen in the engine compartment for the sound of the fuel relay contacts clicking.

Find the wire to the fuel relay coil and cut it. Wire the orange engine power input wires from pins 10 and 11 of the Power Module to the power source and the yellow wires from pins 12 and 15 to the relay coil. Warning: It is important that the orange wires receive the voltage and the yellow wires deliver the power to the load. The circuit MOSFETS are unidirectional, so if the wires are reversed, the Power module will be damaged.

The second alternative is to cut power to the fuel injectors. The Injectors are wired together with the wire bundle terminating at a multipin connector. Measure the voltage at each wire as the engine is running. Only one wire will carry a constant 12 volts. The voltage on the others will be lower.

Accelerate the engine to obtain a better reading. The injector wire voltage drops as engine revolutions per minute are increased. An oscilloscope screen will show a narrow negative pulse imposed on the 12-volt level at the injector wires. Wire a connection into the constant power wire that supplies all of the injectors.

Cut the constant 12-volt wire to all injectors. Connect the 12-volt wire to the two orange (engine power input 1 and 2) wires from pins 10 and 11 of the Power Module. Connect the other end of the cut wire (to the injectors) to the two yellow engine power output 1 and 2 wires from pins 12 and 15 of the Power Module. Caution: Reversing these wires will damage the Power Module.

Another alternative is to use the fuel power cutoff circuit as a starter interrupter. A thief or carjacker might panic if the engine shuts down completely within seconds after an attempted carjacking, especially if the vehicle has an automatic transmission.

To delay engine shutdown, cut the small start wire from the ignition key to the starter solenoid and wire the power source to the orange engine power input wires, and the solenoid wire to the yellow engine power output wires.

Mechanical fuel systems

On cars that do not have fuel injectors, the power cutoff circuit can cut power to the ignition coil. Follow the instructions for wiring the ignition cutout circuit given earlier. The ignition input to both the coil and the points or ignition module is 12 volts.

If the green coil negative wire from pin 9 to the points or igni-
tion module has been connected, cut the 12-volt ignition power to the coil positive and wire the orange engine power input wires to the power source, and the yellow engine power output wires to the coil power input.

The power cutoff circuit can also disable the starter in those cars instead of removing ignition power. Alternatively, an electric fuel cutoff solenoid (a standard part available at most automotive supply stores) can be installed.

Caution: If the power cutoff circuit is installed to cutoff power to the fuel or ignition system, the engine will be shut down completely 10 seconds after the voice warning.

Motion sensor
Mount the motion sensor on a vertical metal surface within the engine compartment (avoid plastic surfaces) on the driver’s side as close to the firewall as possible so that sound vibrations will be conducted effectively. Connect the black hood shaker wire from pin 5 of the Power Module to the motion shock sensor.

Connect the red +12V power wire from pin 1 of the Power Module to the motion sensor and ground the two black wires from pins 13 and 14 of the Power Module.

When adjusting the motion sensor, temporarily disconnect any plunger or pin switches. Adjust the motion/shock sensor so that it requires at least a heavy impact through a distance of about one foot directed at either the front or rear bumpers to respond.

Pin/plunger switches
There is no limit to the number of grounded pin or plunger switches that can be connected to the black hood/shaker wire from pin 5 of the Power Module.

The ProCar circuit will operate reliably even if any of the pin/plunger switches connected to the black wire are filled with water or have mildly corroded contacts. The resistance across a pin switch should be zero ohms when actuated and have an infinite value when open. The ProCar circuit considers any resistance value less than 400 ohms to be equivalent to zero ohms and any value more than 400 ohms to be infinite.

The voltage reading should be 11 volts when all entry points are closed (The system need not be armed to make this measurement.) If the voltage measurement is lower than 10 volts, examine all pin switch or the motion/shock sensor for defects. If both sirens are activated immediately after the system arms itself, the fault is probably a defective or intermittent pin switch or sensor.

Any “stuck” sensor that causes the voltage to drop to zero will prevent the system from arming itself, and status indicator LED1 will stay green. Install only pin/plunger switches with plastic rather than steel bodies to eliminate false alarms due to moisture condensing on the switch contacts.

Keyless-entry system
The logic module can be wired into any vehicle with a digital (keyless) entry system that provides a positive pulse from the door lock solenoid. Refer to Table 2 and Fig. 17. The yellow wire from pin 5 (+ Disarm from OEM keyless entry) will disarm ProCar with a positive pulse. To integrate ProCar into a vehicle’s factory-installed remote control or keyless-entry system, tap into the wire on the car’s door lock motor that becomes positive when opened.

If the high security level is selected, the keyless entry will only unlock the doors. The ProCar system will let the driver in, but the alarm will sound if the system does not receive the secret signal within 15 seconds.

Four-function remote
If you plan to install the optional remote radio-frequency receiver, mount it high enough

---

**TABLE 4
LOCK-CONTROL WIRE IDENTIFICATION**

<table>
<thead>
<tr>
<th>Color</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>Red</td>
<td>+12 V Battery</td>
</tr>
<tr>
<td>Black</td>
<td>Negative ground</td>
</tr>
<tr>
<td>Orange</td>
<td>Positive switch lock</td>
</tr>
<tr>
<td>Yellow</td>
<td>Negative switch lock</td>
</tr>
<tr>
<td>Green</td>
<td>Driver door motor</td>
</tr>
<tr>
<td>Blue</td>
<td>Driver door motor</td>
</tr>
<tr>
<td>White</td>
<td>Driver OEM wire</td>
</tr>
<tr>
<td>Brown</td>
<td>Driver OEM wire</td>
</tr>
<tr>
<td>Gray</td>
<td>Ford lock switch</td>
</tr>
</tbody>
</table>

---

**FIG. 20—WIRING FOR AUTOMOBILE DOOR LOCKS.**
under the dashboard so that its antenna wire can be fastened close to the windshield. Terminate the four wires from the Logic Module (see Fig. 13, page 74 March 1995 Electronics Now with the flat plug provided. Plug in the receiver after the red power wire has been connected. If power is applied after the system is wired, ProCar will arm and the remote receiver could then enter the panic mode immediately.

Identify the antenna wire from the module and attach its end as high as possible under the dashboard with a sheet metal screw. The range of the antenna depends on the height of the radio-frequency receiver and antenna under the dashboard.

If the vehicle is started as soon as the red wire is attached, ProCar will auto-arm, and the remote receiver could enter the panic mode immediately. If the sirens and light flasher are activated immediately after the red wire to the logic module is hooked up, push the No. 1 panic button on the remote control, then
disarm the system by holding the No. 2 button for 3 seconds.

**Automatic door locking/unlocking**

Refer to Table 2 and Fig. 18. This feature allows the original power door locks to be synchronized with ProCar. Connect the optional auto lock/unlock module to the green Armed wire from pin 14 of the Logic Module. This circuit will lock all door locks as ProCar arms, and the unlocking relay will unlock the driver’s side door only when ProCar disarms.

The locking feature will lock the keys inside the car if they are left in the ignition switch and all car doors are closed. However, ProCar allows a delay and sounds an audible warning before it arms and locks. If the driver has the remote control, he or she can unlock the driver’s side door while simultaneously disarming ProCar.

If you want ProCar to lock the doors automatically after you leave the vehicle, or if you want to use the remote control and want ProCar to unlock the driver’s side door as you disarm the system, wire the circuit shown in Fig. 20, the door lock control schematic. The lock and unlock circuits are shown separately. Table 4 identifies the functions of the colored wires in Fig. 20. Solder the components directly to the relay terminals.

The door-lock control is designed to be universal for any vehicle, whether positive-switching, ground-switching, or five-wire switching.

Figure 21 is a diagram of a typical Ford automotive five-wire switching system. Fig. 22 is a diagram of a typical foreign car negative switching system; and Fig. 23 is a diagram of a typical General Motors positive switching system. The colors of the wires from the Procar system are enclosed in boxes in these figures.

**Door-monitoring circuits**

The door switches on modern cars are set up in one of two different ways. They can either switch positive voltage to the dome lamps, or with positive on one side of the lamps, switch negative, or ground to the other switch. General Motors vehicles typically have negative switching while Ford vehicles have positive switching.

ProCar monitors the doors individually, but the system has been designed so that the installer need only gain access to the wiring of the switch in the driver’s side door. ProCar circuitry will connect the car’s electrical system to light interior dome lights when any door is opened. Nevertheless, it will discriminate between the different doors.

**Positive switches**

Locate the door-light switching wire. Verify that all of the passenger doors, hatch or trunk are closed. Open the driver’s side door, and remove the

Continued on page 94
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Way back in the seventh grade, I had a brilliant idea on how to “improve” VHF radio vacuum tubes by eliminating all of their internal interelectrode capacitances. That would be achieved by arranging the cathode and plate planar adjacent each other, and then placing the grid at right angles to them. I reasoned that there would be zero capacitance among the three. I vaguely remember assigning magnets to somehow bend the electron beam from cathode through the grid to the plate. I even sent this idea to RCA.

Sorry, but electrical capacitance always exists everywhere. Separate a conducting point from another with an insulator, and you’ve got a capacitor. Period. All that my scheme did was reduce the capacitance slightly. Obviously, I had never heard of transit time, electron ballistics, or parasitics. Or any of the other crucial gotchas important for any high-frequency design.

Naturally, it never dawned on me for an instant that similar ideas might have occurred to RCA’s hired help. History seems to be repeating itself among my helpline callers, so we need to talk about...

"Too good to be true" results

Let’s see. One caller has a zero-inductance scheme that is remarkably similar to my zero capacitance one. Of course, there are all of the usual motors and magnets perpetual-motion folks. Another caller has information traveling faster than the speed of light. One believes that a ridiculous amount of spark advance is all you need for a super efficient gas engine. Yet another claims to have developed an ultra small satellite antenna system.

I would really like to reply to all of these people “You are wrong.” The outcome is not now and never was in doubt. All that remains is deciding whether you want to find out how or why you made your error. Figure 1 shows my guidelines for dealing with “too good to be true” results.

If you have any conductor routed between two points in space, you do have inductance. Period. All that a non-inductive winding does is make the inductor physically larger in size.

Nobody who has ever stayed awake during Physics 101 lectures would even dream of trying to achieve perpetual motion. Without exception, each and every attempt to date has failed spectacularly. There is not one shred of evidence that such a thing is even remotely possible.

