Radio-Electronics

BUILD A TV TRANSMITTER

JUNE 1989

TECHNOLOGY - VIDEO - STEREO - COMPUTERS - SERVICE

BUILD THIS BUG DETECTOR
Sensitive detector helps you find RF bugs!

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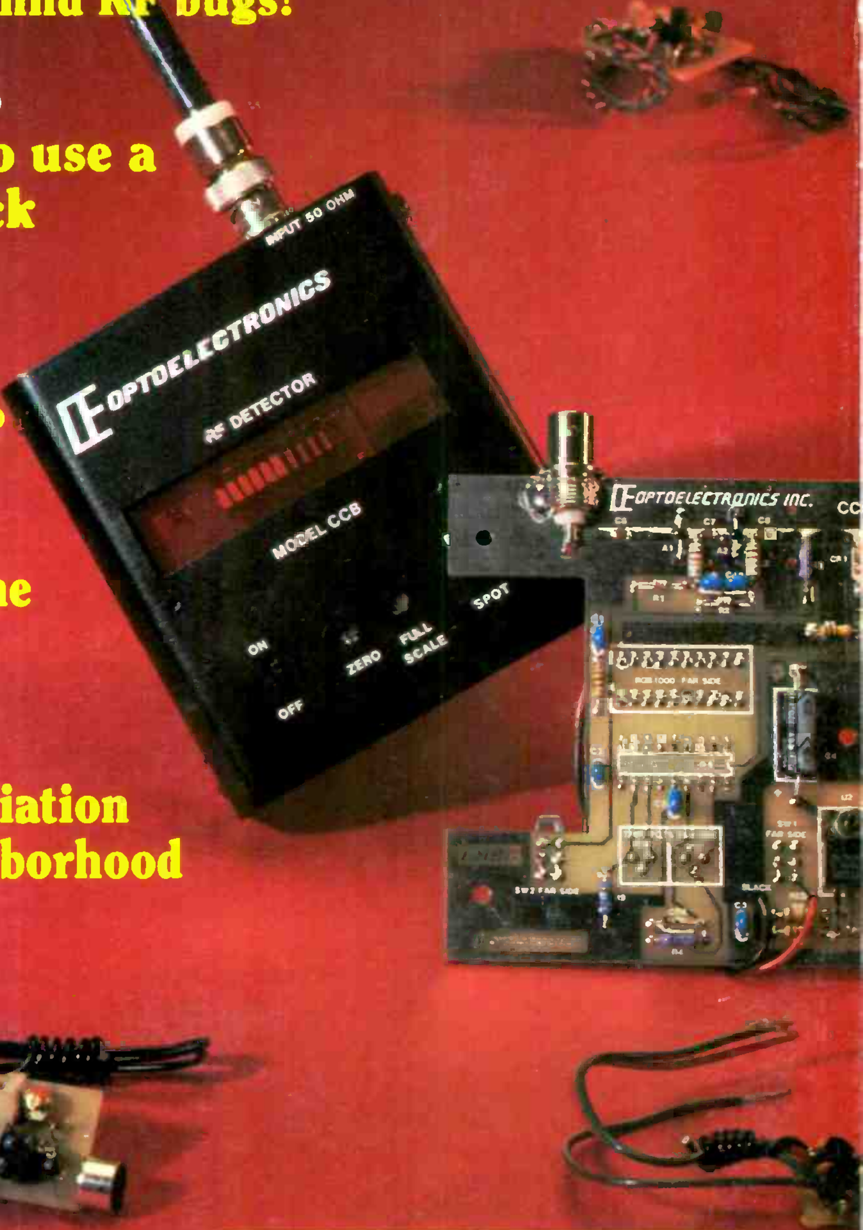
Super sleuth shows how to use a spectrum analyzer to track down bugging devices



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June 1989

Radio-Electronics

Vol. 60 No. 6

BUILD THIS

TECHNOLOGY

CIRCUITS

DEPARTMENTS

COMPUTERDIGEST

PUT A 386SX TIGER IN YOUR TANK!

