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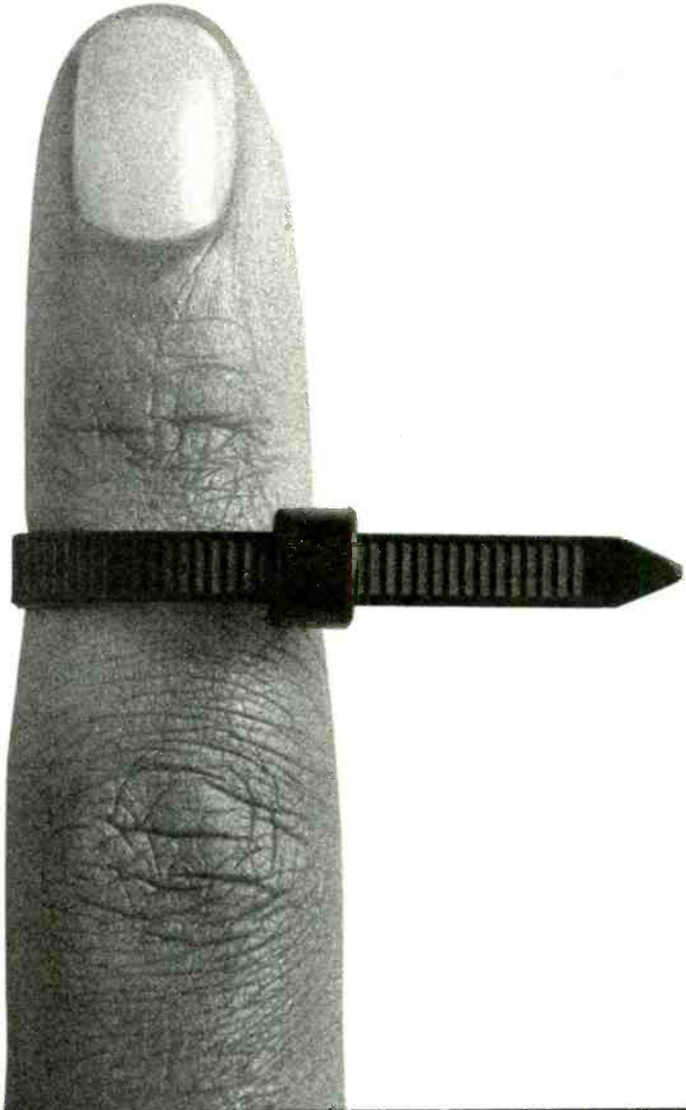

Electronics NOW
Vol. 67 No. 5

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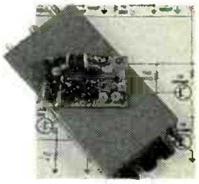

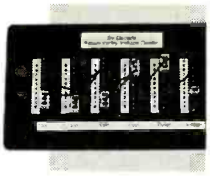

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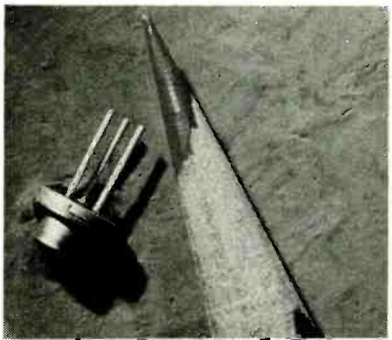
WHAT'S NEWS

A REVIEW OF THE LATEST HAPPENINGS IN ELECTRONICS

Self-pulsating laser for DVD

Toshiba Corporation of Japan has introduced a visible laser diode designed specifically for use with the DVD (digital video disk technology) format. The TOLD9450-MC is the first commercialized self-pulsating laser diode to operate at a wavelength of 650 nanometers. Its short wavelength makes the device well-suited to meet the high recording density needs of DVD applications.



TOSHIBA'S SELF-PULSATING LASER DIODE operates at a wavelength of 650nm, meeting the high recording density needs of DVD applications.

Using Toshiba's Multi Quantum Well (MQW) structure and a saturable absorber layer, the TOLD9450MC provides effective, stable self-pulsation and reduced operating current. The design allows for noise suppression, achieving a relative intensity noise (RIN) of less than -130 dB/Hz at room temperature. Through optimization of the layer structure, stable laser operation is delivered over a wide temperature range.

The small package size (5.6-mm diameter) allows system designers to reduce the size of the optical pickup head. The cathode-case type pin configuration allows a positive power supply to be used.

New superconductor under development

Scientists at the Westinghouse Electric Corporation's Science & Technology Center in Pittsburgh have been studying a more rugged and versatile electronic material for use in semiconductors. The material, silicon carbide (SiC), promises electronic devices that operate reliably at much higher temperatures and power levels than devices made from the materials used today, such as silicon or gallium arsenide.

Although the potential advantages of silicon-carbide devices has been known for more than 25 years, early interest waned because it was difficult to make crystals of the needed purity and uniformity in useful sizes. The Westinghouse program, which recently received a $4.5-million government contract, is devoted to overcoming that problem. The study, funded by the U.S. Advanced Research Projects Agency through Wright-Patterson Air Force Base in Ohio, is a three-year effort to develop low-defect, three-inch diameter crystals and large-area epitaxial layers of semiconductor quality.

SiC-based devices would perform better, be more efficient, and cost less in a variety of uses. For instance, they could serve as sensors in hot environments such as car and aircraft engines and be used in lightweight, high-power electronic systems for applications like electronic vehicles. The devices also have potential applications in radar, computer memories, and broadcasting. In power-plant control systems, SiC devices promise increased reliability thanks to another key advantage(significantly higher resistance to damage from ionizing radiation that devices made with materials now in common use.

300-mm wafer implanted

A newly developed serial process, known as high current ion implanter, has successfully been used to implant 300-mm wafers. The serial implanter was developed by Varian Ion Implant Systems and Diamond Semiconductor Group (DSG), both of Gloucester, MA. Concept and feasibility funding was provided by the Advanced Technology Program of the National Institute of Standards and Technology (NIST).

"As the industry advances to 300-mm, its goals are to increase productivity, reduce costs, and reduce risks," said Bruce Thayer, Varian's marketing manager. "A 300-mm wafer offers 2.5 times the yield of a 200-mm substrate."

"By processing wafers serially, the overall complexity of the system is decreased dramatically, and the reliability can be greatly enhanced," added DSG president Manny Sieradzki. "Serial processing offers major improvements in process flexibility and 'wafer inventory' or 'device factory' management over present high-current ion implanters, which implant wafers in batches of 13 or more."

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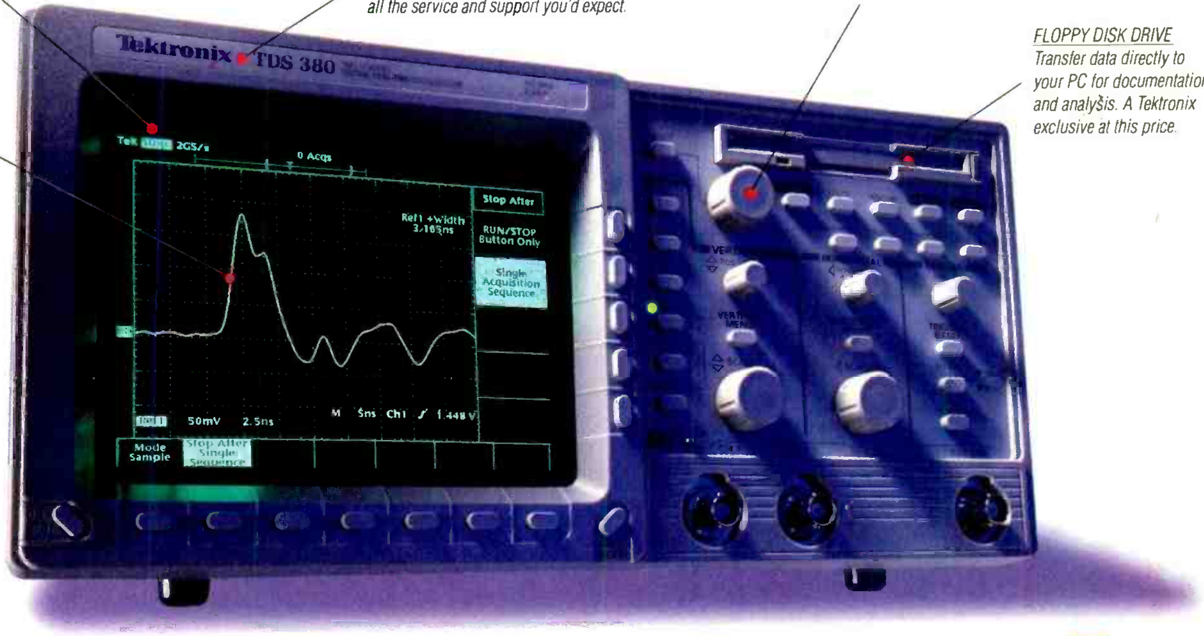
Overpowered.



Underpriced.

Starting at $2,495

With the breakthrough new TDS 300 Series, Tektronix redefines the price-performance benchmark in oscilloscopes. Numbers tell the story: A sample rate of up to 2 GS/s and a bandwidth of up to 400 MHz take you to the highest level of performance, Digital Real Time (DRT).

DRT is an exclusive oversampling technology that lets these scopes beat the real-world challenge of displaying infrequent, single-shot events.

You'll see things the other scopes can't even capture. The new TDS 300 Series also offers FFT and Disk Drives – features others charge hundreds of dollars more for, or don't even have.

The biggest breakthrough, though, is in the number on the price tag. The TDS 300 Series starts at $2,495.* For this price, you get a level of performance you'd expect only in scopes twice as expensive. Contact your Tektronix Authorized Distributor for details, or call 1-800-479-4490, Action Code 311. And prepare to be overwhelmed.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WHATS NEW IN THE FAST-CHANGING VIDEO INDUSTRY

BY DAVID LACHENBRUCH

Making DVD incompatible

One of the advantages of digital video recording is that it finally exorcises an old bugaboo—incompatibility among the world's television systems. Thus any video-recorded DVD disc can be playable on any TV set anywhere in the world, given the proper player (which converts the digital video to analog of the proper national standard). That might be the conventional wisdom—but to the movie industry, that's a major disadvantage. So Hollywood and the electronics-manufacturing fraternity have agreed on a scheme to wipe out that problem and, in fact, make interchangeability more restrictive than ever.

With videocassettes, the movie industry relies on incompatibility to orchestrate release dates, particularly between the United States and Europe. Because an NTSC videocassette is unplayable on a conventional PAL VCR, that results in a national barrier preventing premature release of movies in certain countries.

Most U.S.-made movies are released in this country before their European release. Release on videocassette follows theatrical release by varying periods, depending on the success of the movie in the theater. Thus a videocassette recorded in NTSC could be released here while the same movie is still playing in theaters in England, for example. In the eyes of the movie industry, that's an advantage. Even if a European were to bring a videocassette home from the U.S., he or she couldn't play it on a standard British VCR, which will only play videocassettes in the PAL format.

Such artificial roadblocks don't exist with the digital DVD system. The same disc could be used anywhere in the world(and is made even more universal by being able to accommodate multiple soundtracks for various languages. But that very desirable feature would wipe out the movie producers' ability to control release of their films on home discs. The issue was brought to light by Louis Feola, president of MCA Home Video, who said that his company wouldn't release any of its films to DVD unless the situation were corrected. He was backed privately by several other movie companies.

After some hurried conferences, the DVD Forum, which developed standards for the system in the first place, agreed to consider a proposal which would go far beyond the use of national TV standards to block "interplayability" of discs. The proposal likely to be adopted would divide the world into five to seven different regions, based largely on the normal sequence of theatrical movie releases. Each region would be assigned a code to be installed as a digital flag on DVD discs. All players programmed for sale in each particular region would reject any disc designed to be sold in a different region.

Thus, for example a movie disc designed for sale in the U.S. would be unplayable on players in use in, say, South America or China. That flagging process reportedly is quite simple and wouldn't necessarily hold up the expected September release date for DVD players and discs.

Copyright problems remain

A more serious barrier to the release of DVD movies is the copying problem. Because perfect digital-to-digital copies and near-perfect digital-to-analog copies could be made from DVDs, movie companies are balking about releasing their films on DVD before a law is in place to bar copying of digital discs. Although there is agreement between manufacturers and producers about the contents of such a law, the technical details must still be spelled out, and its passage is far from certain.

While the contents of the agreement had not been released by our press time, it's understood that it involves a technology called Copy Generation Management System (CGMS), which would make it impossible to make a digital copy of a digital disc. To block copying of DVDs onto analog media, such as videocassettes, the legislation is expected to specify "Colorstripe" technology developed by Macrovision. Colorstripe would make bootleg analog copies of digital discs virtually unwatchable because of the presence of disturbing stripes of color.

Although the precedent for digital video anti-copy legislation is the Audio Home Recording Act (AHRA), there are major differences. The AHRA permits one direct digital copy to be made from a digital audio recording (CD or DAT), but prevents that copy from

continued on page 49

Q & A

READERS QUESTIONS, EDITORS ANSWERS

Timing Light As Stroboscope

Q *I have a timing light which operates off a car battery and a connection to a spark plug wire. Is there some way to modify the light for use as a stroboscope? — M. M., Elko, Nev.*

A A timing light is a special kind of stroboscope that flashes whenever a particular park plug fires, enabling you to see what position the engine is in at that moment. What you need is a way to trigger it through a spark plug wire.

Timing lights that connect directly to a spark plug aren't so easy to fool; they are triggered by the high voltage from the ignition coil, which isn't easy to simulate safely.

Bear in mind that the maximum frequency of a timing light is about 20 Hz. Above that frequency, timing lights tend to skip pulses. You might be able to speed up a timing light by reducing the value of the high-voltage capacitor across the flashtube; the light will then be dimmer, but the capacitor will

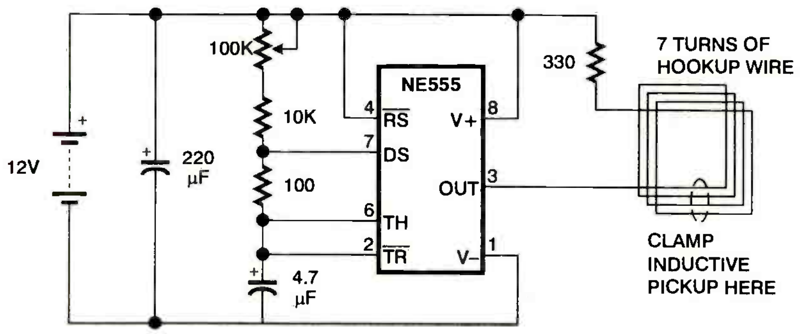

FIG. 1—THIS OSCILLATOR will trigger a timing light for non-automotive use as a stroboscope.

without using an automobile engine.

There are two ways a timing light might attach to the wiring of the engine: by direct connection or through an inductive pickup. If your timing light has an inductive pickup, you're in luck — you can use the circuit in Figure 1 to trigger it. The NE555 produces brief pulses of current in the wire, which is wound into a loop to increase the amount of induction; we used seven turns, but one or two turns may suffice. To the timing light, these pulses look like the pulses that flow charge up more quickly for the next flash.

Xenon Flashtube Theory

Q *I'm interested in building a battery-operated flasher circuit using a xenon strobe tube. I understand that the xenon tube operates in the kilovolt range. Any ideas? — D. B. S., Saylorsburg, Pa.*

A The actual operating voltage across a xenon flashtube is about 300 volts, stored in a capacitor as shown in Fig. 2. To make the tube

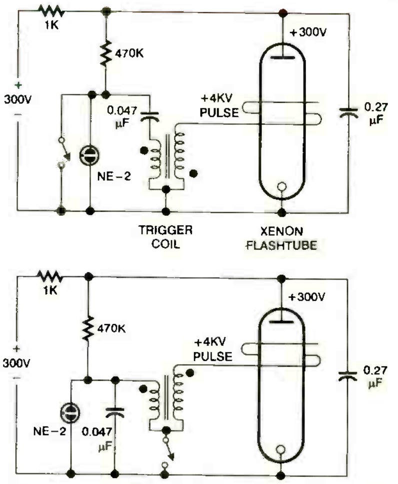

FIG. 2—BASIC CIRCUITS FOR FLASHING a zenon tube. Hoose the circuits that fits the polarity of the trigger coil.

flash, a step-up transformer called a *trigger coil* provides a momentary pulse of several kilovolts to a wire wrapped around the middle of the tube. This is coupled capacitively to the gas inside the tube and makes it start to ionize. As soon as the gas becomes conductive, the capacitor discharges through the flashtube and there is a bright flash of light; then the capacitor has to charge up again for the next flash.

The trigger pulse, in turn, comes from a smaller capacitor which is charged up to about 70 volts and then suddenly discharged through the primary of the trigger coil. As Figure 2 shows, the exact circuit depends on the polarity of the trigger coil, indicated by dots in the diagram; if in doubt, simply try it both ways.

The NE-2 lamp serves as a voltage regulator and "ready" light. The switch can be replaced by an SCR.

Now all you need is a battery-operated 300-volt power supply. The easiest way to get one is to use

a junked photographic flash unit, which will also contain the xenon tube and trigger coil. For complete instructions on converting a camera flash into a stroboscope, see our sister publication, *Popular Electronics*, November 1995, pp. 77-78 (available from our reprint bookstore). And remember, *strobe circuits are dangerous;* the capacitor in a camera flash can deliver a painful or even lethal shock. Always be sure to discharge every high-voltage capacitor through a 1-kilohm resistor before touching any of the components.

Rain Alarm

Q *I need a circuit that will operate a relay or solid state switch when a sensor detects water or rain. — D. B., Aggasiz, B.C., Canada.*

A Fig. 3 shows a circuit that will do the job. It relies on the ability of water to conduct electricity. The sensor consists of two pieces of metal just close enough together that a drop of water will bridge them. An especially good sensor can be made out of two pieces of a metal comb, arranged as shown in the diagram, but much simpler sensors will often do the job. To be sure of catching the first drop of rain, you might feed the sensor through a funnel; make sure it's open to the air so that the water will dry up when the rain ends.

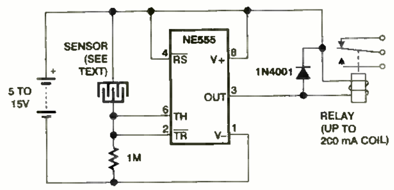

FIG. 3—THIS RAIN DETECTOR circuit closes the relay when water bridges the gap between the metal electrodes.

Electrically, the circuit uses a 555 timer IC as a level detector. The 555 supplies *hysteresis* — that is, its turn-on voltage is higher than its turn-off voltage — and this keeps the relay from "chattering" when a barely-detectable amount of water is present. You can use any low-voltage relay whose coil draws no more than 200 mA; solid-state relays will also work fine.

If the water you want to detect is very pure (such as distilled water leaking from a tank), it may not conduct electricity; in that case, increase the 1-megohm resistor to 2.2 megohms. On the other hand, if the circuit trips too easily and gives false alarms, decrease the resistor to 220k.

Tubes For FETs

Q *I have several pieces of useful tube-type RF and audio equipment that I would like to convert to use FETs in place of the tubes. I could start from scratch, but would feel better if I could benefit from others' experience. Do you know of any publications on tube-to-FET conversions, or could you give me some basic guidelines? Thanks. — B. G., Bellefontaine, Ohio.*

A There is enough electrical similarity between vacuum tubes and N-channel junction field-effect transistors (JFETs) that you can sometimes substitute one for the other. The catch is that most FETs can't handle the high voltages; there is tremendous unit-to-unit variation among FETs of the same type, so you may have to select particular units; and the overall conductance of an FET is higher, so you'll have to add some resistance in series with the FET

The classic article on tube-to-FET conversion, by Howard Sartori, appeared in *QST*, April 1977, pp. 45-50, with follow-ups in September 1977, pp. 38-39, and December 1978, p. 39. (We can't supply copies of this, but your public library can probably obtain them.) Sartori used a special 300-volt JFET, the 2N6449, which is, unfortunately, apparently no longer available.

The best way to convert tube equipment to use FETs nowadays is to reduce the supply voltage to about 20 volts, then put an FET in place of the tube and adjust the values of other components as required. You can use Sartori's circuits as a starting point, but considerable experimentation will be necessary. Fortunately, when the conversion is done, the circuits will be more stable and will consume less power. EN

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LETTERS

SEND YOUR COMMENTS TO THE EDITORS OF ELECTRONICS NOW MAGAZINE

SOUPED-UP ALTERNATOR

R. Christman, whose letter appeared in "Q&A" in the January issue of *Electronics Now*, might be interested to know that the ampicity of at least some automotive alternators can be increased.

I use a full-size Ford to tow a travel trailer. When I bought the car a number of years ago, I soon discovered that the alternator was not up to the task. I obtained an exchange stator for the alternator from a friend in the automotive electric business. That stator had been rewound by a remanufacturer to allow the alternator to put out 100 amps. I'm not sure what the stock alternator was, although it was probably rated at 60 amps. The original rectifier/regulator assembly was reused. After I rebuilt the alternator (using new bearings and brushes as well as the beefed-up stator), I had it tested and found that it could actually put out up to 120 amps. That alternator has been going for many years now, and the diodes and regulator have survived.

The edited note from R. Christman did not indicate what type of car he is dealing with, but it might be worth his while to check with a local automotive electric business.

PETER KNIP
Gilliam, Manitoba, Canada

ELUSIVE HUM

Larry Klein's "Audio Update" column discussing the "elusive hum" in Taos, New Mexico (*Electronics Now*, December 1995) reminded me of a letter published in *Electronics World (Wireless World)* in their October, 1995 issue. After making references to a similar mystery noise, the writer stated, "I found the cause of the sound by accident when I was holidaying in France. A sewerage pump went out of order for a few days, and the low-frequency tone disappeared (there was no other pump for several miles around.) It sounds to me as if that very perceptive person has precisely identified the source, and it certainly "is real and entirely natural."

By the way, thanks for all the material on noisy school dances. I would like to suggest another sonic problem area in schools: their band programs. My daughter has been participating in the marching band program, both as a musician and as a color guard performer. She has reported ringing in her ears for a time after several performances. That problem is potentially more severe than noisy dances, because the events (and practice sessions) are a great deal more frequent.

MIKE HARDWICK
Salem, OR

I am sure that machinery of one kind or another is responsible for many mysterious noises all over the world, but it seem illogical to me to generalize from a French sewerage pump to a phenomenon in the Southwestern United States. It's a safe bet that if a noisy U.S. pump were the culprit, the investigators in the area would have found it.

Thanks for alerting me to the various school band programs as a potential source of ear damage. Regular participants in such events would be well advised to invest in ear protectors such as the EPA-rated E-A-R Hi-Fi Earplugs. They are designed not for maximum attenuation, but rather for an approximately 12-dB reduction across the audio band while preserving a natural sound quality. Write to Cabot Safety Corporation, 5407 West 79th Street, P. O. Box 78130, Indianapolis, IN 46268-8130; phone 317-872-0330; or fax 317-872-5993.–Larry Klein

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

SORRY, MAC

"Buy a Macintosh!" was the title of a letter that appeared in the March 1996 issue of Electronics Now. Well, all I have to say is, "Sorry, Mac."

From what I've observed over the last several years, the Macintosh computer is going the way of the Sony Betamax recorder. Regardless of how many users attempt to protect the machine, no matter how much better its processor than the competition's, people are going to go for the system with the best software and hardware support(IBM and its clones).

My information has been gleaned from break rooms and retail stores. From the common folk, people who want to buy a computer and not have to scour the stores for hardware or software compatible with their "type" of machine. Just ask any Tandy 1000 owner and you'll see what I mean.

I'm not going to defend one architecture against another(I've never owned a Mac (although I have owned a TI-99 and a Color Computer II. I've decided that it's much better to buy a Ford Model T than a Daimler Benz automobile when you live in the United States. One might be better than the other, but try buying accessories (or service) for one or the other and you'd see what I mean.

The word from the break rooms is that Apple is looking for a buyer for the company. Apparently, the school systems in America (major financial backers for Apple) are switching to IBM computers. It seems that they are waking up to the fact that training kids on Macs and sending them into an IBM world is a losing proposition. Also, parents are getting tired of having to buy both types of computer, one for them and one for the kids. And the kids are losing.

If you are a Mac supporter, good for you. I stand behind your decision and wish you luck in your endeavors. If you are undecided about what to purchase for your initial system and are computer illiterate (as we all were, at one time), look around your town. Ask your friends what they use. And, in the end, remember that the final decision is yours and that you will have to live with that decision for a while.

RANDY JONES
Colville, WA

LOW-COST PCB-SOFTWARE ADDITION

I enjoyed the recent reviews of low-cost schematic capture/simulation and PCB software packages (*Electronics Now*, February 1996). However, since the reviewer covered each area separately, he overlooked a great package offered at a super price. Protel Technology bundled their DOS-based schematic-capture and PCB programs in a packaged called DOS Pack Design System, which sells for $395.

It features Autotrax, an enhanced version of Easytrax (reviewed in the January issue of *Electronics Now*). The DOS Pack schematic/PCB system includes 3000 components, a PCB footprint library, a component editor, full auto placement, an auto router, design verification and rule checking, SMD support, linking to 99 sheets, and much more.

In addition, the Autotrax netlist function is compatible with many popular formats. Although Autotrax is a DOS-based program, it is very stable running under Windows. I was able to switch between it and my electronic-simulation software without any problems. In fact, Autotrax quickly (and easily) converted my designs to a prototype-ready layout in just a few minutes. When compared to other programs on the review chart, I found Autotrax ranked first. It received a "Yes" in every category except the ability to neck down between pads.

Protel previously offered the system for as much as $1590. At $395, it is a lot of power for a little price. If offered separately, the schematic-capture and PCB programs would cost less than $200 each, putting them in the range of your reviews. After trying the demo and comparing the competition, I've decided to order DOS Pack. The demo can be found on the Protel BBS at 408-243-0125 or on the Internet at http://www.protel.com.

GEORGE JULIAN
Boise, ID

BAN THE 741 IC!

I am a long-time subscriber to *Electronics Now* and rely on it for the latest electronics news and techniques. I have seen several articles using the 741 op-amp. That chip is an embarrassment to the audio world and should be replaced. It has a low slew rate and a high noise figure. Its only redeeming features are its price and availability.

Younger readers and others new to audio electronics need to be informed of other ICs that can be used to provide superior performance, such as the AD744 and 5543. Those chips are among the best performing audio ICs when combined with high-grade capacitors, low-noise resistors, and regulated power supplies.

In the future, please instruct your authors not to use a sub-standard chip like the awful 741.

WARREN BAIN
Bristow, VA

EN

EQUIPMENT REPORTS

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Every electronic hobbyist dreams of owning a complete set of laboratory-grade electronic test instruments to speed up circuit test procedures and analyze faults quickly and accurately. The principal obstacle, of course, has been the expense. A complete set of dedicated instruments could cost thousands of dollars, a drain on the hobbyist's budget, particularly if he or she has a family, rent to pay, and food to put on the table. This is where computer based virtual instruments enter the picture.

Thanks to the availability of fast, powerful, personal computers at low prices and inexpensive virtual instrument hardware and software, the goal of obtaining many of those instrumenbts can be achieved for less than $400—assuming you own a late model IBM or compatible computer. It is true, however, that some compromises must be made because virtual instruments do not quite match the performance of their stand-alone, dedicated counterparts.

A new virtual instrument from Mission Technology, Inc. (PO Box 3016, Teaneck, NJ 07666, 1-800-880-7688) turns a personal computer into a digital storage oscilloscope, a real-time strip-chart recorder, a dual digital voltmeter, a digital frequency counter, a waveform analyzer and a spectrum analyzer for only $399.

The Multiscope Responsive Oscilloscope (see Fig. 1) connects to a parallel port on an IBM-compatible computer. The software included with the virtual instrument module runs under the Microsoft Windows operating system, and the computer provides both the control and display functions.

The responsive oscilloscope case has two BNC jacks, one for channel A and the other for channel B, and a D-type output connector on its front panel. The virtual oscilloscope has 16 frequency ranges and the recorder has a user-definable sampling interval from 0.055 second to eight hours and a buffer for up to 16,000 samples per channel.

The Multiscope has a digital bandwidth of 20 MHz and an analog bandwidth of 1 MHz. Input impedance is 1-megohm, and it has an eight-bit multiplexed input connector and AC or DC coupled triggering. Accuracy is specified as within 5% for signals of 200 kHz or less. Display update speed is directly linked to the speed of the computer's microprocessor. For example, a personal computer with an Intel i486 DX2 50 MHz processor can update the screen about once every half second on most time-base ranges.

The oscilloscope display has a built-in digital presentation of DC, RMS ,and peak-to-peak AC volts and frequency. Oscilloscope settings can be made automatically or

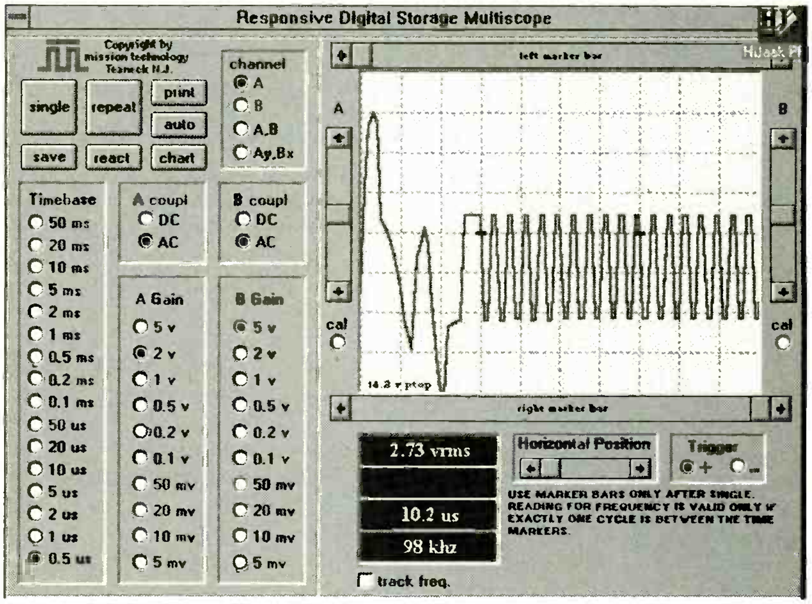

FIG. 1—THE VIRTUAL STORAGE OSCILLOSCOPE display as it will appear on your computer's monitor.

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The system provides protection against overvoltages up to 200 volts, transmitted electromagnetic interference from the computer is eliminated because the Multiscope circuitry is housed in a separate enclosure that acts as a shield. Moreover , the case can be located away from the computer. Input impedance is 1megohm. Multiscope has an eight-bit multiplexed input connector and it can be AC or DC triggering. An AC to DC adapter, two BNC 1 to 1 probes with alligator clip leads, and a parallel printer cable are included in the purchase price.

Multiscope in action

The Multiscope is plugged into the personal computer's parallel port with the data cable provided, and it obtains its power from the AC to DC adapter supplied. An on/off switch is the only control on the unit, and an illuminated LED indicates when power is on.

The operating software is on one 3.5-inch floppy disk. An oscilloscope icon appears on the screen when the software has been successfully installed. Double-clicking on the icon will run the software only if the unit is turned on and connected to the computer's parallel port.

The software will automatically locate the parallel port to which the unit is connected. On our first attempt to run the software all we got was a message box saying that either our port was non-standard or that power was not on. Fortunately, this glitch was solved when we found that we forgot to connect the power cord to the Multiscope. Once power was applied, we were in business.

The first display that appears is the digital storage oscilloscope. Menus pop up when the controls are clicked. The display (see Fig. 1) shows the controls on the left side and the instrument display on the right. An oscilloscope-type display appears above a digital voltage (DC, RMS, and peak-to-peak) and frequency

continued on page 27

NEW PRODUCTS

USE THE FREE INFORMATION CARD FOR FAST RESPONSE

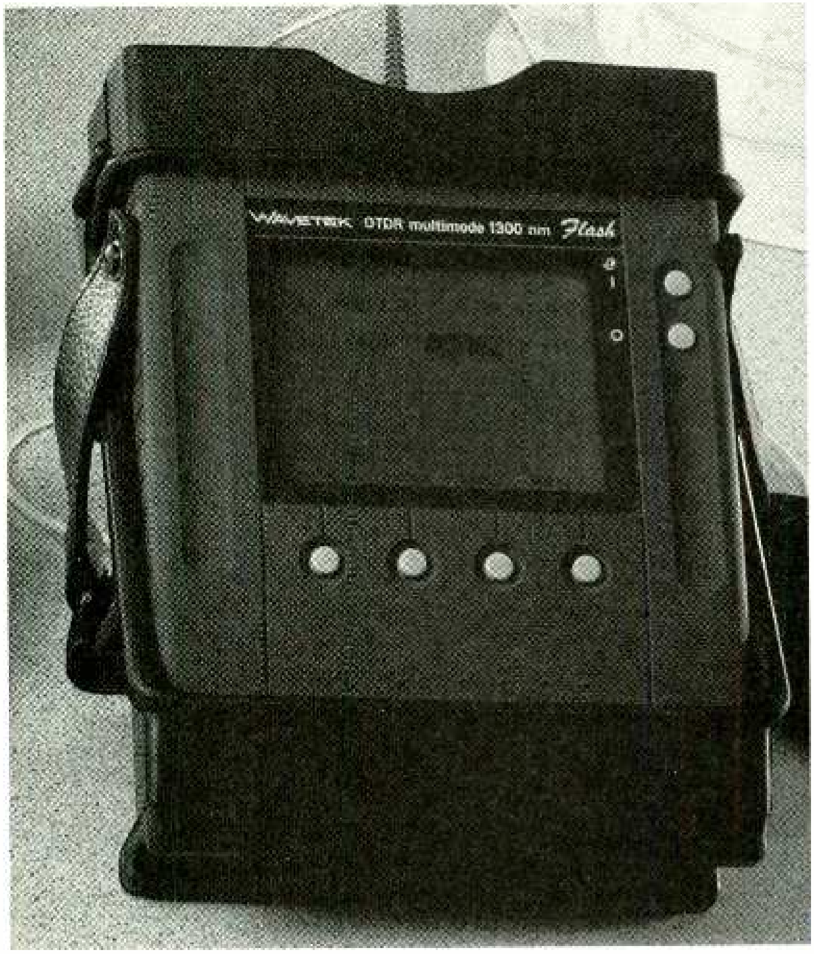
Flash Multimode OTDR

DESIGNED FOR USE IN LAN fiber-optic cable installation and maintenance service, Wavetek's Flash Multimode Mini-OTDR (Optical Time Domain Reflectometer) offers simple four-button operation, allowing any technician to become proficient with its use with little training and in minimal time. At 3-½ pounds, the Flash Multimode is the smallest and lightest instrument of its type today. It is available in 850-nm, 1300-nm, and dual-wavelength models.

The Flash Multimode can be used to test all physical media used in today's complex LAN applications, including copper cable and fiber optics. It provides all the features and functions needed for complete fiber-optic cable installation and maintenance testing, including a unique macro capability for recalling sequences of operations with the push of a single button, ghost detection and elimination, and a small (5 nanosecond) pulse width.

Each standard model includes two rechargeable NiCd batteries with charger, Flash ROM-based Validation software, internal memory for storing 32 trace results, an operating manual, and a carrying case. The Pro models also include an AC adapter, an extended carrying case, Wintrace software for storing and viewing test results on a PC, and 512K extended memory for storing 50 additional traces.

Prices for the Flash Multimode OTDR start at $9300 for the 850-nm Standard model.



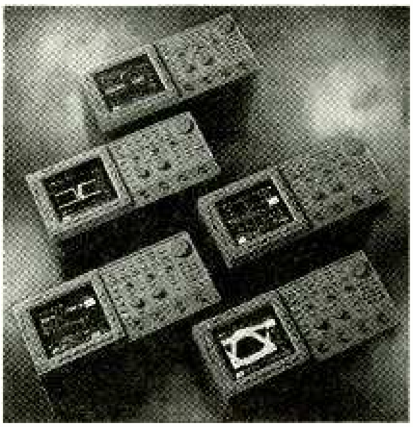
CIRCLE 20 ON FREE INFORMATION CARD

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

Instavu Oscilloscopes

SEVERAL NEW MODELS have been added to Tektronix' TDS700A series of InstaVu acquisition oscilloscopes and TDS 500B series of digital storage oscilloscopes. Both lines offer users the confidence of an analog scope and the power of a digital scope. Proprietary InstaVu signal-acquisition technology lets users capture up to 400,000 waveforms per second, making the new scopes as fast as the world's fastest analog scopes.

InstaVu is designed to quickly pinpoint and capture unpredictable, rapidly changing signals—infrequent glitches, metastable behavior, and time jitter—that might never be detected by conventional analog or digital scopes or specialized triggering. The technology combines high-speed acquisition memory with high-speed display rasterization to increase acquisition performance and ensure instantaneous live display of all signal changes. In design and debug applications, debug time is reduced from hours to seconds.



CIRCLE 21 ON FREE INFORMATION CARD

The TDS 784A, TDS 744A, and TDS 742A each feature color displays, bandwidths up to 1 GHz, sample rates up to 4 GS/s, and acquisition rates up to 400,000 Wfm/sec. The four-channel TDS 540B and the two-channel TDS 520B each feature 500-MHz bandwidth, up to 2 GS/s sample rate, monochrome displays, and up to 100,000 Wfm/sec acquisition rate. All models also offer extendible record length to capture and store complex, long-duration waveforms; sophisticated triggering capabilities, including setup/hold, slew rate, and time-out; and Channel Deskew, which increases time-measurement accuracy by compensating for external timing errors. A simple graphical user interface with more than 200 intuitive icons and on-line help makes the instruments easy to use.

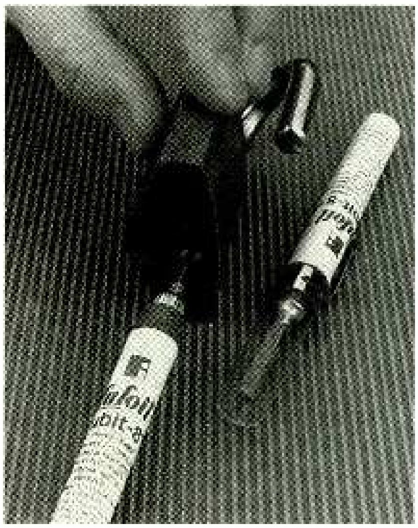
The TDS 540B and TDS 520B cost $14,950 and $9500, respectively. The TDS 784A costs $34,495. The TDS 744A and the TDS 724A cost $17,950 and $12,200, respectively.

TEKTRONIX MEASUREMENT BUSINESS DIVISION
P. O. Box 1530
Pittsfield, MA 01202
Phone: 1-800-426-2200
(when prompted, press 3 and ask for program 493)
E-mail:
http://www.tek.com/Measurement

Needle-Tip Pen Oiler

SYCON CORPORATION'S Lubit-8 Pen Oiler is filled with a lubricant containing Teflonä that is ideal for maintaining a wide variety of products, ranging from scientific instruments to cameras, guns, and fishing tackle. The lubricant is a blend of natural and synthetic oils with microminiature particles of Teflon and Fluonä held in permanent suspension. It is unaffected by −60°F to +500°F temperatures, is very slippery, resists dust, does not coagulate, and leaves no oily residue.

The Pen Oiler features a needle tip that precisely dispenses the lubricant, one drop at a time, making it well suited for use where sprays and oil cans are impractical. About the size of a fountain pen, the Lubit-8 can be clipped to a shirt pocket or carried in a field service kit.



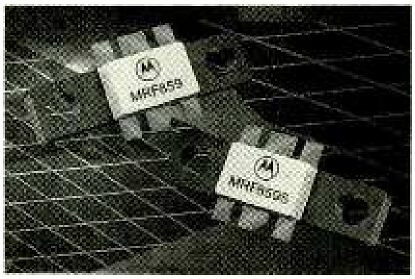
CIRCLE 22 ON FREE INFORMATION CARD

The Lubit-8 Pen oiler is available in cartons of 36 units for a list price of $93.24.