On extreme spark advance: there aren't any dead horses that haven't been whipped as thoroughly as this one. Try the SAE Library for more information.

I got the impression the antenna person never even heard of “Doctor Maxwell's silver hammer,” nor read chapter twelve of H. Jasik's Antenna Engineering Handbook. Nor has he appreciated the zillions of small antenna failures and outright scams littering all of satellite TV history.

An antenna has an effective area. There is a specified amount of input energy flux going into that area. You can do no better than grab it all. But even trying to grab it all will cause ugly sidelobes.

If you want a smaller antenna, raise the frequency and the transmit power. That’s how the direct broadcast satellite (DBS) folks do it for their new services.

I like to encourage people to think about things and then come up with new ways of looking at problems. And, yes, new or improved antennas are certainly possible. But results that seem to be “too good” are always suspect.
New BASIC stamps
Lance Wally of Parallax just sent me a few samples of his brand new BS1-1C BASIC Stamp Module. This $29 module is an entire computer measuring 0.4 by 1.4 inches. Figure 2 shows the stamp’s actual size. The schematic for the new stamp is shown in Fig. 3.

Just in case you’ve come in late, there’s a new microcontroller on the block called a PIC chip from Microchip Technology, Inc. These are clearly the hacker component of the decade. They cost under one dollar in large quantities. Dozens of PIC projects already have appeared in print, and hundreds more are on the way.

Thanks to an unusual architecture and a minimal RISC instruction set, PICs blow away all of the earlier microcontrollers, usually with three times the performance or more. The same unusual architecture makes it possible to distribute any problem among two or more PIC chips.

The PIC chips are far easier to use than, say, a 555 timer. And lead to far lower cost products. If your circuit contains eight or more parts and if one of them is an active de-

vice, then you most likely should use a PIC instead.

As we saw last month, you can easily perform such PIC tricks as creating complete digital sinewave generator with only six bytes of code. But the really great thing about PICs is that they are simple and fun to use. None of the traditional microprocessor hassles remain.

For those of you that don’t want to jump in with both feet, the BASIC stamps make becoming microcontroller-literate quite easy. After a few of the stamp projects, you can step up to “real” PIC projects with blazing speed.

No matter where you look in the PIC universe, amazing and elegant hacks show up. Note the apparent misprint in Fig. 3, where a logic output becomes the supply pin for another chip. This is in fact a cute power-saving trick. If you aren’t immediately using a chip, disconnect it.

I’ll get into these a lot more in future columns. But for now, you get started by picking up the free catalog from Parallax, the “must have” free Microcontroller Handbook and PIC Applications Manual from Microchip Technology, and the really unique PIC Tools and Stamp Extenders from Scott Edwards Electronics.

As our resource sidebar for this month, I’ve listed several more key sources for PIC information and applications support. Don’t miss this one!

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**NEW FROM DON LANCASTER**

**HARDWARE HACKING**

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<td>The Case Against Patents</td>
<td>28.50</td>
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<tr>
<td>Hardware Hacker - Reprints IL, IR, or IV</td>
<td>24.50</td>
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<tr>
<td>Blatant Opportunist Reprints</td>
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<td>Resource Bin Reprints</td>
<td>24.50</td>
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**POSTSCRIPT STUFF**

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<td>Book-on-demand resource kit</td>
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**FIG. 2—NEW $29 BASIC STAMP is an incredibly versatile microcontroller. It is shown here full size.**

You can easily code these by hand without ever going near an assembler or an emulator. In fact, I strongly recommend that you write at least your first 1200 lines of PIC code by hand.

---

**FIG. 3—BS1-IC BASIC STAMP schematic. This is the first microcomputer that is easier to use than a 555 timer.**
AC motor drives

Induction-motor speed controls and electric auto drives are both of major hacker interest these days. In both cases, the key is to come up with a variable voltage and a variable frequency power sinewave cheaply and conveniently.

Sadly, a plain old linear amplifier will not hack it. That’s because there’s no known linear amplifier that offers any decent efficiency. Instead, you might want to go to one of the routes of Fig. 4. A DC power supply is connected to one winding of an AC motor through a pair of switches. The switches are often called a bridge drive.

The trick is to flip the switches just right so that the motor thinks it is seeing a variable voltage and variable frequency pure sinewave. What gets hairy fast is that you’ll want to minimize motor harmonics because harmonics cause power loss, whine, cogging, and even instability. You’ll also want to flip the switches as few times as possible per cycle because each flip costs you dearly in transition losses.

A classic method of dealing with power sinewaves is known as PWM, short for pulse width modulation. A high-frequency carrier becomes duty-cycle modulated with the sinewave. The fundamental is not present at first. It appears only after the PWM waveform has been summed, or integrated. Fortunately, the inductance of the motor winding forms a low-pass filter that doubles as an integrator, thus converting the duty cycle variations into a fundamental sinewave. There will be no low harmonics if the carrier frequency is high enough.

But PWM does have some nasty habits. Nonlinearities, quantization, and DC offset in the modulation shows up as output distortion. And the high-frequency carrier amplitude is always larger than the fundamental—gruesomely so for low-amplitude fundamentals. And there is all that higher frequency energy to contend with. Also ugly is the high number of transitions per cycle.

By using the magic code method, you come up with a switch flipping pattern that looks like a fundamental sinewave. The waveform shown is one of the simplest you can build that has a strong fundamental, zero even harmonics, and a zero third harmonic. It has very few transitions per cycle. On the other hand, there’s only one value available, and it has fairly strong fifth and seventh harmonics.

Note that classic PWM changes both sides of the bridge at the same time. Even for a comparable number of transitions per cycle, PWM has twice or more the losses.

In the simple example shown, the magic code requires only four single transitions per cycle. PWM would require twenty-four double transitions. While I can’t claim this is “twelve times more efficient,” I might say that those high-frequency transition losses are only 1/12th as much. And PWM often uses much higher frequencies for even worse performance.

Fewer losses, of course, let cheaper drivers be used, with lower temperatures and smaller heat-sinks. Thus, the magic waveform method would seem to be better if you could locate some having lots of different amplitudes and low harmonics.

We saw last month that a magic half waveform of 001011111111010 has no DC term, no even harmonics, no third and fifth harmonic, and a fairly weak seventh. To pick up the other half, use a code of 00-10-1-1-1-1-1-10-10. Do this by reversing the bridge to run the current backward through the motor winding.

Go through the 30-bit math, and you’ll also find that the waveform 000101011110101 has an amplitude of about 83 percent and that 00010101010100 has an amplitude of about 62 percent. That’s equal to 69 and 38 percent power, while still keeping a zero third and fifth harmonic. Plus, of course, there’s the good old trivial 0000000000000000 waveform for the zero amplitude.

This gives us four amplitudes to work with at 30 bits. For many applications, you’ll want a lot more than this. The obvious thing to do is increase the number of bits in the word. It turns out that words that are products of low harmonics can force all of those harmonics to zero.

The most obvious next stopping point is a 105-bit half word because
3 × 5 × 7 equals 105. Now, there are a lot of possible 105-bit words. But it turns out that only a mere 2219 or so of them end up with zero third, fifth, and seventh harmonics. These also have zero ninth, fifteenth, and twenty-first harmonics, with no DC term and no even harmonics. This means that harmonics 0, 2–10, 12, 14–16, 18, 20, 21, and 22 are all zero—not half bad.

Some of the magic sinewaves will have too much distortion. Others will have too many transitions. And yet others won't hit the amplitudes we want, or might cause amplitude jitter.

But if you go through the list, you can pick out 103 or so magic sinewaves from the list in Fig. 5. These give you roughly one percent amplitude control. And they have far fewer losses than PWM.

To use this list, you “unfold” the strings to get magic words of length 210. You then stash these in a table lookup memory somewhere. Pick a magic word for an amplitude. Pick a selected delay for a frequency. And that’s all there is to it. If really needed, the few “missing” words in Fig. 5 can be calculated by going to 420 bits.

I do this with PostScript and an Apple IIe. How else are you going to exhaustively explore all possible 210-bit binary words? As always, I’ve found PostScript’s friendly interactivity to be the way to solve a seemingly sticky problem.

As with all sticky problems, once you get inside, things simplify a lot. For instance, to end up with zero even harmonics, you must have half-wave symmetry, which means that you really are starting with 105-bit words. Quarter-wave symmetry makes for easy analysis because it results in sine terms only. Thus, you are down to 52/2 bit words. Always deal with the half bit by splitting a zero.

A 52-bit word results—a mere 4,503,599,627,370,496 states to run a full Fourier series on. All in all, this still might make for a fairly long Postscript evening. But wait. You can easily write 17 equations that

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force a zero third harmonic, and 10 equations for a zero fifth harmonic, and seven for a zero seventh harmonic. Thirty four equations in 52 unknowns should, in theory, reduce to one equation in 18 unknowns—262,144 states or so.

However, these are general equations. But all of our inputs and all solutions have to end up binary ones and zeros. You can thus eliminate some of these 52-bit words immediately and test for the rest. That quickly generates all 2219 possible candidates. You then run your Fourier Series only on the good ones, leaving you with a few hours work at most.

Full details appear on GEnie PSRT in FOURIER PS, ZERO-HARM PS, and SN210CAT PS. Plus a few others.

Many thanks to math genius Jim Fitzsimons for his valuable input on all this. Consulting services are available for this exciting new hacker topic. A kit or two may also be in the works. Surely others have plowed some of this ground before. If you know of any technical papers on power waveform harmonics, please send them to me for a free copy of my Incredible Secret Money Machine II book.

Now, the real challenge is to find the improved 440-bit magic word list. That should give us fewer losses, lower distortion, and more choices, yet still keep reasonable 26.4 kHz switching frequencies. This one might take a tad longer, though...

**New tech lit**

Sony has published new data books, including **Multimedia Computer Audio/Video, CCD Area Sensors, CCD Linear Sensors, and Radio Communications ICs**.

Motorola has a new Rectifier Applications Handbook. It includes some mind numbingly obsolete fil-

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**NAMES AND NUMBERS**

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**Dialog Information Svcs**  
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**Electric Spacecraft Journal**  
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Rockville MD 20850  
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**Historically Brewed**  
Historical Computer Society  
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Supervisor: Akio Tsuzimoto
The table of "magic" values can be used to generate efficient digital power sinewaves having very low distortions and minimum state transitions. Important uses include induction motor speed controls and electric automobiles.