EDITOR'S WORKBENCH

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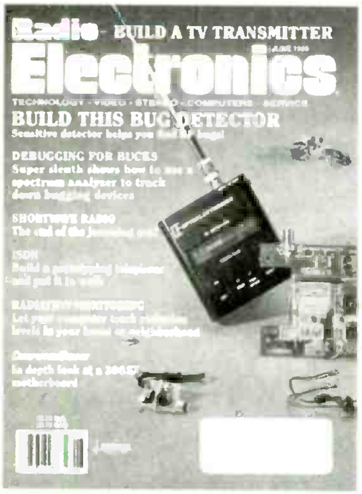
BUILD THIS

AMATEUR TV TRANSMITTER

PAGE 45

AND MORE

ON THE COVER



Maybe you feel like you've been bugged, but lack the skills to know for sure. Here's how to set your mind at ease! Build our bug detector to sweep your home or office for any covert RF-transmitters, no matter how small, or inconspicuous.

Couched in a euphemism, bugs are tiny transmitters that (like a fly on the wall) will eavesdrop on your every word. A few examples of bugging devices from Deco Industries are shown on the cover. They can be planted in your telephone, behind a pillow, or in a kitchen cabinet solely to hear your most intimate conversations.

Fight back by turning to page 42 for our top-secret de-bugger plans.

COMING NEXT MONTH

THE JULY ISSUE IS ON SALE JUNE 1.

TALK ON A LIGHT BEAM
Get up to ½-mile range using an LED and simple optics.

BUILD A CAPACITOR TESTER
Identify and check the values of all your capacitors with this inexpensive tester.

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SELECTING THE RIGHT SHORTWAVE ANTENNA
A little know-how can give your reception a big boost.

SERVICING DIGITALLY TUNED RADIOS
Professional tips for getting electronically tuned radios back in working order.

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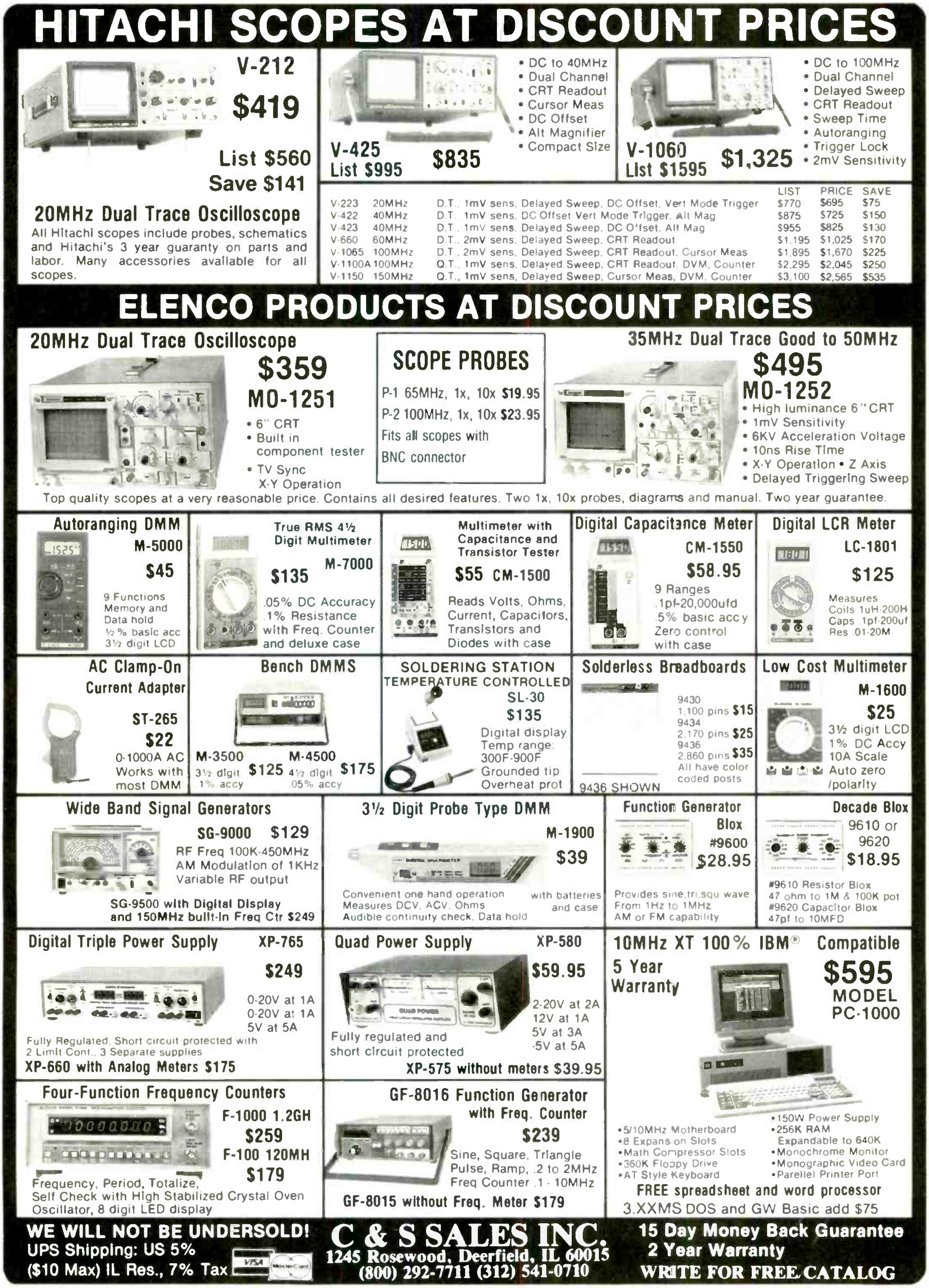