SYON CORPORATION
280 Eliot Street
Ashland, MA 01721
Phone: 508-881-8852
Fax: 508-881-4703

RF Power Transistors

MOTOROLA'S MRF859 AND MRF859S RF power resistors operate in the 800-960-MHz range with an output power of 6.5 watts. The rugged devices can be used in large-signal,



CIRCLE 23 ON FREE INFORMATION CARD

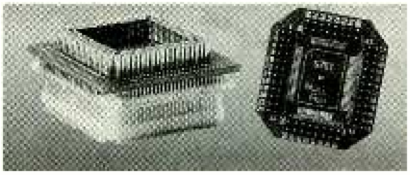
common emitter, class A linear amplifier applications in industrial and commercial equipment. Other features include a 11.5-dB minimum power gain, 3rd order intercept of +47-dBm minimum, and a noise figure of 6-dB typical. The MRF859 power transistor is packaged in a flange case, and the MRF859S is in a flangeless package.

Pricing for the MRF859 and the MRF859S RF power transistors is $48.62 in low volumes.

MOTOROLA, INC.—E 114
5005 East McDowell Road
Phoenix, AZ 85008
Phone: 602-244-6108
Fax: 602-244-4597

Solder-on Adapters

DESIGNED FOR USE IN THE design and testing of new circuitry, where target ICs are sometimes unavailable, ITT Pomona's solder-on adapters offer an economical, risk-free, reliable test interface. As generic interfaces, the solder-on adapters work on standard EIAJ (metric) and JEDEC surface-mount technology layouts for any chips with the same lead pattern.



CIRCLE 24 ON FREE INFORMATION CARD

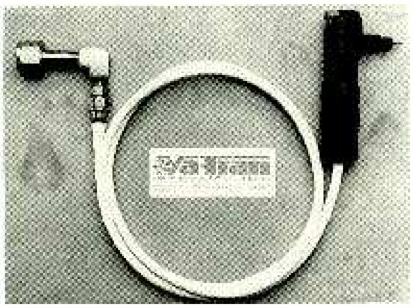
The adapters provide the crucial interface between circuit boards and test instruments so that engineers can design and test circuitry. Each base comes with a breakout board for connection to logic analyzers and other test instruments, with access via 0.025-inch square pins. Providing secure connections, the solder-on adapters are an alternative to "reusable" adapters.

The solder-on adapters range in lead count from 80 to 240 pins, and are priced from $260 to $1190.

ITT POMONA ELECTRONICS
1500 East Ninth Street
Pomona, CA 91766-3835
Phone: 1-800-241-2060
Fax: 909-629-3317

Enviromentally Safe Component Cooler

THE FEDERAL CLEAN AIR Act, which bans the intentional and non-essential release of CFCs, makes the old method of cooling components with canned CFC refrigerants obsolete. Containing no CFCs or HCFCs, Va-Tran Systems' COMP-CO^2LD component cooler component cooler provides a convenient, safe, environmentally sound, and cost-effective way to perform localized component and circuit testing. It is intended for locating thermal intermittent electrical components, cooling and testing boards for continuity or stress fractures, disassembling or mating tight-fitting metal parts, or for freezing adhesives for easy removal.



CIRCLE 25 ON FREE INFORMATION CARD

The COMP-CO^2LD system, which uses common, recycled carbon dioxide, allows components to reach temperatures as low as −109°F. The spray pattern is easily adjustable, allowing the right amount of CO^2 to reach the test area. One small cylinder of CO^2 lasts for hours.

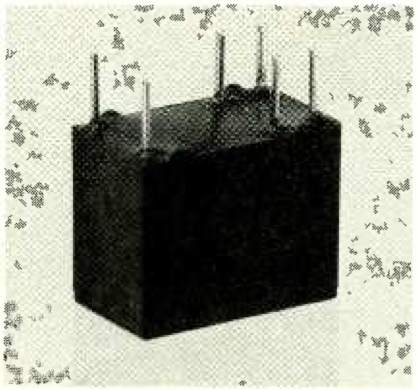
The COMP-CO^2LD with a six-foot hose terminating in a standard CO^2 cylinder adapter costs $350. A complete system including a CO^2 cylinder and cart is available for $650.

VA-TRAN SYSTEMS
677 Anita Street
Chula Vista, CA 91911
Phone: 1-800-379-4231
Fax: 619-423-4604

Subminiature Relays For Telecommunications

THE R70 SERIES OF SUB-miniature relays from NTE Electronics are specially designed for use in telecommunications, computer/peripheral equipment, and interface applications. The high-performance, 1-amp relays feature high sensitivity, compact design, fully sealed construction, and low power consumption. They are intended for use in OEM design and as replacement parts in telecommunications and computer equipment.

The R70 series is available in coil voltages of 3, 5, 6, 12, and 24 volts DC, and come standard with SPDT contacts. The relays weigh only 0.08



CIRCLE 26 ON FREE INFORMATION CARD

ounces and operate at temperatures ranging from -30°C to +70°C. They feature dielectric strength of 1000 VAC between coil and contacts and 400 VAC between contacts of the same polarity. Resistance is 100 megohms maximum.

The R70 series, in 1000-piece quantities, costs less than $2 each.

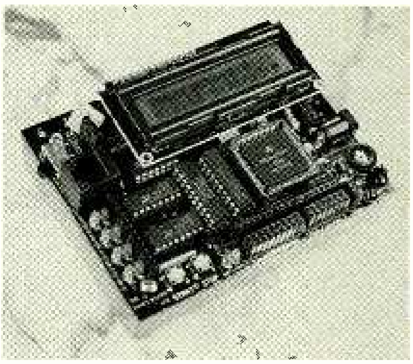
NTE ELECTRONICS, INC.
44 Farrand Street
Bloomfield, NJ 07003
Phone: 1-800-683-6837
(including Canada)
Fax: 1-800-683-3338

Robotics Project Board

THE HANDY BOARD, FROM the Media Laboratory at the Massachusetts Institute of Technology, is a microcontroller board intended for experimental and educational robotics projects. It is the latest in a series of boards released under MIT's free licensing policy, in which the PC board artwork, schematics, and even the driver software may be freely licensed for personal, educational, and commercial applications.

The compact, handheld board features the Motorola 68HC11 CPU with 32K of battery-backed RAM, a 16´2-character LCD screen, four DC motor outputs, 16 powered sensor inputs, infrared I/O, and a built-in nickel-cadmium rechargeable battery. The Handy Board runs Interactive C, a multitasking cross-platform development system for computers running the MS-DOS, Macintosh, and Unix operating systems.

Assembled, complete Handy Board systems cost less than $250; kits cost less than $200. Kits and assembled



CIRCLE 27 ON FREE INFORMATION CARD

systems are distributed by Gleason Research (gleason@tiac.net; 617-641-2551); CW Technology (cwtech@infinet.com; 800-547-7479); and Digital Micro Systems (dutta.4@osu.edu; 614-299-2566). Blank printed circuit boards are sold by Douglas Electronics (info@douglas.com; 510-483-8770).

THE MEDIA LABORATORY
Massachusetts Institute of Technology
Room E15-320
20 Ames Street
Cambridge, MA 02139-4307
http://el.www.media.mit.edu/groups/el/projects/handy-board

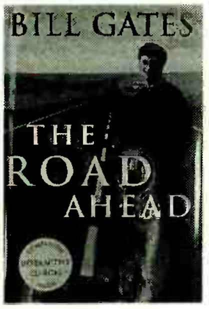
EN

NEW LITERATURE

USE THE FREE INFORMATION CARD FOR FAST RESPONSE

The Road Ahead

by Bill Gates with Nathan Myhrvoid
Viking
375 Hudson Street
New York, NY 10014
Phone: 212-366-2000
$29.95



CIRCLE 40 ON FREE INFORMATION CARD

Where the budding "information superhighway" will eventually lead us is anybody's guess—but if anyone is qualified to do such guessing, it is Microsoft co-founder, chairman, and CEO, Bill Gates. This book presents Gates' optimistic vision of how today's emerging technologies will change the way we work, play, and live in the future.

"We are all beginning another great journey," Gates writes. "We are watching something historic happen, and it will affect the world seismically, rocking us the same way as the discovery of the scientific method, the invention of printing, and the arrival of the Industrial Age did."

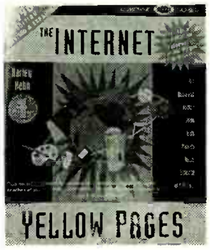
Gates presents a brief overview of the development of the Information Age before turning his attention to the Information Highway—the global network of personal computers and other information appliances that he believes will be available in homes and businesses within the next ten years. He foresees that the world-wide "information market" or "exchange" will provide unprecedented access to information, services, and products, empowering more people to participate in everything ranging from their children's education to the political process.

Gates describes some of the products that he expects will soon become available and that promise to change the way we learn, work, shop, and socialize. He then covers specific areas in which he believes the implications of the Information Highway will be most strongly felt. In education, Gates predicts, on-line textbooks, multimedia documents, and easy authoring tools will allow teachers to customize a curriculum for students who learn at different speeds and allow students to explore information interactively. In politics, on-line forums could be used to mobilize people into a coherent political movement, and e-mail could provide voters with more direct access to elected officials. Gates envisions a business world filled with smaller, more efficient companies, and an electronic global marketplace in which the middlemen are cut out of most transactions. Telecommuting will ease the stress on urban infrastructures and could even cause socioeconomic transformations as workers are no longer physically tied to the workplace. Using his own under-construction home as a prototype, Gates describes the house of the future as one that can anticipate and meet its occupants' needs automatically.

The book includes an interactive, multimedia CD-ROM that contains the complete text, hundreds of multimedia hyperlinks, a special video interview with Gates (which can also be played on an audio CD player), video simulations of future technology, and a World Wide Web browser.

The Internet Yellow Pages Third Edition

by Harley Hahn
Osborne McGraw-Hill
2600 Tenth Street
Berkeley, CA 94710
Phone: 1-800-227-0900
$29.95



CIRCLE 39 ON FREE INFORMATION CARD

Now you can let your fingers do the walking down the information highway, thanks to this comprehensive directory. Arranged in the familiar style of a phone book, its listings are grouped in alphabetical order by category. Each listing contains a brief description, written in a witty, engaging style.

The book has been updated to cover the best and most popular sites on the Internet. The vast array of Internet sites has been pared down to include only those that are useful and fun, and that guide users to other related information. The new edition includes art, games, jobs, humor, movies, pets, religion, sexuality, and more. Those who need a little nudge toward rebellion can check out "Harley Hahn's List of 25 Things to Do When You Should Be Working." And off-beat souls should enjoy the listings found under the heading "Bizarre": Contortionism, Gross and Disgusting, Ouija, Psychic CB, and Roommates from Hell, and several dealing with vampires are just a sampling.

The guide provides more than mere listings of categories and Internet addresses. It offers information about each topic listed, hints about what to expect when accessing sites, and humorous "advertisements" highlighting interesting resources that might otherwise be overlooked.

1996 Electronics Parts & Accessories Catalog

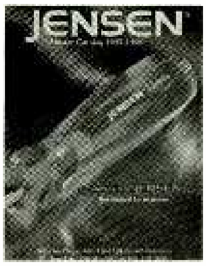
Parts Express
340 East First Street
Dayton, OH 45402-1257
Phone: 1-800-338-0531
free


CIRCLE 38 ON FREE INFORMATION CARD

This 228-page catalog is filled with electronic parts and accessories geared toward the consumer-electronics industry and the technical hobbyist. It includes a broad array of CATV and VCR repair parts, semiconductors, tools and technician aids, test equipment, computer accessories, chemicals, adhesives, telephone products, specialized connectors, and instructional books and videotapes. Its full line of professional sound equipment includes wire and audio accessories such as raw loudspeaker drivers for home, car, and home-theater applications.

1996 Master Catalog

Jensen Tools, Inc.
7815 South 46th Street
Phoenix, AZ 85044
Phone: 1-800-426-1194
Fax: 602-438-1690
free



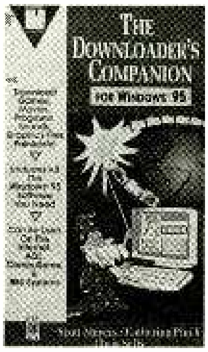
CIRCLE 37 ON FREE INFORMATION CARD

Offering a combination of test and diagnostic instruments with quality tools and accessories, this catalog represents a comprehensive, one-stop source of hard-to-find tools and specialty tool kits for radio amateurs and electronics hobbyists. The colorful, 240-page book presents the latest additions to the Jensen Tool Kit (JTK) line and introduces seven models of the economical new Vantage line.

The catalog also features products from many leading tool and test-equipment manufacturers, including state-of-the-art items from Fluke, B+K Precision, Extech, Biddle, Wavetek, Tektronix, Navtel, Datatran, and others. Also included are wire, cable and connectors, inch/metric tools, PC diagnostics, fiber-optic products, power monitors and meters, soldering and SMT rework stations, cases, and shipping containers.

The Downloader's Companion for Windows 95

by Scott Meyers, Catherine Pinch & Chris Sells
Prentice Hall
1 Lake Street
Upper Saddle River, NJ 07458
Phone: 1-800-383-2419
Fax: 201-236-7141
E-mail: corpsales@prenhall.com.
$21.95



CIRCLE 36 ON FREE INFORMATION CARD

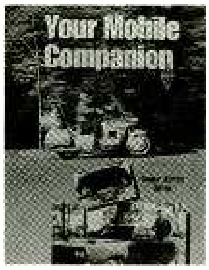
Thousands of games, programs, sounds, pictures, and even multimedia movies are yours for the taking from computer networks such as the Internet, CompuServe, and America Online—if you know how to download them. Downloading is the art of moving files from other computers to yours and translating those files into a usable format. Downloadable files are usually in a form that your computer cannot immediately understand. The files are compressed, archived, encoded, or perhaps even all three. Pictures might be in GIF, JPEG, or some other format.

This book-and-disk package explains all of those terms and formats, and provides all the software you need to effortlessly download programs to your PC. It offers insider's tips that allow you to learn without spending time and money on online trial and error. The book not only tells you how to download files, but also how to determine what's in the file, what it's good for, and how you can use it.

The disk includes WinZip, a Windows 95 compression/uncompression interface that can work with all the most common archive formats. It also provides quick file viewers and instructions for accessing files in a variety of formats, including pictures and graphics in GIF, JPEG, BMP, and TGA; MPEG movies; and sounds and music in WAV, VOC, AU, and others.

Your Mobile Companion

by Roger Burch, WF4N
The American Radio Relay League
225 Main Street
Newington, CT 06111
Phone: 203-666-1541
Fax: 203-665-7531
$12



CIRCLE 35 ON FREE INFORMATION CARD

Whether you're just getting into mobile operating or are looking for new ways to enjoy mobile hamming, this book is for you. The book provides practical, hands-on advice on setting up and mobile station and getting it on the air. It shows what to do and what not to do, and is full of tips and ideas to optimize mobile operating.

The book contains all the information you need to make informed decisions. It helps you pick the best of the bands; sort through all the different models of equipment available to choose the right gear for your needs; successfully complete even the trickiest installations; and choose the best antenna and decide between top, rear, and on-the-glass mounting. Once you're up and running, the book explains where and how to operate to get the most out of your mobile station, and provides proven solutions to automotive interference problems. EN

EQUIPMENT REPORTS

continued from page 20

readout. Slide controls for positioning the A- and B-channel waveforms are located around the periphery of the display.

The autoranging feature works only when periodic signals with constant amplitude are being measured. In all other measurements the time base and gain ranges must be set manually. The autoranging mode takes a few seconds to find the correct settings and display the waveform. A sample of the waveform can be obtained in a single or repeat mode, and then the gain and time base settings should be adjusted to set the instrument on the proper range.

The time base can be adjusted from 0.5 microseconds per division to 50 milliseconds per division in 16 ranges, and gain can be adjusted from 5 volts per division to 5 millivolts per division in 10 ranges. A secondary menu makes it possible for Multiscope to react to a range of different input conditions.

A chart button on the oscilloscope display sets Multiscope in its recorder mode. Start and stop buttons turn the recorder on and off. Pressing a pair of up/down buttons adjusts chart recorder gain, and the sample interval

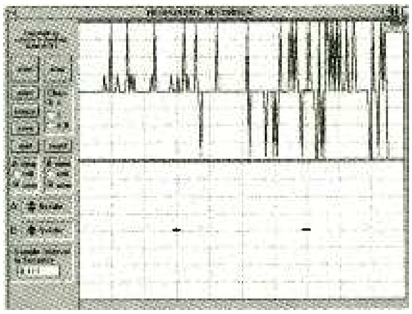


FIG. 2—THE VIRTUAL RECORDER display as it will appear on your computer's monitor.

can be keyed in by the user.

The DB-25 connector on the front panel provides different signals for use with other equipment . Output channels C and D are provided on the connector. Pin 25 goes to an inactive external trigger option. An option that calls for additional software and hardware permits Sample data set on channels A or B to be externally initiated or controlled.

Various accessories are also available from Mission Technologies. A software package that contains the source code (fully commented to explain its operation) is available for an additional $100, bringing the total cost to $499. An external triggering software package and relay (to be installed by the user or at the factory) is an additional $38. An eight-bit ISA parallel port card for computers whose ports are not compatible with the Multiscope is available for $12.

Multiscope is not a true substitute for the stand-alone instruments it emulates, but then it costs a lot less. Rather than buy a bench full of dedicated instruments, Multiscope offers measurement capability that is more than adequate for most hobbyist and experimenter applications. It fills that gap between a multimeter and a bench full of dedicated test instruments. If you want to see how your personal computer can double as a collection of quality test instruments, buy the Multiscope. EN

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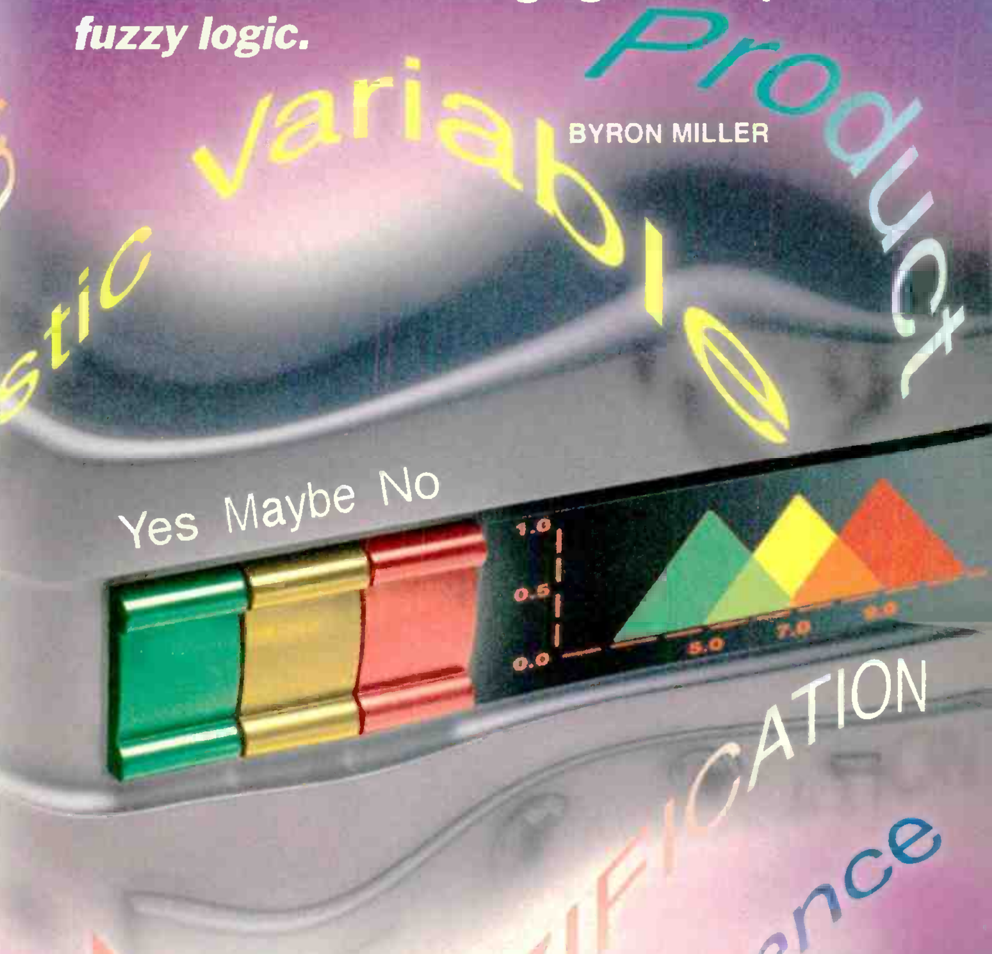
FUZZY LOGIC

A new challenger is threatening to dethrone traditional control techniques as the method of choice. This article describes the challenging techniques of fuzzy logic.

BYRON MILLER



FUZZY LOGIC IS NOT AT ALL AS ITS name might imply. Rather than being indistinct, it is a rigorous mathematical discipline that is based on fuzzy-set theory, which is a cross between multi-valued set theory and Boolean logic. Lotfi Zadeh of the University of California, Berkeley, is credited with its creation in 1965. However, portions of his theory trace their origins to multi-valued set theory of the 1920's.

Zadeh observed that as a system become more complex, the need to describe it with precision becomes less important. He also observed that precision in complex systems is often unnecessary. Zadeh's premise is that it is possible to describe a system's behavior and control laws linguistically.

Precision is expensive, especially when used for solving problems. Getting close is often good enough. Fuzzy logic exploits this "good-enough" mentality through imprecision. It uses imprecision the same way that humans do to solve problems. For example it is certainly possible to heat a room to within a hundredth of a degree. Alternatively, a fuzzy logic controller might heat the same room to within one degree. This is a situation where the extra precision is exorbitant.

Fuzzy logic enables designers to simulate human thinking by quantifying concepts such as hot, cold, far, near, soon, and long. Fuzzy logic relies on the notion that measurements are more useful when they are expressed in linguistic terms, rather than described to the sixth decimal point. In other words, fuzzy logic reduces complex problems into manageable sets called *fuzzy sets*.

Consider, for example, describing a person's height in fuzzy sets. Few would argue that a person who is seven feet tall is "tall," and a person who is three feet tall is "short." But what about someone who is five foot five? Fuzzy logic would give that person some degree of membership in the tall set, and a somewhat higher degree of membership in the short set.

Traditional control theory

Fuzzy set theory has applications in many different disciplines. One, in particular, is fuzzy-logic control theory. Fuzzy-logic control theory is an alternative to traditional control theory.

In traditional control theory, a controller controls a system. A system is a collection of things that are connected in some way. This collection of connected elements performs a single function. Consider a heating system, for example. The heating system is composed of a thermostat, sensors, and a heating unit. All of the individual elements are connected together to perform one function.

A control system is a physical system that either commands or regulates itself or another system. There are many examples of control systems. For instance, an electric switch controls the flow of electricity. A person driving a car controls the speed and direction of that car. A heating system makes use of the thermostat to regulate a

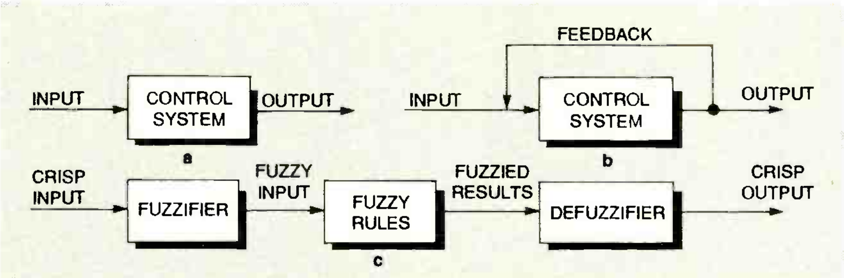


FIG. 1—CONTROL SYSTEM BLOCK DIAGRAMS. A general control system (a), closed-loop system (b), and a typical rule-based fuzzy-logic controller (c).

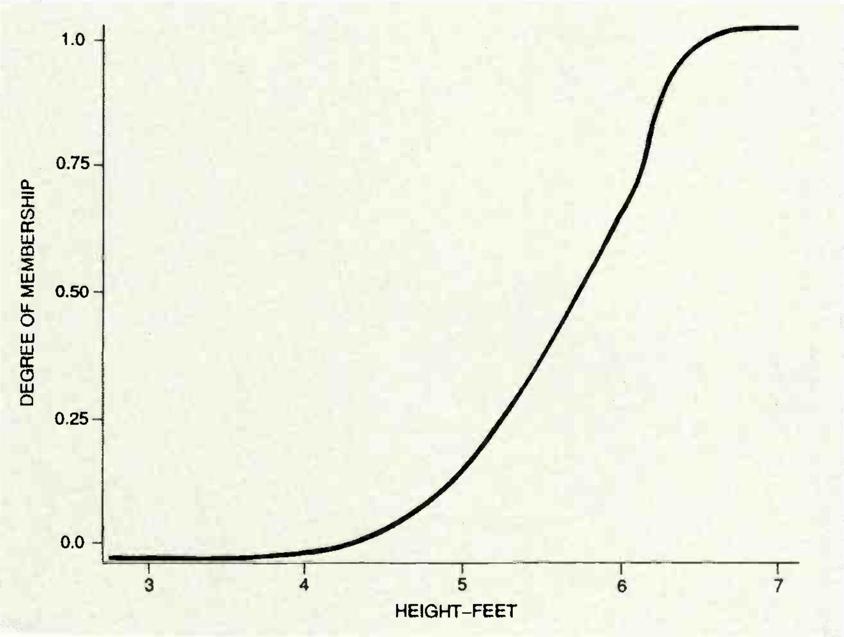


FIG. 2—THE SET "TALL" represented graphically.

room's temperature.

Figure 1-a shows a typical control system. It has one or more inputs and one or more outputs. The box marked "control system" is where the processing occurs. The type of processing that occurs within the control system is classified as either *open-loop* or *closed loop*.

An open-loop control system is one in which the control action is independent of the output. In other words, the control system's output is directly related to its input. For example, an open-loop control system takes its inputs, does some computation on those inputs, and produces an output.

A closed-loop system differs from the open-loop system in that its output is dependent on both the input and the output. Figure 1-b shows a closed-loop system. The output is made a function of both the in put and the output by *feedback*. In most systems, the feedback component forms an extra input to the system.

A calculator is an example of an open-loop system. Input is in the form of number and operation-code (opcode) keypresses. The calculator takes the input, operates on the input based on the opcode, and produces an output based on the result of the operation.

A car being driven is an example of a closed loop system. The person adjusts the speed of the car by pressing the gas pedal. The feedback in this system is the person, who regulates the flow of gas to the engine based on the speedometer. Thus if the person wants to increase speed to 55 miles per hour (MPH) he presses the gas pedal, and the car accelerates. The car continues its acceleration until the person sees that the speedometer reads 55 MPH, and he eases off the gas pedal.

The most commonly used control systems today are based on the proportional-integral-derivative (PID) method. James Watt is often credited for the creation of classical control theory on which the PID method is based. The PID method controls a system by reading the input sensors and applying a mathematical equation to the inputs to produce the output. Typically the output from this type of system is used to control some kind of actuators to regulate the flow of something. One example is an actuator which is used to control the flow of steam from a turbine. The mathematical equations that the PID is based on are usually complex, and are time consuming to define, build, and test.

Fuzzy-logic control theory

In general, a fuzzy-logic control system has three components. The first is the *fuzzification* section. This section is responsible for taking real input data (also referred to as crisp data), and converting it to data that has meaning to the fuzzy system. Next, the fuzzified data is applied to the *fuzzy-rule base section*. Fuzzy control systems are typically the feedback type. Consequently, the feedback in a fuzzy control system occurs within the rule-base section. The result of the rule-base section is fuzzified output data. This fuzzified output data is converted back to real or crisp data through the *defuzzification* section. A typical fuzzy control system is shown in Figure 1-c. When a control system is implemented it is often referred to as a controller.

A fuzzy controller is made up of fuzzy variables, rules, sets, and translation mechanisms that transform input data into fuzzy data, and vice versa. Fuzzy variables are similar to regular variables, except that they are used to describe things that are multi-valued. For instance the

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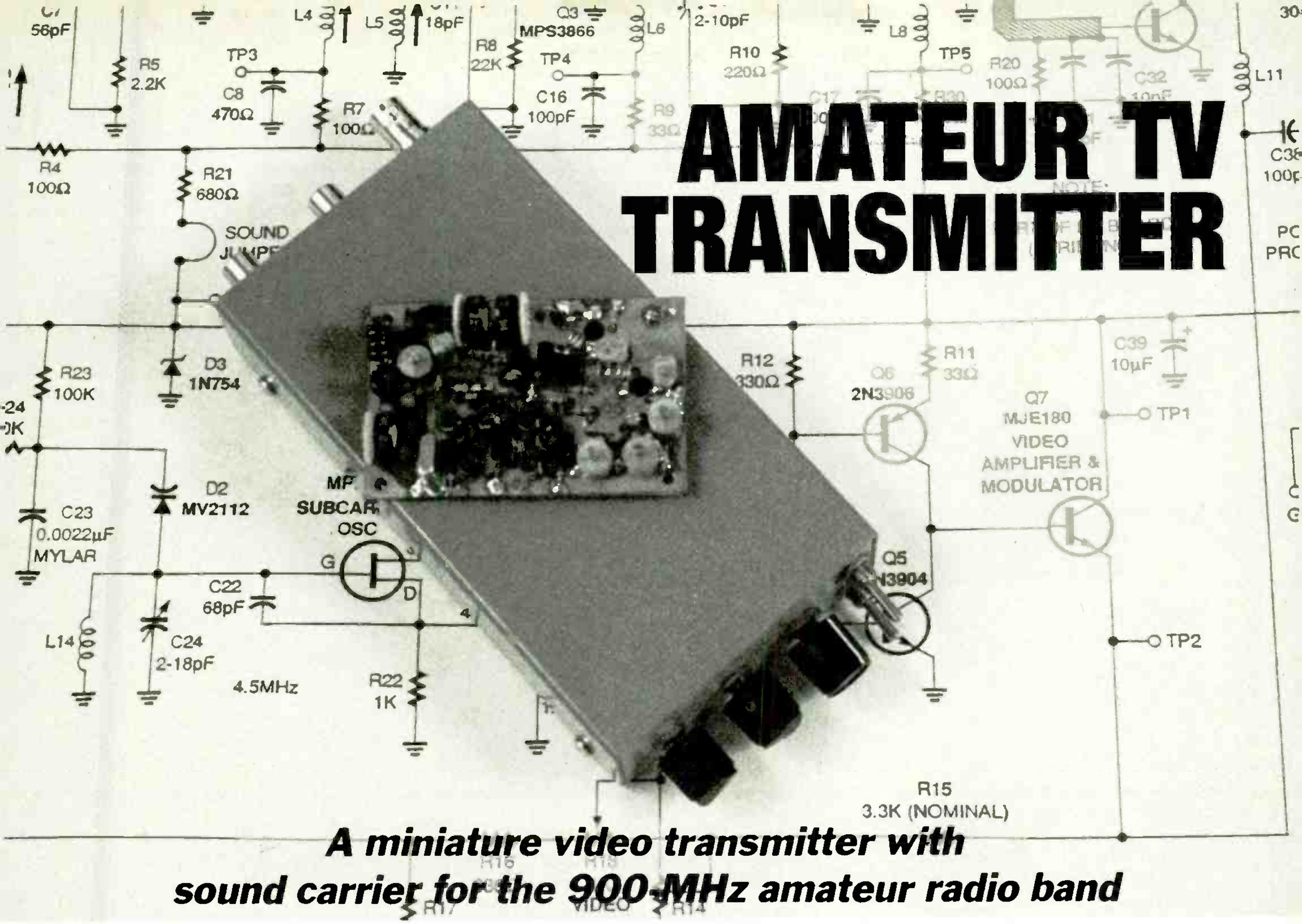
AMATEUR TV TRANSMITTER



A miniature video transmitter with sound carrier for the 900-MHz amateur radio band

William Sheets, K2MQJ & Rudolf F. Graf, KA2CWL

YOU CAN BUILD A MINIATURE AMAteur radio TV transmitter and put it to work in a variety of applications from radio-controlled videography to two-way communications—and just about any other video application that might strike the fancy of experimenters and amateur radio operators. Now, small CCD cameras help to keep the cost low.

Don't confuse the Mini 900 ATV transmitter with video-link devices operating in the 900-Mhz band. The Mini 900 is very small (1.75 × 2.75 × 0.75 inch), develops 500 milliwatts of RF output, is crystal controlled, and has produced clean pictures at distances over 5 miles, using simple antennas at both ends of the transmission path. Note that the 902-928 MHz band is available to ham radio operators holding a valid Technician Class license or higher. A license is required to operate this project in the U.S. (No Morse code test is required for the Technician license.) The transmitter is for experimental non-commercial use only and its application is subject to radio amateur rules and regulations in the U.S. and other countries.

Operation of the Mini 900 ATV transmitter on commercial TV frequencies is illegal in the U.S. and for other nations. The device has *not* been submitted for FCC type acceptance and is *not* legal for commercial use.

The Mini 900 must be operated so that the entire RF signal lies within the 902-928-MHz band when operated in the U.S. This means picture carrier frequencies of 906.5 and 923.5 MHz inclusive. A good choice for most radio amateurs is 910.25 MHz. U.S. operators should check their local areas first. Other common carrier frequency alternates are 922.25 and 923.25 MHz.

The Mini 900 accepts an NTSC video signal and generates a video-modulated RF signal including a standard 4.5-MHz sound subcarrier in the 902 to 928-MHz band. The signal from the Mini 900 can be received on any standard TV receiver fitted with a suitable RF downconverter capable of tuning the 902-928 MHz Amateur band. The transmitter's small size (1.75 × 2.75 inches) is comparable to many small PC board cameras and is small enough for radio-controlled applications in which a video link is needed.

The Mini 900 can operate from a 10 to 14-volt DC power supply, with minor adjustments in the transmitter's video drive. Lead acid, NiCd, or alkaline power packs may be used. RF power output will be 0.2 to 0.7 watts over the power-supply voltage range. Nevertheless, the author used a 13.2-volt DC power supply and it is referenced throughout this article.

Operation over 900-940 MHz

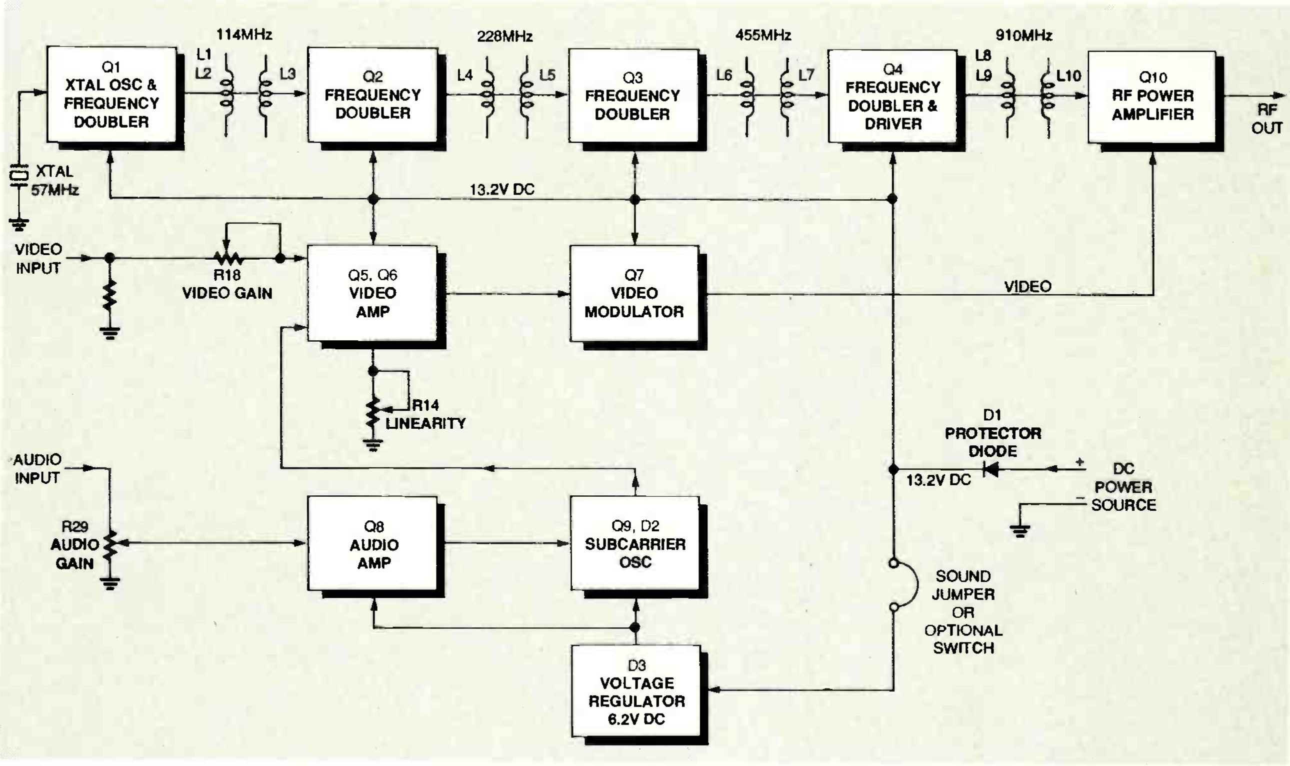


FIG. 1—BLOCK DIAGRAM for the Mini 900 ATV transmitter illustrating signal generation and flow. It is a good idea to refer to this diagram while following the details in the schematic diagram in Fig. 2.

is possible with the Mini 900 for export (non-US) use. The Mini 900 can easily be retuned for a 5.5 MHz sound subcarrier used by the PAL system. The video input requirement is standard 1-volt peak-to-peak, negative sync signal. The video amplifier and modulator are DC coupled, but a capacitor can be installed in series with the input if AC coupling is desired. Audio inputs from 5 millivolts to 1 volt can be accommodated.

This project can be built from scratch, in two to four evenings, depending on the builder's experience. Due to the unit's small size and many small parts, and the high frequencies present, this project is not recommended for beginners.

How it works

The Mini 900 consists of a crystal oscillator operating around 57.5 MHz, a series of frequency multiplier stages to multiply the crystal oscillator frequency by a factor of sixteen, and an RF power amplifier. Refer to Fig. 1 for the functional block diagram of the Mini 900 circuit and Fig. 2 for a detailed schematic diagram. The RF-power amplifier is amplitude-modulated by a video amplifier that boosts the video input signal to a required level. An audio amplifier stage boosts the audio input which in turn frequency modulates a 4.5 MHz VCO (voltage-controlled oscillator) to generate a sound subcarrier. The FM subcarrier is combined with the video in the modulator. If no audio is needed this feature can be disabled by disconnecting a jumper.

Transistor Q1 is a crystal-controlled oscillator using a 56–59 MHz crystal, XTAL1, in a common-base transistor circuit (see Fig. 2). At the series-resonant frequency of the crystal, the base of Q1 is nearly grounded. Coils L1 and C2 are tuned slightly above resonance, causing oscillation at the crystal frequency. The signal generated is rich in harmonic frequencies.

A filter, consisting of L2, C3, C4, L3, C6 and C7, couples the second harmonic of the crystal's 112-118 MHz signal to frequency- doubler stage Q2. This stage further doubles the signal frequency to 225-240 MHz. A filter, consisting of C9, L4, C10, L5, C11, and C37, suppresses all frequencies other than those in the 225-240 MHz range. Also, the filter matches the input of the next stage, frequency doubler Q3. Transistor Q3 doubles this signal to half the final output frequency, 450 to 470 MHz. At this point, about 30 milliwatts of RF power is present.

A filter, consisting of C12, L6, C15, C13, C14, and L7, forms a matching network to couple the RF energy from Q3 to Q4, and also filters out unwanted signals. Transistor Q4 doubles this signal to the final output frequency, 900-940 MHz, supplying about 50 to 80 milliwatts of RF driving power. A double-tuned coupling network, consisting of C18, C19, L9, L10, C20, C31, and C32, matches the output of Q4 to the base of Q10. This network has tuned stripline coupled inductors (see Fig. 2) that are actually copper strips etched on the PC board.