210-bit values shown in approximate one percent steps. Each listing consists of a zero followed by 52 active bits. To form the first half cycle, MIRROR the listing and REMOVE THE FINAL ZERO, giving a 105 bit half word.

To form the second half cycle, duplicate the first half, replacing each 1 with a 0, completing the 210 bit word. DO NOT MIRROR the second half!

To use, stash the words in a table lookup memory and pick the one you want.

More details (including full spectral analysis) in MAGIC210.PS, FOURIER.PS, ZEROHARM.PS and SNCAT420.PS on GENie PSRT.

FIG. 5—103 MAGIC POWER SINEWAVES shown as one percent amplitude steps. Harmonics 2–10, 12, 14–16, 18, 20, 21, and 22 are zero. Harmonics 11 and 13 are tame. Minimum transitions are used for superb efficiency.

Marvin Simon's Spread Spectrum Communications Handbook offered by McGraw Hill does seem to be the definitive tome on the subject—all 1228 pages of it. This textbook clearly shows the military jamming heritage of spread spectrum communication, for it takes until page 1186 or so to get around to mentioning that there might be some commercial uses for this stuff. For a totally different approach to the same subject, check out Randy Robert's Spread Spectrum Scene.

Dave Strom has written a new Power Up book on making battery adapters for military surplus radios. It's published by CRB Research. Scientific American, January 1995, has a great project on sonoluminescence in the Amateur Scientist section. Costs are in the hundred dollar range. Useful results should be obtainable in any fairly advanced home lab.

The fusion energy potential for sonoluminescence is talked about in Science, December 16, 1994, p. 1804. Sonoluminescence can routinely produce temperatures of a million degrees C and pressures of a 100 million atmospheres. All in a flask! Of course, I did tell you all about sonoluminescence long ago. More in HACK73.PS on GENie PSRT.

Lots of information on bright blue light emitting diodes appears in the January 6, 1995 Science on pages 51–55. Few people are aware that LEDs are potentially five to ten times more efficient than an incandescent lamp. As auto taillights, LEDs are also much safer. That quarter second or so turn on the circuit of an incandescent lamp translates to twenty feet of delayed warning at thruspeeds!

For information on speech synthesis and recognition, check into the AVIOS, or American Voice I/O Society. Its next applications conference will be September 12–14 in San Jose, CA. Journals, proceedings, and vendor's directories are also offered.

The Electric Spacecraft Journal is one interesting pseudoscience publication. There is also an Anomalous BBS on related off-the-wall topics.

Historically Brewed is that unique magazine offered from the Historical Computer Society. Trial issues are available for $3.

Free P-Nut connector samples are available through KleinHuis North America. These are a long overdue improvement to wire nuts.
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For most hardware hackers most of the time, patents are an utter and total waste that is guaranteed to cause you a net loss of time and money. The reasons behind this, along with fully tested and proven real-world alternatives, now appear in my Case Against Patents package. That also includes my Incredible Secret Money Machine. Details are found in my nearby Synergetics ad.

A reminder that unique downloads, freebie insider secrets, catalogs, and technical help are available on my GENIE PSRT. A 10-hour free trial time is available per the Need Help? box. A credit card is required to register.

As usual, the resources I’ve mentioned appear in either the Names & Numbers or PIC Resources sidebars. Be sure to check them first before calling our no-charge technical helpline. Let’s hear from you.

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As regular readers may have noticed, one of my favorite critical targets is the publications that cater to the high-end audiophile purist crowd. And, not surprisingly, most of my Electronics Now mail is in response to those potshots. At present, I'm pleased to note, such mail is running about 3 to 1 in my favor—which testifies to the good sense of most of this magazine's readership.

In general, I don't think the purist (I-can-hear-it—even-if-you-can't) publications do grievous harm—other than encouraging those seeking quality reproduction to spend far more than necessary and engendering, by example, an anti-science dumbing down of their readers. Some favorite examples of their recommended, but scientifically implausible, products come to mind: the metal brick that when placed atop an amplifier improves its sound; the adhesive-backed, 1-inch, fuzzy discs that when cemented randomly to the walls of a listening room enhance its acoustic qualities; and a dozen or so brands of speaker cables that magically embellish an audio system's spatial coherence, resolution, speed, and/or harmonic integrity (if not convergence). None of those products appear to employ known laws of physics, acoustics, or electronics to perform its wonders—which opens the question of which alternate physical (or psychological) dimension it or its admirers operate in.

In any case, my generally good-humored attacks on the purveyors of audio excess have generated both bouquets and brickbats (in a 3:1 ratio, as I've noted). Herewith is an interesting sample brickbat from reader Vincent Knoll of Seattle, WA. Mr. Knoll is annoyed at my dismissal of Stereophile's concerns about the adoption of Dolby's AC-3 digital audio system for digital TV. His letter has been edited for space while preserving its tone and major points. Since the issues raised deserve replies, I've keyed my responses to his letter.

Mr. Knoll writes:

(1) Larry Klein's latest attack on Stereophile [Dec. 1994] was unnecessary to say the least.

(2) Far from being an exercise in arrogance, Stereophile's letter to Pioneer [on the AC-3 system] was one of valid concern.

(3) Do we really fail to hear those soft sounds buried under the louder ones? Maybe they do have some influence.

(4) Klein says he is more amused than upset [by Stereophile's open letter]. Really? I wonder, since his comments on Stereophile [to use his term] are becoming "prolix"! What?! I read an electronics magazine and improve my vocabulary too. Such a deal!

(5) Before Mr. Klein's obsession with Stereophile goes beyond prolix—he'll have to help me out here, I don't know a word for that concept—maybe you could persuade him to be more technical and less editorial.
(6) I enjoy both Stereophile and Electronics Now. Stereophile doesn't single out Electronics Now by name for repeated attacks. Please make the courtesy reciprocal.

My response.

(1) Unnecessary? As long as publications such as Stereophile continue to push bad science, bad logic, and unsubstantiated evaluations, I feel I'm doing a small but helpful service by pointing out the absurdity of much of their buying advice and recommendations.

(2) Perhaps. I receive a monthly self-promotional "news release" from Stereophile extolling their latest editorial content and achievements. Their "open-letter" objections were simply an opportunity for them to promote their publication to the press and their advertisers. In my day, we did the same thing at Stereo Review, but I tried to stick with substantive issues, e.g., the quality problems of records and pre-recorded tapes, the audio industry's hanky-panky on power ratings, the FTC's irrational power rulings, etc.

(3) As I said in my original article, we know a lot about psychological masking and how to manipulate it to desirable ends. And psycho-acoustic studies are ongoing, not only among the equipment manufacturers but in the electronics and psychology departments in universities throughout the world. (The preliminary program of the 98th Audio Engineering Society Convention, taking place in Paris this February, schedules no less than 11 separate papers on audio data reduction and its subjective evaluation.) To disregard the results of those ongoing studies, trials, and controlled listening tests on the basis of speculative "maybes" (and the unreliable opinions of self-anointed golden ears) is not how science works.

(4) I've been known to do so. But exactly what is your objection to expanding your vocabulary? If by reading my column you can dis corroborate dual avians with a single lithic formation, why not?

(5) "Logorrhea" is the word you want. I do try to maintain a balance between the technical and the "editorial." At least two-thirds of the column you complain about was "technical," but in any case, I don't see myself as a reporter, but rather as a commentator. This is Handlers very ably in other areas of Electronics Now.

(6) I refer you to response (1). I don't know how much "courtesy" is owed, for example, to a snake-oil salesman selling a fraudulent product, or when pointing out a publication's off-the-wall product evaluations.

Incidentally, I don't mean to leave readers with the impression that there is no worthwhile editorial content in Stereophile and The Absolute Sound, but technical silliness continues to sully both publications.

A final point on the Dolby AC-3 digital audio system that started all this: The Advanced Television Systems Committee (ATSC) has voted to accept the AC-3 system as part of the proposal on digital TV to be forwarded to the FCC for approval. The ATSC includes more than 50 companies, associations, and educational institutions involved in delivering television to the U.S. public. These include television networks, broadcasters, cable operators, motion picture companies—and equipment manufacturers for all of the above. An official count of the six-week mail ballot conducted by the ATSC last November showed 40 members in favor of the Dolby AC-3 audio system and one against. Enough said.

Bouquet department

I received a wonderful, but too-long-to-print, letter from Haynes Davis of MCP Davis Sound of Newberry, South Carolina. Mr. Davis, who is a professional audio design engineer, tells an interesting tale of two prototype preamps, one of which received raves from a high-end reviewer for its "well-defined low end," "high degree of imaging," "silky smooth high end that reproduces the "velvet" characteristics of the string section," etc. and so forth. The unfortunate other unit was judged to suffer from a variety of sonic inadequacies and nases that clearly disqualified it as a truly hi-fi product. The kicker is that they were both primarily off-the-shelf bi-fet op-amp designs from the same textbook circuits using the same high-grade parts and layouts. True, the two units did use different face plates. Perhaps the prettier face won the sonic beauty contest?

Mr. Davis closes with a request that I "continue to educate the masses along these lines from time to time via your column and may logic prevail." Pleased to comply!

Another reader, Professor Gerald L. Park from the Department of Engineering at Michigan State University, recounts some of his past experiences building kits (prompted by my column on the subject) and laments the fact that the reduction in experimentation and building is very noticeable among his engineering students. He suggests that I "keep the good words flowing and don't be afraid to offend the gurus of dollar-fi—the modern version of hi-fi wherein high cost is a positive performance parameter."

Professor Park concluded with an interesting speaker-cable suggestion: "You might suggest to your readers that they consider SO type extension cord cable used for boats (yellow jacket) or in industry (black jacket). They often use #8 gauge stranded wire and differ very little from high-priced oxygen-free (?) hi-fi cables. A few measurements with an audio-spectrum analyzer [HP 3561A] confirmed that conclusion."