CIRCLE 109 ON FREE INFORMATION CARD

EDITORIAL

Radiation awareness

Last June, we presented a construction story that showed how to build International Medcom's Radalert Radiation Monitor. The article generated significant response and even some controversy, as any article that discusses radiation and safety does.

Some of you readers criticized us for irresponsibility for presenting articles on radiation—a subject on which we are not authorities. Others thanked us for a useful, and educational construction article, in the tradition of **Radio-Electronics**.

As an editor, I'm always pleased when an article generates passionate responses. But I'm even happier when an article generates something more tangible. Hundreds of readers built units and put them to use.

Since the article appeared, the need for some type of radiation monitoring device has become very apparent. Government reports released late last year admitted that several nuclear-weapons plants exposed nearby communities to excessive radiation over a period of decades. The EPA has warned homeowners about the hazardous potential of radioactive radon gas buildup.

Dozens of studies reach conflicting conclusions about the effects of the Three Mile Island accident. Of course, if members of the community had some way of monitoring radiation and keeping accurate records, we might have less conflict and more conclusions on the real effect of the accident.

That brings us to this month's "Radiation Monitor Followup." The article, which begins on page 51 shows how the Radalert radiation monitor can be connected to a computer for automated logging of radiation levels. By joining together and uploading your readings to a central computer bulletin board, you readers have a opportunity to contribute to our knowledge of radiation. We hope you take the opportunity.

Brian C. Fenton
Editor

Cable Checklist

ENJOY CABLE TV MORE THAN EVER

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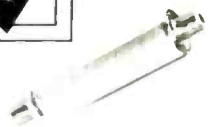

- Prevent cable companies from spying on you to see how many cable converters you have
- Removes beeping sound from your FM when radio is connected to cable TV
- Cable TV descramblers are being sold by the thousands, but few people know descramblers can be detected on most addressable systems

Maintain your privacy with a Snooper Stopper. For more detailed information, send $2.00 for our "Cable TV Snooper Stopper" article.