RF power amplifier Q10 supplies an RF output of between 0.2 and 0.7 watt depending on supply voltage. A coupling network, consisting of L11, C33, L12, C34, C35, L13, and C36, matches a 50-ohm antenna load

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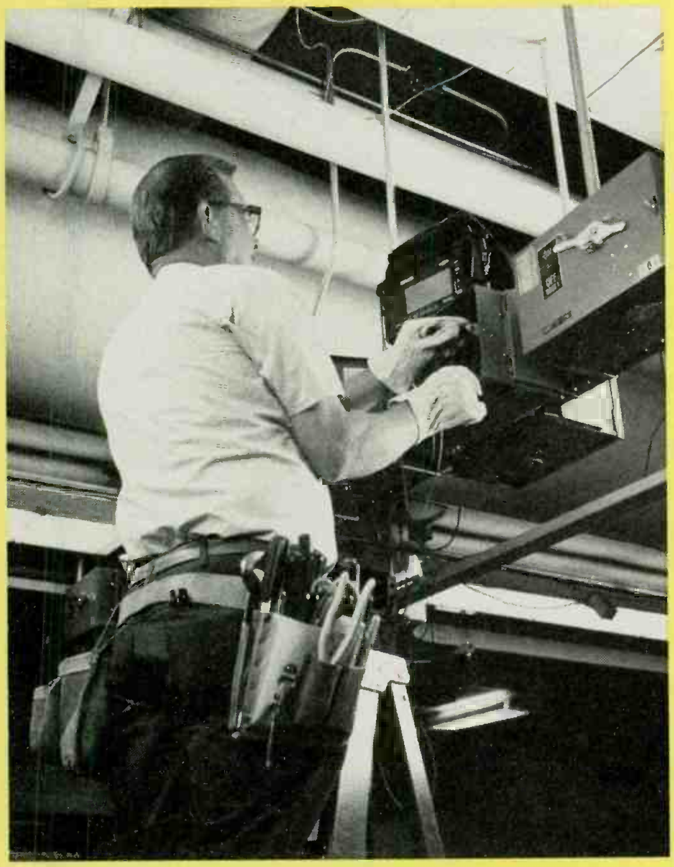

When industrial control systems go wrong, grab a portable scope, and start troubleshooting!

VAUGHN D. MARTIN

Troubleshooting PLC Problems

ALL KINDS OF INDUSTRIAL PROCESSES are controlled electronically these days. The most common control device that an industrial technician is likely to encounter is the programmable logic controller (PLC). Troubleshooting PLC's can be tricky. However, when part of a manufacturing operation is shut down, the technician is under tremendous pressure to isolate the problem, fix it, and get the system up and running again. Last month's article, "All About PLC's", explained how PLCs work and how they are used. This article examines some real-world examples of PLC problems and how they are solved.

A portable oscilloscope is the most important instrument to have when troubleshooting industrial systems on the factory floor. New technology has reduced both the size and weight of the required test gear. For example, the Tektronix TekMeter is a dual-channel, auto-ranging portable scope plus a true rms multimeter in a compact lightweight package with an LCD screen. Although this article references the TekMeter exclusively, it is only one of a growing number of portable instruments in a competitive market. Fluke, for example, offers similar instruments that also target industrial technicians and engineers.

Most PLCs in industrial applications incorporate a variety of self-test features that verify correct sensor operation. However, they are not foolproof. Many electrical malfunctions can be solved only by using an oscilloscope together with your eyes. Take, for example, this case history where an optical sensor was used to count items passing over a conveyor belt.

Too many counts

Figure 1 is a diagram of the packaging operation in which cans were counted as they travelled along a conveyer belt. As each can passed through the optical detector, it produced a pulse that was fed into a PLC's digital input port. The sensor output delivered one pulse for each can that passed by, providing an accurate cumulative total of the number of items.

When the new line was set into operation, it was expected to process 100 cans per minute, or 48,000 cans per eight-hour shift (100 cans per minute times 60 minutes per hour times 8 hours per shift = 48,000 cans.) However, at the end of the shift, the system had counted 50,000 cans, according to the PLC logging function. Nevertheless, there were exactly 2000, 24-can cases, verifying the original 48,000-can computation. Obviously, either the PLC counting program had been incorrectly programmed or the sensor input was receiving pulses for cans that weren't there.

The first step in troubleshooting was to check the counting program by connecting a pulse generator to the PLC input as in Fig. 2, and setting it to generate exactly 10 pulses. An oscilloscope was then connected across the pulse generator to verify proper operation. It showed 10 pulses, and the PLC logging program showed 10 counts. That indicated that the PLC program was probably not at fault, and pointed instead to the sensor or its cabling.

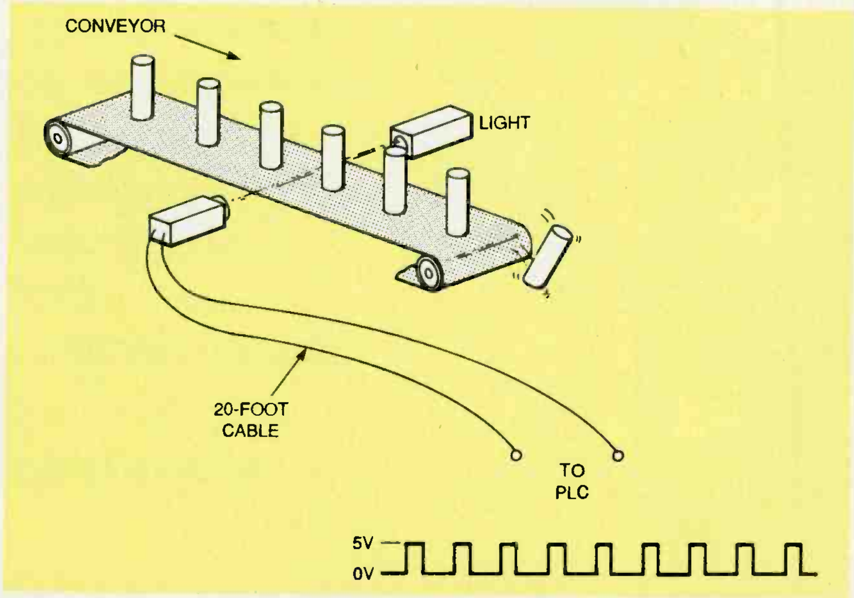

FIG. 1—TYPICAL OPTICAL SENSOR SET UP TO COUNT items as they travel along a production line.

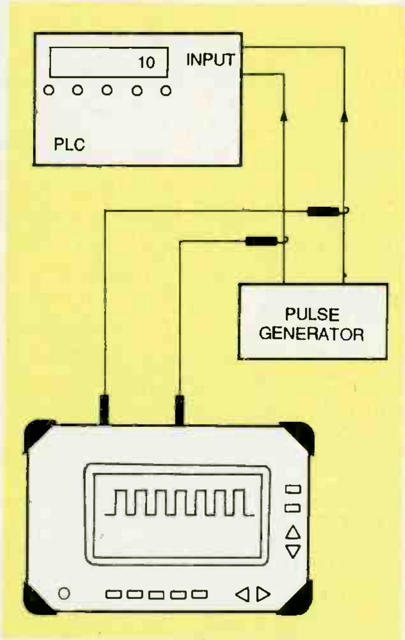

FIG. 2—THIS INSTRUMENT HOOKUP is used to detect the extra, erroneous counts.

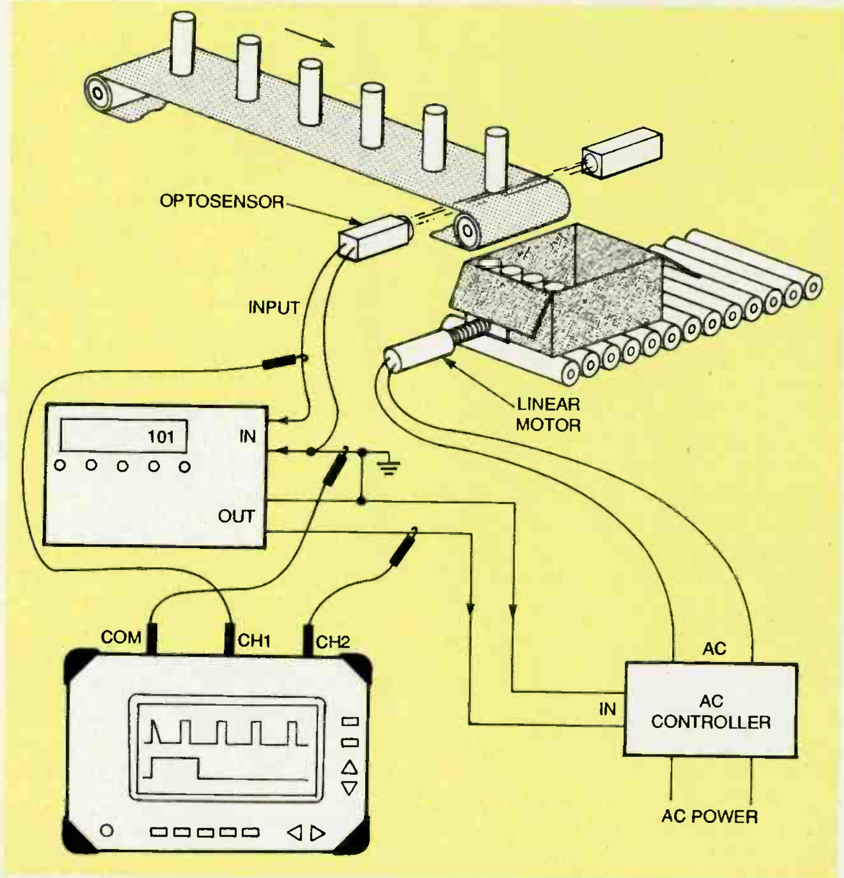

FIG. 3—TROUBLESHOOTING THE PLC CONTROLLER. Connections between the PLC and the process are shown. We can also see how the scope was used to monitor the system.

examine if anything happened in the process only once each carton-filling cycle. We noticed that a small linear motor was energized after each carton was filled to push the carton off the conveyor belt and onto a sealing roller line. Naturally, our investigation then turned to this new suspect.

We reconnected the PLC to the process line and the optical sensor, and connected our scope's channel 1 (CH1) input to the optical sensor output. Then we connected the scope's channel 2 (CH2) input to the linear push motor's control line (ahead of the AC relay or triac controller) as shown in Fig. 3. Then we started the line and set the scope's trigger for the positive edge on CH2; the resulting waveform is shown in Fig. 4. What we discovered is that a stray pulse was being inserted into the optical sensor line each time the linear push motor was

Examining the evidence

Since more cans were counted than were packed, it seemed that some stray pulses had slipped into the optical sensor cable that fed the PLC input. Some 2000 stray pulses, to be exact (50,000 − 48,000). That number proved to be a clue in itself because a little deduction showed that it wasn't a random number. Divide the number of expected cans by the excess pulse error count (48,000 ÷ 2000) and the result is 24. That didn't seem to mean anything at first, but it was the exact number of cans that are in each carton. So now we decided to

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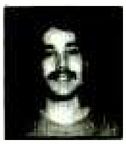

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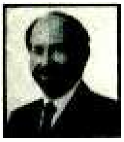

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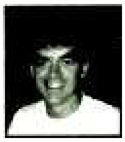

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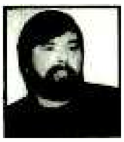

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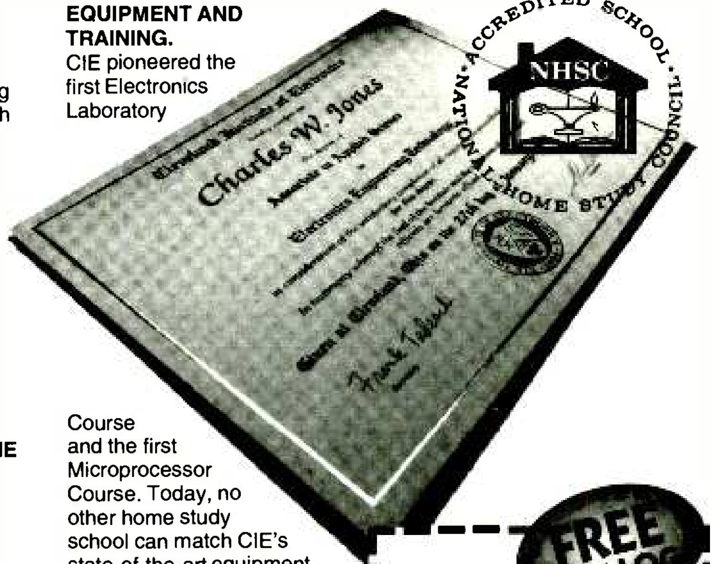

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activated. Not only did the heightened pulse look different from the can-count pulses, it had a different timing delay than that of the 100 can-per-second pulses. But the PLC logged the pulse just as though there were a 25th can in each box.

Diagnose the problem

Using the same scope connections, with the line still running, we attempted to eliminate the extraneous pulse. As we examined the physical layout of the plant floor, we found that the optical sensor cable passed by and directly over the housing of the linear motor. Immediately we suspected that magnetic coupling between the motor and the sensor output line leading to the PLC was causing the extra pulse. As we watched the scope display we tried rerouting the sensor cable. As we did so we noted that the decaying pulse on the sensor line disappeard, eliminating the problem. Then we had a fully operational—and correctly functioning—packing line.

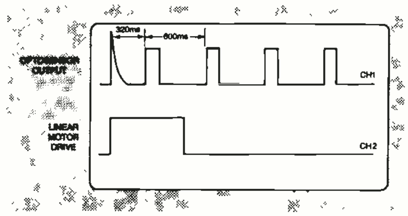


FIG. 4—WAVEFORMS ON THE SCOPE SCREEN quickly identified the problem as an extra spurious pulse.

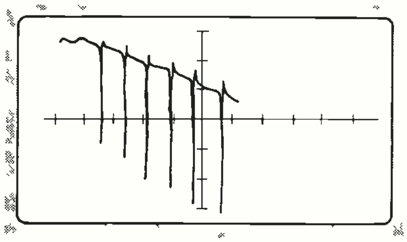


FIG. 5—WAVEFORM OF THE COOL-DOWN thermal output as it appeared on the scope display.

Taking the heat off

Another case history where an oscilloscope saved the day was in solving a problem in an annealing furnace. It had been producing perfect coil springs for two months, but it suddenly began producing weak springs that failed and were being returned by customers as defective. Quality control verified the problem, and they agreed: The springs were weak and lacking proper tensile strength. We immediately suspected some change in the cycle of the annealing furnace. We looked back at the annealing logs for the past few weeks and found that the annealing cycle had been shortened from the original 18 hours to 16 hours. The log revealed that the two-hour change took place during the night when no workers were in the plant, and no one noticed the change. When the crew arrived the next morning they incorrectly assumed that the coils had been properly tempered overnight.

Checking out timers

This time there were two puzzles to solve. First we had to find out why the process failed. Then we had to reset the PLC to provide the correct timing cycle. Most of the cycle was controlled by timers. The only exception was the cooling phase, in which the coils remained in the oven until they cooled to less than 400 degrees Fahrenheit.

Obviously, we checked the timers first, and found that they were all operating correctly. That pointed to a possible cool-down cycle problem. As we examined the PLC operating logs from the past two-week's cool-down cycles, we found that cool-downs were running only about one to two hours, or two hours shorter than what would be normal. Aha! That is where the problem was hiding!

Since we knew that the cool-down time was controlled by the thermocouple reading, we connected a portable scope to the PLC thermocouple input and watched as the furnace switched from its soak to its cool-down phase.

We connected the scope's CH1 to the thermocouple output, selected the autorange mode, and set the sweep to its slowest speed—1 minute per division on the TekMeter. This made ten minutes of cool-down visible at any time. After about six minutes of cool-down we saw the scope trace in Fig. 5. The spikes on the line were abnormal, so we watched closely and noticed that they occurred about once

Continued on page 73

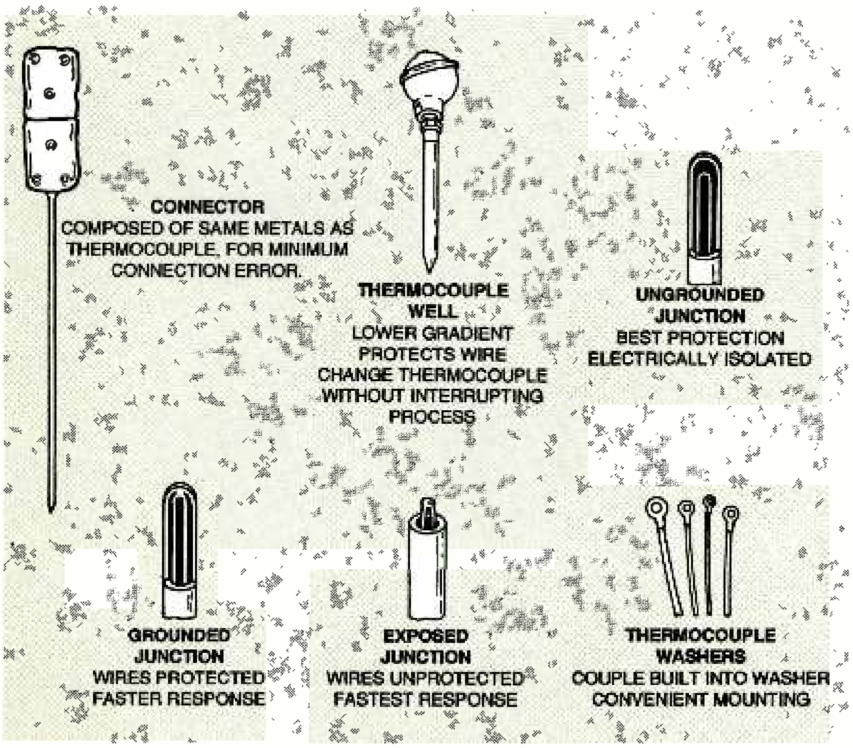


FIG. 6—TYPICAL THERMOCOUPLE CONFIGURATIONS that we will encounter in industrial applications.

MINI METROLOGY LAB

Build a Kelvin-Varley voltage divider to complete the mini metrology lab.

CONRAD R. HOFFMAN

THE FIRST TWO PARTS OF THIS SERIES showed how to build a voltage standard and a null detector. This final article shows how to build a precision voltage divider to complete the mini metrology lab. The voltage divider is a key component of the measurement lab because it allows both larger and smaller voltages to be compared to the voltage standard. It can also act as one side of an ultra-precise resistance bridge, allowing many different values of resistance to be compared to a single known resistance standard.

Of the many types of divider schemes, the Kelvin-Varley divider (KVD) is one of the most useful and desirable because it combines both superb ratio accuracy and high resolution. Found almost exclusively in calibration labs, the KVD is used for the most critical calibrations and measurements.

Commercial KVDs are often accurate to 1 part per million (PPM) or even 0.1 PPM. Unfortunately prices for commercial units start at about $4000, and can easily exceed $10,000. The cost of precision wirewound or bulk metal-foil resistors, multideck switches, and substantial hand labor, conspire to keep commercial KVDs beyond the reach of experimenters.

So can you build a decent KVD without breaking the bank? Absolutely! We'll get into the details shortly, but here are a few specifications to whet your appetite. Our KVD is a full six-decade device, just like the commercial ones. It will resolve 1 PPM. Though the design goal was an absolute accuracy of 20 PPM or .002%, the prototype was twice as good—it was better than 10 PPM at all settings! The total cost of the project is under $75, but a well-stocked junk box can reduce that substantially.

How does it work?

The best way to understand how a Kelvin-Varley divider works is to look at just one decade, shown in Fig 1. There are 11 resistors in the main divider string, but two of them are in parallel with the output divider, in this case, a potentiometer. The value of the output divider is chosen so that the parallel combination of it and the other two resistors is equal to one step of the main divider. Thus, the circuit is the equivalent of a simple ten-resistor divider.

No matter where on the main divider the output divider is placed, the circuit that results is always a ten-resistor divider. Since the output divider is a potentiometer, any voltage between the two tap voltages can be selected.

The simple output divider (potentiometer) can be replaced by another decade constructed in the same manner as the first.

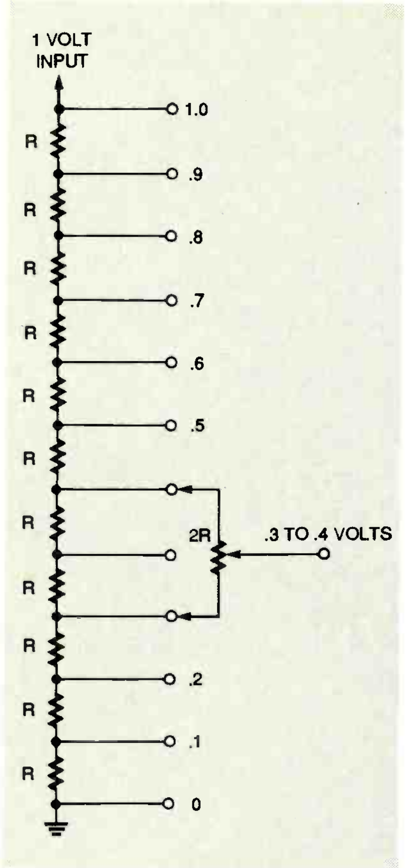


FIG. 1—A SINGLE KVD DECADE. Note that the circuit is equivalent to a 10-resistor divider.

The decade must, of course, have a total resistance equal to twice the resistor value used to construct the first decade. Each additional decade increases the *resolution* by a factor of ten. In theory you can add as many decades as you want, but the divider *accuracy* is always limited by the first decade.

The last decade is a simple ten-resistor divider, since there is no divider in parallel with any of its elements. The top position is the "carry" position, so full output from the KVD will be 9-9-9-9-9-10. Sometimes, a potentiometer is used for the last decade, giving continuous resolution over the full range of the divider.

Figure 2 shows the full KVD configuration. Trimmer networks have been added so that any decade can be shunted to the correct total value. That way you have to be concerned only with resistor matching, not exact resistor values.

You might notice that the resistor values used in each decade set an absolute minimum value for the following decade. The traditional series is 10K, 2K, 400, 80, 16, and 3.2 ohms, with no shunts. This KVD is designed to use standard value resistors, and to have reasonable value shunts. Thus, the values are somewhat different. Remember, you can only shunt a decade one way—down!

PARTS LIST

All fixed resistors are metal film, RN55D, 1%, or better. See text for selection process.

R1–R11—10,000 ohms, selected
R12–R22—2050 ohms, selected
R23–R33—412 ohms, selected
R34–R44—100 ohms
R45–R65—24.9 ohms
R66—806,000 ohms
R67—825,000 ohms
R68—4220 ohms
R69—499 ohms
R70—100 ohm multiturn trimmer
R71, R72—50,000 ohm multiturn trimmer
R73, R74—1000 ohm multiturn trimmer

Connectors

J1–J6—12 Pin Header, Molex 26-48-1121
P1–P6—3-Position Connector, Molex 09-50-8031
J7,J8—5-way Binding Posts, Red
J9,J10—5-way Binding Posts, Black

Miscellaneous

Terminals, Molex 08-52-0072, (Digikey WM2302-ND), case, small rubber grommets, epoxy, hot glue or cyanoacrylate, hookup wire, 22 AWG, insulated, multistrand (two colors required) 9V batteries (3), resistors for comparison bridge (2K, 49.9K), trimmer potentiometer for comparison bridge (1K, multiturn), brass strip (.015" thick, or similar)

Note: For those needing lower temperature coefficient and greater stability, precision bulk metal foil resistors can be ordered in small quantities from: Vishay East, #1 Precision Place, Hagerstown, MD 21742; (301) 739-8722 or Vishay West, 3431-I Pomona Blvd., Pomona, CA 91768; (909) 594-6737. High quality ceramic rotary switches are available for this project from the author. Please inquire as to price and availability: Conrad Hoffman, 4391 County Road #1, Canandaigua, NY 14424-9611; E-mail 73260.2255 @compuserve.com

Design issues

One of the biggest problems in designing this project was finding an affordable way to do the switching. Older KVDs used unique rotary switches which had dual multiple leaf wipers and large brass lugs for contacts. The high contact pressure resulted in very low resistance. Most modern KVDs use high quality two deck wafer switches. Unfortunately, the old switches are no longer available, and the modern replacements are quite expensive. However, the switch design presented here will fit anyone's budget- the "switches" cost just over a dollar each!

The decade resistors are mounted on six twelve-pin headers. Switching is done by moving a plug up and down the header. A three-hole plug is used, with only the end holes connected to the next decade. The physical layout very much resembles the schematic, helping to reinforce the principles of KVD operation. It is also reminiscent of early dividers and bridges that used brass plugs to make connections between adjacent resistors.

The other design issue is the type of resistors to use. Wirewound or bulk metal-foil resistors would be ideal, but they would cost several dollars each, pushing the cost of the KVD out of many people's reach because of the tolerances and quantities required.

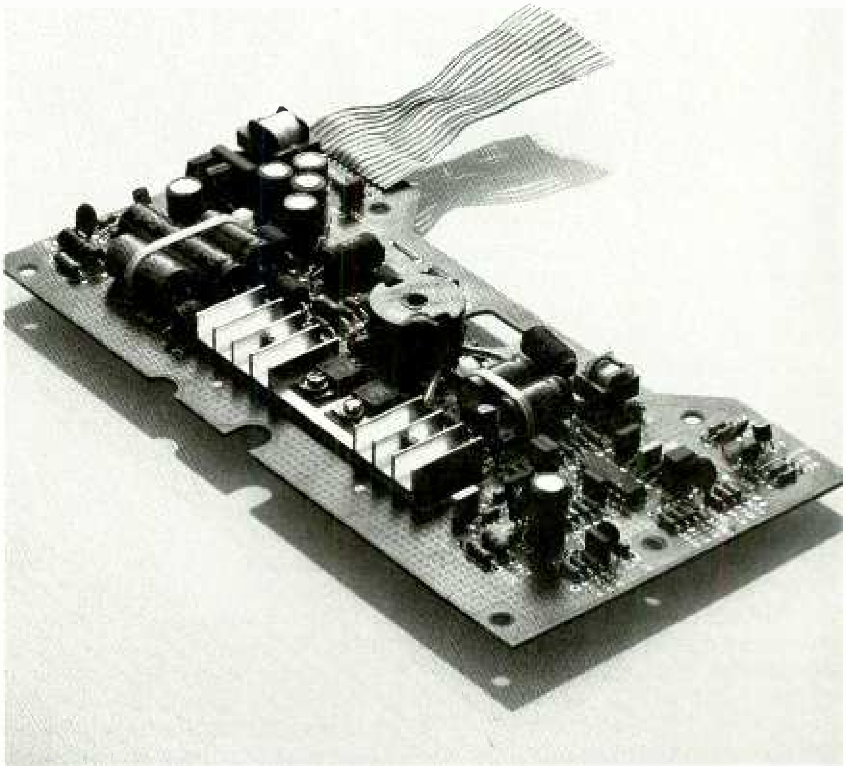
The best easily obtainable resistor is the 1% metal-film type. Its temperature coefficient or tempco is not the best, and its stability isn't well characterized, but those factors can be worked around. If the resistors are selected carefully, and they are put to work over a reasonable temperature range, they can provide quite acceptable performance. However, it is important to check the ratio accuracy occasionally. Although I had some doubts about at-

Continued on page 74

MARK A. McGUIRE

HOW TO SELECT THE RIGHT HEATSINK

From project design to assembly, two easy equations assure sure-fire cooling!



HEATSINKING IS USUALLY OF LITTLE concern in low-power circuits. Most of the time you can bolt the component's metallic tab to a scrap of metal, or maybe to the chassis, without further concern as to how hot it might get. Low-power applications require minimal thermal mass—a few square centimeters of sheet metal–to transfer the small amount of heat generated by a low-power semiconductor to the air.

Nevertheless, heatsinking is of crucial concern for power components in circuits designed to take full advantage of their capabilities. The power component and its driving components can be destroyed when heat cannot be drawn away fast enough.

Two simple formulae will tell you how hot your semiconductors will get in operation. Using them eliminates guesswork and the accompanying apprehension about guessing wrong and making a mistake.

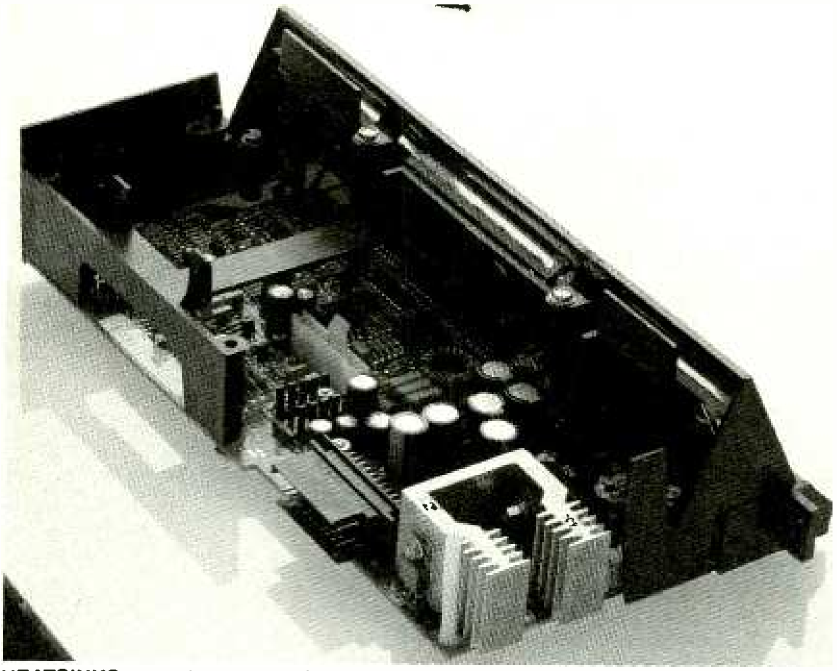
Convection

The design objective for cooling semiconductors is to take advantage of natural convection, which is the transfer of heat by a circulating gas or fluid, in this instance, by ambient air at room temperature. The amount of heat that can be transferred by convection is proportional to the surface area of metal exposed, the velocity of the air passing over the surface, and the temperature difference between the two. This article is limited to the discussion of convective heat transfer to vertical surfaces and natural (as opposed to fan-driven) convective air flow. Nevertheless, even with this limitation, it covers most cooling problems posed by the project designs undertaken by most experimenters.

The power semiconductor is considered a resistive element, as far as the heatsink is concerned. Thus the voltage drop across the device multiplied by the current through it (or I^2R in the case of a power MOSFET) multiplied by the time factor (percent of time it is conducting divided by 100), equals the heat equivalent in watts that the device generates and that must be dissipated into the air by the heatsink. For a simple linear power-supply semiconductor, this is a straightforward calculation. For a semiconductor power switching transistor, the calculation is more involved. For an audio amplifier you might have to estimate dissipation. In any case, make the calculation of the heat to be dissipated equal to the heat in watts as accurate and conservative (on the high side) as you can.

If you have the data sheet for the semiconductor device you will mount on a heatsink, look up its junction-to-case thermal impedance, and case-to-sink thermal impedance. These impedance values are expressed in degrees C per watt, and mean that for every watt of heat power the junction dissipates, it will be a specific number of degrees C hotter than the case–the same applies from the case to the heatsink. If you intend to keep the junction at or below 100° C, and the junction-to-case thermal impedance is 10° C/watt, then 7.5 watts will raise the junction temperature to 100° C, even if the case is kept at a constant 25° C—which might be possible if it were immersed in running water.

Typical junction-to-case ther-



HEATSINKS come in many various sizes and shapes, but the physics of selection is unigue and covered in text. Compare this heatsink with the one on the first page of this story.

mal impedances (Z_{JC}) are 1° C/W for an International Rectifier IRFZ40 MOSFET, and 1.52° C/W for 2N3055. A typical TO-220 case-to-sink thermal impedance (Z_{CS}) is 1° C/W, and for a TO-3 case, 0.12° C/W. Estimate the junction-to-case thermal impedance for your specific semiconductor device using these values for guidance if you do not have the device's data sheet.

Design considerations

What is the maximum temperature the semiconductor's junction should reach? Many circuit designers usually peg the maximum junction temperature at 80° C, because the semiconductor's characteristics will be seriously degraded at higher temperatures, and thermal runaway is a danger for bipolar transistors. Do not take the manufacturer's data sheet claims of maximum watt values and junction temperature seriously. These values are valid only when the device is continuously cooled so that the case is held to a constant 25° C.

Air cooling

What is the ambient air temperature? Remember, the semiconductor device might be inside an enclosure where other heat-producing devices are contributing to the temperature of the ambient air. If you are sure that normal room air can gain free access to the device, you can assume 25° C, but be careful. Recall that the ambient temperature rises in the summer, and 100° F equals 38° C.

Knowing these facts, you can determine ΔT, or the expected temperature difference between the as-yet-unknown heatsink size and the air that will provide the cooling.

$$\Delta T = T_{MaxJ} - [W_J \times (Z_{JC} + Z_{CS})] - T_{AA}$$

where Z_{JC} is the junction-to-case thermal impedance, Z_{CS} is the case-to-sink thermal impedance, T_{AA} is the ambient air temperature, T_{MaxJ} is the maximum junction temperature, and W_J is the junction wattage.

Example: You want to operate a 2N3055 transistor as a motor control, drawing 3 amperes. You will find that the transistor drops 1.2 volts at this current value, and know the maximum duty cycle will be 50%, or 0.5. So, 3 × 1.2 × 0.5 = 1.8 watts. If you decide on a 80° C maximum junction temperature, and 25° C ambient air so that

$$\Delta T = 80 - [1.8 \times (1.52 + + 0.12)] - 25$$

$$\Delta T = 52° C$$

The ΔT computation reveals that the estimated heatsink might be 52° C hotter than the air under these conditions. How big, then, must this heatsink be? The answer is calculated as follows:

$$A = W_J \times 5630 \div \Delta T^{5/4}$$

where A = area of the heatsink vertical surface in square centimeters. If you prefer to work with square inches:

$$A = W_J \times 872.6 \div \Delta T^{5/4}$$

In the case of the 2N3055 transistor and using the previous equation for heatsink surface area in square inches, this is

$$A = 1.8 \times 872.6 \div 52^{5/4}$$

$$A = 11.2 \text{ square inches}$$

Thus a heatsink of at least 11.2 square inches of vertical surface area located in free air will do the required cooling job for the transistor.

If you intend to use two or more identical semiconductor devices on the same heatsink, and they are drawing similar currents (e.g. parallel devices), you can do the calculation as if it is for a single device if you calculate the heat power of the combination, and divide the thermal impedances by the number of devices. Dissimilar semiconductor devices should be mounted on different heatsinks.

Example: Two IRFRZ40 power MOSFETs are connected in parallel in a low-voltage switching power supply. The currents are likely to surge to 40 amperes through both devices, and their duty cycles might approach 80%. The on-resistance of the IRFZ40 (the device is conducting) at 80° C is about 0.036 ohm, so the parallel pair will exhibit a resistance of 0.018 ohm to the 40 amperes, giving 0.018 × 40 × 0.8 = 23 watts. Assume a worst case at 38° C as if you were in an Arizona desert during the summer.

Continued on page 48

BY DON LANCASTER

Switching power supplies, the hot chassis, and more PIC tricks

SWITCHING-MODE POWER SUPPLIES ARE NOW USED PRETTY NEAR EVERYWHERE, ESPECIALLY IN PERSONAL COMPUTERS AND PERIPHERALS. INSTEAD OF DOING A DIRECTLY CONVERTING POWER AT 60 HERTZ, raw DC is first created.

The DC, in turn, powers a high-frequency oscillator of some sort. Isolation, power conversion and regulation are typically done at a 20 kilohertz or higher frequency.

Switchmode advantages include high efficiency, light weight, low heat, small size, tight regulation, reduced heatsinking, and low costs. Transformers in particular are much smaller and lighter then their counterparts in linear power supplies. So are most filter capacitors.

Even though severe safety hazards and oddball circuits may be involved, these supplies can end up fairly easy to understand and service.

Let's take a closer look at some of the fundamentals.

The hot chassis then and now

Your power utility provides you with a 220 volt center-tapped home service. The center tap is grounded. Two individual 110 volt arms are split out to supply various circuits in your home. Thus, one end of each 110 volt line is "hot" and one is "grounded". Should you get between hot and ground, you can receive a fatal shock.

Anything that plugs into the power line needs some way of dealing with possible shock hazards+—both to the end user and to anyone doing service. A power transformer is one costly yet effective solution.

At one time, low cost AM radios avoided the use of a transformer by going to the hot chassis system of Fig. 1. One side of the AC power line was physically connected to the chassis of the radio. Plugs in those days were not polarized, so you had a 50-50 chance that the chassis would be hot. Touch the chassis and you are toast!

The reasoning was that the brittle plastic case and easily broken knobs would sort of protect an average user. Well, so long as no one put their fingers in the back. And service techs were supposed to know better. Besides, none of the fatalities ever complained.

I am utterly amazed that scads of people weren't electrocuted by these obvious hazards. Service people (at least the ones that survived) quickly learned to respect a hot chassis.

If you were brave, you touched the chassis through a neon test light. If the lamp dimly lit, you then reversed the plug. If you were smart, you used an isolation transformer instead.

Premium hi-fi's and television sets made use of weighty and expen-

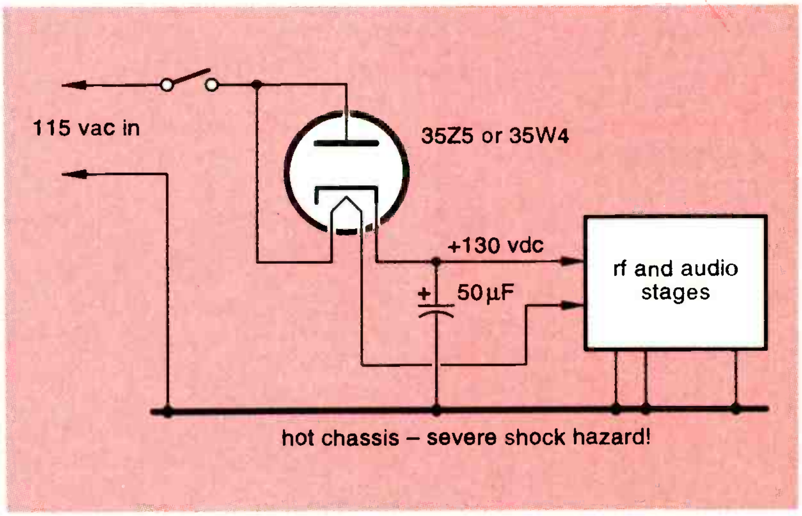


Fig. 1—THE HISTORIC "HOT CHASSIS" PROBLEM. Tube type "AC-DC" am radios had one side of the ac power line connected directly to their metal chassis. Depending on how the line cord was plugged in, you had a 50-50 chance of receiving a bad shock when you touched the chassis.)

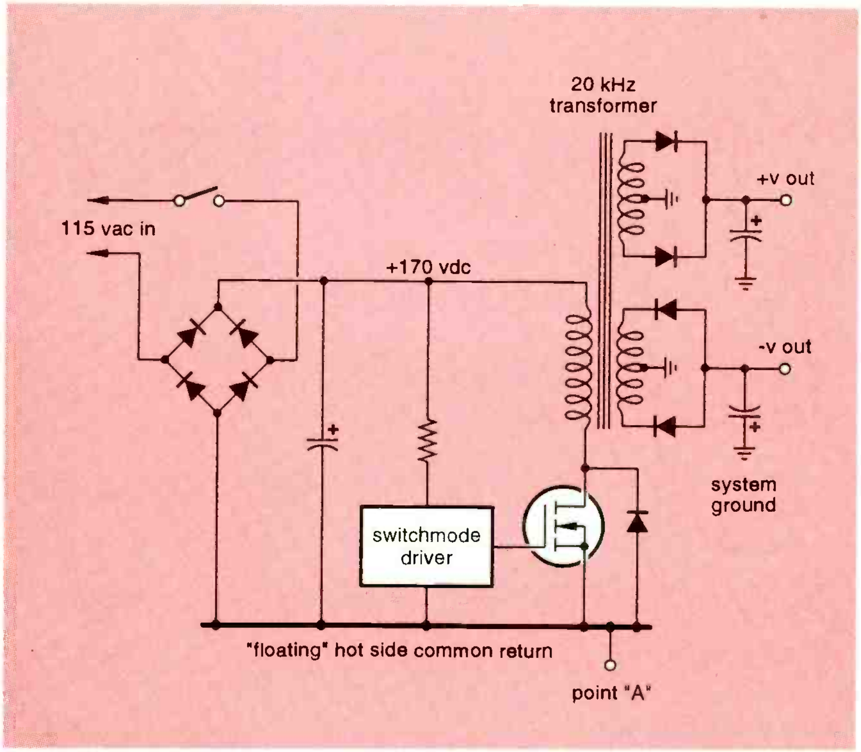


Fig. 2—A TYPICAL SWITCHING POWER SUPPLY. Note that there is an EXTREME shock hazard to the left of the transformer. Be sure to note that connecting a scope ground lead to point "A" will instantly blow one or more power diodes! An isolation transformer MUST get used for ALL service.

sive power transformers. As circuits went solid state and the total power needs dropped, at least some of these went to today's lower power wall-mount transformers. The only hazard here is inside your small throwaway unit.