Thank you, Professor Park, and all the others who have taken the time to write and let me know your thoughts. I appreciate your comments, whether we agree with each other or not.
THE REQUIREMENTS FOR THIS project were determined when our club historian assembled a slide show to run during an upcoming banquet. Everyone wanted to eat, and no one wanted the responsibility of operating the slide projector and advancing the slides. Unfortunately a slide projector that would sequence them automatically was not available. The circuit described here solved the problem by adapting a standard carousel slide projector for automatic operation. Only the remote control cable that plugs into the slide projector must be modified—the projector is left in its original form.

The circuit for the unmodified remote control of the Kodak carousel projector is shown in Fig. 1. The remote originally provided forward and reverse advancing of the slides. It was replaced by a variable timer and a relay that simulated the remote's forward switch and controlled the projector.

Theory of operation
The timer circuit is shown in Fig. 2. A 555 timer, IC1, is the heart of the circuit. The value of resistor R3 determines a minimum time delay, and potentiometer R4 sets the maximum delay. The values indicated provide a time delay that is variable from 1 to 15 seconds. If only one time delay is required, R3 and R4 may be replaced with one equivalent fixed resistor. The reset time of IC1 is sufficient to energize relay RY1 for a duration roughly equivalent to a person momentarily depressing the forward button on the original remote control. Resistor R1 provides current limiting for the 5-volt reed relay, also extending the life of the battery.

No power switch is required. Power is supplied by a 9-volt battery (B1) and it is switched on when pins 1 and 4 of DIN plug P1 are shorted by DIN jack J1 as shown. The circuit works only when connected to the projector. This saves parts and labor and eliminates the chance of forgetting to turn off power.
when the stepper is not being used.

**Construction**

The parts can be assembled on perforated construction board using point-to-point wiring. All connections to the board are made to 5-pin DIN plug P1. The positive lead of the battery connector connects to the circuit board, while the negative lead connects to pin 1 of plug P1. The board can be installed in any suitable case, as long as there's room for the 9-volt battery, too.

**PARTS LIST**

- **All resistors are 1/2-watt, 5%.**
  - R1—150 ohms
  - R2—1000 ohms
  - R3—100,000 ohms
  - R4—1000,000 ohms, potentiometer
- **Capacitors**
  - C1—47 µF, electrolytic
- **Semiconductors**
  - IC1—TLC55 timer
- **Other components**
  - J1—5-pin DIN jack (or equivalent connector)
  - P1, P2—5-pin DIN plug (or equivalent connector)
  - B1—9-volt battery
  - RY1—5-volt, SPST relay
- **Miscellaneous:** 9-volt battery clip, circuit board, case, one 8-pin IC socket

The projector's remote control cable must be modified to work with the timer circuit. Cut the cable approximately 8 inches from the projector connector end. Reconnect the remote end to DIN plug P2, and the projector end to DIN jack J1. This will allow the remote and the stepper circuit to be swapped easily.

Connect the modified remote control cable to the projector and make sure that the forward and reverse functions of the remote control still work. With the projector turned off, disconnect the remote from J1 and connect the stepper circuit. You should hear the relay click with a steady time delay. Potentiometer R4 should vary the time delay. Now you can turn on the projector, set the advance delay, and join the party.

**MAGNETIC STORAGE**

continued from page 68

magnetized screwdriver near magnetic heads. Magnetic heads should be cleaned and demagnetized according to manufacturers' specifications.

The effect of a dirty head varies greatly in different storage technologies. Floppy disk drives rarely fail due to dirty heads, whereas many tape drive failures can be corrected simply by cleaning the heads.

Laboratory-grade alcohol and a cotton swab will clean most recording heads and tape paths. Special cleaning and demagnetizing kits are available for the various media. These kits use alcohol substitutes due to regulation of shipment of flammable substances. Avoid using rubbing alcohols containing oily lubricants that can foul or prematurely age drive components.

Maintain proper operating environment. Severe line power problems such as brownout or surges can result in momentary loss of recording quality in an open-loop recording system such as analog audio tape. This can be caused by heavy switch-ed loads such as a refrigerator or certain models of laser printer sharing a circuit with recording equipment.

In dry climates static buildup on your body or inside recording equipment can cause problems. Some equipment is not specified to work below 20% humidity. Review your equipment's specifications. Monitor your humidity. Purchase humidifiers or employ anti-static carpeting and handling procedures as indicated. Discharge your body before handling magnetic media.

Park your media. Tape media should be parked at the beginning of tape position or at the end of tape position before being removed from the drive.

Long term storage of a cartridge in a drive can cause the drive or cartridge roller hubs to deform. This deformation can be repaired by performing multiple retension passes.

**EQUIPMENT REPORTS**

continued from page 14

In a hot thermal jet-flow attachment allows a temperature-controlled blast of air to be directed at SMD parts to melt the solder paste. This allows surface-mount parts to be replaced without heating the entire board.

Holder assemblies mount on the top of the SMD-250 to hold the accessories when they are hot. A wet and dry tip maintenance kit is also included that mounts on top of the unit to keep all kinds of tips clean and ready for use.

The front panel of the SMD-250 contains most of the unit's controls and displays. A lighted on/off switch indicates when power is on. Two separate temperature displays can show the exact temperature of any two attachments. Pushbuttons allow exact temperatures to be set by the user.

With a list price of $1995, the SMD-250 is competitively priced. Anyone who is running a modern electronics repair shop will undoubtedly need the capabilities of this machine.

Repairing PC boards with the wrong equipment can end up causing more damage than one set out to repair in the first place, and so the SMD-250 could pay for itself in time saved and in damage not done.
POWER CONTROLLER SAFETY CONCERNS

I read with interest Richard Roane’s “Power Controller” article (Electronics Now, January 1995). It is a clever microprocessor-based board for controlling eight channels of 120-volt loads at various power levels. However, as a licensed industrial electrician, I’d like to point out a few safety considerations with regard to projects powered from the 120-volt AC line.

First, unless 14-gauge wiring is used throughout, an appropriately rated fuse should be added to protect the wires from overheating and from accidental overcurrents. In any case, an 18-gauge wire is the minimum wire size that should be used.

Second, the “neutral” wire must be identified. It must be distinguishable from the “hot” wire. This can be done by color-coding the wires. The neutral wire should always be white and the ground wire should always be green, but the hot wire can be any color except white or green.

That color coding should be clearly marked on the schematic as well. If it is ever necessary to troubleshoot the board, you’ll appreciate the coding. It always helps to know what’s on a board before you start building a circuit.

The hot wire should go to the main terminals (MT1) of the triacs. The neutral wire should go to J2, for connecting to the various loads. That was correct in the Power Controller schematic but wrong on the foil pattern. Confusion like that always stems from not identifying the wires in the first place.

Third, the article does not mention enclosures. I’ve seen far too many circuits like this one that are either put in a flimsy wooden box of some sort, or they are not put in any enclosure. The electrical code is very clear on this: An enclosure must be provided. The enclosure can be made of any material as long as it is not flammable. That means that wood is unacceptable, as are many plastics. Metal is best.

If you are considering the use of a plastic enclosure and don’t know if it’s flammable or not, shave off a thin strip from it with a knife put it in a match flame. If the strip burns, don’t use that enclosure.

Fourth, the ground wiring from the Power Controller’s input power cord need not go to the PC board, as the schematic indicates. It is earth ground, not circuit ground. Its purpose is to connect metal parts of your equipment to the earth. If a metal enclosure is used, then you would ground it. If your enclosure is plastic, leave a lug so the ground wire is available if it’s needed for light fixtures or other equipment that connects to your circuit.

These pointers are not meant to discourage electronics enthusiasts. However, a sense of responsibility and attention to detail will help in making your project safe. This will not only benefit yourself, but the people around you—members of your family, and others you care about.

JIM STEINMAN
Kitchener, Ontario, Canada

Q & A

continued from page 9

small, but you can use ⅛ inches of ordinary No. 20 copper wire, which has a resistance of 0.0008 ohm per inch. Be sure to make excellent solder joints. For best results, place the shunt a few inches away from the meter, and run wires to the meter from it; the reason is that when 50 amperes flow through the shunt, there will be an appreciable magnetic field, which could make the meter read wrong. Also, make measurements only momentarily, because the shunt will get hot.

SCANNER MODS WANTED

I’m using a Realistic Pro-57 programmable scanner which has several bands of frequencies that are blocked off, including FM broadcast stations, TV broadcasts, VHF airline and military frequencies, and cellular phones. Could you suggest an easy way to modify this receiver so that there are no blocked fre-

quencies within its desired range?—T. Rozzi, Norwalk, CT

There are two reasons why a digitally controlled receiver may not get a particular range of frequencies: either its front end isn’t designed to let them in; or its microcontroller isn’t programmed to tune to them.

Federal regulations require cellular phone frequencies to be blocked out by programming the microcontroller not to tune to them, even though the front end and the rest of the radio may work just fine on those frequencies. By law, this “blockout” must not be easy to undo. As you should know, listening to cellular phone calls is illegal in the United States.

FM and TV signals are blocked out because they’re too strong! A well-designed scanner will have a front end that rejects these frequencies so that it doesn’t go haywire when you get near a high-power TV station. FM broadcast and TV sound signals are much wider in bandwidth than the signals your radio is designed to demodulate. Similarly, VHF aviation signals are AM and your radio would not demodulate them.

INTERMITTENT RECORD PLAYER

I have a 22-year-old stereo system. The sound from the radio portion is fine, but when I play a record, the sound is uneven, often alternating between two speakers or coming out of only one speaker. How can I correct this problem?—E. Chambers, Jr., Pittsburgh, PA.

Look for loose connections in the cabling from the phono cartridge to the amplifier. It may be as simple as a plug loose in its socket—but more likely, there is a break in the thin wires inside the tone arm. After all, they move around every time you play a record. Another possibility is a defective cartridge or stylus (needle). Still another possibility is that the selector switch might not be making good contact when you switch from radio to phono. Try turning it back and forth a few dozen times; if the problem diminishes, the switch should be cleaned or replaced.
door switch. Ford, and other car makes with positive switching, have three wires. One wire is connected to the positive side of the battery, the second is typically to a “key-in-ignition” buzzer, and the third is for lights.

Check out each wire with a test light. With the door switch depressed, turn the dashboard domelight switch on and off, observing which wire from the switch turns on the light. After identifying the door wire, turn off the dashboard domelight switch and release the door switch so the domelight remains on.