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- Remove copy-protection from video cassettes
- Digital filter type; removes only Macrovision pulses

JMAK-4 BLACK BOX $14.95

Original box as shown in ad with two feet and four holes to mount pc board.

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#23H-Tuneable to ch. 2 & 3 (50-66 Mhz) also 6 meter HAM TVI interference filter
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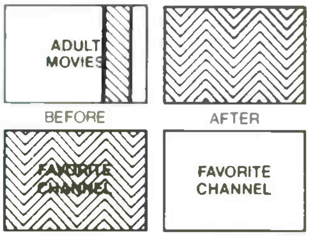
#713-Tuneable to ch. 7-13 (174-216 Mhz)
#1417-Tuneable to ch. 14-17 (A-D) (120-144 Mhz)
#1822-Tuneable to ch. 18-22 (E-J) (144-174 Mhz)

ELIMINATE a Channel that you find unsuitable for family viewing, but is poorly scrambled by your cable company. **OR**

CLEAR UP a Channel that presently contains severe interference by ELIMINATING whatever signal is causing this.



Note: If picture and sound are equally affected, this IS interference and CAN be removed by our product. If only picture is affected, this usually IS NOT interference and CANNOT be removed by our product.

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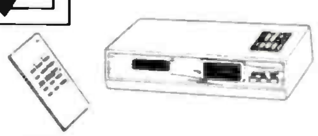

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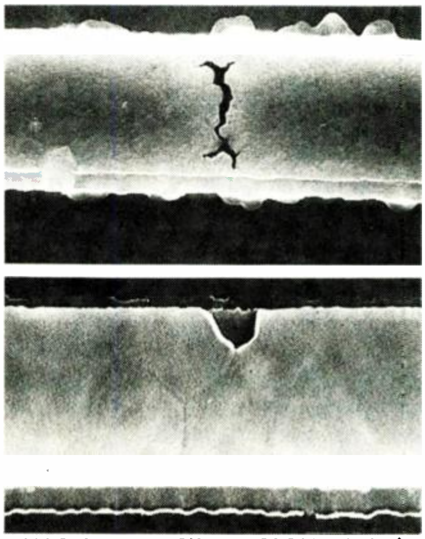
CIRCLE 65 ON FREE INFORMATION CARD

WHAT'S NEWS

Predicting IC defects

Metallurgic researchers at Sandia National Laboratories have developed a model that explains and predicts a type of defect that seriously affects the reliability of integrated circuits with 4-micron aluminum metallization lines. (The problem is seemingly caused by miniaturization, as the defect is rarely found in circuits with 6-micron metallizations.) Metallizations are the thin conductors, made of aluminum, aluminum-copper, or other alloys, that link circuits on an IC. The defects, which are manifested as cracks or wedge-shaped voids in the aluminum, appear after months of storage for no apparent reason in previously acceptable IC's. Using Sandia's quantitative model, researchers can predict under what conditions and at what rates the voids will form.

While high current can cause voiding (called electromigration), Sandia's research focused instead on a second cause of breakdown—the formation of cracks and wedge voids in the absence of a current flow. Researchers Frederick G. Yost, Alton D. Romig Jr., and Roy J. Bourcier investigated the stresses that develop after the metallizations are made and then covered by and bonded to a deposit of glass (a "passivation layer") at temperatures of 400° to 450°C, and then cooled. They discovered that as a result of aluminum's much larger coefficient of expansion, the tightly bonded passivation layer resists the tendency of the aluminum grains to move differentially while cooling. That causes extremely high stresses—high



DEFECTS IN AN IC'S 4-MICRON-WIDE aluminum conductor lines are visible in scanning electron micrographs. The top photo depicts a crack; the bottom shows a wedge-like void.

enough to transport sufficient mass to create voids.