But transformers were still needed if higher powers or lots of different supply voltages were required. These remained big and expensive. Until someone got the brilliant idea to use high frequency transformers instead of 60-Hz ones.

All other things being equal, a 20 kHz transformer only needs $^{1}/_{333}$rd the weight and volume of a 60-Hz one. Even better yet, you saved two ways on filter capacitors. First because of the increase in frequency. And even more so since you were now dealing with easily-filtered square waves.

These new high frequency circuits are known as switching mode power supplies. As Fig. 2 shows us, the end user is fully safety isolated and has nothing to worry about.

Not so the service person.

For there is now a hot side and a cold side to any switch mode supply. There are high to very high voltages on the hot side. A person servicing tube radios gets a shock every now and then as a painful reminder. It was not nearly as unheard of as in most modern repairs.

There is an extreme shock danger on the hot side of any switching mode power supply!

Moreover, there is usually a diode bridge on the input. So, the negative side of the filter capacitor is always one diode drop removed from the hot side of the AC power line!

If you connect a scope ground to the "ground"side (point "A") of your filter capacitor, you will immediately blow out at least one of the diodes in the bridge regardless ow whether any fuse is present. The diode will usually blow first because you just put the full line voltage directly across it. Also, in the process, you are likely to vaporize your scope probe lead, burn yourself, and receive a severe shock.

So, the old "hot chassis" problem is now back in spades. And it's much worse than before. Because reversing your line cord (A) is not possible and

(B) will not work anyway.

Any attempt at servicing any line operated switch-mode supply +imust+r make use of an isolation transformer! In addition, you +imust+r be extremely careful where you place your scope ground lead!

You should first run through a 110 volt safety isolation transformer. 200 watts is often good enough for most modern gear. This could optionally be followed by a Variac.

Variacs are particularly handy to troubleshoot problems where the fuse instantly blows. Even without a fuse blowing, doing your troubleshooting around 85 volts may reduce the fault currents. Always place the optional Variac *after* the isolation transformer, never before.

If you can't afford a Variac, one ploy the old timers used was to put a large light bulb or two in series with their load. Plus a bypass switch.

By one of those utterly astounding coincidences that seem to infest this column, I just happen to have a few isolation transformers and one variac left from my recent surplus sale.

Servicing switcmode power suppies Repairing a modern switch mode power supply can be tricky because their non-standard circuitry may not be all that obvious. Second, because of the really extreme safety and isolation problems. And third, because everything is connected to everything else in obscure ways.

Let's look at a repair example. I'll show you a little-known sneaky trick that I personally use. One that might make things a lot easier for you. But: *Do not even attempt a repair unless you have a decent scope, total safety isolation, and accurate service information on hand!*

A full schematic is ideal. At the bare minimum, you should know the pinout of all output lines and have data sheets for all integrated circuits and power semiconductors involved.

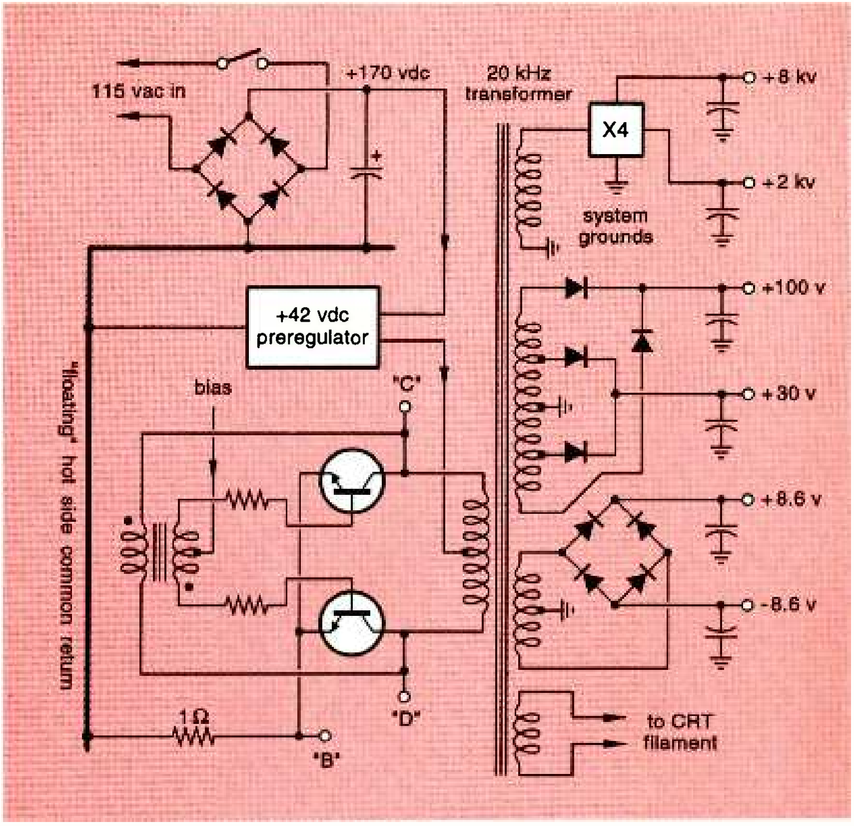


Fig. 3—A PARTIAL SCHEMATIC for the switching supply on a Tektronix 2215A oscilloscope. To resolve a power problem, first use an isolation transformer and monitor the current waveform at point "B". Then remove the line cord and all grounds. Next, inject a 0.4 volt peak-to-peak 20 kHz triangle wave at points "C" and "D". Noting when and how the triangle wave clips can quickly isolate a defective transformer, diode, circuit load, or filter capacitor.

A Case History

I picked up a Tektronix 2215A scope at an auction. Plainly marked "power supply bad". Sure enough, there was no trace and not even a power-on LED. Thankfully, the fuse was fine and did not blow on power up. Figure 3 shows a simplified schematic of the switch mode power supply used.

The main linear power transformer outputs on several windings for all of the needed scope supply voltages. That second feedback transformer is a saturating one that will set the base drive feedback.

I did have a not-quite-right manual for the older model 2215. Its appended change information section was "sort of" like the circuit in use. A look-and-sniff inspection revealed nothing obvious in the way of burned transformers or discolored parts.

The usual 10X resistance check of the output transistors found that all junctions were still working+—neither open nor shorted. A resistance check on all of the output voltage lines also showed nothing suspicious.

Later on, hindsight revealed that Murphy's Law had indeed struck. In misreading a key point. Owing to a missing (but still marked!) jumper. One used on the 2215 but not on the newer 2215A.

I hooked up the required isolation transformer, followed by a Variac and ran it up to 85 volts. The preregulator never got out of its startup mode. It would try, but it quickly shut down from excess current.

It would wait a few seconds, and then try again.

A scope viewing at the common emitter resistor "B" on the converter showed current ramping up above the one amp limit and then shutting off. A look at points "C" and "D" revealed that the transistors were not able to pull their windings down very far at all. But they did at least seem to try. And there were some encouraging 20 kHz "fumes" present.

This said that the main transformer was shorted, excessively loaded, or improperly driven. And Tektronix's factory list replacement transformer pricing nearly equals the wholesale value of the entire scope.

So, here's the sneaky trick I used to

isolate the real culprit: Very few integrated circuits or diodes do much of anything below 0.3 to 0.6 volts. I next injected an 0.4 volt peak-to-peak triangle wave to points C and D, with the power cord disconnected and all grounds removed.

With any 42-volt, one-amp supply, you'd expect that the 20 kHz no-load input impedance at this point to be well above 42 ohms. Instead, it was way down in the milliohms. Telling us that the short was real. Gotcha!

But a check on the high voltage output winding did reveal a smallish triangle wave. And, on switching to a square wave, transformer-type droop and ringing appeared. So there was at least some hope.

Tektronix does provide some jumpers to simplify servicing. Cutting these did not help at all.

But we already knew that from the previous resistance tests! Duh.

The next logical step would have been to remove the transformer from the circuit board and thoroughly test it. That, however, is a slow and painful process. So, just for luck, I first ran an ohmmeter around the diodes. Sure enough, there was a dead short across the diodes on the 30 volt supply.

The usual candidate for a shorted part is the filter capacitor. A shorted diode in any properly designed and inherently current limited supply is extremely unlikely.

But a good diode would never let this weak test signal even reach the capacitor! If the capacitor were bad, a larger input signal (above 0.6 peak volts) would clip, not reveal a total short, which was my reason for using a triangle wave in the first place.

I ignored this obvious fact, and removed the filter capacitor anyway. Sure enough, as you might expect it tested just fine out of the circuit. At least as a quick and dirty "watch it kick" ohms test.

Lifting one end of each diode did in fact reveal one of them to be a dead short. In my experience, that's very rare indeed.

Note that these are higher speed power diodes that have special short recovery times. But even direct from Tektronix, their exact part cost only fifty-five cents.

POWER SUPPLY RESOURCES

Analog Devices
PO Box 9106
Norwood MA 02062
(617) 329-4700

Coilcraft
1102 Silver Lake Rd
Cary IL 60013
(800) 322-COIL

Electronic Component News
1 Chilton Way
Radnor PA 19089
(215) 964-4345

Electronic Products
645 Stewart Ave
Garden City NY 11530
(516) 227-1300

Ferroxcube
2001 W Blue Heron Blvd
Riviera Beach FL 33404
(407) 881-3200

Galco
26010 Pinehurst Dr
Madison Heights MI 48071
(800) 521-1615

International Rectifier
233 Kansas St
El Segundo CA 90245
(310) 322-3331

Linear Technology
1630 McCarthy Blvd
Milpitas CA 95035
(408) 432-1900

Magnetics Inc
Box 391
Butler PA 16003
(412) 282-8282

Maxim
120 San Gabriel Dr
Sunnyvale CA 94086
(800) 998-8800

Motion Magazine
Box 6430
Orange CA 92613
(714) 974-0200

Motorola
5005 E McDowell Rd
Phoenix AZ 85008
(800) 521-6274

National Semiconductor
2900 Semiconductor Rd
Santa Clara CA 95052
(800) 272-9959

PCIM
2472 Eastman Ave #33-34
Ventura CA 93003
(805) 658-0933

Phillips Magnetics
1033 Kings Highway
Saugerties NY 12477
(914) 246-2811

Power Transmission Design
1100 Superior Ave
Cleveland OH 44114
(216) 696-7648

Sensors
174 Concord St
Peterborough NH 03458
(603) 924-9631

SGS
1000 East Bell Road
Phoenix, AZ, 85022
(602) 867-6100

Supertex Inc
1350 Bordeaux Drive
Sunnyvale CA 94089
(408) 744-0100

Surplus Traders
PO Box 276
Alburg VT 05440
(514) 739-9328

Teccor Electronics
1801 Hurd Drive
Irving, TX 75038
(214) 580-1515

Texas Instruments
PO Box 809066
Dallas TX 75380
(800) 336-5236

Toko
1250 Feehanville Drive
Mt Prospect IL 60056
(708) 297-0070

Unitrode
580 Pleasant St
Watertown MA 02172
(617) 926-0404

SomeTips

Once again, please remember that any misplaced scope ground lead can instantly ruin a line-operated switch mode supply! Always use an isolation transformer, and think before you connect or measure!

Getting information and parts from Tektronix can sometimes be tricky. Older parts and manuals are no longer available, and certain key newer items seem to be outrageously overpriced.

An outstanding alternate Tektronix resource is Stan Griffiths and his fine *Oscilloscopes* —Restoring a Classic book. Stan also knows of several low cost sources for long-gone to modern Tektronix parts. These private sources did not wish to be listed in any national magazine, but they sometimes can be made available to you when you call or write Stan.

I've also got a major collection of genuine Tek manuals available at reasonable prices. Write or call for info. Or grab the listing off GEnie PSRT as file SURPCAT1.PDF.

Power supply resources

For this month's resource sidebar, I thought we'd review a few places to go for power supply information.

Your finest supplier is probably Maxim, who provide lots of application notes and free samples. Other chip sources include National, Motorola, Analog Devices, Unitrode Inc, International Rectifier, Texas Instruments, and Linear Technology.

One useful trade journal is PCIM. A good power supply web site can be found at http://motioncontrol.com

A complete review for all power electronics appears as NUTS46.PDF in my GEnie PSRT library. I've also got a large pile of aerospace quality lab power supplies at very low prices in our freebie surplus flyer. Printed copies are available with a phone request or can be obtained online interactive as SURPCAT1.PDF.

Another PIC trick

I've been doing a lot more with the PIC microprocessor, especially for new magic sinewave development. Uh, it seems that plain old shift-right and shift-left commands are missing from the PIC instruction set. Among many other uses, these are real handy for dividing or multiplying by two.

Several helpline callers have also requested these commands. Fig. 4 shows some easy workarounds. Just use a rotate right or left through the carry, and then repair the possible damage with a second zero-forcing code byte. Even with two clocks and two cycles, this patch still blows the competition away.

Let me know if there's any other PIC programming tricks you want to see. A free Incredible Secret Money Machine II book will go to a dozen of the best requests. A magic sinewave tutorial appears as MAGSINT.PDF on GEnie PSRT. I'll also be happy to mail you a free copy on request.

REGISTER SHIFT RIGHT–

This method first clears the carry...

```
SRIGHT1  BCF S,C    ;clear the carry flag
         RRF F,1    ;rotate all bits right
```

This method repairs possible damage instead...

```
SRIGHT2  RRF F,1    ;rotate all bits right
         BCF F,7    ;force bit 7 to zero
```

REGISTER SHIFT LEFT–

This method first clears the carry...

```
SLEFT1  BCF S,C    ;clear the carry flag
        RLF F,1    ;rotate all bits left
```

This method repairs possible damage instead...

```
SLEFT2  RLF F,1    ;rotate all bits left
        BCF F,0    ;force bit 0 to zero
```

OPTIONS–

Use of RLF F,0 or a RRF F,0 puts shifted result into the accumulator instead.

To shift a value already in the accumulator on low end PIC devices, MOVWF to temporary register storage, then use above methods. Note the accumulator is already register mapped on 17CXX PIC chips.

Note also that the carry flag exits in an unknown state.

Fig. 4—THE PIC MICROCOMPUTER lacks simple "shift right" and "shift left" instructions. Here is how to provide them in two or three code bytes.

Cheap low current fuses

As we've seen a time or two in the past, Recharger magazine is the best source for all laser printer cartridge reloading info. It appears that some epsilon minuses at Xerox have recently been including sequentially blowable fuses in their laser printer cartridges. Their intent is to make recharging a tad more challenging.

The fuses are apparently rated at 20 milliamperes and 200 volts. The host blows the first fuse after a few hundred copies, the second when it thinks toner is low, and third when it decides your toner is out.

Several Recharger authors are now looking for a low cost source for low-current fuses. A fast check into any distributor's catalog reveals that low-current fuses are insanely expensive and ridiculously hard to find.

Well, in nearly all lower current protection schemes these days, you substitute a cheap and automatically resetting posistor instead. Such as those made by Raychem. A posistor's resistance sharply increases with the heating caused by an increasing load current. This resistance change will in turn greatly reduce the available power delivered to the rest of your circuit. Reset is automatic, happening shortly after the overload goes away. But a posistor clearly will not work where any fuse is to be intentionally and permanently blown.

Instead, try using a single strand of #000 steel wool! These have a near zero cost and typically will open in the tens of milliamperes. The strands are usually solderable if you do not touch them. And if you use a better grade of liquid solder flux.

This same trick works just fine in a student lab to protect milliameters and microammeters. Hang a pair of reverse-parallel silicon diodes across the meter terminals, and put a single strand of steel wool in series.

New tech lit

From Mitsubishi, a superb *ASSP Availability Guide*. Covering all sorts of interesting chips. Including the M65830 digital echo, M50194 digital reverb, 66330 fax codec, the 67405 surround sound processor, and 66512

HEATSINKING

continued from page 46

$$\Delta T = 80 - [23 \times (0.5 + 0.5)] - 38$$
$$\Delta T = 19° C$$

The size of the heatsink is then:

$$A = 23 \times 872.6 \div 19^{5/4}$$
$$A = 506 \text{ square inches}$$

The required 506 square inches might seem excessive, but a typical large heatsink that measures 5 × 4 × 2⅝ inches which has 250 square inches of surface area would require another one to adequately dissipate the heat. Of course, those big heatsinks can be expensive, and if they cost more than the device itself, you might want to redesign the circuit with more semiconductor devices in parallel. This will lower the resistance and the heat that must be dissipated.

Experimenter's notes

Your finger is a rather unreliable temperature measuring device. A small thermistor, calibrated on the kitchen stove in a pot of distilled water with a confectioner's thermometer, is a much better approach if you must know how hot things will be for your project's semiconductors.

Be sure to coat the contacting surfaces of the semiconductor and heatsink with thermally-conductive grease before mounting the device on the heatsink. Without adequate heat transfer through the contacting surfaces, the semiconductor will be destroyed regardless of the size of the heatsink. The thermally-conductive grease might be supplied with the semiconductor or the mounting hardware kit or it can be obtained separately.

If you have trouble with the 5/4 exponent of ΔT equation, find the logarithm of this number in a logarithmic table, multiply it by 1.25, and find the antilog of the result. If this doesn't help, a scientific or engineering calculator can provide the numbers. Ω

NAMES AND NUMBERS

Comlinear
4800 Wheaton Drive
Fort Collins CO 80525
(970) 226-0500

Stan Griffiths
18955 SW Blanton
Aloha OR 97007
(503) 649-0837

ITS World
859 Willamett Street
Eugene OR 97401
(541)343-1200

Eastman Kodak
343 State
Rochester NY 14650
(716) 724-4385

LZR Electronics
8051 Cessna Avenue
Gaithersburg MD 20879
(301) 921-4600

The Mart
899 Presidential Ste 110
Richardson TX 75081
(800) 864-1155

Mitsubishi
1050 E Arques Ave
Sunnyvale CA 94086
(408) 730-5900

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

Raychem
300 COnstitution Drive
Menlo Park CA 94025
(800) 227-7040

Recharger
4218 W Charleston Blvd
Las Vegas NV 89102
(702) 438-5557

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

Tektronix
PO Box 500
Beaverton OR 97077
(800) 835-9433

Telecom Gear
15400 Knoll Trail Ste 500
Dallas TX 75248
(800) 866-3241

Temic
2201 Laurelwood Road
Santa Clara CA 95056
(408) 970-5700

Tessco
34 Loveton Circle
Sparks MD 21152
(800) 472-7373

Vetra Systems
275J Marcus Blvd
Happauge NY 11787
(516) 434-3185

laser beam controller.

From Comlinear, a data book on high performance analog amplifier chips. From Tessco, a new full line catalog of wireless communications equipment and supplies.

A very useful *IRDA Compatible Data Transmission Design Guide* is now offered by Temic. Included are the IRDA infrared commnications specifications.

Ricoh has application notes and data sheets available on the new 5A128 low-cost speech-recognition circuits. A free new *Glossary of Image Sensor Terms* tutorial is offered by Kodak.

There's a brand new trade journal on intelligent transportation systems called, of all things, *ITS World.* This one features everything you might ask about from smart highways to GPS to CD ROM maps.

The best two telecommunication shoppers are Telecom Gear and The Mart. One source for phone premise wiring and parts that I've found is LZR Electronics.

I do get a lot of calls from readers wanting remote PC keyboards, RS232 adaptors and extenders. Dozens of products to handle these tasks are offered by Vetra Systems. A PIC is the obvious choice to build your own instead. Start with the *Basic Stamp* from Parallax.

A reminder that I've just reprinted my *Active Filter Cookbook* for the seventeenth time. Refer to my nearby Synergetics ad in this issue for full purchasing details.

I've also acquired quite a unique collection of classic microprocessor trainers. Everything from genuine KIM-1's to gold plated HP 5036A's to superb little book-shaped Z80 Micro Professors. The latter with printers, no less. They all are both usable and highly collectible. You can write or call for bargain pricing. EN

WHAT'S NEWS

continued from page 4

Source of high-temperature superconductivity found?

IBM scientists have found evidence suggesting that a fundamentally new type of electron behavior is responsible for the so-called "high-temperature" superconductivity first discovered a decade ago in a certain class of ceramic materials. The finding is considered an important step toward understanding the details of why superconductivity (the flow of electricity without energy-robbing resistance (requires much less cooling in some materials than in others.

It is hoped that understanding the mechanism that creates high-temperature superconductivity will eventually lead to the creation of new materials with predictable superconducting properties. The ultimate (though perhaps impossible (goal, is to find superconductors that don't require any cooling. Such materials would revolutionize the distribution and use of electricity by eliminating the substantial heat and energy loss caused by electrical resistance.

It is believed that all superconductivity results from the ability of electrons to overcome their mutual repulsion and pair up in ways that allow them to pass unimpeded through the host material. Conventional "low-temperature" superconductivity is caused by a form of "s-wave pairing," in which charge-induced vibrations in the material hold the pairs together.

However, not all physicists believe that s-wave pairing should be the starting point for explanations of high-temperature superconductivity. Some postulate that "d-wave" electron pairing, in which the electrons' magnetic spins are critical, might be the basis for the phenomena.

Scientists at IBM's T.J. Watson Research Center in Yorktown Heights, New York, and their collaborators at State University of New York campuses in Buffalo and Stony Brook present the most convincing evidence yet for d-wave electron pairing. While the IBM research does not pinpoint a particular mechanism as creating high-temperature superconductivity, it does limit the choices significantly.

At the heart of the experiments are four tiny rings (0.002 inches, about the diameter of a fine human hair) of a high-temperature superconducting material in which the elements thallium and barium are interspersed between sheets of copper oxide ($Tl_2BA_2CuO_{6+\delta}$, or Tl2201). The scientists created the rings atop a substrate material made of three wedges, each with a different crystalline orientation. The rings were placed so that two of them spanned two crystalline orientations, one touched none, and only one crossed all three crystal boundaries. Because the atomic spacings of Tl2201 are nearly equal to those of the substrate, the crystalline orientation of any part of the superconducting ring exactly matches that of the wedge beneath it, and a transition region was forced above each wedge boundary.

When a scanning SQUID microscope was passed over the rings and recorded the observed magnetic fields, the scientists detected a spontaneous magnetic field emanating only from the ring that crossed all three crystal boundaries. That ring had a total magnetic field (or flux) exactly half the fundamental unit that occurs in rings of conventional superconductors.

The presence of that "half-flux quantum effect" was a sure indication of unusual (most likely d-wave (pairing. That is because d-wave superconductors with the specific crystalline orientations chosen in the experiment exhibit a "phase inversion" in the superconducting current that runs around the ring covering three orientation changes. Theory predicts that to compensate, such a phase inversion produces an extra current and an associated magnetic field equivalent to a half-flux quantum. The rings with no change of orientation, or with two changes, have no such inversion, and therefore show no spontaneous magnetization. Such phase inversions are now impossible in superconductors having standard s-wave pairing. EN

VIDEO NEWS

continued from page 6

software to be placed in a special fund to reimburse copyright owners. Neither the one-copy nor the royalty provision is expected to be incorporated in the DVD legislation. Whether the slow progress of anti-copy legislation will hold up the release of movies on DVD still remains to be seen.

"Living-room" PC/TV

Gateway 2000, the direct-sale personal-computer manufacturer, thinks that it's time for the family computer to come out of the den and into the living room, swallowing up the family TV and stereo as it moves. Gateway has developed the "Destination" system to let the entire family gather around the computer in the living room for a game of Mortal Kombat, a CD-ROM visit to a museum, a trip on the Internet—or, perhaps, just "Sesame Street" on PBS.

The Destination system has a 31-inch Mitsubishi data-grade monitor, a computer with a 120-MHz Pentium processor, and other goodies including 6×CD-ROM, a fax modem, and the works. In addition, it has a TV card and circuits to double the apparent resolution of TV programs by non-interlaced line interpolation. It can be purchased with our without its own stereo sound system, including speakers. Finally, it features a wireless keyboard, an RF wireless remote control, and a wireless "FieldMouse," along with an on-screen program-guide grid system. All that for "under $4000." In the future, Gateway plans to integrate the system with a Digital Satellite System (DSS) receiver and DVD player.

The use of PCs is "becoming more and more group-oriented," according to Gateway's research. "We found that PCs are inherently flawed from a usability standpoint when more than one person tries to use it. The screens are too small, the cables on the inputs are difficult to pass between users, and the furniture that generally surrounds a desk in a den doesn't lend itself to hours of comfort while in use. EN

BY JEFF HOLTZMAN

Backing up is hard to do

SOME COMPANIES ARE TAKING THE WINDOWS 95 PHILOSOPHY TOO FAR. THERE SEEMS TO BE A MOVEMENT AFOOT TO "DUMB DOWN" THE CAPABILITIES OF SOFTWARE PACKAGES SPECIFICALLY BUILT FOR WINDOWS 95.

I've seen several examples of this recently, but the most troublesome is a tape backup program I bought to run another recent purchase, a SCSI-based Digital Audio Tape (DAT) unit (model C1533A) made by HP.

I'm very happy with the hardware. It is unbelievably fast compared with the Colorado QIC-80 system I'd been using for several years. The HP can store up to 8 GB of data, has built-in hardware compression, and from the SCSI point of view, was completely plug and play.

DAT drives are more expensive than QIC drives, but they're about ten times faster, and the media cost is much lower. For example, in single-unit quantities, a name-brand 90-meter DAT tape costs about $10 and stores about 2GB. A name-brand 120-meter tape costs about $20 and stores about 8 GB. (The 120M tapes use a higher recording density, if the DAT drive supports it.)

By contrast, a 250-MB DC-2120 (QIC) tape costs about $12. Enough tapes to hold 2 GB cost nearly $100; 8 GB would cost about $400. And swapping out all those tapes would not be fun. In fact, tape swapping to accomplish a single backup was what drove me to a higher performance system in the first place.

On the other hand, $200 buys enough DAT tapes to implement a decent tape-rotation scheme, so that you can keep off-site archival copies in case of catastrophe. The tellers at my local bank all know me now because they see me so often as I drop off the latest backup in my safe-deposit box.

In addition, the DAT drive is so much faster, and the capacity so much higher, that I can perform redundant backups and still have plenty of room for occasional system snapshots as the need arises. The bottom line is that for the first time in years, I've got a backup system that really makes me feel secure.

HW+, SW–

As much as I like the hardware, however, the software leaves something to be desired. Actually, the drive itself came with no software. When I managed the network at a former employer, I used a DOS-based version of a program called NovaBack. I never had any trouble with it, and at about $100, the cost was right. So I ordered a copy of NovaBack to accompany the drive. (The backup program that comes with Windows 95 supports QIC but

LISTING 1—DAILY.BAT

```
@echo off
rem backup all local drives, no logging
rem 4dos required

rem Append to tape
rem Modified files only
rem Subdir logging
rem Don't update archive bit

set xxDate=%_dow, %_date
set xxStartTime=%_time
set xxLog=C:\nb95\BACKUP.LOG
set xxTargets=C: D: E: F:

cdd C:\nb95
start /w bkp )%xxLog {VDHY-*SMGlEI=("HP
[4]")T"%xxDate"}%xxTargets ("EXCLUDES.BUP")
echo Daily Backup %xxDate: Start=%xxStartTime,
Done=%_Time, Result=%? >>%xxLog
exit
```

not SCSI tape drives.)

NovaBack came with a diskette and a little card with four screen shots that documented portions of the user interface and provided no useful information. My prior experience with NovaBack led me to believe that there was a richness not covered by the card, so I ordered a manual for an additional $20. The order card described the manual as "the Ultimate Backup & Restore Operators Manual," but it didn't quite live up to that description. Rather, it arrived with a more-detailed explanation of obvious features of the user interface.

I called the company and a very grumpy tech-support guy promised to fax me what I needed. Two days later, no fax. By now I was starting to get angry. Called again. Another promise made, another promise broken. Called again, finally reached someone who seemed both pleasant and competent, and within an hour the fax arrived.

Now there was an example of clear, expository technical writing! Actually, it was a warmed-over version of the "technical" documentation for a version of the program that ran on a different platform. Nonetheless, it had enough detail that I was able to accomplish my goal.

All I wanted to do was automatically perform different types of backups with different sets of parameters (daily, weekly, monthly, ...). I knew the DOS version supported an extensive set of command-line parameters for specifying what to back up, what to skip, how to perform logging, and so on. I assumed that the Windows 95 version would support at least a similar set of parameters. And I didn't want to use the Windows 95 user interface to the backup program. The graphical front-end to NovaBack is not what I would call a study in usability or convenience.

Also, NovaBack comes with a scheduler, but it's weak compared to the one that comes with Microsoft's Plus pack for Windows 95, which I was already using for other purposes. Configuring an automatic backup under NovaBack thus entailed modifying parameters in two separate applications. I wanted a more uniform approach, one that would allow me to tweak settings as various needs arose.

I ran a few tests and pretty much got things working the way I wanted using the Microsoft scheduler and the OS/2 version of the NovaBack command-line parameters, with a couple of exceptions. The backup program is supposed to return a DOS ERRORLEVEL code to specify the result of a backup, but the routine always returns a zero. And the logging function doesn't exactly work as advertised.

4DOS and logging

Part of what I wanted this new backup system to do was provide a quick go/no-go indication so that I could check the status of last night's backup each morning on arriving at the office. To accomplish that, I built a 4DOS batch file. In case you're not familiar with 4DOS, it is a COMMAND.COM replacement that allows you to run programs and batch files, and to perform general system maintenance chores.

4DOS has a much richer command language, both at the command line

RESOURCES

4DOS
JP Software
P.O. Box 1470
East Arlington, MA 02174
(617) 646-3975.

Microsoft Windows 95
Resource Kit ($49.95) Microsoft Press
Redmond, WA
ISBN: 1-55615-678-2

Windows 95 Secrets
Brian Livingston and Davis Straub
IDG Books
Foster City, CA
ISBN: 1-56884-453-0

NovaBack,
Novastor Corp.
80-B West Cochran Street
Simi Valley, CA 93065
(805) 579-6700

and in batch files, than plain old DOS. 4DOS has been around for years; in all the time I've been using it, I've run across only one program it was incompatible with, and that was a very specialized industrial-monitoring system. Versions 5.51 and later of 4DOS support long file names.

Microsoft's System Agent (the scheduler) launches a 4DOS shell at 1:30 am six days a week. The command line for the 4DOS shell includes a call to DAILY.BAT, shown in Listing 1.

DAILY uses several neat 4DOS features to provide my snapshot log. First it sets up local environment variables to store copies of the current day of the week (Mon, Tue, ...), date, time, log file, and backup targets.

DAILY then uses 4DOS's CDD command to change both drive and directory at once.

It then uses the Start command (available in both 4DOS and from the Windows 95 command line) to launch the backup program with the parameters specified by the environment variables.

The "/w" following Start means that the batch file must wait for the specified program to complete before going on to the next line. Without the "/w," the batch file would start the backup program and immediately perform the next line. In this case the start and end times are equal.

The next line simply appends a status line to the specified log file. The status line shows the date, start time, stop time, and the ERRORLEVEL. Right now the latter is always zero, but maybe NovaStor will get its act together one of these days. I can still get a good indication of health by observing start and stop times. Any large divergence from one day to the next warrants further investigation.

Last, the Exit command terminates the 4DOS instance after DAILY completes.

Dumb and dumber

In sum, I'm very happy with the hardware, but less than impressed with the software. What really concerns me is what appears to be a growing tendency to provide dumbed-down versions of software for the Windows 95 environment. Some vendors appear to be operating under the assumption that Windows 95 users have no use for command-line driven utilities, and so don't document advanced features, and perhaps even disable some capabilities. In the case discussed here, it's particularly ironic, since the graphical user interface provided to insulate us poor users from the command line is itself so poor.

Bookshelf

If you do want to dig beneath the surface of Windows 95, two indispensable resources are Microsoft's own *Windows 95 Resource Kit*, and *Windows 95 Secrets*, by Brian Livingston.

The resource kit contains more than 1300 pages of information on Windows 95 setup, customization, and configuration. If you're interested in Windows 95 networking, user and system configuration, user and system policies, file sharing, or custom installations, the Windows Resource Kit is must-have documentation.

If the Windows Resource Kit is oriented toward system administrators, Livingston's 900-page book is geared toward end users. Fortunately, the author realizes that few will have the patience to read every word, so he thankfully highlights many of the real nuggets with marginal icons.

Both books come with disks containing various documentation files and utility programs. The Windows Resource Kit comes with a hypertext version of the book, a utility for changing screen resolution without rebooting, sample installation scripts, a registry backup tool, a command-line based shortcut maintenance utility, and more. *Secrets* comes with a CD full of shareware programs, of which a few seemed useful.

E-mail

Concerning Microsoft's dominance of desktop computing, Lauren Colby writes, "I run a law office. Law offices account for 90% of the market for word processing software. In a law office, the secretaries need two things: SPEED and RELIABILITY. We can't possibly use Windows in our office. Even though we're running 90 MHz Pentiums with 16 MB memory, Windows is just too slow and too unreliable."

Owen Rubin and I exchanged some heated email. Owen upbraided me for my attitude about Apple: "It is obvious you have a PC and hate the Mac so you proclaim the death of something you do not have. Perhaps you bought PC before Macs were affordable and are now stuck? Exactly like the Ford driver who trashes a BMW driver really because they don't own such a car. It's called envy, and it is showing badly." As I told Owen, I own both PC's and Macs. For me it's not a question of religion, but of business, and I support clients on both platforms. By the way, Owen and I did end up friends. I still think Windows 95 is a better Mac than Mac, and I'm sure he still thinks the opposite.

Concerning my February column, Ed Glembotski writes, "Again your column hit it right on the head. I am 75-year-old has-been, Ham (K6SAR), and retired electro-mechanical engineer who feels like I am left holding the bag every once in awhile. I enjoyed the Commodore 64 trip with a full bag of programs (including Geos), and when Jack T. dropped us midstream, I finally gave away that boat anchor. The same with the great Atari 1040st. Now I'm running Windows 95 with a home-assembled 486DX2-66, with 20 MB of RAM and a 1 GB hard disk. I do hope to hang in there for a while."

Let me know what you think: jkh@acm.org. EN

FUZZY LOGIC

continued from page 30

fuzzy variable "tall" can be defined for a range of values. Traditional Boolean variables assume only true or false values, so a person can be either tall, or not tall, depending on how you define what tall is.

In fuzzy logic, the person can be a "somewhat tall", or some percentage of what you define as tall. This percentage of tall is often referred to as the *fuzzy membership set*. Unlike Boolean logic, fuzzy logic provides a way to describe partial membership. Figure 2 shows how the degree of membership in the fuzzy set "tall" might be defined as a function of height. A person who is three feet tall has zero membership in the set. Conversely, someone who is seven feet tall has a membership of one. Well, the difference between Boolean set theory comes in when a person is five feet, three inches—then they are described as being a 0.25 percent member of the set tall

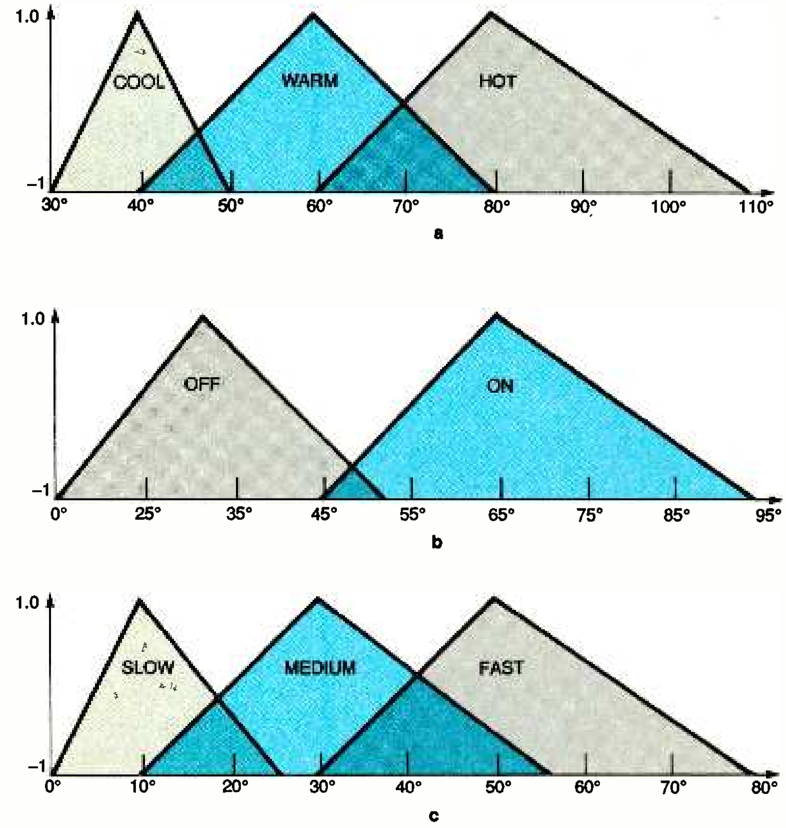


FIG. 5—INPUT AND OUTPUT MEMBERSHIP SETS for room temperature (a), thermostat state (b), and fan speed (c).

Groups of sets are defined in fuzzy controllers. Usually they overlap, and are odd in value. This is because better performance can be achieved when doing so. When grouped together, these sets form what is referred to as the *total membership set*, or just the membership set. The controller has one or more variables which are applied to the membership set, and an output is chosen based on the rules. Fuzzy rules are a series of "if-then" rules that are used to produce an output. Figure 3 shows what a typical membership set of a fuzzy controller might look like.

As previously mentioned, a fuzzy variable represents a relationship to a given set. For instance, a variable "height" might take on several values relating to the height set. Potential values are *short*, *medium*, and *tall*. If-then rules perform the processing of the variables and their associated sets. Now assume that some action is taken based on the value of the variable "height." For example, consider another variable, "amount-of-fabric." A hypothetical rule might be: If "height" is *tall* then "amount of fabric" is *large*. As you can see, the new variable "amount of fabric" has a set of values associated with it.

In summary, a rule performs some action based on the value of some other variables. The terminology usually used to describe components of the if-

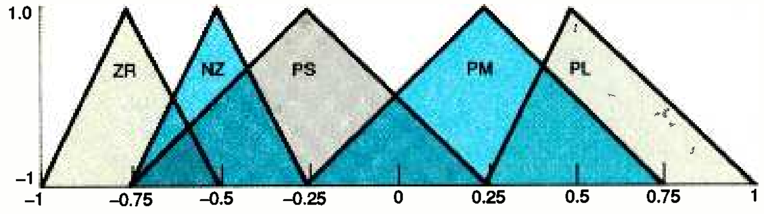


FIG. 3—A TYPICAL MEMBERSHIP SET might be represented as shown here.

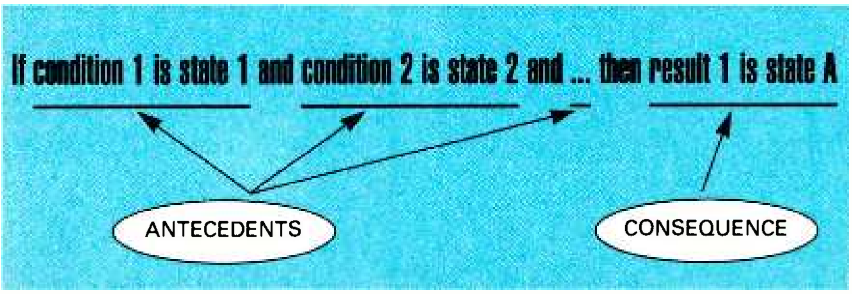


FIG. 4—THE ANTECEDENT AND CONSEQUENCE portions of a rule.

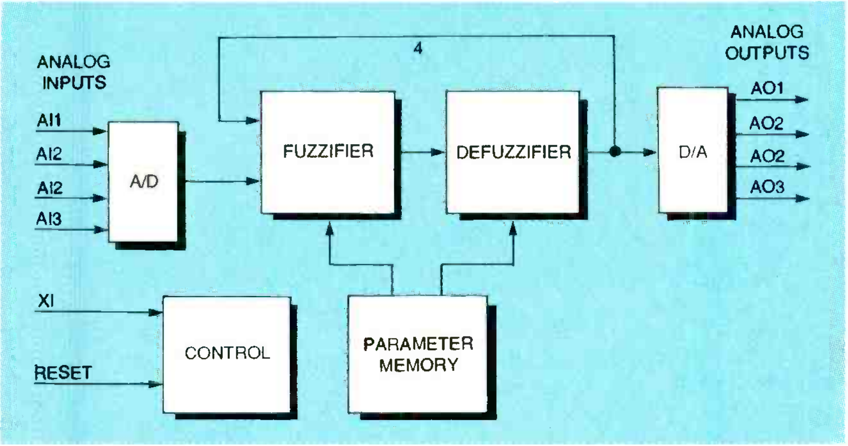


FIG. 6—BLOCK DIAGRAM OF ADAPTIVE LOGIC'S NLX220 fuzzy-logic controller.

then statement is *antecedent* and *consequence*. The antecedent is the portion of the statement that precedes the "then," and the consequence is the portion that follows. Thus, "height is tall" is the antecedent portion of the statement, and "then amount-of-fabric is large" is consequence. Figure 4 shows the antecedent and consequence portions of a typical if-then statement.