Cut the wire about two inches from the switch; the domelight should go out. Connect the short wire from the switch to the brown wire from pin 11 (DRI, Driver door) of the Logic Module. Connect the other end to the gray wire to pin 12 (PAS, passenger door) from pin 12 of the Logic Module.

The Logic Module must be programmed for the specific host vehicle. Remove the four screws and cover from the Logic Module to expose its circuit boards. There are header pins on the Alarm board for the driver’s side and passenger doors for (+) and (-) switching. Then program both doors for + switching.

Negative switching
Identify the door light switching wire. Verify that all car doors and hatch or trunk are closed. Open the driver’s side door, and remove the door switch. On General Motors and other cars with negative switching, there will be two wires to the switch. One will be for the “key-in-ignition” buzzer, and the other will be for the domelights. With the switch removed, the dome light will be out.

Touch one wire and then the other to ground. Cut the wire that turns the light on about two inches from the switch. The short wire from the switch connects to the brown driver’s side door wire from pin 11 of the Logic Module. Connect the other end to the gray passenger side door wire from pin 12 of the Logic Module.

Test and checkout
The fourth installment of this article will include a 29-step test and checkout procedure to determine the fitness of your completed ProCar system. It will also contain an “instruction manual.

“It is recommended that a copy of that text be kept in your car at all times as a reference when teaching ProCar system operation to authorized persons and as a personal refresher course in the features of the ProCar security system.
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2 Dual Component Tester/Comparator
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New Rad System functions as a: Spectrum Analyzer (450KHz to 30MHz), Signal Generator (450KHz to 30MHz), Square Wave generator, AM transmitter exciter, plus a receiver for AM, LSB, USB & ISB from .45 to 30MHz. System includes RX card, DSP card and Windows software. Requires Windows PC w/2 open card slots 486 or better preferred. Complete package with 2 cards and software $599.00.

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The Ultra 4500 sets a standard in value and performance for home satellite receivers. This unit features automatic satellite programming. 160 favorite channels can be instantly recalled for easy access. All 160 can be changed or updated at any time. The IRD features a stereo processor, enabling you to tune both left and right channels for a full stereo effect from over 100 radio stations found in satellite. The Quick Tune feature quickly optimizes the satellite picture for the sharpest image. The 4500 offers other features including IR/UHF remote, 55 satellite position memory and direct satellite access. The versatility makes this an excellent choice.

The Uniden UST 4900 is one of the most sophisticated satellite television receiver systems available today. This receiver will open your home to the universe of satellite viewing and is designed to be one of the most user-friendly IRDs available anywhere. Sophisticated microcomputer technology brings crystal clear audio and video broadcasts with a minimum of user effort. The UST 4900 front display features easy-to-read icons that show you vital information including satellite channel, polarity, timer status, antenna position and much more. This receiver is capable of storing the positions of the satellites, as well as the tuning details for each channel. The picture-in-picture feature allows you to view two video sources at the same time. You can have it all, including advanced technology and lasting quality, with the UST 4900.

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- Saves time, reduces maintenance. Cool-Amp is so simple to apply on the job. It assures maximum conductivity for copper, brass, or bronze contacts and prevents losses due to oxidation.

**Conducto-Lube**

How it works:
- This is the conductive lubricant; highly conductive because it contains pure silver.
- Originally developed to lubricate switches, to the point tension can be adjusted to factory specs allowing full rated capacity of the switch to be maintained at all times.
- Uses have continued to expand—from switches and breakers—to any application where a conductive lubricant is needed.

Various tests were performed on both products in the Electra-Test, Inc. facilities in Portland, Oregon during January-March, 1994. Evaluation of plating thickness of Cool-Amp was performed by Surface Science Laboratories of Mountain View, California.

---

**Table and Graphs**

<table>
<thead>
<tr>
<th>Elapsed Time</th>
<th>Conductivity (micro-ohms)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>210</td>
</tr>
<tr>
<td>1</td>
<td>220</td>
</tr>
<tr>
<td>2</td>
<td>225</td>
</tr>
</tbody>
</table>

**Current in Amperes**

<table>
<thead>
<tr>
<th>Conductivity (micro-ohms)</th>
<th>Conducto-Lube</th>
</tr>
</thead>
<tbody>
<tr>
<td>30</td>
<td>No Lube</td>
</tr>
<tr>
<td>40</td>
<td>Factory</td>
</tr>
<tr>
<td>50</td>
<td>Conducto Lube</td>
</tr>
</tbody>
</table>

---

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<table>
<thead>
<tr>
<th>Voltage Input (DC)</th>
<th>Voltage Output (DC)</th>
<th>Current Output</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.75VDC (max)</td>
<td>3VDC</td>
<td>3mA</td>
</tr>
<tr>
<td>1.5VDC</td>
<td>9VDC</td>
<td>15mA</td>
</tr>
<tr>
<td>3VDC</td>
<td>9VDC</td>
<td>40mA</td>
</tr>
</tbody>
</table>

Power Table

TINY TRACKBALL
This is probably the finest trackball ever made! Measures only 1.71" x 1.316" x 3/8"H. Made by Alps for a major laptop computer maker that went out of business. They are very precision made and highest quality. The components are all SMD with an IC marked 3A41D70/27B6127C2 and a tiny position connector. They appear to be complete, new and very recent in manufacture. We have no hookup info or schematic, but at this price we know that you'll be impressed and want to experiment with them. Use them for replacement or figure out the hookup in any case we are not going to. Many, these may not last long!

G5514 $1.95
10/$15.00

SUPER SENSITIVE
SOUND ACTIVATED
2 CHANNEL
COLOR ORGAN

This ultra sensitive 2 Channel Color Organ produces brilliant flashes of light from any incorporated range of your choice - up to 200V in, in response to music or other sounds. This is probably the best and brightest color organ we have ever seen. It is fully assembled (except for line cord and outlets) and features:

- Two response controls, on/off switch, sensitive FET microphone to hook up to an answering machine or transistor 2 SC100 circuitry. Operates from standard 120VAC and requires only that you supply your line cord and 2 outlets (for your lamp socket) to the board. We strongly recommend that you install the color organ in an unheated case for safety reasons as it operates from the AC line. Connect up a couple of(3) the brightest, colorful lamps and watch the fireworks with each note of the music! Great for DJ's as there is no connection to the sound source. Size of board: 3.1/2" x 3/4" DC. Color organ board only - no supply lamps, line cord, knobs, case and outlets. Hurry, these will sell very fast.

G3319 $9.95
SALE $4.95

A7 JET COUNTERMEASURES
ANTENNA

We were told that these were made for Navy A7's. They are brand new (part P24743G2G) and in sealed military packaging. The antenna looks like a 5/16" ice cream cone with 2 bolt spirals. At the base of the cone is a TNC female connector. We used an adapter to connect this antenna to a scanner and the increase in sensitivity of the scanner to frequencies above 500MC was amazing! Antenna is encapsulated to rugged use, very high quality and it does nothing else, makes a great conversation piece. Can you imagine what the Navy must have paid for these things? Own a piece of high tech military history before another out!

G6662 $8.00

HEAVY DUTY
12VDC MOTOR
WITH REGULATOR
Precision 1/76" Dia. motor has a 3 transistor regulator type battery board attach. We don't have the hookup diagram on hand, but they look like sophisticated electronic regulation boards. Size of board: 1 1/2" x 1 1/8" 7/16". The shaft is a "D" type and 1/2" long. Brand new no other info available except that they were made by Sonar Radio Corp. part 23709-008

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Ceramic 24 pin DIP package. Mfr. Sony, Part# 016AL

4096 element CCD $29.00

2048 element CCD $15.00

**HACKER CORNER**

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$99.00

These transceivers were designed for operation in an AMPS (Advanced Mobile Phone Service) cell site. The 20 MHz bandwidth of the transceiver allows it to operate on all 866 channels allocated. The transmit channel is 870.300-888.990 MHz with the receive channel 45 MHz below those frequencies. A digital synthesizer is utilized to generate the selected frequency. Each unit contains two independent receivers to demodulate voice and data with a Receive Signal Strength Indicator (RSSI) circuit to select the one with the best signal strength. The transmit controller provides a 1.5 watt modulated signal to drive an external power amplifier. Channel selection is accomplished with a 10 bit binary input via a connector on the back panel. Other interface requirements for operation are 26 VDC (unregulated) and 18.960 kHz reference frequency for the digital synthesizer. The units contain independent boards for receivers, encoder, synthesizer, translator front end, and interface assembly which includes power supplies and voltage-controlled oscillator. Service manual, schematics and circuit descriptions are available.

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The Proxim is a small communications device that replaces the use of an RS-232 cable hook-up with wireless (Radio Frequency) technology. Each module combines the functions of an RS-232 compatible modem (or any other RS-232 device) and a transmitter/receiver operating in the 902-928 MHz range. Receives and transmits directly for up to 5 miles of over land, water and building using standard 1/4 wave antenna. Units support data rates up to 9.6 Kbps (full duplex) and use multiple channels to allow for noninterfering overlapping systems. Message format is 8 data bits, no parity, and 1 stop bit. Each unit requires 5 VDC supply at a maximum of 230 mA. A wide variety of configurations can be accommodated with parameters stored in non-volatile memory (EEPROM). Configuration changes are supported by menu driven, on-board software. Installation schematics and application details are available. Original cost on these units is around $600.