Assume that you want to implement a fuzzy-logic controller to regulate a room's temperature. You would begin by defining the variables. The thermostat controller has two inputs and a single output. The first input is called "room-temp," and it represents the room's temperature. The second input variable is called "fan-speed," and it controls the fan motor that blows air over the heating element. There is a single output variable for this example called "thermostat," which controls the fan.

Your next step would be to define the fuzzy values for each of the input and output variables. "Room-temp" might have several value options, such as *cool*, *warm*, and *hot*. Fan-speed is either *slow*, *medium*, or *fast*. And finally, "thermostat" is either *on* or *off*. Figure 5 shows the ranges for the input and output variables. Once the variables, and their values are defined, you are ready to describe the rules that process the input.

As previously mentioned, rules are a series of "if-then" statements. It is important to define enough rules to adequately define the behavior of the system over its operating region or *control surface*. In our example, our rules may look something like:

- *if room-temp cool and thermostat on, then fan-speed slow*
- *if room-temp cool and thermostat on, then fan-speed medium*
- *if room-temp warm and thermostat off, then fan-speed slow*
- *if room-temp warm and thermostat on, then fan-speed medium*
- *if room-temp hot and thermostat off, then fan-speed slow*

By examining the rules, you can determine exactly how the system will behave for a particular input. The specific ranges of the values are up to the user to define. Thus, *cool* might be defined as a number between 40 and 75 degrees, *warm* between 60 and 95, and *hot* between 90 and 110. It is up to the user to define the range for the fuzzy set, and make sure the rules describe all values within this range.

Based on our model, if the room temperature is 70 degrees and the thermostat is on, then conditions are set for the second-to-last rule, and the fan speed will be set to medium. But what if conditions are met for more than one rule? Then all the rules that have their conditions met are summed together to produce a weighted average for the fan-speed output variable. Remember that on and off for the variable thermostat consists of a range that is defined, say between zero and one. The summation process ensures that result is in the ball park that is needed. After the result is computed, it is then run through the defuzzifier to produce a usable output.

Hardware solutions

Hardware and software solutions are available to help developers quickly create new products based on fuzzy logic.

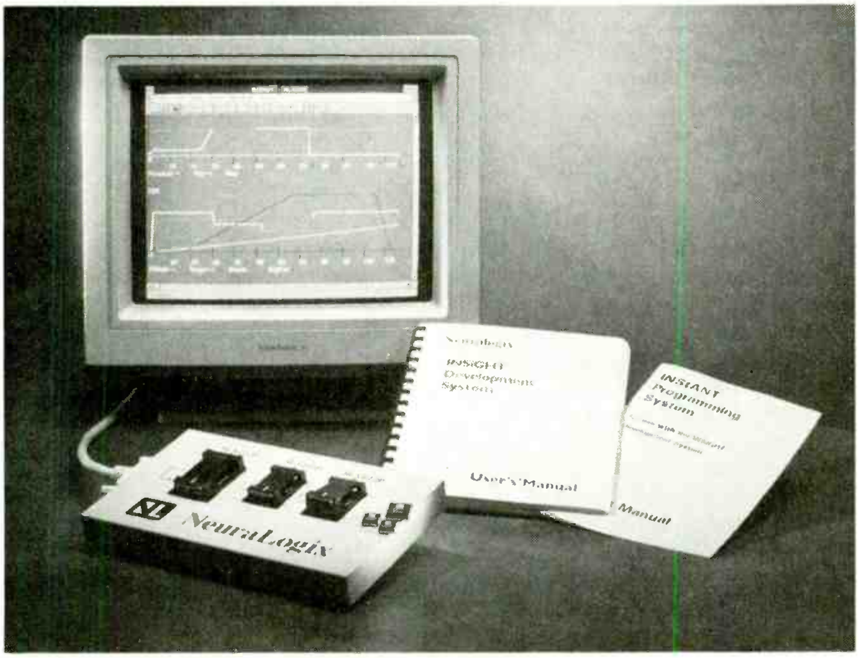


FIG. 7—THE DEVELOPMENT SYSTEM for the NLX220

Fuzzy logic controllers can be implemented with general-purpose microprocessors. This hardware approach is very popular among developers because fuzzy logic is not memory- or computation- demanding. Typical code for these controllers requires less than 1,000 bytes of memory storage. Also for the majority of applications, an eight-bit microprocessor can handle the necessary computations. The microprocessor approach is used after a model is verified by software simulation. The resulting code composing the fuzzy controller is burned into read-only memory (ROM). Microprocessor-based fuzzy-logic controllers work for a wide range of systems. However, there are situations when another hardware solution is required.

Dedicated fuzzy integrated circuits are used in situations where either speed or a large rule set is required. Fuzzy chips are 10 to 100 times faster than general-purpose microprocessors that run fuzzy-logic code in software. Several manufacturers make hardware to handle these demands.

Togai Infralogic, Inc. for example, makes a line of dedicated fuzzy controllers that the company claims are 10 times faster than an Intel 486 configured as a fuzzy controller. Its RISC (reduced instruction-set computer) FC110 IC handles up to 800 rules. Similarly, it processes these rules at a rate in excess of over 200,000 rules per second.

Siemans dedicated fuzzy controller is the 81C99, which is a coprocessor that interfaces to most microprocessors. The 81C99 acts as an accelerator for a general purpose microprocessor by off-loading resource-intensive calculations of complex fuzzy-logic systems from the microprocessor. This device is also RISC-based. Additionally, it can support as many rules as external memory allows, and it can process these rules at a rate of 7.9 million rules per second!

Adaptive Logic (formerly American NeruaLogix, Inc.) also makes a dedicated fuzzy logic controller, the inexpensive, high-performance NLX220. A block diagram of the controller is shown in Fig. 6. It handles up to four analog inputs and outputs. It accomplishes real-time I/O through on-chip analog-to digital (A/D) and digital-to-analog (D/A) converters. Furthermore it supports 111 rules, and can process them at a speed in excess of 800,000 rules per second. The NLX220 also has software development support through the NeuraLogic Insight development system (Fig. 7), which enables users to simulate and configure the NLX220 quickly to produce products. Applications for this device include temperature, motion, power, and pressure control.

FIG. 8—SATURN'S FUZZY-LOGIC transmission controller is based on the 68HC11 microcontroller.

Software-development tools for fuzzy logic are not essential, but they are extremely helpful for two reasons: First, the simulations offer immediate feedback on whether or not the model is valid. Second, the resulting output can be used to feed hardware implementation models.

Several software packages exist which aid in the development of fuzzy systems. These packages have a wide range of functionality. All of the packages allow models to be simulated. Some restrict the number of inputs and outputs available, while others provide users with added functionality such as graphical user interfaces, plotting ability, and even code generation for hardware. Some are packages for development, and others are for educational purposes. Most of the full-blown development tools are available at prices ranging from several hundred to several thousands of dollars. FIDE, Cubicalc, and TeachFuzz are representative of packages that are in the high, medium, and low price range.

FIDE stands for Fuzzy Inference Development Environment. It is a tool developed by Aptronix, and also sold through Motorola. It is at the high range of the price spectrum costing between $1995 and $3495, depending on the configuration. FIDE is a graphical development tool for Motorola's microcontroller line. It features a graphical input via matrix rule grid (similar to a spreadsheet). It simulates fuzzy systems as well as producing assembly output for the 6805, 6811, 6816, and 68000 microprocessors. It also generates C code which allows the implementation of portable embedded controllers.

CubicCalc is a development tool by HyperLogic. This tool is typical of the medium priced development systems. It costs in the range of $495 to $795, depending on the options. It has a graphical front-end for simulating and plotting fuzzy systems. It also supports tracing for debugging. CubicCalc also produces C code output like the high-end solution. Similarly HyperLogic also produces a low-end version ($175) called CubiQuick. It is meant as an educational tool, and is a limited version of CubicCalc.

TeachFuzz is an educational tool for exploring fuzzy-logic concepts. This product is at the low-end of the fuzzy logic product spectrum. Priced at $24.95, TeachFuzz is an application that allows users to simulate a two-input, one-output fuzzy logic controller to teach how a fuzzy controller is built. This product runs as a shell, and requires text files as its inputs and outputs. This product runs both on the Macintosh and the PC. This is a good tool for those interested in experimenting with fuzzy-logic fundamentals.

Fuzzy-logic design methodology

Designing a fuzzy-logic controller is a four-step process. It consists of knowledge extraction, model construction, model testing and model tweaking. Moreover, the successful implementation of a fuzzy controller depends on common sense and intuition.

Knowledge extraction is the process of learning how a system works or how it should work. This is usually accomplished in one of two ways. The first is to analyze or observe a system in operation. And the second is to interrogate an expert.

The observation/analyzing process consists of watching the system in operation, looking for relationships between components of the model. For instance, referring back to the heating system, notice that a relationship exists between the setting of the thermostat, the blower motor, and the room temperature. System relationships are isolated, and defined as variables. Thus the relationship between the thermostat, the motor's speed and the room temperature is described by making each a variable. Once the variables are defined, the exact nature of their relationship must be determined. This is done by looking for cause and effect relationships between the variables. For instance, is the motor's speed affected by the thermostat, or vice versa?

An expert is someone who knows the system very well. He might not know the system variables, or their direct relationships, but what he does know is how the system behaves overall. When dealing with a system expert, it is up to the designers to quantify the expert's knowledge of variables and relationships. This process begins by interviewing the expert, starting with the general and moving to the specific. A log of questions should be asked. The goal is to quantify the expert's knowledge about the system into input and output variables, and how they relate to each other. First extract the variables, and then zero in on how they relate. This process is time-consuming, and there is no cookbook method for gathering this information.

Once the system behavior is understood, the system must be documented. The documentation's notation can be as formal as mathematical formulas, or as informal as English. Since fuzzy logic is linguistically rich, it makes sense to use English to describe a system's behavior. The input and output variables are words that accurately describe the set they represent such as tall, distance, and temperature. Additionally, succinct words are used to describe the multiple values that a variable has. For instance variable distance may be close, intermediate, and far. The next step in documenting is recording its behavior.

The behavior of the system is described in a fuzzy-logic control system in terms of its set of rules. Rules are a set of "if-then" statements. A typical rule might be:

If temperature is hot and pressure is high, then valve is open.

This example has two antecedents and one consequence. However, a rule's antecedents and consequences are not limited. Any rule may have one or more antecedents and consequences. Moreover, the behavior of a particular system is made up of a series of rule statements. The number of total rules is dependent on the complexity of the system. If the system is simple, it may be defined by only a few rules. On the other hand, if the system is complex, it may take several hundred rules to describe.

After the model is documented it is ready to be built. Building the model consists of translating the variables, rules, and their corresponding sets to an implementation tool. This tool can be one of the hardware or software development tools previously mentioned.

Assume that the implementation tool is software. Then the variables, sets, and rules must be put into a format that the tool understands. Input for the tool occurs through files, or through a user interface. For instance the TeachFuzz application gets its input from files. The files are made up of definitions of sets, rules, input/output variables, and input data. Once the files are formatted for the tool, the model is ready for testing through simulation.

The software tool tests the model through simulation. During the test, all types of inputs are run through the model to see if it behaves as expected. If it does, the model is considered good, or valid. Otherwise, the model needs tweaking.

Tweaking consists of iterating the previous steps until the model tests out as valid. Invalid models occur for several reasons. The most common is the set of rules for the system are incomplete. Typically, this problem occurs as a result of insufficient rules to handle all input data for a specific region.

The next cause of invalid models is undefined sets, which

FUZZY RESOURCES

Adaptive Logic
800 Charcot Ave., Suite 112
San Jose, CA 95135

Aptronix
2150 North First Street, Suite 300
San Jose, CA 95131

HyperLogic Corp.
1855 East Valley Parkway, Suite 210
Escondido, CA 92027

Siemens
10950 N. Tantau Ave.
Cupertino, CA 95014

Togai Infralogic, Inc.
5 Vanderbilt
Irvine, CA 92718

occurs when a set for an input or output variable is missing altogether. Correcting this problem when the set is completely missing is straightforward. This is accomplished by figuring out the domain for a given variable, formatting it in terms of the tool notation, and including its definition so that the tool can find it.

The third reason for an invalid model is incompletely defined sets. This is a variation of the previous problem, except in this case the set is defined, but it is not adequately defined for the region.

Usually this problem occurs when there are not enough partitions of a variable's set. In the thermostat model the variable thermostat is has possible values of either on or off. What if the thermostat variable requires more states? Then additional subsets must be defined to accommodate this situation. For example, extra states like "nearly on" and "almost off" or "just turned off" may be added to fix this problem.

An extra word is in order concerning building the model. Before going through the effort of converting the model to the implementation tool's format, make sure the model makes sense. Walk through the model with test data on paper. Give it some random values and compute the output. Then check it to see if it falls within the defined region. For fuzzy logic this is easy, because of its linguistic nature.

Applications

Fuzzy-logic applications are sweeping the globe. Japan presently is producing more products than all other countries combined. However, this situation is changing rapidly as Asia, Europe, and even the U.S. discover that fuzzy-logic methods can reduce the time required to produce a product.

In Asia, fuzzy logic provides additional features for appliances while improving efficiency and simplifying the user interface. Matsushita produces a washing machine that effectively has 600 settings! The machine uses sensors as feedback elements to gauge the washer system. One set of sensors measures how well the soap dissolves in the water. Another set of sensors captures the amount of dirt in the water. A third set of sensors keeps track of the load of the washer. Thus if the water is fairly clean, the fuzzy logic controller specifies a short wash cycle. On the other hand, if the water is dirty a fairly long wash cycle is set. Similarly, if a few clothes are in the machine, the washer uses less water. Conversely a full load of clothes causes the washer to use the most water. Efficiency is always maximized.

European countries are also embracing fuzzy logic controllers in their products. Klockener-Moeller GmbH in Germany is using fuzzy logic in its industrial programmable logic controllers (PLC). One application of its fuzzy PLC is wind power. The PLC controls the pitch in wind generators. The fuzzy PLC improves system efficiency under complex control situations. For example, when a rotor blade passes the tower, it crosses the wind shade created by the tower itself. The wind shade causes a dip in the energy output, and the PLC compensates for this dip.

Japan claims that most products it produces are fuzzy-based. For instance, several manufacturers make smart vacuum cleaners that operate by detecting differences in floor conditions, and adjust the brush height accordingly. Panasonic uses fuzzy logic technology to produce jitter-free pictures in its line of video camcorders.

Cannon makes use of fuzzy logic to create an auto-focus feature for its cameras. One of Japan's most impressive achievements is the fuzzy-logic controlled transit system. All facets of the journey are controlled via this system. The ride is so smooth that many officials boast that this system provides a smoother ride and more accurate stops than human operators could hope to.

In the U.S., fuzzy logic products are beginning to emerge. Allen-Bradley produces a line of fuzzy PLCs. Eaton is using the technology to inspect soda cans for printing defects. Whirlpool is making use of fuzzy controllers in some of its refrigerator models.

Cars are a natural application of fuzzy logic. Saturn is an advocate of fuzzy-logic technology, using it in anti-lock brake systems and for transmission control. (See Fig 8.) For instance, Saturn's transmission controller is based on Motorola's 68HC11, and takes up only 500 bytes of code! Saturn's transmission controller works by using fuzzy logic to assist in braking on downhill grades. The controller accepts information about speed, throttle, position, brake-application intensity, and the amount of braking time. With this information, the controller determines the appropriate gear for downshifting as a car accelerates downhill. The resulting operation is smooth, and the average driver never notices the downshifting. However, as a result of the controller's action, less braking is required, resulting in longer brake life.

Fuzzy logic allows you to become a controller designer without the overhead of traditional techniques. You do not have to learn calculus to use fuzzy logic. This results in a faster learning curve than traditional techniques. It is a natural choice for designers due to its linguistic nature, as well as its ability to speed up the product development cycle.

Augmenting the development cycle decreases the time to market for a product. That is, the time it takes to put a product on the market is compressed. Furthermore, this compression is due to several factors. The first is a shorter learning curve. Secondly, designs are implemented quickly using superior tools. Thirdly, once implemented the design is quickly verified and modified if necessary. All of these factors translate to a robust technique which is hard to beat in the controller design arena. Ω

ATV TRANSMITTER

continued from page 32

connected to the collector of Q10 and suppresses harmonic frequencies. The RF output is a relatively pure signal between 900-940 MHz.

Video and audio modulation

To apply video modulation to this RF carrier, the supply voltage for Q10 is taken from the emitter of video modulator Q7. Transistors Q5, Q6, and Q7 are connected as a feedback amplifier with a gain of about 5 to 10. Video input to the transmitter is amplified in this circuit and also inverted in polarity so that sync and black levels are positive going. The video signal at the emitter of Q7 is superimposed on the supply voltage to Q10. In turn, Q10 amplitude modulates the RF output from Q4. Potentiometer R14 sets the carrier level of the RF output for symmetrical modulation and potentiometer R18 sets the modulation level for maximum without distortion or clipping.

The Mini 900 also provides a 4.5-MHz audio subcarrier. Incoming audio is fed to gain control R29. Audio from R29 then is fed through C27 to the base of Q8. Audio from Q8 is fed to varactor diode D2 via C25 and R24. Diode D2 is part of the frequency- determining network of 4.5-MHz subcarrier oscillator Q9. Circuit elements D2, C24, C21, C22, and L14 make up the 4.5-MHz tuned circuit. Audio voltage on D2 changes its capacitance, causing frequency modulation to occur. Trimmer capacitor C24 sets the 4.5 MHz sound subcarrier frequency.

The subcarrier output from Q9 is fed into the video modulator via C30, where it is mixed with the video. A jumper in series with the supply to 6.2-volt Zener diode D3 and R21 permits disabling Q8 and Q9 if no sound is necessary. An optional external switch or removed jumper will power down the sound circuit for longer battery life. Diode D3 and C29 supply a clean, regulated 6.2 volts bias to Q8 and Q9. Resistor R21 and C28 decouple the sound circuit from the DC supply. For PAL systems the number of turns on L14 is reduced to allow 5.5-MHz operation.

Diode D1 protects the Mini 900 circuitry against accidental reverse polarity from the external power supply and C39 provides supply line bypassing.

The DC voltage supply to the transmitter should be very clean and stable. Any noise or ripple in the supply voltage can modulate the RF carrier and cause severe distortion in the received video. Less than 50 millivolts of ripple and noise is permissible, less being more desirable. Dedicated battery packs offer the best option for a noise-free voltage source, otherwise voltage regulation and additional filtering should be considered.

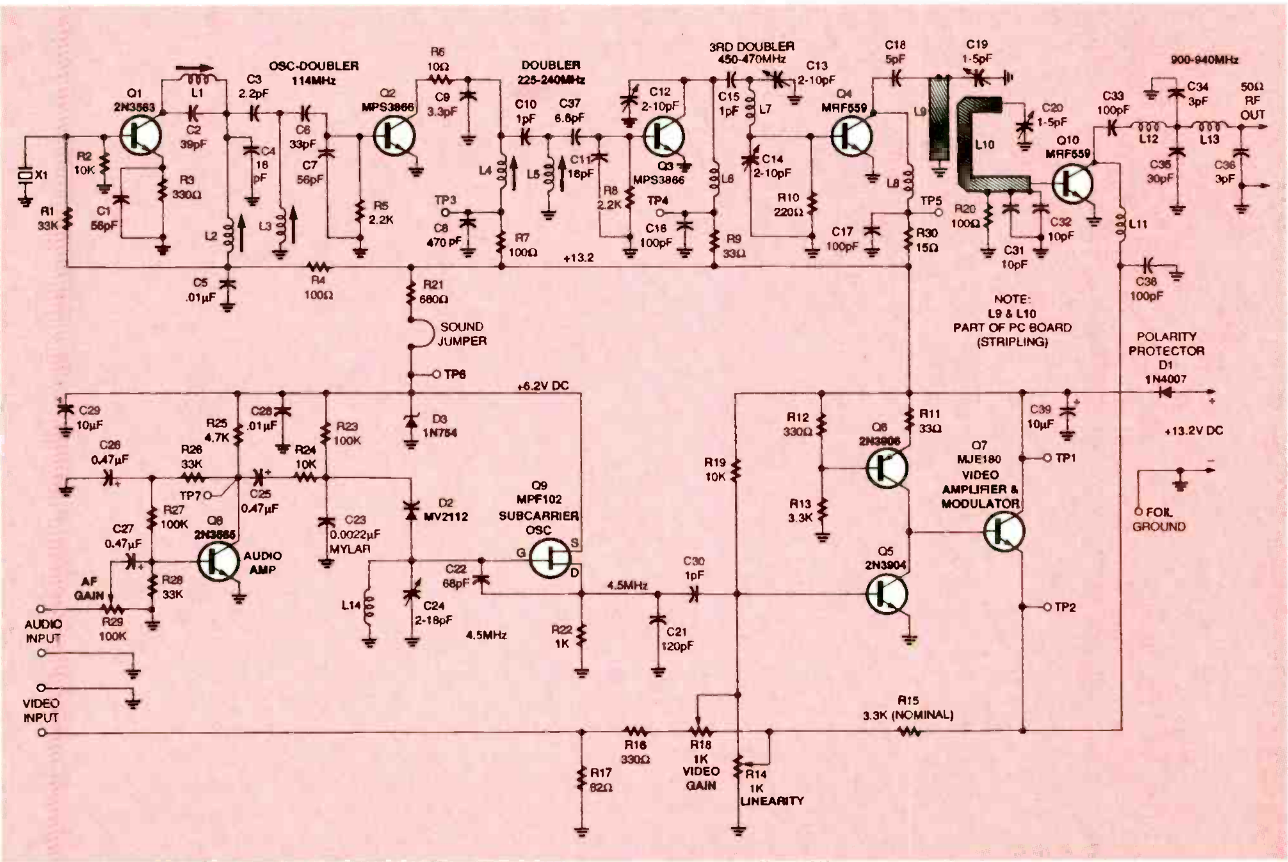


FIG. 2—SCHEMATIC DIAGRAM for the Mini 900 ATV transmitter. All the parts in the diagram fit on a 2¾ × 1¾-inch two-sided foil printed circuit board. An understanding of the circuit diagram will enable builders to easily perform alignment and troubleshooting procedures.

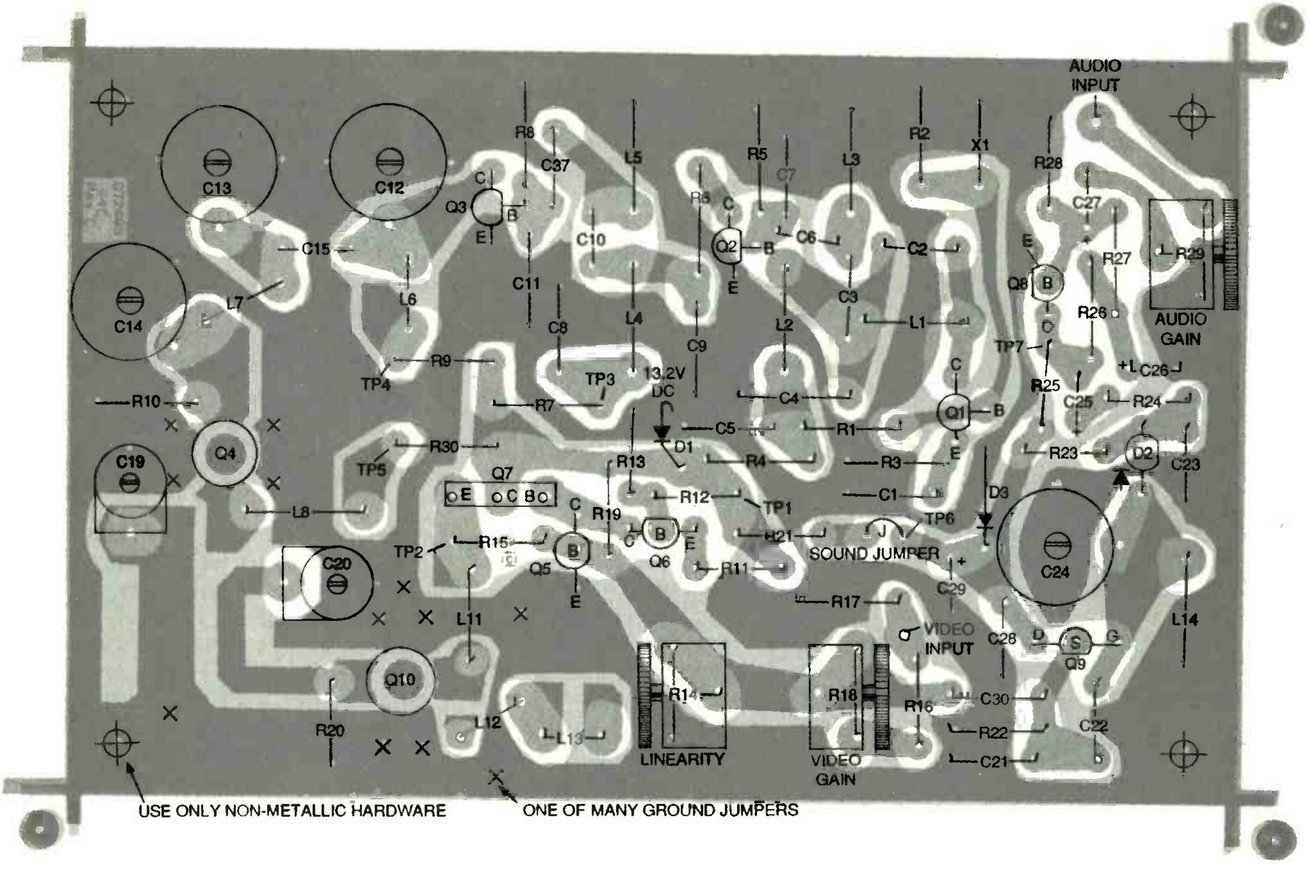
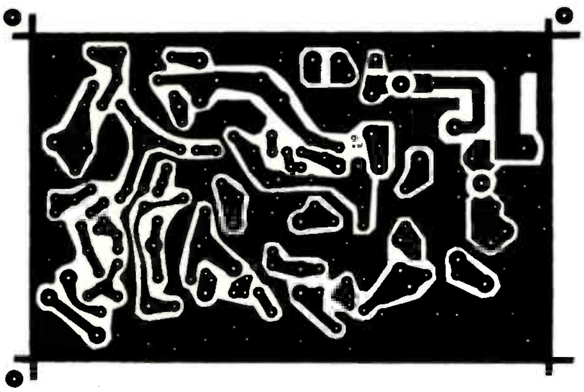
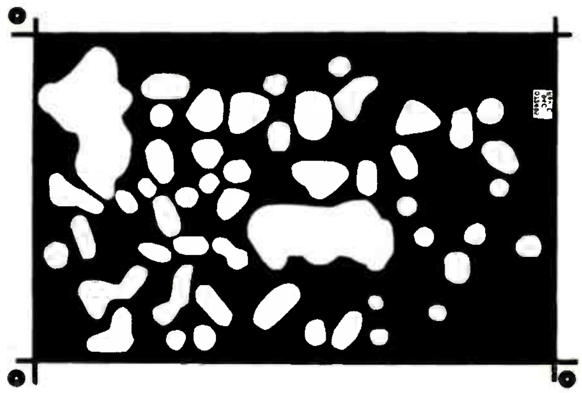


FIG. 3—COMPONENT SIDE PARTS PLACEMENT diagram for the Mini 900 ATV transmitter PC board. Solder all component ground leads to the top and bottom foil surfaces. Use #22 bare and tinned wire to jumper together the ground planes of the top and bottom foils.



TOP VIEW (component side) of PC board shown same size.



BOTTOM VIEW (solder side) of PC board shown same size.

Putting it together

Before beginning construction, familiarize yourself with the circuit diagram in Fig. 2 and the PC board layout. Refer to Figs. 3 and 4. To get an idea of the compactness of the printed-circuit board, glance at the same-size foil diagrams in this article. Use good lighting.

It is helpful to insert first a few large parts such as trimmer capacitors and potentiometers to serve as landmarks. Constantly refer to the parts placement diagrams in Fig. 3 and 4 to avoid mistakes. The grounded leads of all trimmer capacitors and grounded leads of all resistors must be soldered on both sides of PC board because the board holes are not plated through. This is essential for good RF grounding. Except where access may be difficult later in construction, *do not* solder any connections until as many components as possible are inserted. All coils are installed after the other components are inserted and soldered.

All parts are mounted tight and close to board—there can be no exceptions. *Zero* lead length is essential in high- frequency RF circuits. Remember that the Mini 900 operates at UHF frequencies and lead lengths are critical—they intro-

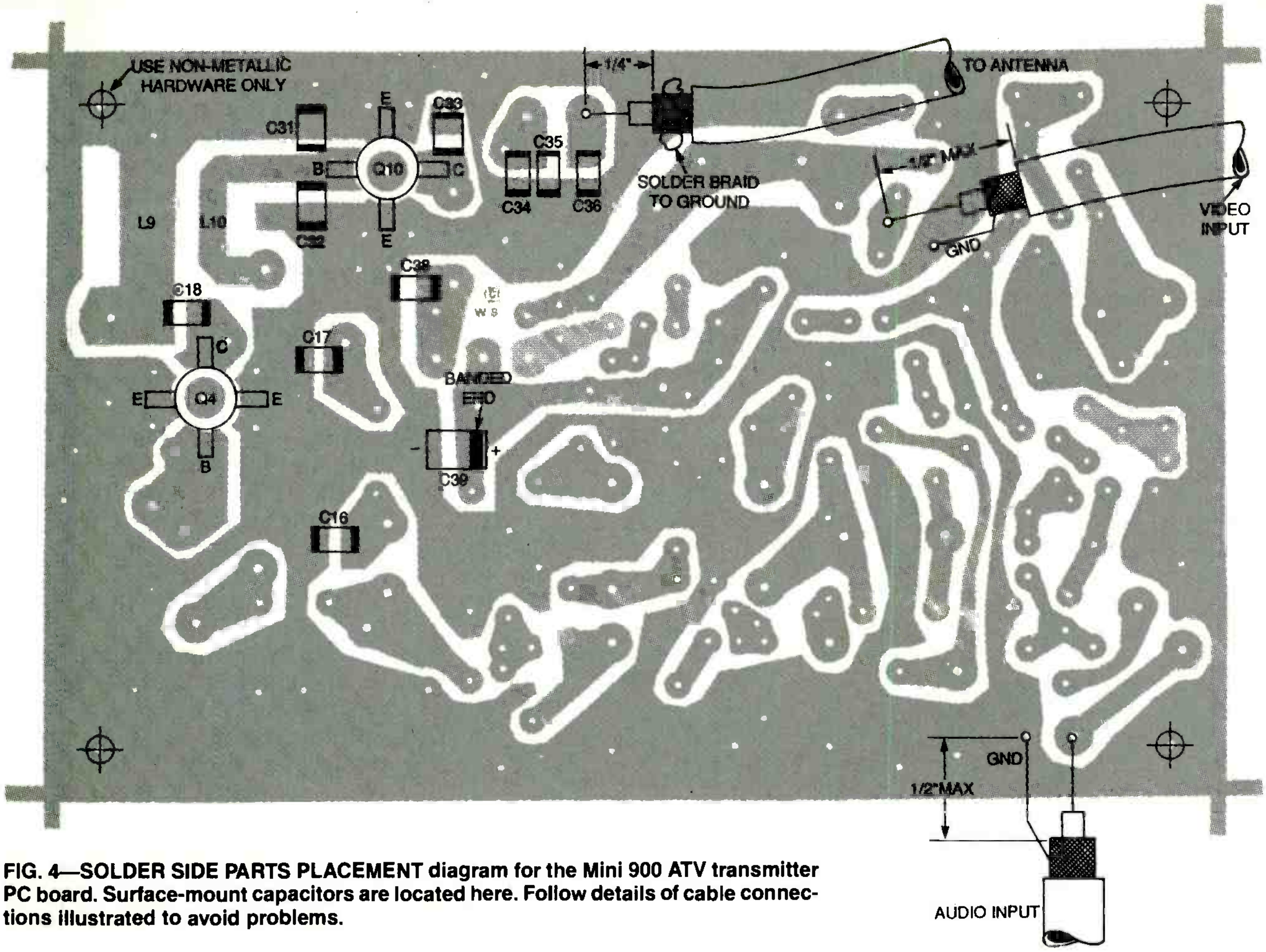


FIG. 4—SOLDER SIDE PARTS PLACEMENT diagram for the Mini 900 ATV transmitter PC board. Surface-mount capacitors are located here. Follow details of cable connections illustrated to avoid problems.

duce unwanted inductance and stray capacitance.

Install all fixed resistors and solder in place (see Fig. 3). The next step is to install and solder trimmer side terminals to top side of the PC board. Be careful not to melt the plastic. Do not solder the bottom at this time. Install all ground-plane jumpers that connect top and bottom ground planes (See Fig. 3).

Install capacitors with wire leads. Pre-formed leads should be straightened with pliers so as to fit as close to board as possible. Watch polarity of all electrolytic capacitors so as not to accidentally reverse polarity. Do not install surface-mount capacitors until a later step. Install all transistors, except Q4 and Q10. Check for correct orientation of transistor leads. All transistors should be 1/8 inch from surface of board. Solder the emitter leads of Q2 and Q3 to the top of the PC board where they pass through the ground foil.

Install D1, D2 and D3, checking the polarity (marking band) before and after soldering. Solder the ground lead of D3 to the top side of the PC board where it contacts it. Note that D1 (1N4007) has only one lead inserted in board (banded end). The other end is formed into a hook and is used as a terminal for attaching the DC supply positive lead wire. Diode D2 looks like a transistor with only two leads. Refer to Fig. 3 before installing D3.

Using scissors, trim the crystal leads to 3⁄16 inch and install. *Do not* use diagonal cutters as the mechanical shock produced during cutting can damage the crystal. Solder a short wire to the top of the crystal and run this lead to ground.

Carefully fabricate all coils and install them in the PC board. The winding of the coils are detailed in a sidebar entitled "Coil Winding Data." Be sure that no turns short together on L6, L7, L8, L11. The bottom turn of L1 connects to the collector of Q1: L2 bottom turn, to the junction of C3 and C4: and L3 bottom turn, to the junction of C3 and C6. Use an 8-32 screw to hold L1, L2, L3, L4 and L5 during installation. After installing coils, remove screw and insert tuning slugs fully into coils. Note that coils L11, L12, L13 are fabricated on a 6-32 screw while all others except toroid L14 use an 8-32 screw as a winding form. Use a small drop of paraffin wax or candle wax to retain tuning slugs in coils.

Install C16, C17, C33, C38 (100-pF surface-mount capacitors); C18 (5-pF surface-mount capacitor); then C31 and C32 (10-pF surface-mount capacitors); C34, C35 and C36 (3-pF surface-mount capacitors) and C39 on the *underside* of the PC board. Refer to Fig. 4 for capacitor location and sidebar entitled "How to Install Surface-mount Capacitors" for soldering details. Caution: Check the polarity on C39 as it is soldered in

PARTS LIST

All fixed resistors are ⅛-watt, 5%, unless otherwise specified.
R1, R26, R28—33,000 ohms
R2, R19, R24—10,000 ohms
R3, R12, R16—330 ohms
R4, R7, R20—100 ohms
R5, R8—2,200 ohms
R6–10 ohms
R9, R11—33 ohms
R10—220 ohms
R13—3,300 ohms
R14, R18—1,000 ohms potentiometer, thumbwheel type, PC mount
R15—3,300 ohms (see Note 1)
R17—82 ohms
R21—680 ohms
R22—1000 ohms
R23, R27—100,000 ohms
R25—4,700 ohms
R29—100,000 ohms potentiometer, thumbwheel type, PC mount
R30—15 ohms

Capacitors (See Note 3)
C1, C7—56 pF, NPO
C2—39 pF, NPO
C3—2.2 pF, NPO
C4, C11—18 pF, NPO
C5, C28—0.01 µF disk, GMV
C6—33 pF, NPO
C8—470 pF, GMV
C9—3.3 pF, NPO
C12, C13, C14—2-10 pF trimmer
C10, C15–1 pF, NPO
C16, C17, C33, C38—100 pF, surface-mount type
C18—4.7 or 5.0 pF, NPO, surface-mount (use either value)
C19, C20—1.5-5 pF trimmer
C21—120 pF, NPO or SM
C22—68 pF, NPO
C23—0.0022 µF, 50-volt, Mylar
C24—2-18 pF trimmer
C25, C26, C27— 0.47 or 1.0-µF, 35-volt tantalum electrolytic (use either value)
C29—10 µF, 16-volt electrolytic
C30—1 pF or 2.2 pF, NPO (see Note 2)
C31, C32—10 pF, NPO surface-mount
C34, C35—3 pF, NPO
C36—30 pF, NPO
C37—6.8 pF, NPO
C39—10 µF, 16-volt, surface-mount

Inductors
See Coil Wind Chart for details of coil construction.
L1, L2, L3, L4, L5, L14—No. 22 enameled solid-copper wire
L6, L7, L8, L11, L12, L13—No. 22 bare tinned solid-copper wire
5—Ferrite slugs, blue, 8-32
1—Toroid core for L14

Semiconductors
D1—1N4007 rectifier
D2—MV2112 varactor
D3—1N754 Zener diode, 6.2-volts
Q1—2N3563 transistor
Q2, Q3—MPS3866 transistor
Q4, Q10—MRF559 transistor
Q5—2N3904 transistor
Q6—2N3906 transistor
Q7—MJE180 video amplifier modulator
Q8—2N3565 transistor
Q9—MPF102 JFET

Miscellaneous
X1—56.890625-MHz crystal (910.25 MHz). Note: Alternate crystal frequencies are 57.640625 MHz (922.25 MHz) and 57.703125 MHz (923.25 MHz).
1—printed-circuit, 2-sided board, etched and drilled.
1—8-32 screw for coil winding
1—6-32 brass screw for coil winding and tuning aid

Note 1: R15 resistance range is 2,200 to 4,700 ohms depending on the video gain desired. Default value is 3,300 ohms. Estimated video gain vs. R15 resistance values are: 5× = 2,200 ohms, 7× = 3,300 ohms, and 10× = 4,700 ohms.
Note 2: Use either 1 pF or 2.2 pF for C30. Value selected determines sound subcarrier level.
Note 3: All capacitors less than 120 pF are NPO types with ceramic bodies. All capacitors with a specified working voltage are electrolytic types. All 0.01 µF and 470 pF capacitors are GMV ceramic disk types.

A complete parts kit for the Mini 900 ATV transmitter, consisting of the PC board and all parts that mount on it, is available from: North Country Radio, PO Box 53, Wykagyl Station, New Rochelle, NY 10804. Kit is furnished with crystal for 910.25 MHz as standard, or alternately 922.25 or 923.25 MHz if specified with order. Kit price: $81.50 plus $4.50 for postage and handling. New York residents must add 8.25% sales tax. A catalog packed with cameras and other amateur TV kits and electronic projects is available. Please send SASE (75 cents) plus $1.00 to cover handling (refundable with order).

place and afterwards: the banded side is positive (+).

Install sound jumper (J) near D3 (see Fig. 3). Install all ground jumpers in the holes indicated in layout. Solder as many component leads that pass through top ground and bottom ground planes as possible. Disc capacitors may be somewhat difficult, but solder as many as possible. This very important step provides good RF grounding. Be careful not to melt plastic trimmer capacitors and potentiometers.

Now install the MRF559 transistors, Q4 and Q10 (see Fig. 4). The long lead of the MRF559 is the collector. Trim leads to length and install Q4 and Q10 with thicker side in holes provided in the PC board. The manufacturer's logo on the transistors will be visible from the bottom of PC board. The plane of leads should be flush with bottom of PC board.

Carefully inspect all work completed thus far. Look for solder bridges, poor or cold solder joints, missing parts, incorrect parts placement, etc. You are ready to electrically check out the board once the assembly is satisfactorily done and you check the accuracy of the placement of each part and solder joint.

Checkout and tune-up

Do not proceed with this section until you have thoroughly checked out the construction as described in the last step of the instructions. You should have access to the suggested basic test equipment if you are to obtain optimum performance. It is futile to try to tune for best picture. It is, for example, possible to get a good picture and have only ten foot range of transmission. It is also possible to inadvertently overload the video monitor and get a lousy picture on it from a perfectly operating circuit board, and spend hours tracing nonexistent problems. Therefore use our procedure and experiment later when you are sure everything works properly.

The use of a metal standoff or other metallic material in the vicinity of L9 near the corner mounting hole in the PC board (See Figs. 3 and 4) can upset the stripline coupling network L9-L10. This will affect the setting of C19 and also may reduce the attainable RF power output from the transmitter. For this reason, note the following precautions:

- Only use nylon or other non-metallic hardware in the corner hole next to coil L9.
- Keep the PC board at least ¼ inch from metallic or RF lossy materials.
- Keep any external wiring away from PC board especially near L9 and L10.

First verify that the DC voltages are correct and that the video modulator is working. Set the power supply to zero volts. Connect the negative lead of your power supply to the ground foil on the board. Next connect a lead from the positive terminal of the power supply through an ammeter (0-500 mA range) to the power input terminal which is the hooked end of diode D1. If the power supply has an ammeter, you can use it instead of an external ammeter. Now slowly raise the voltage to 10 volts. If more than about 100 mA is drawn, turn off the power supply and check your board for wiring errors, short circuits, solder bridges, etc. Power up again and if more than 100 mA is drawn, check to see if any part gets hot or smokes. If so, find the cause and repair assembly errors and/or damaged parts before proceeding.

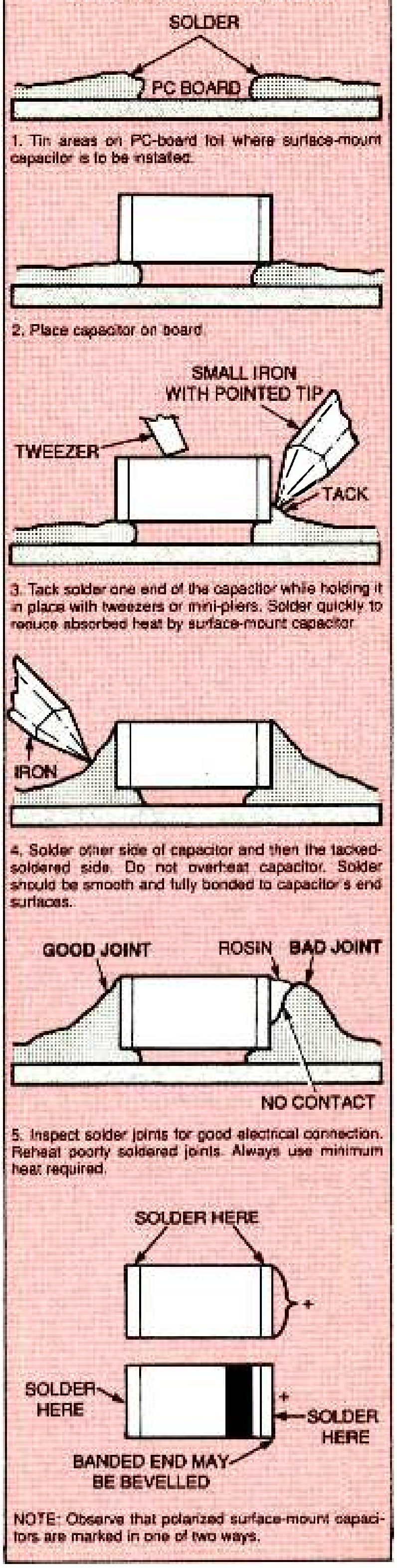
Test points

Seven test points are shown on the schematic diagram in Fig. 2. These are intended for tune-up and diagnostic use on a finished, operating transmitter. Not all of the test points (listed below) are used in the tuneup procedure.

Test Point	Location	Volts DC
TP1	Collector, Q7	+13.2
-	Collector, Q1	+12.6
-	Collector, Q2	+13.2
TP6	Drain, Q9	+6.8
TP7	Collector, Q8	+3.5
-	Colelctor, Q4	>+2.0 to <+11.5*
TP2	Emitter, Q7	>+2.0 to <+11.5*

*These voltages depend on the setting of R14 and R18. Verify this before proceeding further.

HOW TO INSTALL SURFACE-MOUNT CAPACITORS



1. Tin areas on PC-board foil where surface-mount capacitor is to be installed.

2. Place capacitor on board.

3. Tack solder one end of the capacitor while holding it in place with tweezers or mini-pliers. Solder quickly to reduce absorbed heat by surface-mount capacitor.

4. Solder other side of capacitor and then the tacked-soldered side. Do not overheat capacitor. Solder should be smooth and fully bonded to capacitor's end surfaces.

5. Inspect solder joints for good electrical connection. Reheat poorly soldered joints. Always use minimum heat required.

NOTE: Observe that polarized surface-mount capacitors are marked in one of two ways.

If everything is satisfactory at 10 volts, set the power supply voltage to 13.2 volts. Connect a voltmeter negative lead to the power supply negative terminal and check for following voltages using the positive lead of the voltmeter:

Set potentiometer R14 so that voltage at emitter of Q7 (TP1) is 6.0-volt DC. Connect a frequency counter between TP2 and ground. You should see a stable reading between 4 to 5 MHz. Set C24 for a counter reading of 4.495 to 4.505 MHz. This sets the sound subcarrier frequency. If you cannot obtain this frequency, but obtain a stable reading that is either too low or too high, remove or add a turn, respectively, to toroidal coil L14. You must have a *stable* reading. Ignore anything else. Use an oscilloscope to verify high-frequency oscillation at the source terminal of Q9. (For PAL applications this frequency will be 5.5 MHz and not 4.5 MHz.)

If all voltage tests are satisfactory, set potentiometer R18 at mid-range and set potentiometer R14 for maximum voltage reading on the emitter of Q7 (TP2). There should be at least 11.0-volts DC at TP2. If necessary, reset R18 so you get the 11 volts or more.

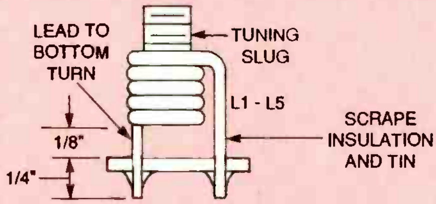
Tuning the RF circuits

RF stages Q2, Q3, and Q4 and video amplifier Q5 are operated in class C mode. In the absence of an input signal, they are "off" and draw no current. An input signal causes the stages to turn *on* and draw a current that is somewhat proportional to the input signal. Therefore, by monitoring the collector current of a stage, the drive signal supplied to that stage can be monitored. Test points are used to monitor stage currents by reading the DC voltage drop across resistors in the collector circuits. Typical collector current of stage Q2 is 25-40 mA; Q3 and Q4, 30-60 mA. Transistor Q5 is tuned for maximum RF output into a 50-ohm dummy load.

Connect the negative (−) lead of your VOM or DVM TP3 and the positive (+) lead to test point TP1. Make sure the supply voltage is set to 13.2-volts DC. Set the slug in oscillator coil L1 all the way inside. Now back out the slug with a *plastic* align-

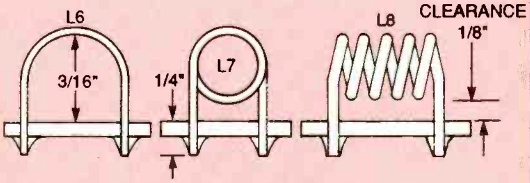
COIL WINDING DATA FOR THE MINI 900 TRANSMITTER

Coil	No. of Turns
L1	7.5
L2, L3, L5	3.5
L4	2.5



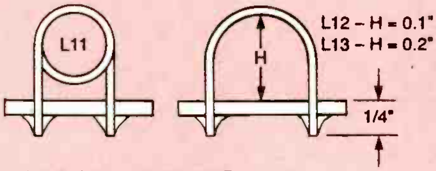
Wind coils L1-L5 using #22 enameled wire on an 8-32 screw. Form leads as shown in diagram. Scrape off enamel and tin wire ends as shown. Bottom of last winding is mounted 1/8-inch above PC board. Install coils on PC board using 8-32 screw as holder. Once soldered in place, remove screw and thread in 8-32 Cambion blue tuning slug.

Coil	No. of Turns
L6	0.5
L7	1.5
L8	4.0



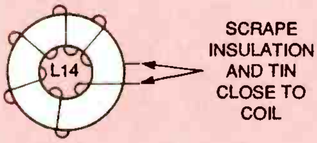
Wind coils L6-L8 using #22 bare, tinned wire on an 8-32 screw. Form leads as shown in diagrams to allow 1/8-inch clearance for L7 and L8. Remove screw. Spread turns evenly to fit on PC board mounting holes and solder in place.

Coil	No. of Turns
L11	2.5
L12	0.5
L13	0.5



Wind coils L11-L13 using #22 bare, tinned wire on a 6-32 screw. Form leads as shown in diagrams. Remove screw. Spread turns of L11 evenly to fit on PC board mounting holes and solder in place. Solder coils L12 And L13 in place carefully observing height dimensions.

Coil	No. of Turns
L14	13



Toroidal coil L14 is wound on a 0.375-inch diameter ferrite core. Use fine sandpaper to remove sharp edges from the toroid-hole ends to avoid scraping of wire insulation when winding coil. Use #22 enameled wire (about 10-inches long). Pass the wire through the hole 13 times—each pass is a turn. Space turns evenly on toriodal form. Scrape off enamel and tin wire ends as shown. Install on PC board tight to surface.

ment tool, while watching the meter. At some point the voltage reading on the meter should sharply jump up to a higher reading, then tune for a peak reading. Then back the slug of L1 out of the coil so the reading decreases about 5-10%. Next adjust the slugs of L2 and L3 for a maximum reading. Repeat adjustments of L2 and L3 until no further voltage increase is obtained on the meter. Next remove the power and set trimmer capacitors as follows:

C12 35% mesh
C13 20% mesh
C14 20% mesh
C19 35% mesh
C20 50% mesh

See Fig. 3 for locations of the above trimmer capacitors.

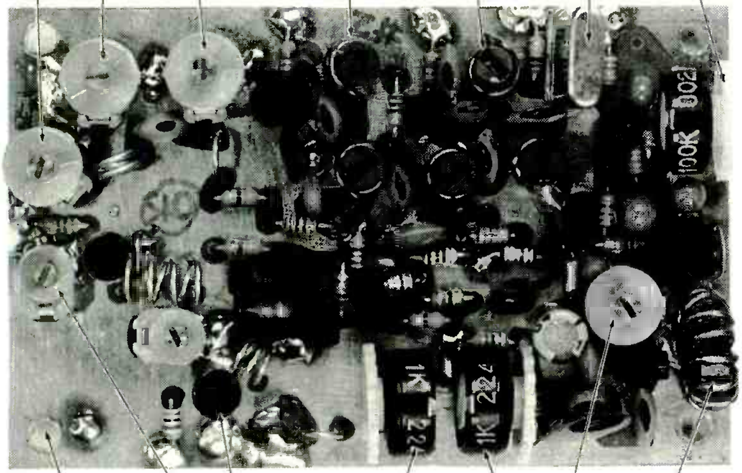
Connect a 50-ohm dummy load suitable for 900 MHz across the output of the RF power amplifier (junction C36 and L13, and foil ground.). Use 50-ohm coaxial cable and make the connection *short*. See Fig. 4 for proper cable-connection method. Connect the cable to the 50-ohm dummy load using a suitable connector to match your load (BNC or N-types, usually). Use proper adapters as required. Type RG188 or RG316 coaxial cable is preferred. Cable type RG174 is also satisfactory, but tends to melt rather easily when soldered. Some sort of indicator on the load is necessary to see the RF output, but it does not need to be calibrated—a relative reading is satisfactory.

Restore power to the PC board. Readjust L2 and L3 as before. Now remove the negative meter probe from TP3 and connect it to TP5. The meter's positive probe is still connected to TP1 (13.2- volts DC).

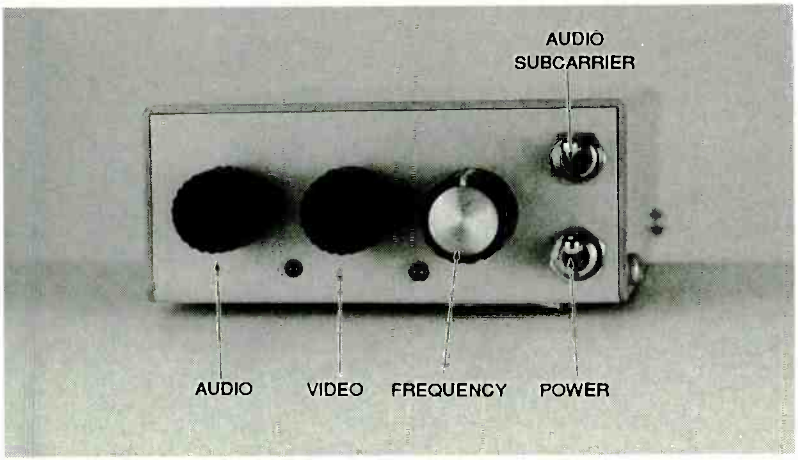
Start with a range setting on the multimeter that will adequately show readings in the 1-volt DC range. Verify that the trimmers are preset. Adjust L4, L5, C12, and C13 for maximum meter reading. Then, readjust L2 and L3 to further increase this reading as much as possible. Repeat this procedure until no further improvement is noted. Capacitor C14 is not touched and is left as preset during this step. The reading obtained in this step may be typically 1 to 1.5 volts.

Repeak L4, L5, C12 and C13. Continue this process until no further increase in the meter reading can be obtained. The settings for the trimmer capacitors should not be too far from the original preset positions. If they are radically different, check to see if L4, L5, L6, and L7 are properly wound and that the correct parts are installed in the circuit board positions. Coil L4 has only 2.5 turns and may not securely hold the slug in position. Use a small drop of paraffin wax as a temporary cement to prevent the coil's slugs from falling out or shifting during handling and tune-up.

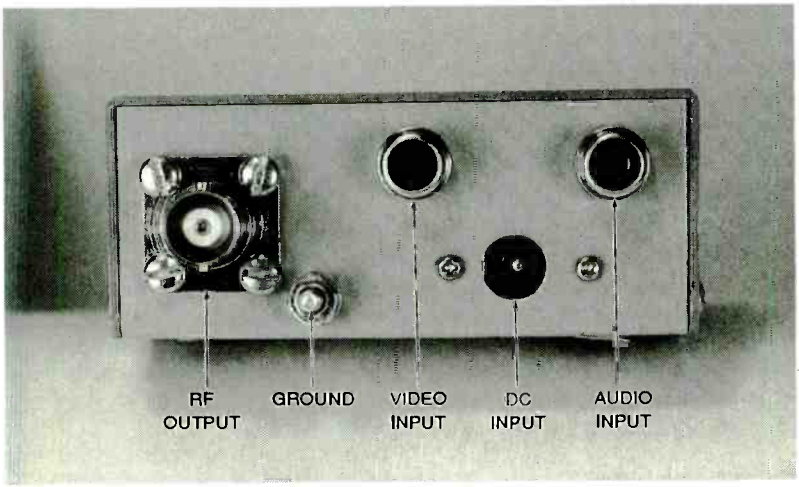
Adjust C14 for a dip (minimum reading at TP5) from the reading in the previous step. This dip in the reading may be around 30-50%. Do not worry about the exact amount as long as a significant dip is obtained. It should be fairly near the preset mesh, 10 to 30% or thereabouts. If the dip occurs at over 35% mesh, this indicates something has been improperly tuned or there is an error in assembly. Capacitor C14 should not be meshed more than 35%



Component side of the PC board shown with all the parts installed and ready for cable connection to video and audio inputs and antenna. A few of the components are identified to facilitate compatible recognition with Fig. 3.



FRONT PANEL for the Mini 900 shows the operator's controls. The FREQUENCY control is a modification that was eliminated in the final prototype.



THE REAR PANEL is where all input and output connectors are located. A screw-terminal grounding post should not be ignored when setting up the transmitter.

as this indicates incorrect tuning.

Carefully and slowly adjust C19, while watching the RF output power meter and the power-supply current. A sharp rise in power-supply current and an indication on the RF power meter will be noted at some point around the preset position of C19, typically 30 to 40% meshed. *No other setting is acceptable.* The tuning elements are fixed in the PC board and therefore have close tolerances. Next, adjust C20 for maximum RF output. Then, go back to L4 and L5, and readjust them for maximum RF output, followed by repeaking C12, C13, and C14 to further improve output. Reduce the supply voltage to 10-volts DC and verify there is still RF power output as seen at the indicator on the dummy load. About 20% or more of the previous output should still be obtained. If not, repeat previous steps starting with L2 until you achieve this.

You should be able to obtain RF output below 8.5 volts from the power supply before the RF power drops out completely and the RF power should vary smoothly with supply voltage, no sudden jumps or reversals at higher voltages, if the tune-up procedure was done correctly. There is some interaction between tuning adjustments. Also, the power-supply voltage can affect the value of transistor internal capacitances, resulting in some slight variation of optimum tuning settings over a voltage range. It is strongly recommended to perform initial tune-up at 13.2-volts DC, and make sure that all is functioning properly. If other supply voltages are to be used (9 to 15-volts DC) you should then re- tune the Mini 900 at the alternate supply voltage.

At 15 volts (maximum) power-supply voltage, the Mini 900 will have less tolerance to fault conditions such as over-voltage and high antenna VSWR (greater than 2:1). Conversely, at 9-volts DC (minimum) power-supply voltage, there is no room left to allow for lowered supply voltage (weak or exhausted batteries, etc.). For this reason, 11 to 14-volts DC is suggested as an operating supply voltage.

About 0.5-watts RF output or more should be obtained with a 13.2-volts DC supply. At 10-volts DC, typically 0.2 watt; at 15-volts DC, typically 0.7-watt will be obtained. This is *peak envelope power* (PEP) and occurs on video signal's sync tips. Average power varies with video modulation and will be 20 to 60% of this figure, depending on the modulating signal. If, after all tuning adjustments are optimized, power output seems a little low, it is possible that the inductances of L12 and/or L13 are too high.

Check L12 and L13 by bringing a brass or copper screw near the coils, first L12 and then L13. The presence of the brass screw reduces the coils inductance. If the power output increases slightly, reduce the size of the corresponding inductor until this test fails to produce an increase. These inductors are electrically and physically small and there is a tendency for most builders to make them too large. Conversely, if no improvement is detected, leave them alone, and check C33, C34, C35, and C36 to see if they are correctly mounted and are not cracked or broken. Make sure that R14 and R18 are set for maximum voltage (at least 11.5 volts) at TP2.

The final adjustments

The last step is the checkout of the video modulator. You will need a suitable receiver or monitor capable of tuning to 902-928 MHz or to whatever crystal you have installed. Connect the transmitter to an antenna such that its radiating element is at least 5 feet from the PC board and at least 10 feet from the receiver. No antenna should be needed on the receiver. Connect a source of video (1-volt, peak-to-peak, 75-ohm, negative sync) to the video input of the transmitter (across the junction of R16- R17 and ground). Connect audio signal to audio input point (across R29). A VCR with a tape playing is an excellent video/audio source.

Set R18 and R29 to mid-range settings. Apply power to the Mini 900 and adjust R14 so the RF power output drops to half its original level. Turn on the receiver and activate the VCR or other source of video and audio. Watching the picture, adjust R14 and R18 for a good stable picture, without rolling, or white or black level clipping. Adjust R29 for best sound. Set the receiver's volume at normal level during this adjustment. Readjust R14, R18 and R29 as needed.

Do not attempt any RF adjustments using the received picture. If a satisfactory picture cannot be obtained, make sure you are not overloading your receiver with excess RF signal or that you are not causing the RF signal to interfere with your source of video. Some video equipment may not work properly in strong RF fields so do not immediately assume the transmitter is to blame.

The video modulator in the Mini 900 is DC coupled. A drop in supply voltage due to battery depletion may cause sync clipping to occur. If this operating condition is expected, set the alignment adjustments at lowest expected supply voltage. An increase in supply voltage usually has no effect in this regard. The circuit design assumes a reasonably constant supply voltage, −1 to +2 volt variation at 12 to 14-volt levels. At 10 volts, no more than 0.75 volt drop would be advisable without readjustment of R14 and R18.

After alignment procedure is completed, it is a good idea to glue the tuning slugs in L1 through L5 in place, and to coat the toroidal coil L14. Use Duco cement or any clear lacquer for this purpose. Avoid pigmented paints as certain pigments can introduce losses into the coils. After the cement dries, a slight readjustment of the 4.5 MHz subcarrier frequency (C24) might be required.

Using the Mini 900

The Mini 900 ATV transmitter can be used in a variety of applications for video transmission and should be suitably mounted. Current amateur band plans for 902-928 MHz suggest the use of two channels (picture carrier frequencies) for ATV use at 910.25 and at 922.25 MHz. This is not a legal requirement but a recommendation to follow that avoids possible interference with other amateur stations. Check the ARRL repeater directory or with local amateurs active in ATV to determine what picture carrier frequencies to use.

Also remember to maintain good RF practice and to shield all cables (video, audio and DC) to the board. Shielded audio cable can be used for short runs for video and audio, but for the antenna lead use a short length of RG188, RG316 or RG174 cable. These cables are very lossy so do not be surprised to experience a 20% power loss in a 2 or 3-foot cable.

Make sure to mount the transmitter in a shielded enclosure. If the overall weight is a consideration, a thin plastic enclosure wrapped with sheet copper foil might be used. Copper foil with a thickness of 0.001 or 0.0015-inch is usually available at hobby and craft stores. Solder all seams in the copper where possible. Keep the radiating antenna as far as you can from other devices that may be RF sensitive. This can be a challenge in R/C models. Use the best antennas possible. The Mini 900 may be limited to a low-gain antenna such as a simple quarter-wave whip. The 900-MHz receiver might require a higher gain antenna. Resist the temptation to use those cute little stub and rubber duckies when significant range is required. The larger types of antennas perform better, all things being equal.

The authors used a pair of corner reflectors for the range test and obtained a clean picture at over 5 miles, and a fair picture 12 miles away at favorable locations. Range is more a function of terrain than anything else. A corner reflector antenna consists of a half-wave

Continued on page 73

JAMES MELTON

A specialized two-lead semiconductor is a complete project that will protect your modem communications from interruptions.

PHONE-LINE PRIVACY MODULE

MODEMS ENABLE COMPUTER owners to communicate with other computer owners, and access fax machines and network services all over the world. You can download more information about almost any subject than is found in your local library in less time than it takes to get there! You can send orders for merchandise, requests for information, or send your opinion to a radio station right from your keyboard.

With all this convenience comes a problem: You can be interrupted during the middle of all this high-speed, compressed-data, multiple handshake communications by the simple act of your two-year-old child picking up a phone in another part of the house and saying "Hi Granny" into the mouthpiece! Even five minutes lost can be aggravating.

One obvious solution is to have two phone lines—and the accompanying two bills from the phone company. A better solution would be an automatic way to ensure that the person, modem, or machine using the phone line has exclusive use of the line. Such an arrangement is possible without the resources of NASA and the national budget. In fact, the exclusive use of the phone line can be arranged at your house or business just by adding a single semiconductor in series with each phone that might interfere with modem operation.

Phone basics first

Although the "how" of operating a phone across the phone network is so simple as to be second nature to everyone (remember that two-year-old child), the behind-the-scenes operation is more complicated. Consider the operation of a phone line that runs from the telephone company's CO (central office) to your home.

Start with the phone on-hook (hung-up is the common expression) waiting for a call to be made. When all the phones on the same line are on hook, the phone line from the CO is an open loop. There will be a voltage of between 30 and 50 volts DC standing on the line, and no current will be flowing.

When a phone goes off-hook, a switch inside the telephone connects the phone instrument to the phone line, and presents a terminating load of approximately 600 ohms. This 600-ohm load causes a DC current to flow in the loop between your home and the CO. This DC current signals the CO that you wish to make a call. The amount of current flowing depends on the distance the phone is from the CO, since the current has to travel many miles through the phone lines to your house. The farther away your home is from the CO, the lower the loop current, and consequently, the lower the voltage seen at your home telephone. Typically, the off-hook voltage might vary between 12 and 18 volts.

Equipment at the CO places an audio dial tone signal on the line going to your house to let you know that connection to the CO has been made and you can now proceed with dialing. The CO listens for the DTMF (digital-tone, multiple-frequency) signals from the phone's key pad, and the call is routed at the CO to a destination. The equipment at the CO then waits for you to break the connection by hanging up, which it determines when the loop current no longer exists.

For incoming calls, the CO places an AC ringing voltage from 90 to 130 volts AC onto the DC voltage standing on your open-loop line. A capacitor in the telephone provides a closed loop for the ring signal when the phone is on hook. The capacitor passes the AC through to the ringing circuitry, and your phone rings. When you pick up the phone, you complete the DC loop as mentioned previously, and the CO knows you have picked up the phone. The CO discontinues the ringing signal, interconnects the originator's phone to yours, then monitors the loop current, waiting for you to hang up.

One-component project

To isolate the modem from the phones and achieve uninter-

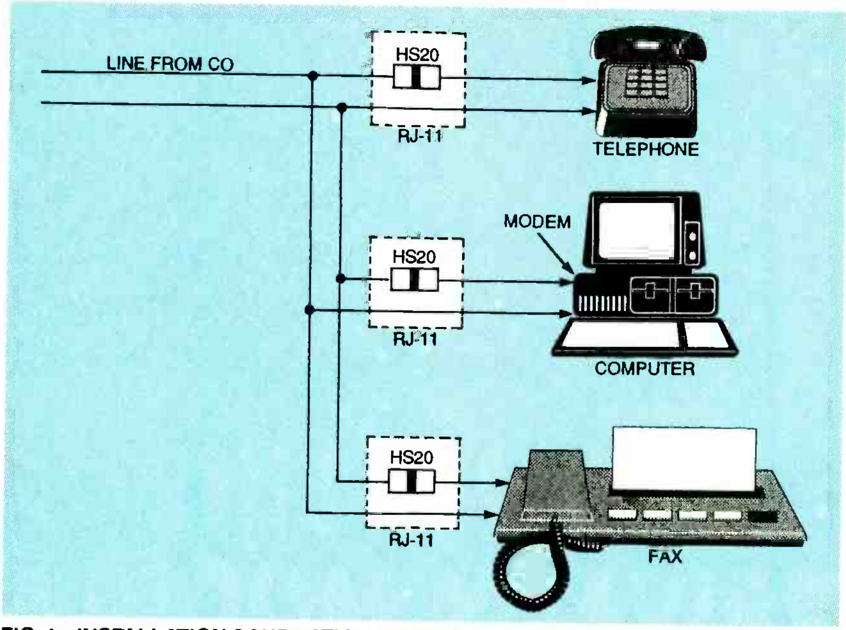


FIG. 1—INSTALLATION SCHEMATIC DIAGRAM for installing the HS20 bilateral silicon trigger switches in your home-phone network. The HS20's can be installed within the communicating device or inside a RJ-11-type terminal block.

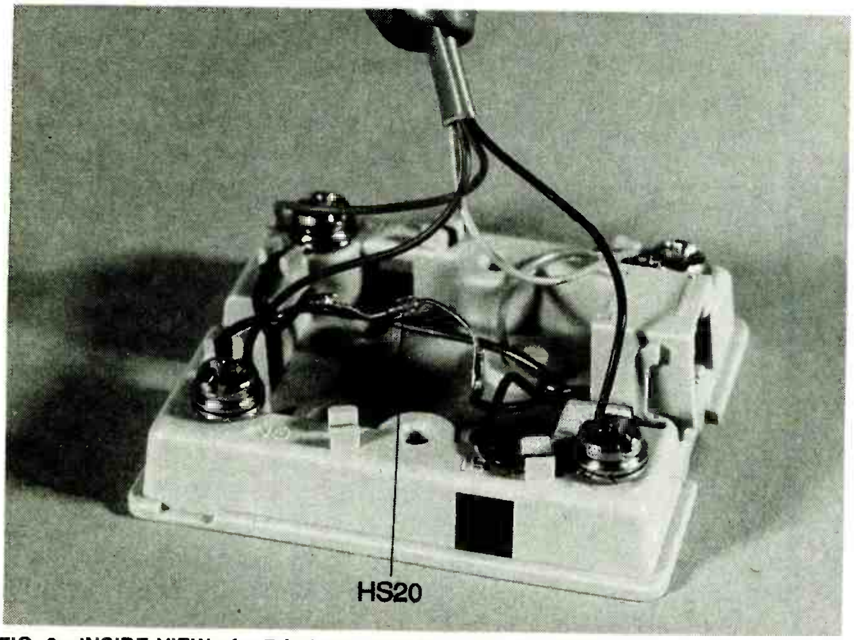


FIG. 2—INSIDE VIEW of a RJ-11 type terminal with the HS20 bilateral silicon trigger switch installed. Communications emanating from a phone or modem plugged into this block will not interfere with other similarly connected devices.

rupted communications requires the installation of HS20 bilateral silicon trigger switches manufactured by Teccor Electronics. Normally, the HS20 is used in commercial light dimmers as part of the triggering circuit for a triac. It prevents current from flowing until the voltage has built up to a definite, repeatable value, then fires (or begins conducting) at a point in the AC waveform that allows for positive triggering of the triac. However, those performance characteristics are ideal for this application. All you have to do is install one semiconductor in each of the phones that you want to safeguard from jamming your modem's communications.

Basic plus one part

Here is how your home phones will operate after the installation of the HS20 bilateral silicon trigger switches: With the modem and the phone line on-hook, 30 to 50-volts DC is standing on the line, and is present at the modular plug for each phone. If your modem goes off-hook, it closes the loop, and the HS20 sees the 30 to 50 volts across it.

Because the HS 20 is manufactured to trigger at 20 volts, it triggers, and becomes a very low resistance (about a 2-volt drop) part of the loop circuit. Should the other phone(s) in the circuit now try to access the line, nothing will happen. The voltage on the circuit, with the modem accessing the line, has dropped to somewhere between 6 and 18 volts. This voltage is not enough to fire the trigger switch at the phone's site, and the HS20 remains in a high-impedance (resistance) state. You do not have loop current flowing in the line to your voice phone, and you have not interrupted the modem's reception or transmission.

The HS20 works equally well the other way: If you are on the voice phone first, no other phone equipped with a trigger in the loop can interfere. The other phone will be silent, and cannot hear your phone conversation. Also, you cannot use your modem.

Installation

You can determine from the schematic drawing in Fig. 1 that the HS20 can be placed anywhere in each telephone's line so as to effect only that device. The RJ-11 block (Fig. 2) is the best place to install the HS20 in series with one wire of the inner pair of the modular jack. Unless you have more than one phone line, the inner pair of the modular cord will always be the pair from the CO. In some cases, it might be easier to open the phone's plastic case and locate the inner pair of wires, and solder the HS20 into one of the lines.

It does not make any difference which of the two wires of the line is used, and you do not have to stay on the same wire from one device to the next. The HS20 is also not polarity sensitive, so either lead of the semiconductor can be connected to either line in the loop. Again, you need to put one HS20 in the line for each device you want to protect including the modem. Any phone connected to the line without the HS20 in its line will be able to butt-in on your conversation, or on your data or fax transfer.

One HS20 bilateral silicon trigger switch is required for each phone and modem you intend to protect; the minimum quantity is two semiconductors for a home with one modem and one phone. If you are having trouble obtaining the HS20 bilateral silicon trigger switches from electronic parts suppliers, you can purchase them from SolarWorks, 2747 Wentworth Drive, Grand Prairie, TX 75052 for $4 each, plus $0.50 postage and handling per order. Ω

TROUBLESHOOTING

continued from page 38

each minute. As we listened to the machinery and watched the pulses, we heard a cooling fan switching just as each new spike occurred. Then we realized that the problem was the spike. It was fooling the PLC, and making it think that the temperature had dropped below threshold during one of the spikes, when the temperature dropped near 400 degrees.

THE TEKMETER saved the day!

Now it's so obvious

A visual inspection of the thermocouple cables revealed that a portion of its shield had been worn away because of the vibration of a nearby cooling fan. Figure 6 shows some typical thermocouple hardware for those who are not already familiar with them. Replacing the cable got the annealing cycle back to normal, and the springs were springy again! We and our portable scope found and eliminated a costly factory problem.

The preceding examples illustrate just a few of the ways that a portable scope can be used to find and cure factory process problems. In addition to these simple cases, we can use the DVM and oscilloscope functions to find power-quality problems caused by dirty AC, bad power factors, and unbalanced phase power. We can also evaluate SCR- and triac-based motor controls for voltage, phase, and frequency conditions, factors governing efficiency. Finally, we can detect and cure sensor signal degradation with the simplicity of using a pocket DMM. Ω

ATV TRANSMITTER

continued from page 68

dipole mounted near a reflecting surface consisting of two plane conducting surfaces at an angle, usually 60 to 90 degrees. The dipole is parallel to the line of intersection of these surfaces and 0.25 to 0.4 wavelengths away from the intersection. Typical gain of these antennas is 8 to 12 dB over a dipole.

A fair quality picture with minor snow requires better than 20 dB signal-to-noise ratio of the received signal. A 20 dB signal- to-noise ratio voice signal means very comfortable copy (assuming AM modulation). A fair picture means it has some snow, certainly useful for facial identification.

In the author's tests, the Mini 900 was mounted on the back of a corner reflector with 11-inch square sides at a 90-degree angle. The antenna was 30 feet above ground on a hilltop at the author's home, 12 air miles east of Glens Falls, NY. The receiver setup used a similar but slightly smaller antenna with a low-noise downconverter mounted on the back of the antenna. The matching downconverter for the Mini 900 ATV transmitter project and corner reflector antenna construction will be covered in future issues.

The downconverter was feeding a 12-volt DC TV receiver, the receiving setup located on the front seat of the author's vehicle. At best sites, the transmitter location was visible with high-power binoculars, so line-of-sight conditions were had, but a good picture was still obtained with some obstructions. However, in hilly terrain with heavy foliage, range was as short as half a mile when hills blocked the signal. R/C airplanes typically have line-of-sight conditions in most cases. Typical range with 3-inch whip antennas at the transmitter and receiver would be about one mile or so line-of-sight, less for obstructed paths. Use the best antennas possible for the situation you face. Ω

continued from page 40

tempting this project with commonly available resistors, the results have been excellent.

Selecting resistors

You must select resistors for the divider out of a batch of ordinary 1% metal-films devices. Even though 1% is more than two orders of magnitude worse than what we need, any given bag of 200 resistors is almost certain to contain at least one suitable set, and usually more than one.

The process of selecting eleven resistors that are matched to better than 40 PPM is not difficult, merely tedious. To make the job as easy as possible, you can build a comparison bridge with "quick insertion" clips, just like commercial bridges use.

A simple comparison bridge circuit is shown in Fig. 3. Build it on some scrap perforated construction board, and be sure to use a multi-turn trimmer potentiometer, or the bridge will be impossible to zero. The resistor clips are made from .015-inch brass, cut with scissors and bent with needle nosed pliers. Drill the brass strips, deburr them, then clean them with steel wool before bending.

Bridge power is supplied from three 9-volt batteries in series. The best detector is the null detector described last month. However a DVM that can resolve 0.1 millivolt is also acceptable. With a resistor installed on the clips, you should be able to zero the bridge by adjusting the trimmer potentiometer. Note

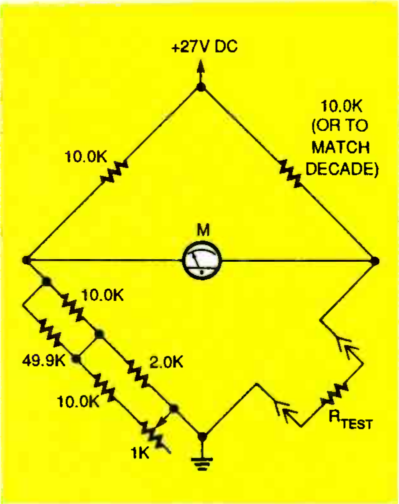


FIG. 3—BUILD THIS COMPARISON BRIDGE to match resistors for the KVD.

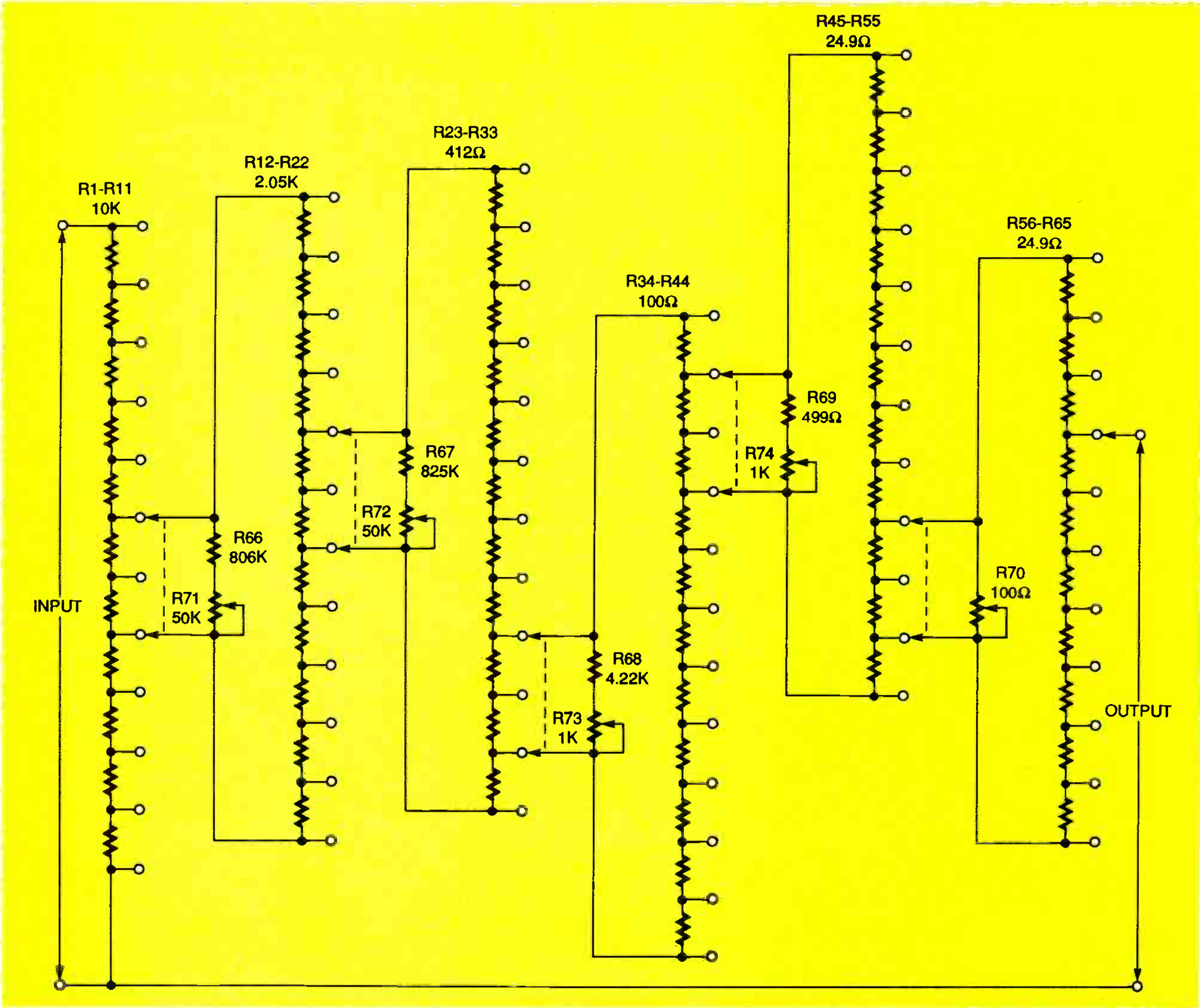


FIG. 2—THE COMPLETE KELVIN-VARLEY DIVIDER. The setting shown equals 0.45187.

that it takes 10–20 seconds to get a stable reading to the precision you need.