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**Non-Enclosed TTL**

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$29.00


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5mW of 780 nm, single transverse mode $10.00

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```
HUMIDITY CONTROLLER

10 CALL B132
20 ONTI ME 200
30 PRINT "BLUE EARTH RESEARCH": (LIBRARY FUNC. Initialize LCD)
      (Initialize 1 second interrupt)
    ; (Display sign-on message)
  40 PRINT "\ : ACTUAL RH", FREQ : (Display actual sensor frequency)
    ; (Display desired setpoint value)
  50 PRINT "\ : SETPOINT RH", S : (LIBRARY FUNC. Get keypad input)
  60 CALL B140
  70 IF DBY 27=6 THEN S=S - 1
     (Decrement setpoint if down arrow)
  80 IF DBY 27=7 THEN S=S + 1
     (Increment setpoint if up arrow)
 100 IF FREQ 0<5 THEN BIT 180 = 1
     (If actual < setpoint then relay on)
 110 IF FREQ 0>DS THEN BIT 180 = 0
     (If actual > setpoint then relay off)
 120 GOTO 40
 200 PRINT "\ TIME ": DBY 51, 1: (This 1 second interrupt routine)
      ; DBY 49, 1: IRET (refreshes LCD with current time.)
 210 PRINT DBY 50, 1, 1, 1, 1
```

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24hr catalog, call from your FAX machine.

Most homes and offices have hot spots with strong artificial electromagnetic fields, where chronic exposure may cause mental or physical problems. Even the EPA names these fields as suspected carcinogens. You can reduce your risk by avoiding these high-field areas.

The TriField™ meter detects far more of these fields than any other electromagnetic pollution meter. It's the only one that independently reads AC electric fields, AC magnetic fields, and radio/microwaves. It also reads field strengths in all directions simultaneously. Every other meter that sells for under $500 reads only magnetic and only one direction. You can easily miss a magnetic field unless pointed correctly and are blind to radio/microwaves and electric fields, both of which cause biological effects.

The TriField™ meter reads all three types of fields numerically and with a SAFE/BORDERLINE/HIGH SCALE, weighted proportional to the effect on the body. Thresholds are based on epidemiological and laboratory studies. (While no absolute hazard thresholds have been established, relative reduction of exposure is prudent.)

The TriField™ meter comes ready-to-use with battery, instructions, and one-year limited warranty. The cost is $144.50 postpaid.

AlphaLab, Inc. 1280 South Third West / Salt Lake City, UT 84101-3049
For literature and information, call (503) 543-6545

CIRCLE 226 ON FREE INFORMATION CARD

Electronic Now, May, 1995

120

www.americanradiohistory.com
substitute for the VCR, because it won't record. There was talk, however, of a recordable version in 1998 or 1999, when blue lasers are in mass production. One of the most intriguing features of the DVD—presumably both the Toshiba and the Sony versions—is its extreme flexibility, allowing a single disc to suffice for many purposes, thereby reducing dealers' inventory requirements. Multiple soundtracks on a single disc can appeal to various language groups in a single country or in several countries. The same disc can satisfy different types of TV receivers and viewing preferences, supply a letterboxed picture (for viewing on a standard set with black bands above and below), a full-resolution 16:9 picture (for viewing on a widescreen set), or a standard 4:3 pan-and-scan version. By the same token, a single movie can be viewed in the original theatrical release version, or in an abridged version with the "adult" scenes eliminated to protect kiddie viewers.

The Sony-Philips reaction to the Toshiba-Time Warner announcements and demonstrations was rather confusing. While publicly favoring a single standard to avoid a repetition of the Beta/VHS standards war, Sony first announced that it planned to go ahead with its system anyway. Later, it hinted that it was open to talks with the rival camp, possibly to develop a compromise version. However, at our press time, no formal talks were going on.

Although the odds now appear to favor the Toshiba-Time Warner proposal, a compromise—or even a reversal—can't be ruled out at this time.

No matter which side wins, or if the two systems are combined into a single one, we should have a new—and superior—home video system in a year or so.

### CABLE TV DESCRAMBLER KITS

**New & Improved Version**

Universal Descrambler
Includes all the parts and an etched & Drilled PC Board. Not included is AC adaptor or enclosure

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Includes all the parts and an etched & drilled PC board & AC adaptor. Not included is the enclosure

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It is not the intent of M & G Electronics, Inc. to assist any individual to defraud any pay TV operator or to violate any state or federal laws regarding the use of the descrambler kits. You must understand the kits being purchased for educational or experimental use only.

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**NEW PRODUCT**

**MODEL 5000 Fully Assembled $199.95**

Our fully assembled product is tested and Guaranteed to work on your system. We will also include an AC adaptor and complete hookup instructions. This unique product will be available for a limited time only!

**4000 And 5000 Features**

- The latest in Video Amplification Technology.
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The 4000 KIT comes with electronic components and Cad designed PC board. We provide schematic, parts list, wiring diagram, tutorial guide, and FREE in-house support.

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The "Checker 12" is a hand held, battery/AC operated computer color monitor pattern generator.

The "Checker 12" fills a need in both the field service and shop maintenance areas. With the "Checker 12", a field service technician can quickly isolate display problems without having to open the computer. By simply connecting the monitor to the "Checker 12", most problems can be quickly isolated. No more swapping video cards or monitors. The field service technician will no longer need to search for the correct video card, or tie up a computer system to test or burn a monitor. With its support of CGA, EGA, MACII, and VGA modes (128, 320x200, 1024x768N1, 1024x768N2), anyone can quickly check out a monitor in all of its modes.

With the "Checker 12", it is easy to test those monitors in the warehouse or on a storage shelf. You can quickly tell if the monitor is a VGA, SVGA, or a MACII. No more guessing. With its ease of operation, anyone can check out a monitor. Even a non-technical person can demonstrate proper monitor operation for the customer.

The "Checker 12" provides various test patterns for VGA monitors. Cross hatch, White screen, and Color bar with Gray Scale, monitor testing is easier than ever. The pattern and mode are selectable with the single mode switch. Both size and position can be set with the "CHECKER 12". Its colorbar/gray scale gray pattern allows quick evaluation and setting of color balance and tracking.

The "Checker 12" is one piece of equipment that any organization that supports monitor must have.

Price: $295.00 includes battery, AC adapter, MAC adapter, and 120 day warranty.
We also have the "Checker II", a 6 pin, stand alone VGA (640x480) monochrome generator. No computer required. Only $300.00

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If you are not completely satisfied with your purchase from our company, return it (Freight Prepaid) within 30 days with your original invoice; we will gladly replace the product, give you credit, or refund your money in the original method of payment.
TEKTRONIX 492 SPECTRUM ANALYZER

Covers 50KHz - 21 GHz. Solid state portable unit features internal phase lock, minimum sensitivity is -95 dBm. This unit includes OPTIONS 1,2,3. (1-RF Preselection),(2-Digital storage),(3-Freq stabilization 100Hz Resol'n)

Price:$8,450.00 Fully checked.
Mixers 18-26.5 GHz & 26.5-40GHz $1,200.00 pair. with purch of above.

TEK 7000 SERIES

7834 STORAGE OSCILLOSCOPE
Nothing beats a top quality laboratory o-scope like this unit. It features 2500 cm/writing speed, 400MHz bandwidth and superior construction. Our complete system includes: 1-7A24 / 1-7A26
1-7BB80 / 1-7BB85. SYSTEM PRICE: $1,495.00
*OUR SCOPES FEATURE BRIGHT SHARP CRT's !!!
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A classic HAM 100w tranceiver. These units are true to the classic collins style and quality, built to last more than a lifetime. Limited quantity !!!

Price: $595.00 with piggyback pwr-supply.
: $445.00 complete as-is w/pwr supply.

RACAL RECEIVER RA 6790/GM

Superior quality and design are standard in this 500KHz-30Mhz general coverage receiver. Modes of operation are AM,FM, CW, LSB/USB-optional, with room for seven bandpass filters. The illuminated LCD display features large readable digits for frequency and mode status as well as AF or RF signal strength. Tuning can be directly entered via keypad or with a tuning knob. Three different gain modes are Manual, Automatic, and Automatic with selectable threshold. Fully Checked & Operational.

Price: $995.00 Radio only-less filters.
Bandpass Filters: 400Hz/1.2KHz/2Khz/6.8KHz 16KHz /USB/LSB are $65.00 ea. max 4 per unit.

**NOTE: if there are specific items you are looking for regardless of whether or not they appear in this ad, we would be happy to provide you with a quote including, availability, pricing information and shipping details.
**TEKTRONIX 465B**

Proof is in the pudding when it comes to this instrument's track record. There's no doubt, that popularity speaks many languages when speaking of the "465B". This excellent instrument continues the tradition of the standard 465 oscilloscope by adding useful features such as CH-1, CH-2 sum or difference, trigger view in any combination, alternate sweep and trace selection versatility. Many technicians dream of owning a quality 100-MHz oscilloscope, but funding fairly permits. Fortunately, we were recently able to aquire a limited supply of 465B-s in nearly new condition. Our LOW PRICES will likely permit "you" to own one of the best scopes anywhere in the country. If your needs are current and action swif you too will be a member of a growing club!!!

**SELECTED EXCELLENT COND.....$849.00**

**VERY GOOD CONDITION.............$695.00**

These instruments are fully checked out and calibrated. They are supplied with an original front panel cover and complete service manual. Original TEK Probes are $75.00 each with each purchase.

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**Model 2018**

Freq range 80KHz-120Mhz with calibrated output levels from -127 dBm to +13dBm. Resolution 10Hz. It can be freq, phase or amplitude modulated from ext or int modulation sources. RF output resolution is 0.1dB, reversepower protection of up to 50W is possible without damage to the instrument. This instrument is microprocessor controlled and very easy to use, a must for any serious repair or development lab.Price : $1750.00 Checked