The first order of business is to get an idea of the average value of your resistors, and sort them into roughly matched groups. Since all of the resistors have values within 1%, the bridge will be nearly balanced at all times. You will not have to re-zero it; instead, just read the deviation on the null detector (or DVM). The bridge has a very narrow range of adjustment. You might have to pad one of the upper legs slightly if it won't zero.

An excellent way to keep track of the resistors is to use a piece of perforated construction board as a sorting board. Put a piece of masking tape on the long edge and label the holes. Start with zero in the center, then 10 millivolts per hole, going outwards from zero each way. Minus should be on the left. You will soon see where most of the resistors fall, and can re-zero the bridge to put this value in the center. I find that a four by six inch board is enough. If the average value is near the center, resistors off the edge are unlikely to match, and can be put aside.

Measure each resistor, put it into the appropriate hole in the sorting board. As you test more and more resistors, the sorting board becomes a visual histogram of the resistor values!

With luck, there should be several columns with high numbers of resistors. Separate these columns, combining them with the columns on either side. Measure these resistors again, increasing the sensitivity of the detector, and sorting them every 1/2 millivolt.

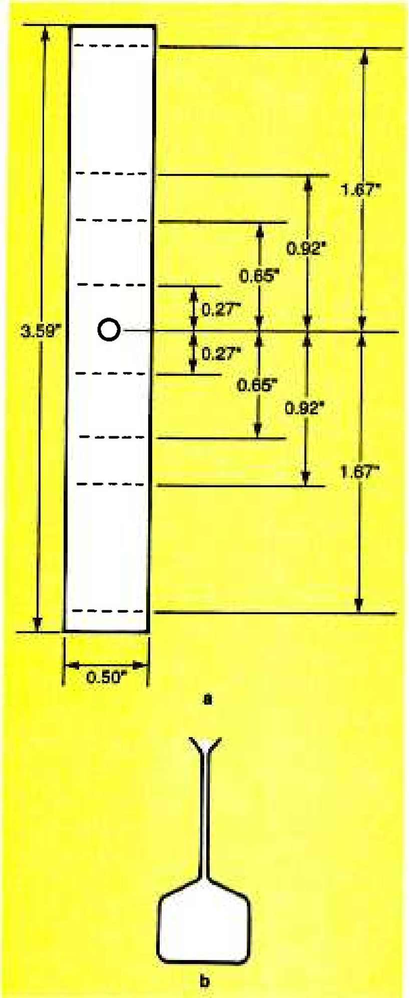


FIG. 4—BEND A 0.015-inch BRASS STRIP as show to form a clip for inserting resistors into the comparison bridge.

From adjacent columns, it should be possible to find 11 resistors that are all within 1/2 millivolt of each other, and hopefully, a few spares. No doubt there will be a few people who don't "win" on the first bag of resistors. If this is your fate, either order another bag, or live with a bit lower accuracy.

Once you have resistors for the first decade selected, remeasure them a few times until you have confidence that all the parts are within a 1/2 -millivolt window. Congratulations, the hardest part is over!

Select the resistor sets for each subsequent decade in the same manner. You will have to change the reference resistor in the bridge for each value. The required match for each succeeding decade becomes less critical. The last three decades don't require matching, but I like to check them on a DVM just to be sure they are close. See Table 1 for values and matching requirements.

Assembly

The connector headers are epoxied to the top panel of the enclosure. I used a piece of phenolic sheet, but a piece of circuit board material would work equally as well. Remove the copper by etching or peeling it off.

Figure 5, a 1:1 copy of the panel layout, makes a handy drill template. Just tape a copy of it in position on the panel, then use a center punch to mark the holes. Drill on the punch marks. Clean everything carefully, then epoxy the connector headers in place. Try to keep the epoxy off the pins. Small rubber grommets in the wire exit holes will protect the wires and give the unit a more finished appearance.

Solder the decade resistors to the underside of each header as shown in the photo. Since excessive heat can change the resistor values, be sure to leave the leads long and heat-sink each lead while soldering. A pair of long nose pliers can be used as a heat sink.

The padding networks are at-

TABLE 1—MATCHING REQUIREMENTS

KVD Decade	Resistor Value	Resistor Match	Bridge Offset with 27V Applied	Padding Network (Typical)	Padded Value
1	10KΩ	±0.0037%	±0.25 mV	-	-
2	2.05KΩ	±0.037&	±2.5 mV	820K (806K+50K pot)	20K
3	412Ω	±0.37%	±25 mV	844.6K (825K+50K pot)	4.1K
4	100Ω	±1%	-	4.68K (4.22K+1K pot)	824Ω
5	24.9Ω	±1%	-	1.01K (499Ω+1K pot)	200Ω
6	24.9Ω	±1%	-	62.25Ω (100Ω pot)	49.8Ω

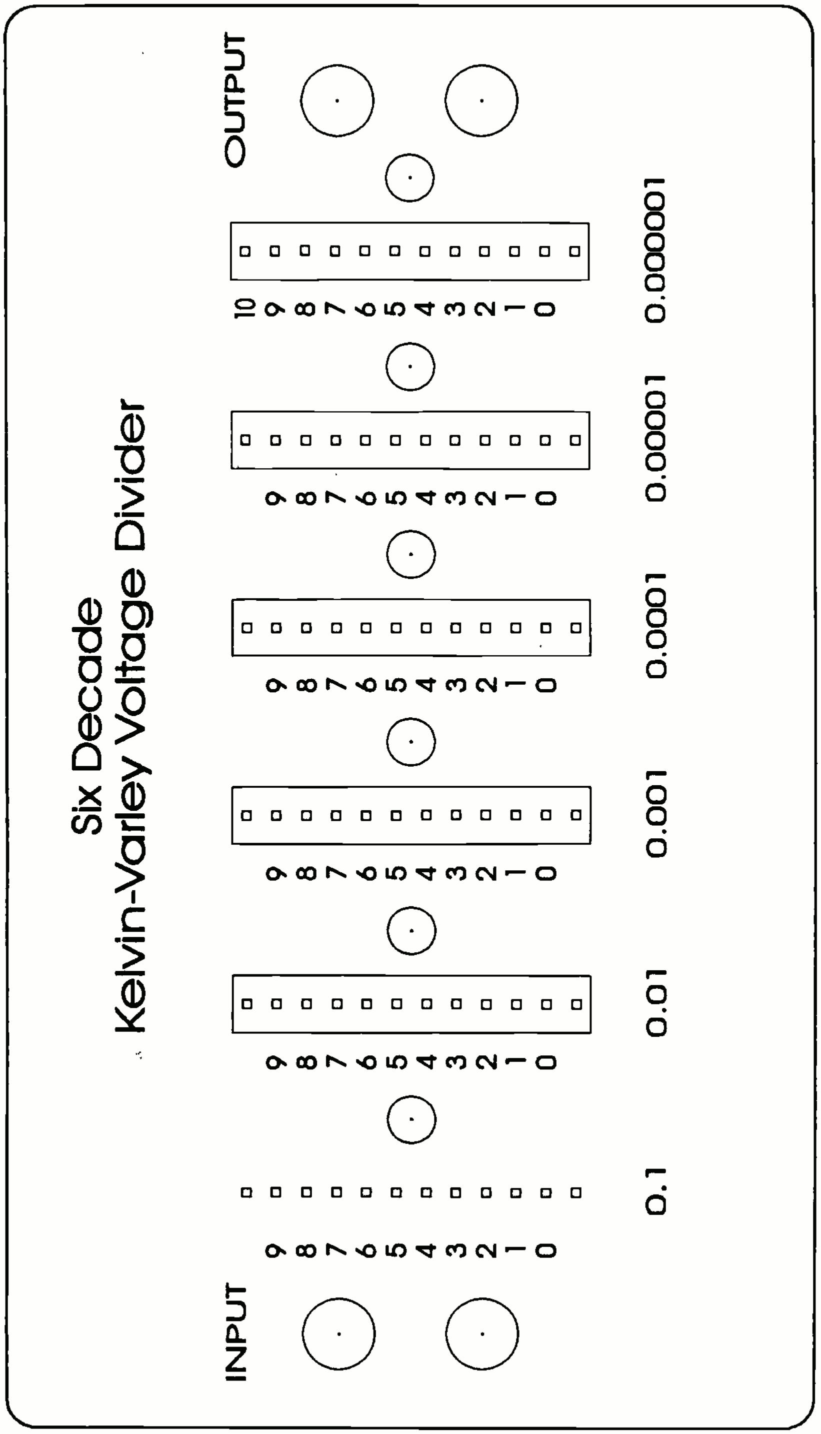


FIG. 5—THE KVD FRONT PANEL makes a handy drilling guide. It is shown full-size here.

tached across the full decades, and can be held in place with a drop of hot glue or epoxy. Each decade connects to its plug via a 6" twisted wire pair. Since the plugs are reversible, use two different colors of wire to avoid confusion. The plug for the last decade uses only one wire, so you may want to saw off the unneeded portion. Also, cut off the unused header pin from the same decade.

If you build a KVD using rotary switches, you will have to work out the connections for the particular switches you use. Generally, the resistors will be mounted in series around one of the decks, and the other deck will be wired in parallel, but offset by two positions.

Adjustment

The final step is to adjust the padding networks. This step has the potential to be confusing, so study the figures and instructions carefully. What you will do is attach clip-leads to turn each decade into a Wheatstone bridge, with the previous decade included as one of the bridge's arms. It is then a simple matter to adjust the previous decade and null the bridge.

This technique isolates each decade, and is the only way to accurately adjust the KVD. Do not attempt to adjust the decades with an ohmmeter, because it is not accurate enough, and the multiple current paths will give incorrect readings. Note that the voltages used are common battery voltages, if you don't have a suitable power supply handy.

1. Start with the output decade (No. 6). Attach power supply, the null detector, and a shorting lead to decade No. 5, as shown in Fig. 6. Because the resistances are low, do not apply more than 3 volts DC. Adjust the trimmer network on decade No. 6 for null.
2. Shut off the power and carefully move all of the clip-leads to the next decade (No. 4). Apply 3 volts DC and adjust the trimmer network on decade No. 5 for a null reading.
3. Move to decade No. 3 and adjust the trimmer network on decade No. 4, using about 9 volts DC.
4. Move to decade No. 2 and adjust decade No. 3, using about 18 volts DC.
5. Finally, move to decade No. 1 and adjust decade No. 2. Use 27 volts DC and make this adjustment as carefully as possible.
6. Recheck all the decades until you are confident that they are stable and correctly adjusted.
7. Finish up by installing the KVD in its enclosure

Making precision measurements

The simplest application of the KVD is to measure voltages

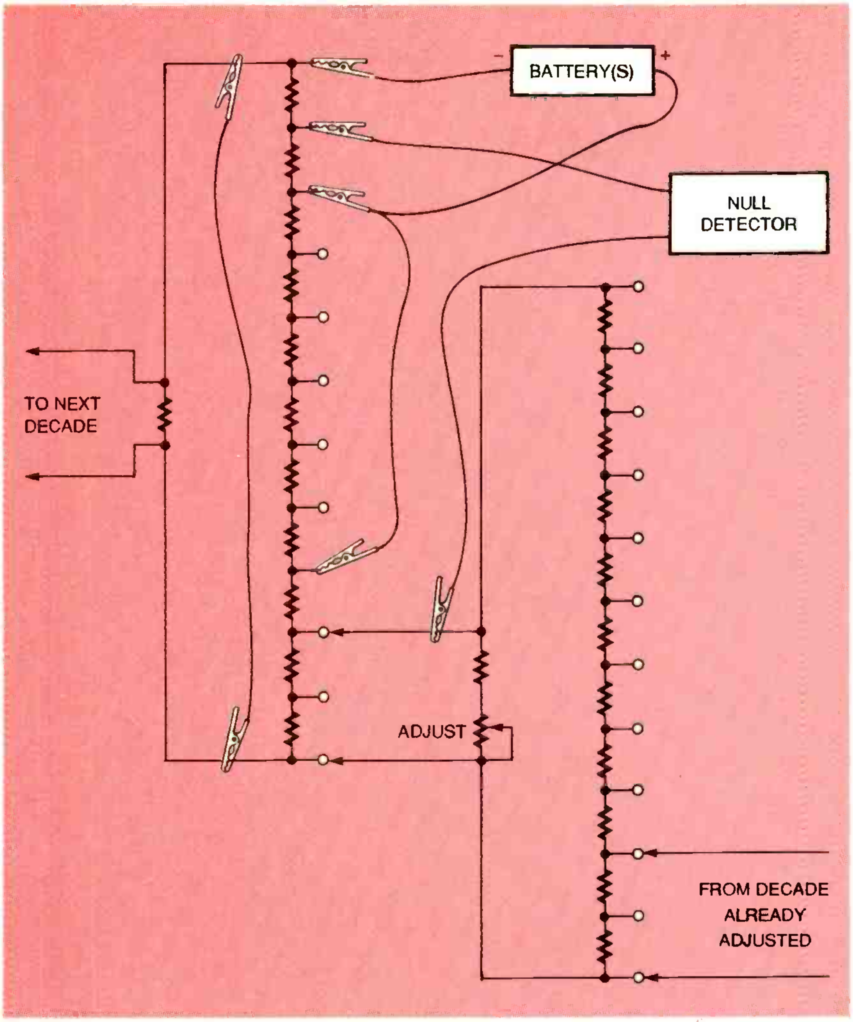
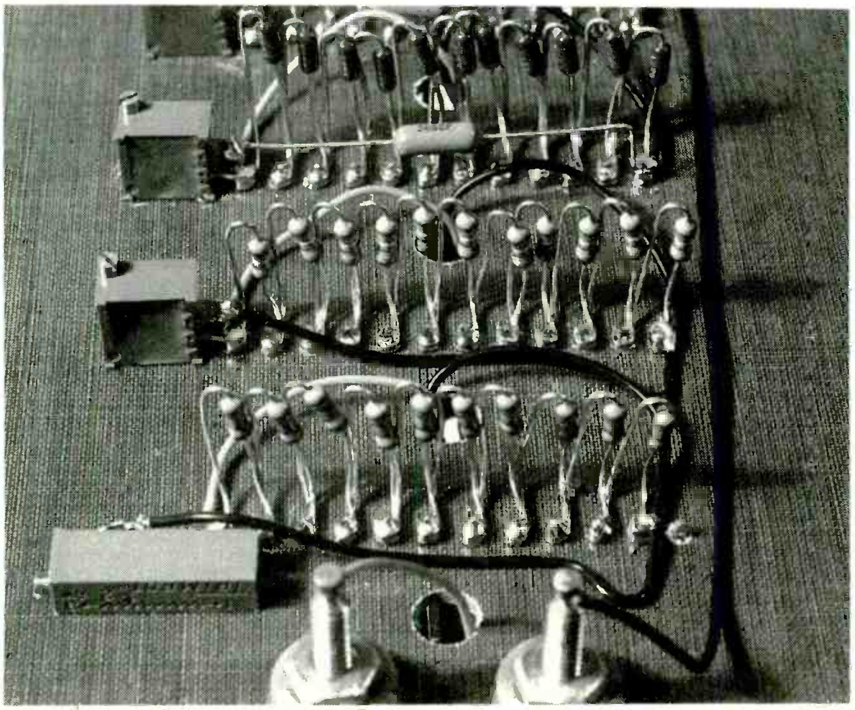


FIG. 6—HOOK UP CLIP LEADS AS SHOWN to adjust the padding networks.



A CLOSE-UP view of the KVD wiring.

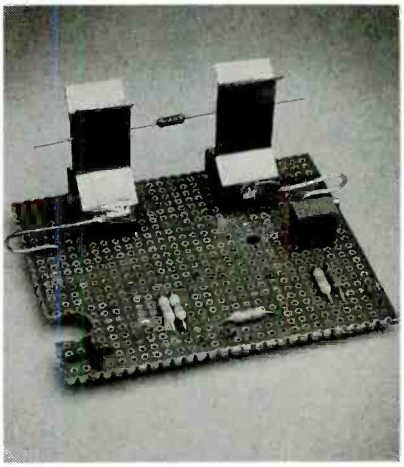
from zero up to the value of your voltage standard. The setup is shown in Fig. 7. Adjust the KVD settings until the null meter reads zero, then multiply the KVD reading times the exact value of the voltage standard.

Warning: Because the divider connections are exposed, do not use this divider with high voltages (above 40 volts), as there would be a risk of shock.

Using the voltage standard from the first installment of the series, this setup will easily check or calibrate the references used in 14-bit digital systems.

Remember: *The KVD is only accurate if no current is flowing in the output leg*. Thus, it is always used for null measurements, never as a source of current. For example, you cannot accurately measure the output of the KVD with a voltmeter, because the resistance of the meter would form a divider with the KVD, lowering the voltage slightly.

To measure voltages higher than the voltage standard, you can divide them down with the KVD, then null to the voltage standard. See Fig. 8.



THE COMPARISON BRIDGE can be built on perforated construction board.

This method does load the source. To avoid that, another stable voltage source can be used. The source drives the KVD, and is adjusted to null with the voltage standard. The unknown voltage is then measured as in Fig. 7, but with the higher temporary standard.

The KVD can also be used as

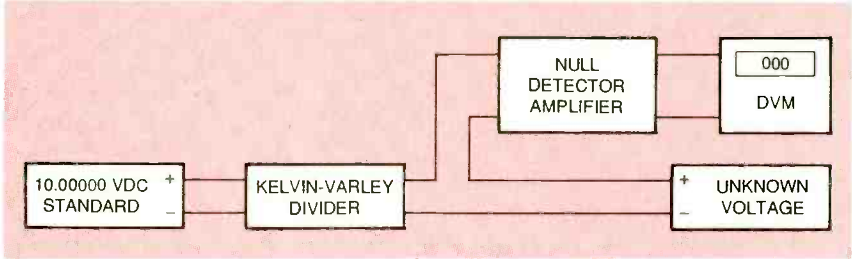


FIG. 7—THE SIMPLEST KVD MEASUREMENT SETUP.

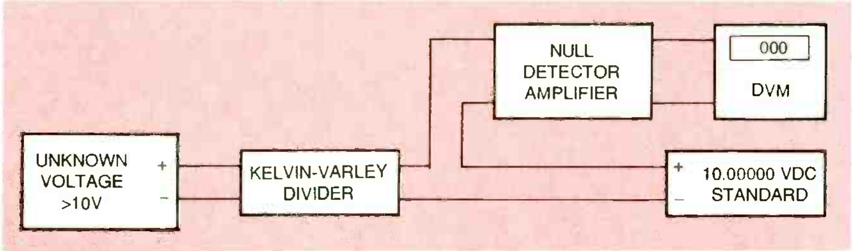
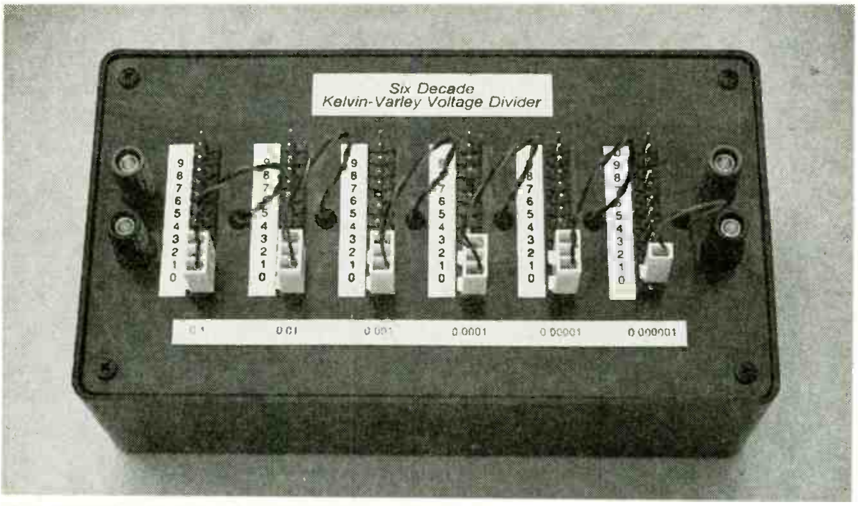


FIG. 8—THE KVD CAN BE USED TO MEASURE VOLTAGES above 10 volts with this setup.



THE COMPLETE SIX-DECADE KVD installed in its case.

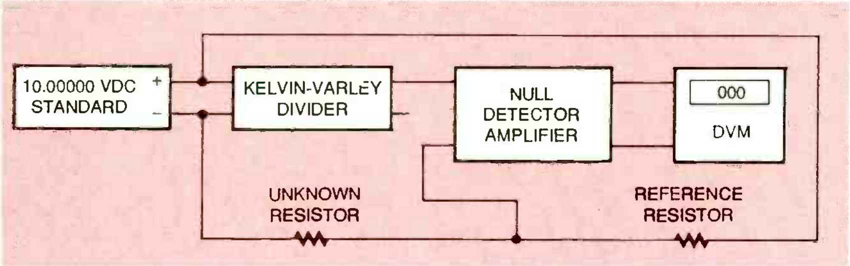


FIG. 9—USING THE KVD AS A BRIDGE.

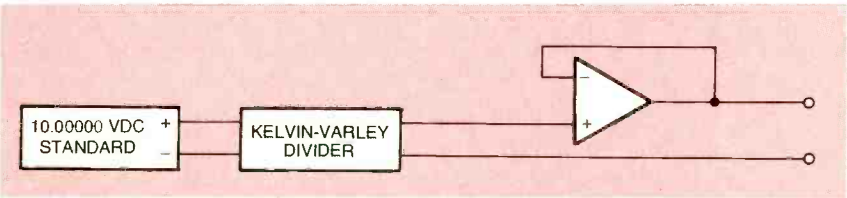


FIG. 10—THE KVD CAN BE USED AS A VOLTAGE SOURCE with this setup.

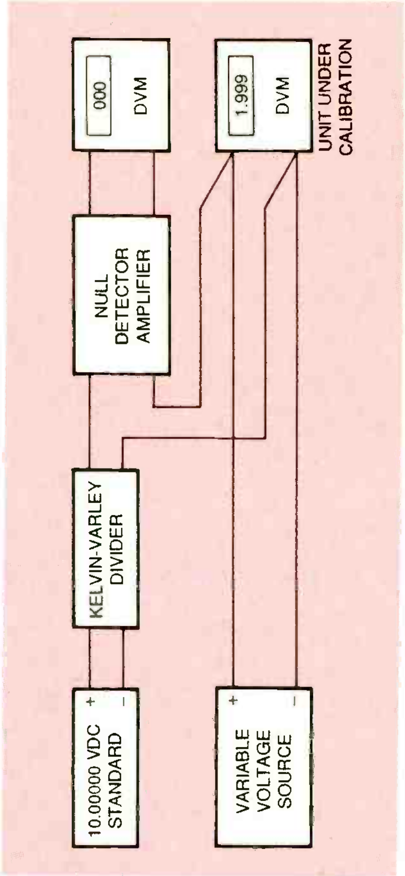


FIG. 11—TYPICAL CALIBRATION SETUP for the KVD.

one half of a Wheatstone bridge. If you have one or more precisely known resistors, you can accurately compare many different values to them. See Fig. 9.

Finally, the voltage standard and KVD can make a superb low current voltage source. The KVD is accurate only if no current is flowing in the output tap, so it must be buffered. See Fig. 10. This is a particularly useful arrangement for checking analog-to-digital converters.

We hope you enjoy building the equipment presented, and increasing your knowledge of traditional metrology techniques and making measurements that are accurate! Ω

REFERENCES

Basic Electrical Measurements, Melville B. Stout, Prentice-Hall, 1950
Calibration: Philosophy in Practice, Fluke Corp., 1994
JRL Precision, Vol. 1 No. 2, Julie Research Laboratories Inc., 1958
JRL Precision, Vol. 3 No. 5, Julie Research Laboratories Inc., 1960

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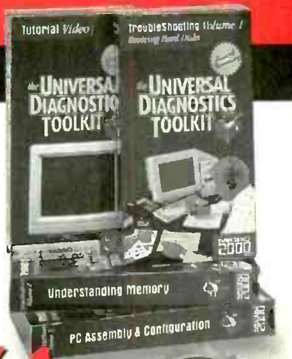

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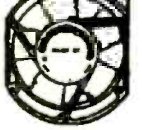

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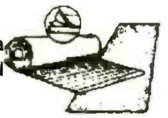

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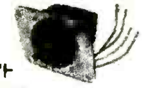

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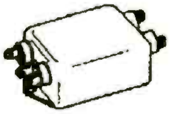

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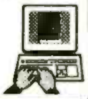

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HP 140T Non-Storage Display	425
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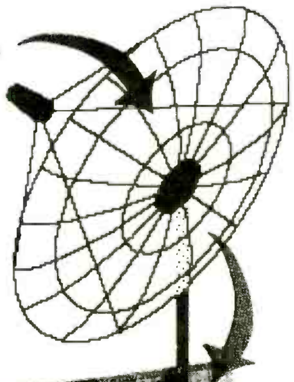

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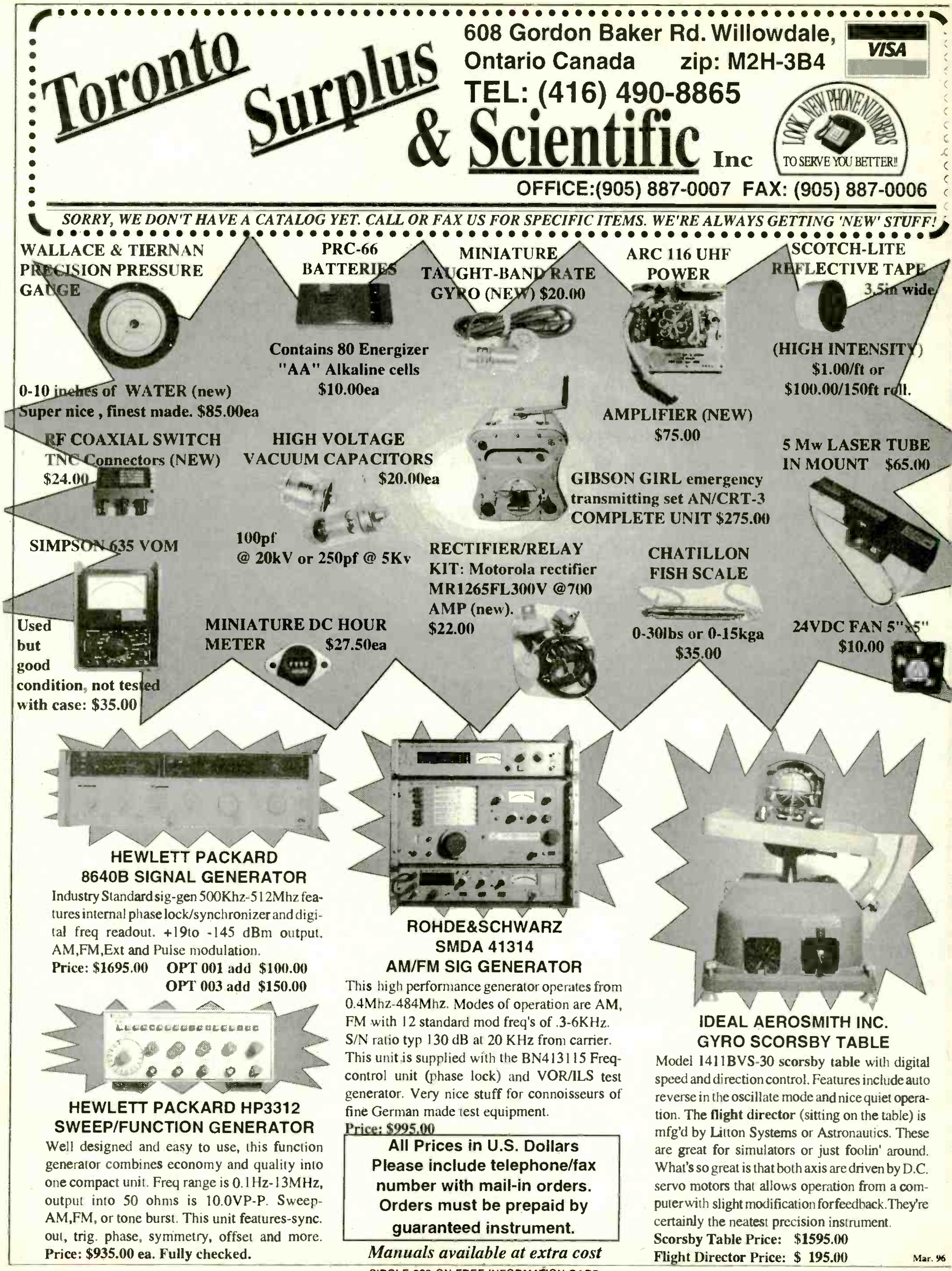
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This high performance generator operates from 0.4Mhz-484Mhz. Modes of operation are AM, FM with 12 standard mod freq's of .3-6KHz. S/N ratio typ 130 dB at 20 KHz from carrier. This unit is supplied with the BN413115 Freq-control unit (phase lock) and VOR/ILS test generator. Very nice stuff for connoisseurs of fine German made test equipment.
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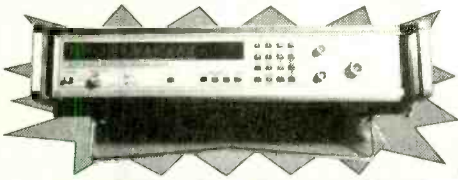
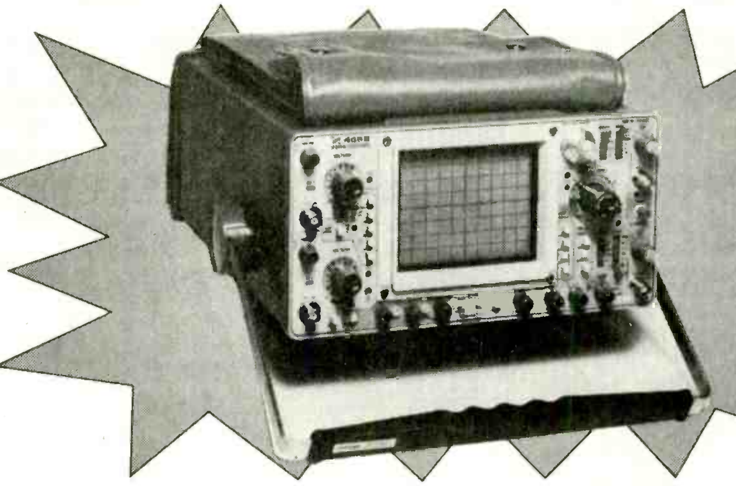


MICROWAVE FREQUENCY COUNTER
EIP MODEL 545A

The 545A easily covers 10 Hz-18GHz frequency range with -30dbm relative sensitivity and 10 watt (+40dB) input damage protection. In addition, the 545A also measures RF power to 0.1 dB with an overall acurracy of 0.5dB.The unit comes with internal ovenized oscillator. Like-new conditon. **Price: $2295.00**



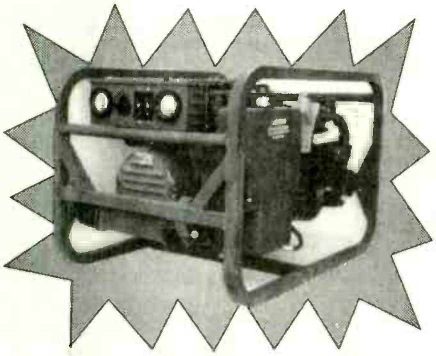
TEKTRONIX 465B

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" or 465M. 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 rarely permits. Fortunately, we were recently able to acquire 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 need is current and action *swift* you too will be a member of a growing club!!!

SELECTED EXCELLENT COND......$849.00

TEKTRONIX 465-M. 100MHz...........$695.00

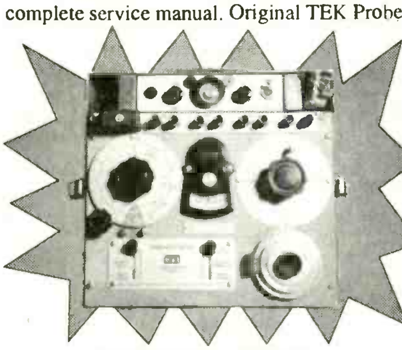
These instruments are fully checked out. They are supplied with an original front panel cover and complete service manual. Original TEK Probes are $75.00 each with each purchase.



MILITARY STANDARD D.C. GENERATOR

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

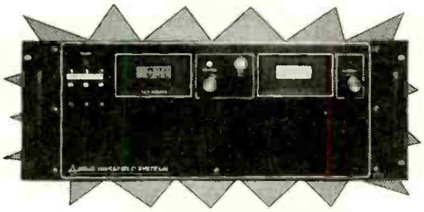
Price: $379.00 New in Orig. Carton.
You will be impressed!!!



ESI MODEL 250 DA IMPEDANCE BRIDGE

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

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



"*SERIOUS*" POWER SUPPLY TCR 20S135

Output voltage is adjustable from 0-20V With a current limited maximum output of 135 clean DC amps. Digital LCD meters present both voltage and current along with LEDs for CC or CV operation. These units are currently wired for 220v operation but can be reconfigured for 110v operation. They're good & heavy but lightly priced **at: $895.00 Good condition.**

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1-7/8" dial

Great collectors item for the ham shack, fifties vintage funct/chkd.

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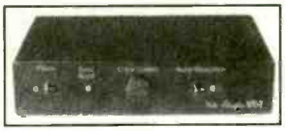
ELIMINATES ADVERSE EFFECTS OF VIDEO COPY-GUARDS!

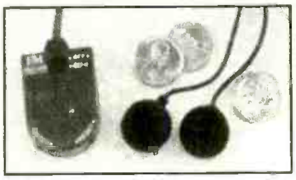


State-of-the-art circuitry restores original (master) quality to all video tapes. Allows for flawless viewing of all prerecorded video's whether rented, purchased or produced at home (even copy-protected tapes),for your personal home use. Unique auto Sync Boost feature eliminates horizontal instability and restores tapes to broadcast quality. Noise Reduction Circuit filters out the "snow" and other annoying interference. Compatible with all VCRs and T.V.s. Includes AC adapter.

CAT #VC-1 **$59.95 each**

ULTRA-MINI FM RADIO

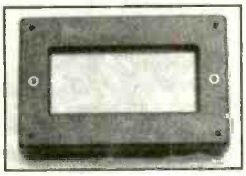
WOW! SOUNDS GREAT!



Fit an entire orchestra in the palm of your hand and still have room for the concert tickets with this Mini FM Radio that has an incredible sound. Features on/off button, seek button and reset button. Includes battery. If this isn't the world's smallest, it's close to it. But the sharp, clear sound that comes out will make you think you have a jam box. Black.

CAT #FM-1 **$19.95 each**

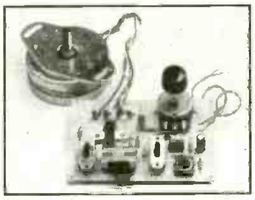
3 1/2 DIGIT PANEL METER



This meter has many useful applications such as Voltmeter, Thermometer, Db Meter, Watt Meter, Current Meter, Capacitance Meter, Lux Meter and LCR Meter. Features include: 200mV full scale input sensitivity, single 9VDC operation and decimal point selectable. In addition, it has 13mm figure height, automatic polarity indication, guaranteed zero reading for 0 volt input and high input impedance (>100M ohms). Specifications: Max input 199.9mV DC-Max. Display: 1999 counts (3-1/2 digits). Measuring method: Dual slope integration A-D converter system, plus many other features.

CAT #PM-1 **$9.95 each**

STEPPER MOTOR CONTROLLER KIT



This kit allows you to adjust the speed and direction of a stepper motor. You can move the motor in one step increments or rotate it at a constant speed. There are a set of visual indicators that show the sequence of motor. Includes stepper motor, pc board, parts and instructions.

(12Vdc power source not includ.) CAT #SMK-1 **$25.00 each**

LASER POINTER

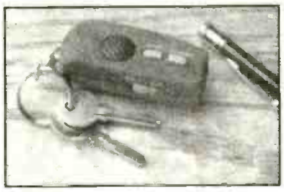
5mW LASER POINTER!

Make a point with your laser pointer. Pointers are the most effective way to demonstrate your drawings, schematics, presentation, and charts. Just press and point! The beam shoots out across the room and puts a red dot on the wall up to 350 feet away. Operates on 2AAA batteries (included). wt. 2.3oz, wavelength 670nm/5mW output. Measures: .5" diameter x 5.75" L

CAT #LP-1 **$39.99 each**

TALKING MEMO RECORDER

TALKING MEMO RECORDER / KEY CHAIN



Records and plays messages up to 16 seconds (i.e. parking spaces, things to do, etc.).16 seconds is a long time to dictate! Measures 3" x 1.25". Battery operated (included).

CAT #TM-1 **$19.95 each**

FM WIRELESS MIKE KIT

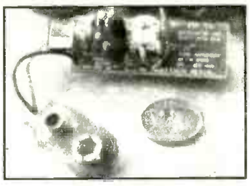
POWERFUL

2 stage, wireless mike kit transmits over .5 mile (up to 1 Km in the open) Tunable to the upper part of FM broadcast band. Circuit does require the ability to "Tweak" RF circuits by stretching or compressing coils. With mike and 9V battery clip. Operates from 6-12V DC. 2.75" x .625" x .5" WT .06

CAT #FM-32 **$10.95 each**

9V DC FM TRANSMITTER KIT

POWERFUL



FM transmitter. Transmits over 100 meters in building and over 500 meters outside using .25 or .5 wavelength of wire. Transmits to the upper part of FM broadcast band (100-108MHz). Circuit requires the ability to "Tweak" RF circuits. Operates on 9V DC. 1.75" x .75" x .375" WT .05

CAT #FM-18 **$9.95 each**

CAMCORDER VIDEO TAPES

HI-8 120 MINUTE VIDEO CASSETTE TAPES (used)

They were recorded on once and played only a few times. Made by a major brand name manufacturer. Professional series metal tapes. Includes plastic jewel box.

NOTE: Other tapes available.

CAT #CCT-1 **$3.00 each**

10 or more - 2.80 each

EMERGENCY LIGHT

THE AMAZING EMERGENCY LIGHT!

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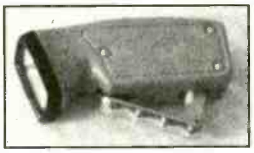

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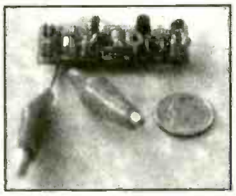

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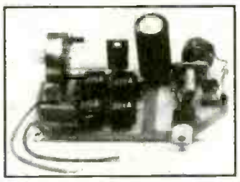

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Unit is EL back-lit. Dim: 5¹⁄₁₆"L x 4¹⁄₁₆"H.
The built-in controller allows you to do text and graphics.

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

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

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size	Mfr.	price	size	Mfr.	price
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index guided. Threshold current 40 ma typical.

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

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Includes: • 20 character dot matrix display with full alpha-numeric capability • keypanel with full alpha-numeric entry • separate 7.5 VDC/0.5 Amp power supply • standard telephone interface extension cord • lithium battery and flat-cone speaker.
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IBM 370 option XT and AT emulation boards $35.00

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5 inch Amber	**$35.00**
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"The Spy In The Sky" $29.00 — **MATRIX TYPE**

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

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

Hacker Corner

CELL SITE TRANSCEIVER $99.00

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

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IR viewing to 1000 nm 7 ½ L x 2 ¾ W x 1 ¾ H
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Portable Micro Terminal $99.00 or 2 for $149.00
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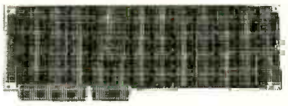
PM-129	3-1/2 Digit LED Panel Meter	11.49	9.54	8.67	7.95	6.95
PM-328	4-1/2 Digit LCD Panel Meter	19.88	16.40	14.90	13.66	11.93

PC218902 (AT-BUS)



- Board Length: 13-1/8" (333mm)
- Board Width: 4-5/16" (110mm)
- Double Sided, 3-Hole Solder Pads and Power Buses
- Space Reserved for: Header, 32x2, 0.1" Spacing and Pin Grid Array

Vector Cross Ref. #4617

CAT NO	PRICE EACH 1	5
PC218902	$25.66	$20.25

PC218904 (AT-BUS)

- Board Length: 13-1/8" (333mm)
- Board Width: 4-5/16" (110mm)
- Double Sided, Pad-Per-Hole and Power Buses
- Space Reserved for: 1 D-Type Connector, 25-pin

Vector Cross Ref. #4617-3

CAT NO	PRICE EACH 1	5
PC218904	$25.42	$20.06

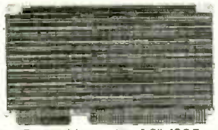
PC218903 (XT-BUS)

- Board Length: 13-1/8" (333mm)
- Board Width: 4-5/16" (110mm)
- Double Sided, Pad-Per-Hole and Power Buses
- Space Reserved for 1 D-Type Connector, 25-Pin

Vector Cross Ref. #4613-3

CAT NO	PRICE EACH 1	5
PC218903	$23.51	$18.63

PC232904 (Multi-BUS)

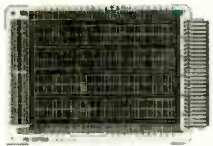


- Board Length: 12" (305mm)
- Board Width: 6-3/4" (171mm)
- Double Sided, Pad-Per-Hole and Power Buses
- Space Reserved for 1 Header, 100x2, 0.1" Spacing

Vector Cross Ref. #4608

CAT NO	PRICE EACH 1	5
PC232904	$38.40	$29.80

PC207905 (STD-BUS)

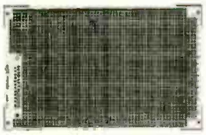


- Board Length: 6-1/2" (165mm)
- Board Width: 4-7/16" (113mm)
- Double Sided, 3-hole Solder Pads, Ground Plane and Power Bus
- Space Reserved for 1 Header, 34x3, 0.1" Spacing

Vector Cross Ref. #4610

CAT NO	PRICE EACH 1	5
PC207905	$13.66	$11.25

PC412902 (VME-BUS)



- Board Length: 6-5/16" (160mm)
- Board Width: 3-15/16" (100mm)
- Single Sided, Pad-Per-Hole and Power Buses
- Space Reserved for 1 D-Type Connector, 25-Pin

Vector Cross Ref. #4614-3

CAT NO	PRICE EACH 1	5
PC412902	$7.06	$6.00

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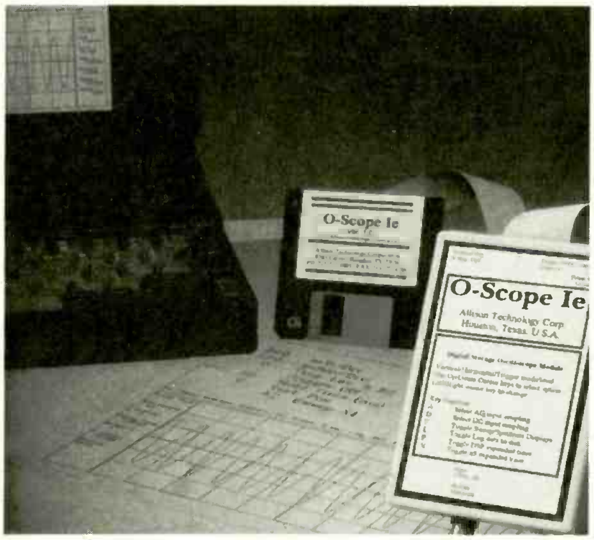

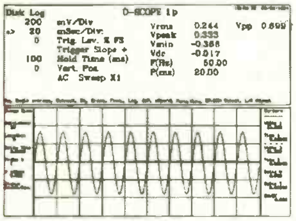

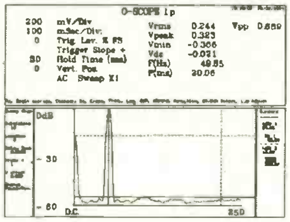

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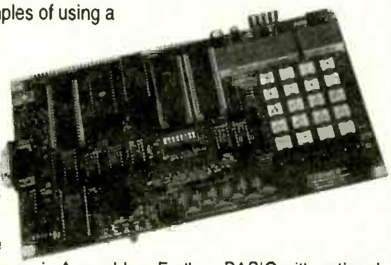

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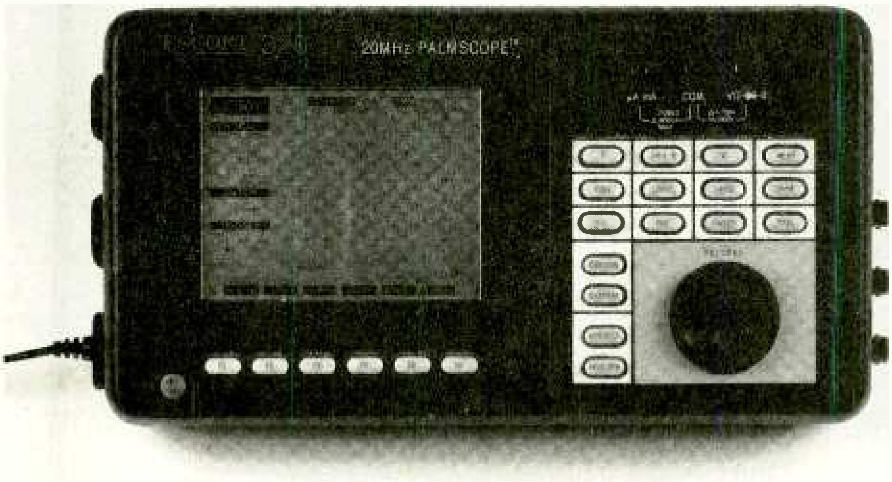

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- Frequency Counter (7 digits, 20 MHz)
- Logic Scope (8 channels, 50ns sample clock)

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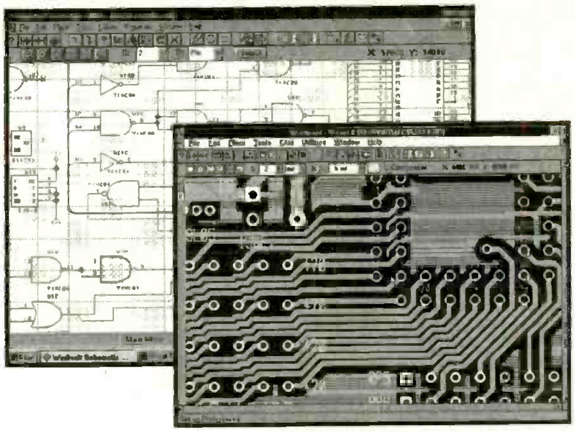

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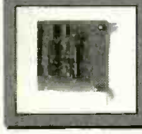

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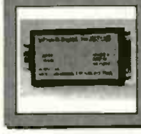

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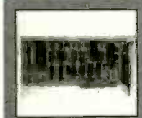

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- 4 ANALOG OUTPUTS
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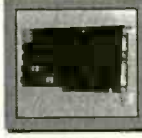

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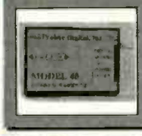

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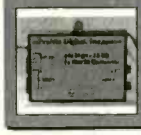

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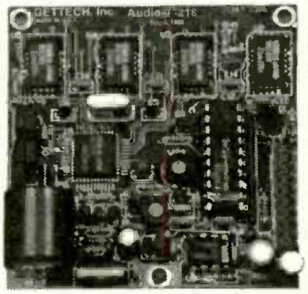

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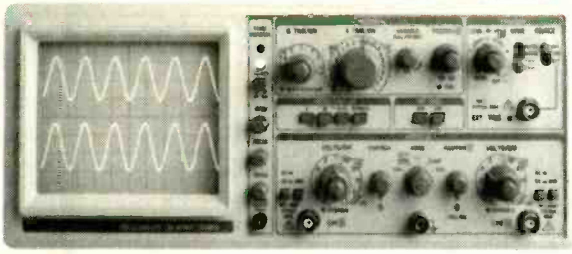

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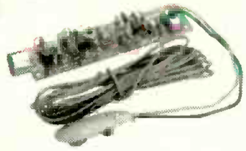

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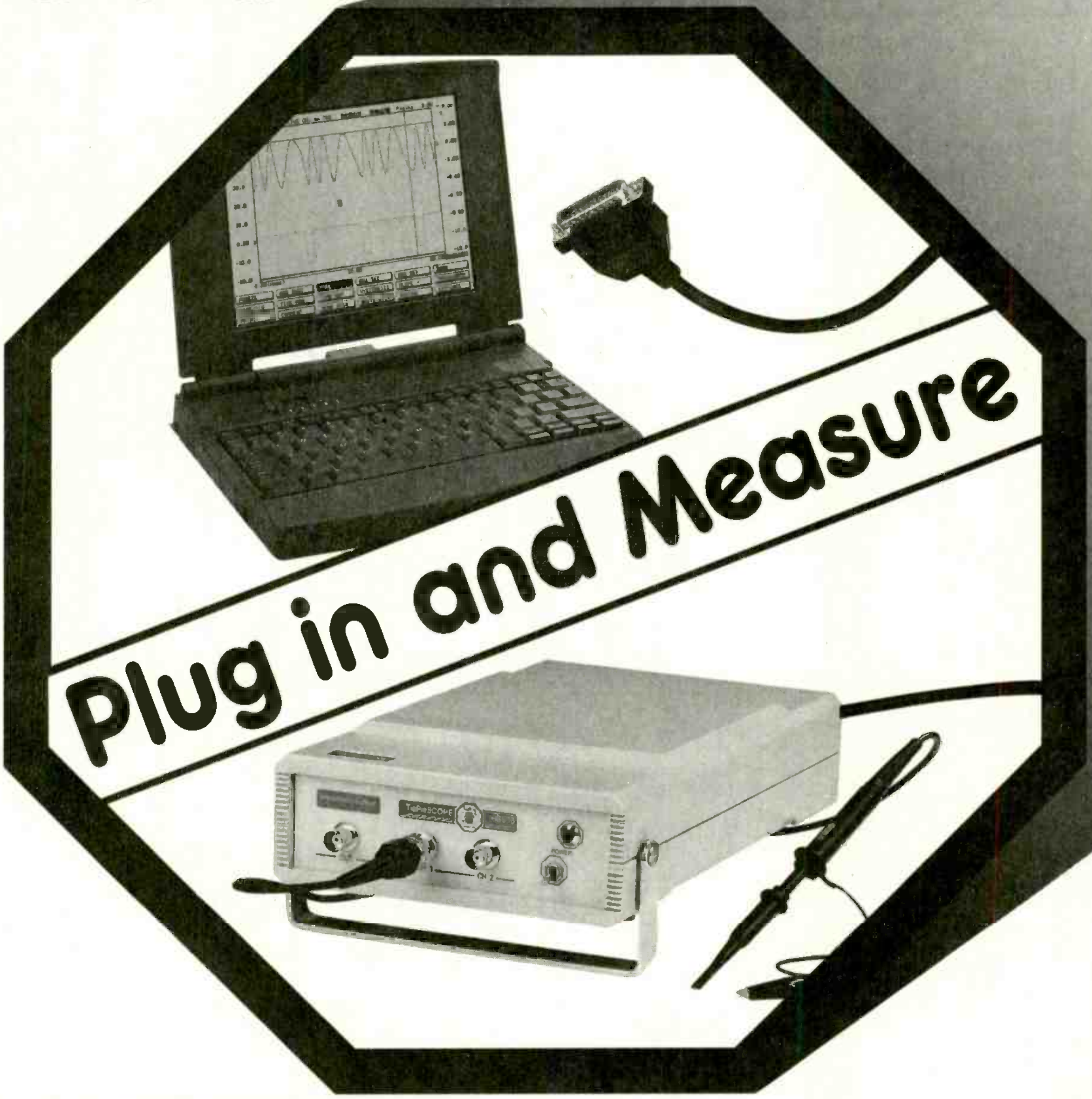

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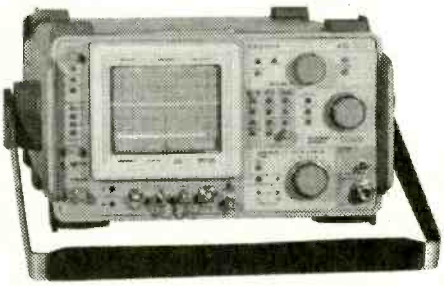

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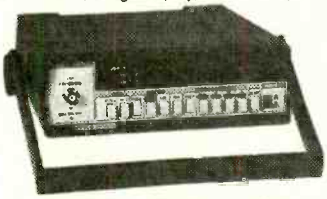

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Hewlett-Packard 8568A
Spectrum Analyzer, 100 Hz to 1.5 GHz, 10 Hz resolution, trace markers w/ amplitude/frequency readout.
$13900.00

Hewlett-Packard 8569B
10 MHz to 22 GHz, input preselection,1.7 to 22 GHz, resolution 100 Hz to 3 MHz.
$9200.00

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DANBAR SALES COMPANY

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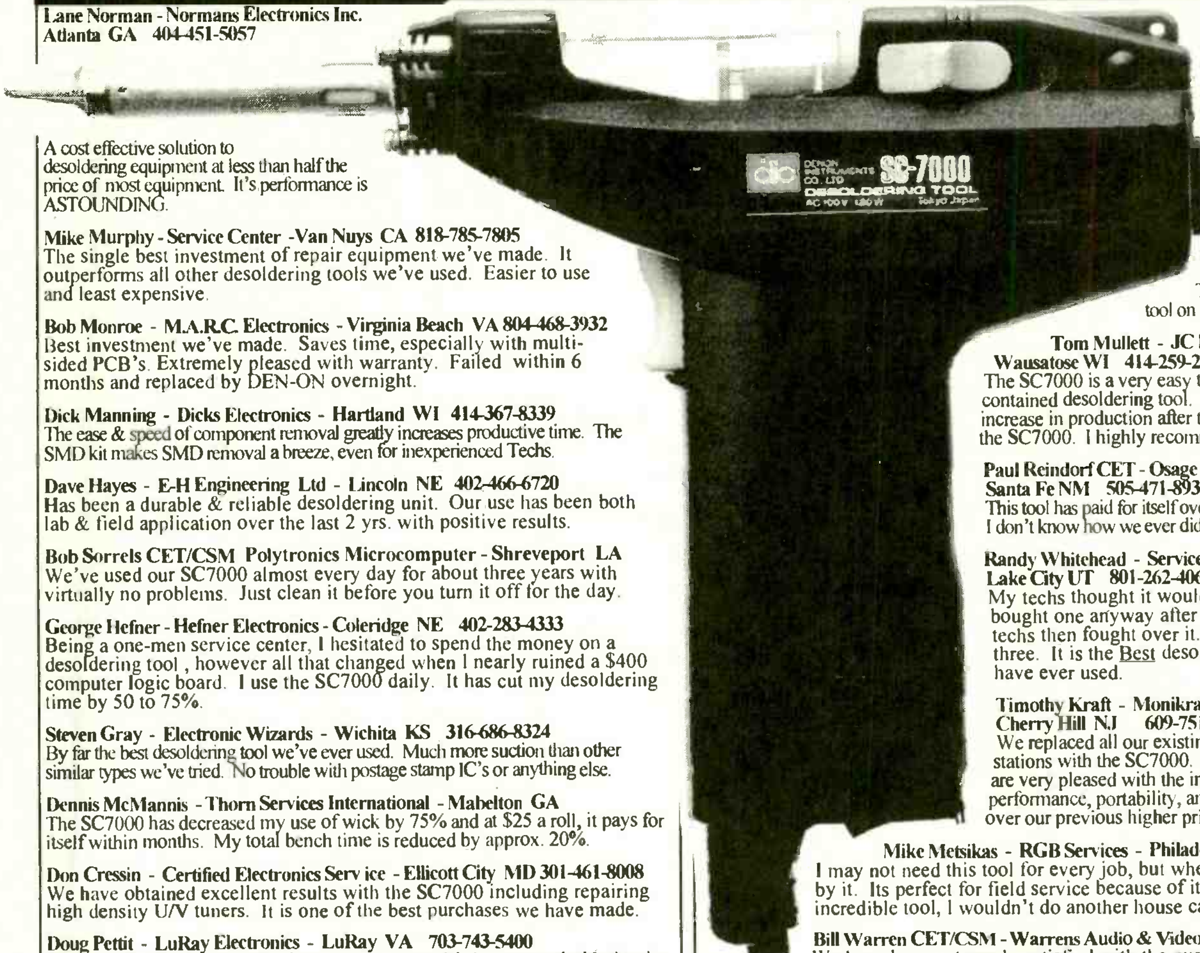
PROFESSIONAL DESOLDERING with the

Lane Norman - Normans Electronics Inc.
Atlanta GA 404-451-5057



A cost effective solution to desoldering equipment at less than half the price of most equipment. It's performance is ASTOUNDING.

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

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

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

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

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

George Hefner - Hefner Electronics - Coleridge NE 402-283-4333
Being a one-men service center, I hesitated to spend the money on a desoldering tool , however all that changed when I nearly ruined a $400 computer logic board. I use the SC7000 daily. It has cut my desoldering time by 50 to 75%.

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

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

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

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

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

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

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

Paul Reindorf CET - Osage TV &Comm. - Santa Fe NM 505-471-8930
This tool has paid for itself over & over again. I don't know how we ever did without it.

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

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

Mike Metsikas - RGB Services - Philadelphia PA
I may not need this tool for every job, but when I do, I swear by it. Its perfect for field service because of it's size. An incredible tool, I wouldn't do another house call without it.

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

David Dumber - Video Tech Center, Inc. - Belair MD 410-893-8448
The compact design of the SC7000 boast optimum efficiency. I wouldn't trade it's performance for any system at even twice the price.

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

Ray Wurmnest - Ray's Electronics, Inc. - Bloomington IL
The SC7000 saves time when changing out parts in the home or in the Service Center — Worth every penny we spent.

DEN-ON SC7000

- Totally Self Contained diaphragm vacuum pump and AC motor for high vacuum suction or reversible hot air blow for SMD removal.
- 100Watt Ceramic heater with zero-crossover switching heater control circuit which prevents spikes and leakage currents.
- Unique patented long lasting filter cartridge design. Solder builds up on easily cleaned baffle, while air flows around the outside of baffle.
- Totally ESD Safe. The housing contains carbon and the tip is at ground potential for complete ESD Protection.
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VC-6524 - Storage 20MS/s $2295
V-695 - 60MHz w/ Cursors $1549
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V-552 . . . . $949
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VC-6523 - Storage 20MS/s $1995
V-252 . . . . $449
V-209 - Battery Operated . $1425

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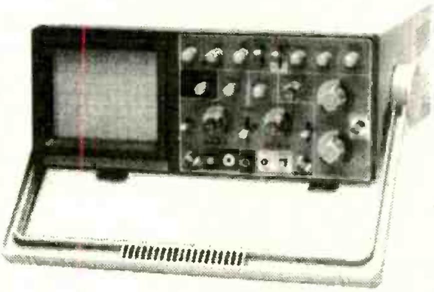


60MHz

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

S-1365 $795
- Analog w/ Cursors

S-1360 $759
- Analog with Delayed Sweep

40MHz

S-1345 $569
- Analog with Delayed Sweep

S-1340 $489
- Analog

2 Year Warranty

25/30MHz

DS-303 $1095
- Analog / Digital Storage

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

S-1325 $335
- 25MHz Analog

OSCILLOSCOPE SELECTION CHART

ANALOG

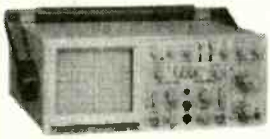
Model	Bandwidth MHz	Sensitivity (max)	No. of Channels	Sweep Rate Max ns/div	Delayed Sweep	Video Sync	Component Tester	Beam Find	Time Base
S-1365	60	1mV/div	2	10ns/div	Yes	Yes	Yes	Yes	2
S-1360	60	1mV/div	2	10ns/div	Yes	Yes	Yes	Yes	2
S-1345	40	1mV/div	2	10ns/div	Yes	Yes	Yes	Yes	2
S-1340	40	1mV/div	2	10ns/div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

DIGITAL STORAGE

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

B&K Precision at Discount Prices

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



Model 1541C
40MHz
$695
Dual Trace

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

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

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

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92 . . . . . . $1525
96 . . . . . . $1795
97 . . . . . . $1795
97A $2945
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INSTRUCTIONS FOR PLACING YOUR AD!

HOW TO WRITE YOUR AD

TYPE or PRINT your classified ad copy CLEARLY (not in all capitals) using the form below. If you wish to place more than one ad, use a separate sheet for each additional one (a photo copy of this form will work as well). Place a category number in the space at the top of the order form (special categories are available). 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 ads or multiple ads in the same issue, but in all cases, full payment must accompany your order.

WHAT WE DO

The first word and company name 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 $2.50 per word. Minimum charge is $37.50 per ad per insertion (15 words). Any words that you want set in bold are each .40 extra. Indicate bold words by underlining. Words normally written in all caps and accepted abbreviations are not charged anything additional. State abbreviations must be post office 2-letter abbreviations. A phone number is one word.

If you use a Box number you must include your permanent address and phone number for our files. ADS SUBMITTED WITHOUT THIS INFORMATION WILL NOT BE ACCEPTED.

For firms or individuals offering Commercial products or Services. **Minimum 15 Words.** 5% discount for same ad in 6 issues within one year; 10% discount for same ad in 12 issues. **Boldface (not available as all caps),** add .40 per word additional. **Entire ad in boldface,** add 20%. **Tint screen behind entire ad,** add 25%. **Tint screen plus all boldface ad,** add 45%. **Expanded type ad,** add $4.00 per word.

General Information: A copy of your ad must be in our hands by the 13th of the fourth month preceding the date of issue (i.e. Sept issue copy must be received by May 13th). When normal closing date falls on Saturday, Sunday or Holiday, issue closes on preceding work day. Send for the classified brochure.

DEADLINES

Ads not received by our closing date will run in the next issue. For example, ads received by November 13 will appear in the March issue that is on sale January 17. ELECTRONICS NOW is published monthly. No cancellations permitted after the closing date. No copy changes can be made after we have typeset your ad. NO REFUNDS, advertising credit only. No phone orders.

CONTENT

All classified advertising in ELECTRONICS NOW is limited to electronics items only. All ads are subject to the publishers' approval. WE RESERVE THE RIGHT TO REJECT OR EDIT ALL ADS.

AD RATES: $2.50 per word. Minimum $37.50

Send you ad payments to:
ELECTRONICS NOW 500 Bi-County Blvd, Farmingdale, NY 11735-3931

CATEGORIES

100 -- Antique Electronics	270 -- Computer Equipment Wanted	450 -- Ham Gear Wanted	630 -- Repairs-Services
130 -- Audio-Video Lasers	300 -- Computer Hardware	480 -- Miscellaneous Electronics For Sale	660 -- Satellite Equipment
160 -- Business Opportunities	330 -- Computer Software	510 -- Miscellaneous Electronics Wanted	690 -- Security
190 -- Cable TV	360 -- Education	540 -- Music & Accessories	710 -- Telephone
210 -- CB-Scanners	390 -- FAX	570 -- Plans-Kits-Schematics	720 -- Test Equipment
240 -- Components	420 -- Ham Gear For Sale	600 -- Publications	730 -- Wanted

CLASSIFIED AD COPY ORDER FORM

Place this ad in Category #__________ **Special Category $30.00 Additional** __________

1 - $37.50	2 - $37.50	3 - $37.50	4 - $37.50	29 - $72.50	30 - $75.00	31 - $77.50	32 - $80.00
5 - $37.50	6 - $37.50	7 - $37.50	8 - $37.50	33 - $82.50	34 - $85.00	35 - $87.50	36 - $90.00
9 - $37.50	10 - $37.50	11 - $37.50	12 - $37.50	37 - $92.50	38 - $95.00	39 - $97.50	40- $100.00
13 - $37.50	14 - $37.50	15 - $37.50	16 - $40.00				
17 - $42.50	18 - $45.00	19 - $ 47.50	20 - $50.00				
21 - $52.50	22 - $55.00	23 - $57.50	24 - $60.00				
25 - $ 62.50	26 - $65.00	27 - $67.50	28 - $70.00				

Total words __________ $2.50 per word = $__________

Bold Face __________ $0.40 per word = $__________

Special Heading __________ $30.00 = $__________

Other __________ = $__________

Total classified ad payment $__________ **enclosed**

TOTAL COST OF AD $ __________

[ ] Check [ ] Mastercard [ ] Visa

Card # _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ Expiration Date _ _/_ _

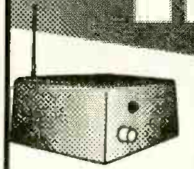
Signature__________________________

Name __________________________ Phone __________________________

Address__________________________City State Zip __________________________

RAINBOW KITS

Many of our kits are available completely built



FM STEREO TRANSMITTER

Own your own FM radio station. Any stereo signal you plug into the FMST-100 will be transmitted to any FM radio tuneable from 76 to 108MHz FM. Transmit a wireless link through an auditorium, from your car to your camper, listen to your CD's while mowing the lawn, Play music on one channel sing on the other. Clarity is excellent, aprox. 40dB stereo separation. Length of antenna determines the distance of transmission. Complete with stereo input level controls & crystal for stereo separation. 9v battery operation. SIZE: 1.5" x 2.5" x 3"

FMST-100 Cabinet $8.95 KIT $29.95

PHONE TRANSMITTER

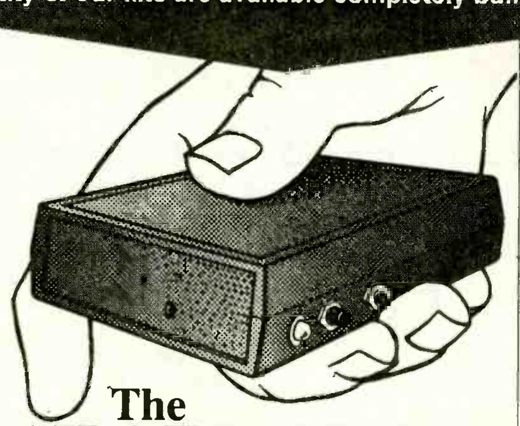
Small but mighty, it fits anywhere. Phone line powered, never needs batteries. Transmits both sides of a phone conversation loud and clear, wireless, to any FM radio at great distances. Variable tunes from 70MHz to 130MHz FM. You can also use it as a speaker phone. SIZE:1.25" x .6".

TEL-B1 BUILT $29.95 KIT $12.95

SUPER SNOOPER BIG EAR

Listen through walls, hear conversations across the room. Add a parabolic reflector and hear blocks away. The BIG EAR can be hidden about anywhere. Makes an ultra sensitive intercom. Can be used as a 1.5W AMP. We supply a mini-electret mike in the kit. Power requirement 6 to12v DC. SIZE:1.75"x 1"

AA-1 BUILT $29.95 KIT $10.95



The "ZAPPER II"

With it's new and improved design it will not only test your radar detector...BUT it's tuned to the amateur radio band.

- While your out on American highways personally test yours and your fellow travelers radar detectors.

The "ZAPPER II" is a 10.450 GHz to 10.550 Transmitter

KIT $39.95 BUILT $49.95

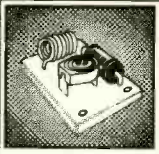
This Manual contains schematics, parts lists & P.C. board layouts for many of the Rainbow Kits. Use your own parts to construct our kits.

KIT BOOK $14.95
$9.95 with the purchase of any kit.

WIRELESS FM MICROPHONE

Small but mighty this little jewel will out perform most units many times its price. It really stomps out a signal. The WM-2 kit is a buffered wireless mike that operates from 80MHz to 120MHz FM, the frequency of any broadcast FM radio. Includes a mini-electret mike. 6 to 12v DC. SIZE: 1.25" x 1"

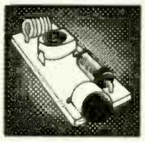
WM-2 KIT $14.95



MICRO-MINIATURE PHONE TRANSMITTER

We haven't seen a smaller phone transmitter than the MMPT2 kit. Powered by the phone, it requires no battery. Transmits both sides of a phone conversation to an FM radio up to a 1/4 mile away.Tunable from 88 to 108MHz FM. Attach it to one phone or add it to the line to pick up all incoming calls. The MMPT2 is undetectable if properly installed. Unit has surface mounted parts, you install the leaded parts. Size .45 "x .6"

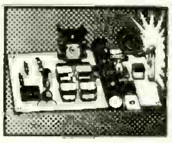
MMPT2 KIT $29.95



MICRO-MINIATURE WIRELESS MIKE

So small you could hide this one on some real bugs! It's the smallest we've ever seen. With it's super sensitive mike it transmits a whisper or a room of conversation to an FM radio, tunable from 88 to 108MHz FM. With a proper antenna it transmits about 1/2 mile. The kit is made with surface mounted parts, we have already mounted these parts. You install the leaded parts. Power requirement 6 to 12v DC. Size .35"x.9"

MMWM5 KIT $34.95



STROBE LIGHT

Do you need an attention getter, warning light,or flashing light for model airplanes? Then this kit is for you. Use it as an emergency light for your auto, radio tower, even use it on your bicycle. Has a variable flash rate. Power requirement 6 or 12v DC . Size 3.5"x1.9"

ST-1 KIT $11.95

Press a button and learn every number dialed on your phone

Okay. Caller ID's tell you what number is calling you. But what about the calls made from your phone? Now, return from work or vacation and know the answer. The new DTMF Recorder electronically logs and saves every number dialed. This is the same high-tech magic used by detectives and government spies. Now yours. Does your wife or husband make expensive long -distance calls and then deny it? Does your son or daughter call that low-life you forbade them to talk to? Now know.

- Decodes digits 0 thru 9, #, *, A, B, C, on a 2 line 16 character LCD display.
- Clicks into your phone or extension in seconds, with no special wiring or hassles, or jack it to the incoming service panel in your garage.
- Records all numbers dialed, including local numbers that don't appear on your bill.
- Records credit card numbers entered through your phone key-pad.
- Records Voice mailbox, answering machines, and modem access numbers.
- Records Cellular or repeater phone numbers heard over your phone. Even hook to a scanner, and learn scores of emergency phone numbers. Also decodes tones stored on a tape recorder. Never before has such sophisticated gear been available to the public. And not at this price.

Power requirement 9v DC.SIZE: 3.5" x 4" x 1" BLACK ANODIZED ALUMINUM CABINET

DIS-1 KIT $119.95 BUILT $159.95

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FOR CHANNELS 2 thru 22 ONLY

Our TV filters eliminate unwanted TV channels or interference that alters both sound and video with a beep beep beep. Works on cable channels 2 thru 22) only.

NOTE: All TV Filter Kits are sold for educational purposes only. You must obtain permission from your local cable company before using these filters on your cable system.

DF-222 KIT $14.95

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6A

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PARTS KIT INCLUDING:

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- Keypad 5 X 4
- 4 MHz clock oscillator, reset switch, R, C

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FM TRANSMITTERS MINI (KITS)

- 3-VOLT FM XMTR, up to 300 ft. indoors, 1500 ft. outdoors
- PHONE XMTR, range to 500 ft., uses phone-line power
- Sound-Activated XMTR, range to 500 ft.
- 2-STAGE XMTR, 9-Volt, very powerful

All above require simple soldering at 2 to 4 places. **$29.95** ea.**

TELE FM WIRELESS MONITORING SYSTEM. (Kit) **$99.00***

TELE CALL FORWARDER. Transfers incoming calls. **$99.00***

CALLER ID. Registers incoming number. **$99.00***

TEL REGISTER WITH PRINTER. Records dialed number, duration, and prints record. **$139.00***

12-HOUR LONG-PLAY RECORDER. Modified Panasonic. Records 6 hrs. on each side of 120 tape (supplied). Compatible with VOX and Tel Rec Adapter. **$119.00***

VOX VOICE-ACTIVATED SWITCH. Makes recorder self-activating with voices or other sounds. **$28.50****

TELE RECORDING ADAPTER. Records incoming and outgoing calls. **$28.50****

TELEPHONE SCRAMBLERS. Over 4,000 separate codes. **$199.00***

VOICE CHANGER. Changes man's voice to lady's and vice versa. **$49.00***

For Shipping & Handling add *$5.00 and **$2.00 per item. Colo. residents add sales tax. Mail Order, VISA, M/C, COD's o.k. Inquire for dealer prices. Free catalog.

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Robot Kits

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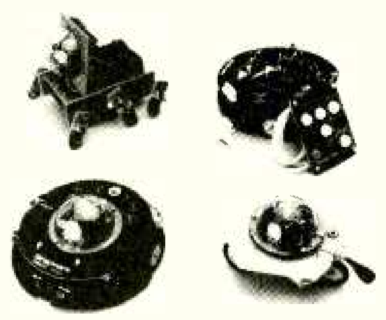
✓ Build it Yourself
✓ Action Packed

EASY TO BUILD You do ALL electronic & mechanical assembly using 2-color Instruction Books with step-by-step, well-illustrated directions for assembly, experiments and testing. Each Robot Kit applies different electronic & robotic principles. Learn how Robots work and have fun at the same time!

606A *"Scrambler"* **All Terrain Robot** This 6-legged Robot walks over rough terrain. Uses high-tech infrared beam to sense and avoid avoid objects in its path. 32 page Book. **$37.95**

603A *"Copycat"* **Programmable Robot** Program direction, light and sound using detachable keypad (included) or optional PC. Learn digital logic basics. 44 page Book. **$57.35**



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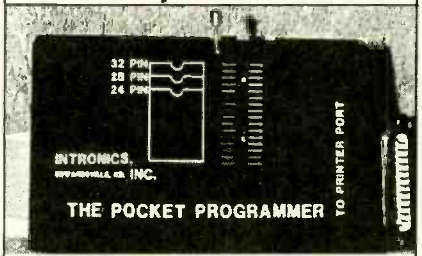

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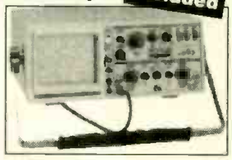

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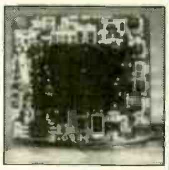

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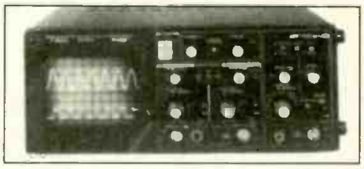

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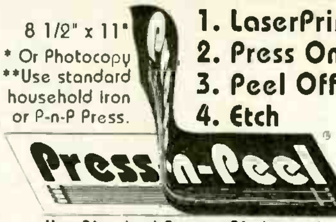

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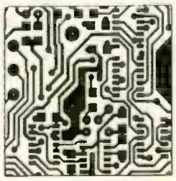

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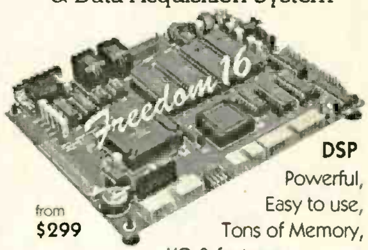

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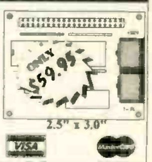

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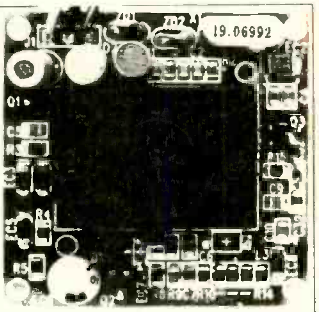

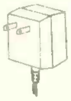

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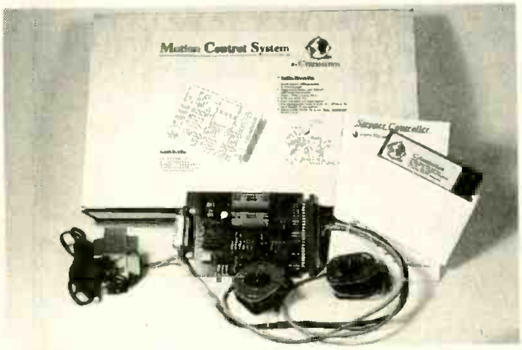

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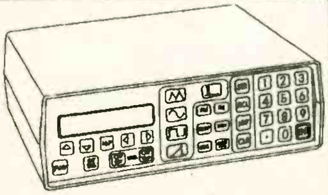

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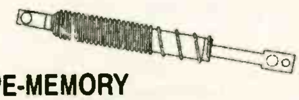

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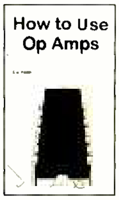

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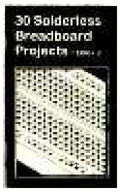

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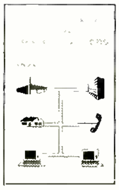

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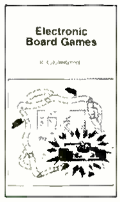

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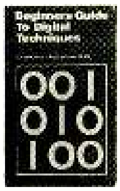

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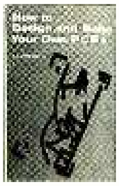

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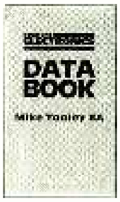

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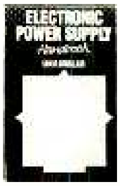

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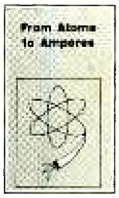

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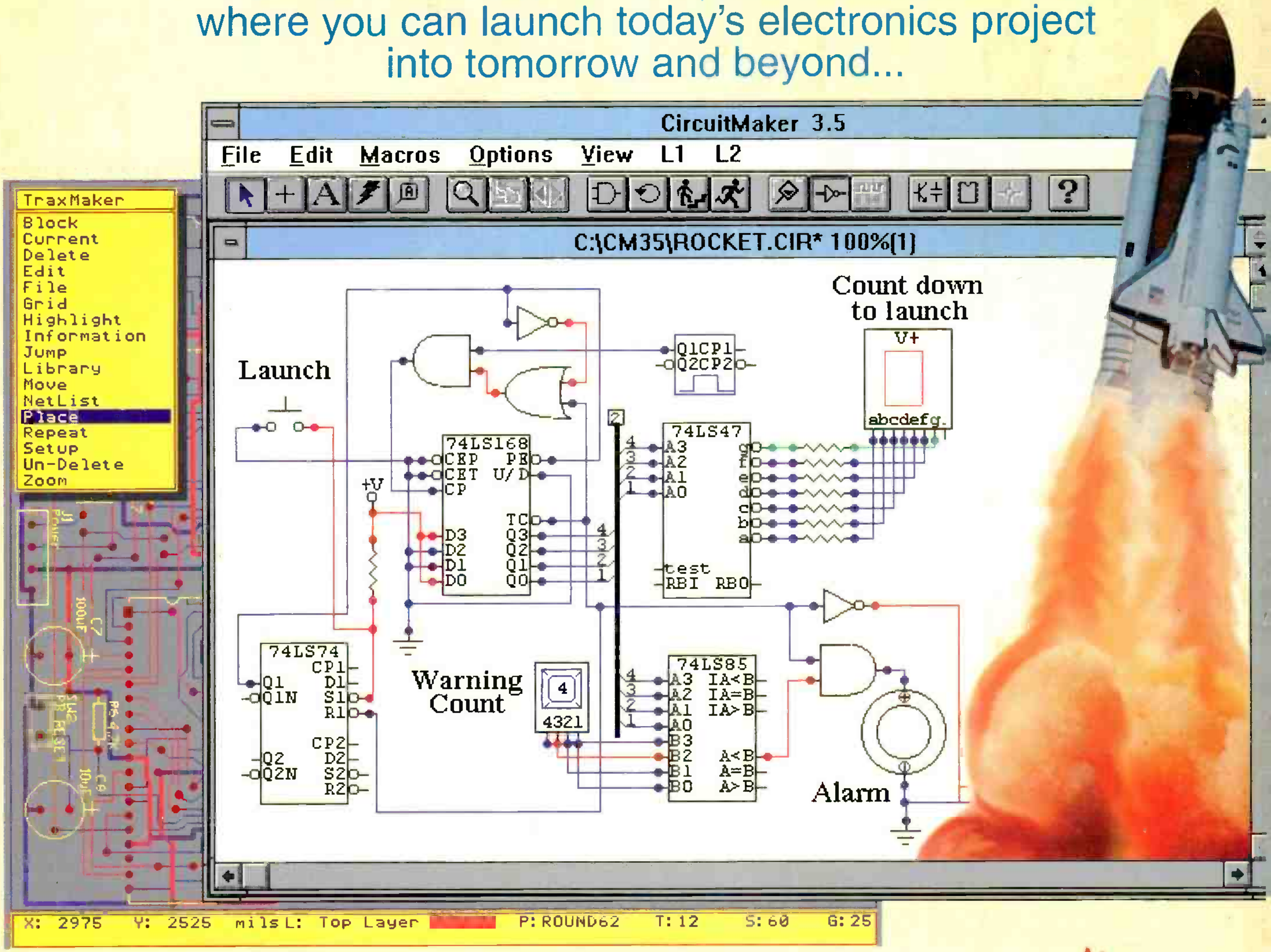

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