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INSTRUCTION FOR PLACING YOUR AD!

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

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

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

RATES
Our classified ad rate is $1.25 per word. Minimum charge is $18.75 per ad per insertion (15 words). Any words that you want set in bold or caps are 20¢ each extra. Bold caps are 40¢ each extra. Indicate bold words by underlining. Words normally written in all caps and accepted abbreviations are not charged as all-caps words. State abbreviations must be Post Office 2-letter abbreviations. A phone number is one word.

CONTENT
All classified advertising in the Electronic Shopper is limited to electronics items only. All ads are subject to the publisher's approval. We reserve the right to reject or edit all ads.

DEADLINES
Ads received by our closing date will run in the next issue. For example, ads received by April 1 will appear in the July, 1995 issue that is on sale in June 1. Shopper ads will appear Jan., Mar., May etc. No cancellations permitted after the closing date. No copy changes can be made after we have typeset your ad. NO REFUNDS, advertising credit only. No phone orders.

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<tr>
<th>AD RATES: $1.25 per word, Minimum $18.75.</th>
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<tbody>
<tr>
<td>Send your ads with payment to:</td>
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<td>Electronic SHOPPER, 500-B Bi-County Blvd. Farmingdale, NY 11735</td>
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<td>100 — Antique Electronics</td>
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<td>130 — Audio-Video-Lasers</td>
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<td>160 — Business Opportunities</td>
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<td>190 — Cable TV</td>
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<td>240 — Components</td>
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<td>450 — Ham Gear Wanted</td>
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<tr>
<td>480 — Miscellaneous Electronics For Sale</td>
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<td>510 — Miscellaneous Electronics Wanted</td>
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<td>540 — Music &amp; Accessories</td>
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<td>570 — Plans-Kits-Schematics</td>
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<tr>
<td>Ad No. 1—Place this ad in Category #</td>
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| Ad No 1—Total words | x $1.25 per word = $ |
| All Caps words | x .20 per word = $ |
| Bold words | x .20 per word = $ |
| Bold Cap words | x .40 per word = $ |

| TOTAL COST OF AD No. 1 |
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| Expiration Date / |
| Signature |
| Phone |
| City State Zip |

Electronic Now May 1995

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Wear this handy magnifier with its velcro clasp. One size fits all so it's always comfortable. Magnifier assembly tills up out of the way when not needed. Fixed lens gives 1.8x magnification for most close-up activity. For a closer look a second binocular lens tilts down from inside visor. (MP242) $23.95 each

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Features include ventilation holes, self-adhesive rubber feet. Front and rear panels are 0.05" aluminum alodine painted white. Top and bottom covers are 0.04" phosphated steel painted black.

SEAMLESS LEAD-ACID BATTERIES
Five different, rechargeable units operate in any position. Charge at 10% of AH capacity for 14 hours, less if partially discharged. (Limit charge voltage to 14.5V for 12V units, 7.25V for 6V units.) Sizes given are approximate.
- 12V, 4AH, 2.75" x 4.25" x 3.5". (95E003) $6.95 each
- 6V, 10AH, 1.875" x 3.75" x 5.75". (95E004) $7.95 each
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- 6V, 3AH, 1.875" x 2.375" x 5.25". (95E006) $2.95 each

SHRINK TUBING ASSORTMENT
Stock up on a good supply of four-foot lengths of popular sizes ranging from 0.125" to 1.5" in various colors. Compare at $70.00. (922042) Twenty 4" Pieces for $8.95

RESISTOR RIOT
1/8, 1/4, 1/2 Watt, power, precision, fixed, adjustable, etc. Thousands of pieces. (92P023) 5 Lbs. for $4.95

100° LOW NOISE AMPLIFIER
For TVRO applications. 3.8-4.2GHz input, 950-1450 mHz output. Apilica P/N MTI-AG1021. (95G002) $9.95 each

ULTRASONIC LIGHT SWITCH
Replace your light switch with this motion detector. Turns lights on when you enter a room and turns them off when you leave. Has sensitivity and delay adjustments. Specs and instructions included. (95U002) $8.95 each

SNIP?
This was designed to be a thread nipper, but in reality it is a spring-loaded stainless steel cutalotstiff tool. The handy eyering allows you to dangle it from your pinky between ops on repetitive work. (SC123) $8.95 each

AMPLIFIED SPEAKER PAIR
These units have excellent audio for their small size (approx. 3" x 3" x 5") and are loud enough, too. A 3.5mm stereo plug brings the audio in, and each speaker has its own volume control. They run on 6VDC (four "C" batteries) or an external 6VDC wall transformer. (94V007) $9.95/pair

 powerSave 500
UNINTERRUPTIBLE POWER SUPPLY
We have just received a quantity of these internally mounted battery backup units for PCs and PC clones. They use one full-size slot in your PC and monitor the power supply for hookups or outages. When the power goes out:
- 0-2 seconds: PowerSave provides system power to "ride through" short power interruptions without any effect on the user.
- 2-20 seconds: PowerSave initiates a complete system data backup to the hard drive, and returns to user when AC returns.
- 20+ seconds: PowerSave completes system backup and shuts PC off after completion. Application is restored whenever PC power is restored. Application restoration may be automatic or manual, returning you to exactly where you were just before power loss.

Cool unit! (95C004) $49.95 each

SNIPPER
This was designed to be a thread nipper, but in reality it is a spring-loaded stainless steel cutalotstiff tool. The handy eyering allows you to dangle it from your pinky between ops on repetitive work. (SC123) $8.95 each

ULTRASONIC LIGHT SWITCH
Replace your light switch with this motion detector. Turns lights on when you enter a room and turns them off when you leave. Has sensitivity and delay adjustments. Specs and instructions included. (95U002) $8.95 each

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Fan and heatsink with a state-of-the-art peltier junction attached to keep your 486 CPU ice cold. (95C007) $44.95 each

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Box of ten brand new diskettes. (95C009) $5.95/box

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Holds 48 disks. Perfect Micro P/N PM-48L. (95C008) $4.95 each

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2 Hard drives, 2 floppies, 3.1 interleave. (92C071) $24.95 each

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Even the finest equipment cannot guarantee noise-free operation. One "dirty" connection anywhere in the signal path can cause unwanted noise, distortion and signal loss. Considering the hundreds (if not thousands) of connections in electronic equipment today, it is only a matter of time before they begin to fail.

ProGold and DeoxIT increase the performance and reliability of electrical components and equipment. They provide long-lasting protection, reducing the expense of repeated cleaning with expensive ozone-depleting solvents. As a general rule, use ProGold for best performance and protection on plated surfaces and DeoxIT as a general purpose treatment.

ProGold™ Conditioner & Preservative

ProGold outperforms all other contact cleaners, enhancers and lubrices. Due to its unique properties, not only does it deoxidize and clean surface contamination, but it penetrates plated surfaces and molecularly bonds to the base metals. This increases conductivity and contact surface area and reduces arcing, RFI, wear and abrasion - the major cause of intermittent signals, distortion and signal loss. ProGold is the only product that conditions and protects plated surfaces and their base metals.

DeoxIT & PreservIT™

Deoxidizes, Seals & Protects Electrical Connections

DeoxIT is a fast-acting, deoxidizing solution that cleans, preserves, lubricates and improves conductivity on all metal surfaces. Use as a general treatment for connectors, contacts & other metal surfaces.

PreservIT seals, lubricates and preserves metal surfaces for protection from oxidation and contamination. For use on clean new surfaces or those pre-cleaned with DeoxIT.

Both have excellent migration properties that coat the surfaces and protect them from future oxidation & contamination. These formulas contain improved deoxidizers, preservatives, conductivity enhancers, anti-tarnishing compounds, arcing & RFI inhibitors and provide extended temperature range.

Electronically-Safe! Environmentally-Safe! Environmentally-Safe!
THE TOTAL COST FOR SHIPPING MOST MIXED ORDERS FROM THIS ADVERTISEMENT BY FEDERAL EXPRESS IS $15 - $25 ALL PRICES ARE IN US DOLLARS.

HEAD MOUNTED IR BINOCULARS

These lightweight USSR made binoculars will produce good vision with 1/4 moonlight illumination, but can also be IR assisted at lower light levels: Work well with our $11 IR filter. Powered by 4 AAA batteries (6V), 1 X magnification, angle of vision 28 deg., focuses from 2' to infinity.

$380

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Just the basics: A 6mW / 670nm visible laser diode plus a collimating lens, plus an APC driver kit UNBELIEVABLE PRICE:

$26

INTENSIFIED NIGHT VIEWER KIT

See in the dark! Make your own night scope that will produce good vision in sub-starlight illumination! We supply a three stage fibre optically coupled image intensifier tube, EHT power supply kit, and sufficient plastics to make a monocular scope. The three tubes are supplied already wired and bonded together.

$200 for the 25mm version
$280 for the 40mm version

We can also supply the lens (100mm f2: $50) and the eyepiece ($12) which would be everything that is necessary to make an incredible viewer!

$145

MONOCHROME CCD CAMERA

Monochrome CCD Camera which is totally assembled on a small PCB and includes an Auto Iris lens. 9-12V DC operation. It can work with illumination of as little as 0.1Lux, and is IR responsive: Can be used in total darkness with Infra Red illumination. A suitable illuminator is our HIGH POWER LED IR ILLUMINATOR kit. Overall dimensions of camera are 24 X 46 X 70mm and it weighs less than 40 grams! Can be connected to any standard monitor or the video input on a Video cassette recorder: EIA ( US - NTSC) compatible.

$145

FIBRE OPTIC TUBES

These US made tubes are "pulls" from equipment, in excellent condition. Have 25 / 40 mm diameter, fibre - optically coupled input and output windows. The 25mm tube has an overall diameter of 57mm and is 60 mm long, the 40mm tube has an overall diameter of 80mm and is 92mm long. The gain of these is such that they would produce a good image in approximately 1/2 moon illumination, when used with suitable "fast" lens, but they can also be IR assisted to see in total darkness. Our $11 IR filter is suitable for use with these tubes. Suitable for low light video preamplifiers, wild life observation, etc. Each of the tubes is supplied with an 18V - 180V power supply kit. REDUCED PRICES:

$75 .....For the 25mm intensifier tube and supply kit.
$110 .....For the 40mm intensifier tube and supply kit.

We also have a good supply of the same tubes that may have a blemish which is not in the central viewing area: Satisfaction guaranteed! NON SPECIAL $40 .....For a blemished 25 or 40mm (Specifying preference) image intensifier tube and supply kit. Matching good quality eyepiece lens only, $6 Extra! That's almost a complete night viewer kit for $46.

$80

MINIATURE FM TRANSMITTER

Not a kit, but a very small ready made self contained FM transmitter enclosed in a small black metal case. It is powered by a single small 1.5V silver oxide battery, and has an inbuilt electret microphone. SPECIFICATIONS: Tuning range: 86 - 108Mhz, Antenna: Wire 3" - 12", Dimensions: 1.0 X 0.9 X 0.4".

$25

SECOND GENERATION TUBES

WE SHOULD HAVE A REGULAR SUPPLY OF SOME NEW USSR MADE 18mm 2'1D. GEN. FIBRE OPTICALLY COUPLED IMAGE INTENSIFIER TUBES @ APPROX. $500.

Very high quality IR filter and a RUBBER lens cover that would fit over most torches including MAGLITE's, and convert them to a good source of IR. Suitable for use with passive and active viewers.

$11

For the filter and the rubber lens cover.

GLASS PRISMS

Precision 90 deg. glass prisms with a mirrored backing. We have a limited quantity of these prisms.

$10

For the smaller prism: Approximately 18 X 18 X 24 X 64mm.

$20

For the larger prism: Approximately 18 X 18 X 24 X 127mm.

PASSIVE NIGHT VIEWER KIT

See Electronics Now Oct. 94. This kit is based on a BRAND NEW passive night vision scope, which is completely assembled and has an EHT coaxial cable connected. This assembly employs a high gain passive tube which is made in Russia. It has a very high luminous gain, and the resultant viewer will produce useful pictures with starlight illumination. It needs an EHT power supply to make it functional, and we supply a suitable supply and it's casing in kit form.

$220

MISCELLANEOUS ITEMS COMPONENTS AND KITS

FM TRANSMITTER KIT - MKII: $8
SINGLE CHANNEL UHF REMOTE CONTROL KIT: One transmitter and one receiver: $32 additional transmitter $11 4 CHANNEL UHF REMOTE CONTROL KIT: Two transmitters and one receiver: $68 ELECTRIC FENCE KIT: PCB and components $128 GARAGE - DOOR - GATE REMOTE CONTROL KIT: 6x $13 . Rx $56 LASER BEAM COMMUNICATOR KIT: Tx: Rx plus IR Laser $60 PLASMA BALL KIT: PCB and components kit, needs any bulb: $39 HIGH POWER IR LED's - 880nm / 30mW / 12deg. @ 100mA .10 for $6

5 LANDSWONE PDE OATLEY SYDNEY NSW AUSTRALIA 2223

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May 1995 Electronics Now

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<th>Value Voltage</th>
<th>Dimensions</th>
<th>Weight</th>
<th>Price (1-15)</th>
<th>Price (16-UP)</th>
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</thead>
<tbody>
<tr>
<td>EN-029-1000</td>
<td>1,000,000 uF at 16 VDC</td>
<td>3&quot;(dia.) x 8-1/2&quot;</td>
<td>1 lbs.</td>
<td>$59.80</td>
<td>$52.80</td>
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Passive infra-red Talking Motion Detector III $27.50
"Stay out of that refrigerator!" Watch your stuff! The possibilities are mind-bending with this talking motion detector. You speak into it to record your message (up to 12 seconds long), turn the unit on, and instantly your voice (or your mother-in-law's) reminds everyone in the vicinity that you are watching. Messages can be changed with the flip of a switch. Uses 4 AA batteries (not included), or an external power source (batteries back). May be used independently (80 dB output) or with an amplified speaker to blast your message throughout the house. Approx. 4" x 3-1/2" x 1-1/2"

5 mW LASER $55.00
Mini 5 mW visible laser module
wavelength 630 - 650 nm
3/4" x 1/2" complete unit has a built-in power supply and an adjustable collimating lens. Operates on 3 volts DC (a pair of AA or AAA batteries work great)
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BIG BROTHER IS WATCHING
VIDEO CAMERA AND MONITOR COMBINATION $125.00
You're probably wishing for a closed circuit camera/monitor system for your home or business, but those cost big bucks. Well, once again, Gateway comes to the rescue. We've got a 10" solid state video monitor with black and white camera and 10' interconnecting cable. Runs on 115 VAC. There is a microphone in the camera for one-on-one talking and you can make camera run up to 500 feet with twisted 3-pair wire. Requires 8 conductor round telephone cable and RJ-12 modular plug. Why so cheap? The surplus market is an amazing place! We hook 'em up, make sure they get a picture, a delivery, and ship out the monitor/that's quality control and sell 'em to you at such a deal price! Great for ATV's, business monitoring, and 1-spy surveillance. approx. dimensions: camera 2-1/2" x 4-1/4" x 8" monitor 8-1/2" x 8-1/2" x 2-5/8"
(wooden case please include $15.00 per system, for shipping 0 handling)

AUDIO REVERB / SURROUND SOUND KIT $99.95
An inexpensive audio effects kit that really has to be heard to be appreciated. The surround portion converts stereo or mono audio signals into 5-dimensional sound. The reverber effects portion is great for producing the reverber sound that manybody likes. Add to the reverber to the voice on the telephone (what will ground him)!!! Go crazy on the office PA system (haven't you always wanted to leave with a resounding 'what's going on outside the building'!!)? Obviously, the possibilities are endless. Adjustable controls for volume, delay rate, decay time, and reverb duration. Powered by a standard battery (not included.)

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AF-2 ▲▲ 120-250W MOSFET POWER MONO AMPLIFIER (6 lbs.)
Power Output: 250W into 4 ohms RMS(42VX2 6A transformer is used). Frequency Response: 3-22,000Hz.
THD: <0.03%. Signal to Noise Ratio: 91dB, Sensitivity: 1V RMS at 47K. Load Impedance: 4 or 8 ohms. Power Requirement: ±48VDC 4A or ±60VDC 6A. Suggested Mark V model 012 transformer. Capacitor: 10,000uf 80V model 016. Recommended Metal Cabinet LG-1925.
Kit: $98.80 Asmb. $188.80

AF-3 ▲▲▲ 300W MOSFET HIGH POWER MONO AMPLIFIER (7 lbs.)
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: ±56 to ±65VDC 6A. Suggested Mark V model 009 transformer. Capacitor: 10,000uf 80V model 016. Recommended Metal Cabinet LG-1925.

TA-800MK2 ▲ 120+120W PRE & MAIN STEREO AMP. (4 lbs.)
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.
Kit: $165.00 Asmb. $215.00

TA-1000A ▲▲▲ 100W DYNAMIC CLASS A MONO AMP. (4 lbs.)
Power Output: 100W into 8 ohms RMS, 125W into 4 ohms RMS. Frequency Response: 10HZ-100KHZ. THD: <0.006%. Signal to Noise Ratio:80dB. Sensitivity: 1V. Power Requirements: 35 to 45VDC @ 3A. Suggested Mark V model 001 or 008 transformer. Capacitor: 10,000uf 80V model 016. Recommended Metal Cabinet LG-1924.
Kit: $54.00 Asmb. $74.00

TA-388 ▲▲▲ CLASS A FET DYNAMIC BUFFER STEREO PRE-AMP (1 lb.)
Frequency Response (at overall): Overall 10HZ-100KHZ +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): 300-800mV. Maximum Output Level: Pre-Amp output 1.8V (0.1% THD). Power Requirement: 30V X 2 AC 600mA.
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SM-100 ▲▲ 150 MHZ 6 DIGIT FREQUENCY COUNTER (2 lbs.)
Frequency Range: 10HZ-150MHZ. Gate Time: 0.01s, 0.1s, 1s, 10s. Input Sensitivity: KH range 10HZ-10MHZ 20mV(min.). MH range 1MH-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: 0.1HZ. gate time, 1HZ: 1s gate time, 10HZ: 0.1s gate time. Hold the last input number. Reset function to start counter to 0. DC 9V power adapter or 1.5Vx4"size batteries(Adapter is not included)
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LG-1924 4x19x111/4" 38.25
LG-1925 5x19x111/4" 42.00
LG-1983 2x19x198" 35.25

POWER TRANSFORMERS & *TOROIDAL TRANSFORMERS (5-12 lbs.)
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002 36Vx 2 3A 25.00
003 40Vx 2 6A 32.00
**006 28/30V x 2 6A 40.00
**009 48/53V x 2 8A 66.00
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TR-503 ▲ REGULATED DC POWER SUPPLY
It is short circuit proof and has overload protection. Output voltage is 0-50V. Current limit trip is adjustable up to max of 3A. Suggested Mark V 002 transformer. (1 lb.)
Kit: $19.75 Asmb. $27.05 variable over a range of 0-50V. Current limit trip is adjustable up to max of 3A. Suggested Mark V 002 transformer. (1 lb.)

SM-302 ▲▲ 60+60W STEREO POWER AMP
It provides 3 input jacks. One pair accept a high impedance microphone. The two remaining pairs are for high & low level input sources. Power Output: 60W per channel into 4 ohms RMS. 20HZ-20KHZ. THD:<0.1%. Input Sensitivity: Mics/Guitar 10mV/H, 360mV/L, 640mV. Ready to plug in when assembled. (11 lbs.)

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TA-201 Microphone Mixer Mono Amp ▲ $ 20.79
TY-45 20 Bar/Dot Level Display ▲ $ 41.45
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<tr>
<th>Frequency</th>
<th>Model</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>60MHz</td>
<td>S-1360</td>
<td>$775</td>
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<tr>
<td></td>
<td>S-1365</td>
<td>$849</td>
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<td></td>
<td>S-1366</td>
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<td>40MHz</td>
<td>S-1340</td>
<td>$495</td>
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<td>S-1345</td>
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<td>25MHz</td>
<td>S-1325</td>
<td>$349</td>
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<tr>
<td></td>
<td>S-1330</td>
<td>$449</td>
</tr>
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</table>

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<table>
<thead>
<tr>
<th>Model</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>V-212 20MHz</td>
<td>$425.00</td>
</tr>
<tr>
<td>V-222 20MHz</td>
<td>$695.00</td>
</tr>
<tr>
<td>V-422 40MHz</td>
<td>$849.00</td>
</tr>
<tr>
<td>V-522 50MHz</td>
<td>$975.00</td>
</tr>
<tr>
<td>V-531 50MHz</td>
<td>$995.00</td>
</tr>
<tr>
<td>V-525 50MHz</td>
<td>$1,069.00</td>
</tr>
</tbody>
</table>

**HITACHI COMPACT SERIES SCOPES**

<table>
<thead>
<tr>
<th>Model</th>
<th>Price</th>
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<tbody>
<tr>
<td>V-660 60MHz</td>
<td>$1,375.00</td>
</tr>
<tr>
<td>V-661A 60MHz</td>
<td>$1,449.00</td>
</tr>
<tr>
<td>V-1065A 100MHz</td>
<td>$1,549.00</td>
</tr>
<tr>
<td>V-1065B 100MHz</td>
<td>$1,695.00</td>
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<tr>
<td>V-1066A 100MHz</td>
<td>$2,125.00</td>
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<table>
<thead>
<tr>
<th>Model</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>VC-5045A 50MHz</td>
<td>CALL</td>
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<tr>
<td>VC-6025A 50MHz</td>
<td>CALL</td>
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