With Sandia's model, which uses numerical stress analysis to calculate the stress gradients in conductor lines, researchers determined the time to failure for various widths of conductor lines when subjected to different temperatures. The results, as they expected, showed that time to failure decreases as the lines get narrower and as the temperature increases. In 3-micron conductor lines, the minimum time for the development of cracks is 1.5 years, and 2.3 years for wedges to form.

Those results, which are consistent with the experience of the microelectronics community, suggest that mass movement and the resulting void formation could be reduced by alloying the aluminum with copper.

Engineers predictions for life in the 22nd century

The results of a survey entitled "Engineers Preview Highlights of the 22nd Century City" were presented by Robert E. Hogan, president of the American Consulting Engineers Council, during National Engineers Week (February 19–25, 1989). The survey, which was distributed to over 2,000 American engineers of all disciplines, asked the respondents to describe in detail the technological advances that would be achieved by the 22nd century.

While some of the results came as no surprise—we will live to an average age of 80 to 100, and critical environmental problems will include lack of clean air and water and hazardous-waste disposal—others were more innovative. More than one-third of those surveyed believe that we will communicate with extraterrestials; that we will inhabit the Moon and man-made planets, but not Mars or other planets; and that artificial body parts will be so commonplace that they will be sold as "off-the-shelf" items to be purchased as needed.

Although we will not control the earth's weather, and despite the lack of natural resources and longer lifespans, the engineers think there will be enough organic food sources to feed the world. The likelihood of an adequate food supply is due, in part, to our becoming less "earth-dependent" as we expand our frontiers to work in space.

Respondents also predicted that nuclear power and solar power captured with proactive satellites would be our main energy sources; railroads will travel at 200–400 MPH, air travel could increase to as much as 3 to 4 times the speed of sound, and computer-driven cars made of composite parts would navigate the highways, equipped with collision-avoidance systems; newspapers will be replaced by new communications techniques; and buildings as high as 300-stories tall will be constructed.

National Engineers Week is dedicated to honoring the achievements and contributions of the nation's engineers. **R-E**

VIDEO NEWS

• **Digital HDTV.** Is the United States being stampeded into high-definition TV by the Europeans and Japanese—and by congressmen looking for a glamorous issue? Recently, three different experts have at least hinted that they think it would be a mistake to adopt an analog HDTV-broadcasting system in this digital age. Former FCC Chairman Mark Fowler, in a New York speech, said that a broadband digital fiber-optic network could leapfrog Japan's "inferior" analog HDTV technology. He branded "analog technology in a world increasingly moving to digital" a "fallacy" and added, "We should consider television as part of the computer industry rather than the radio industry."

Speaking at a Society of Motion Picture and Television Engineers seminar, Julius Barnathan, president of ABC Network Broadcasting and Engineering, said that any analog-based HDTV would have the same problems that plague NTSC. "We need better TV sets—smart digital sets that can minimize noise and interference" before HDTV should be considered. John Sie, senior vice president of Telecommunications Inc. (TCI), a major cable-TV operator, proposed the use of a digital signal for all video—including broadcast, cable, and satellite. He urged that a compatible, improved, analog HDTV system be adopted as an interim measure, with the industry switching to a process digital system when the technology is ready.

• **Introducing Hi8.** The 8mm group has answered Super VHS with the "8mm Hi-Band" system, or "Hi8," as it will be known. The specs of Hi8 are very similar to those of S-VHS: white peak 7.7 MHz, sync peak 6.7 MHz, frequency deviation 2 MHz, white clip 220%. Like S-VHS, Hi8 is claimed to provide a picture with more than 400 lines of horizontal resolution, and has separate luminance and chrominance outputs for sets with Y/C inputs; Hi8 VCR's will be capable of recording and playing back in the standard 8mm mode, but standard 8mm recorders won't be able to play back Hi8 tapes. Two improved types of videotape are being introduced for Hi8—a higher coercivity metal-particle tape and the first metal-evaporated tape to be mass-produced.

As the first major manufacturer to introduce Hi8, Sony was careful to explain that it views the new product somewhat differently from the VHS group's view of S-VHS. It's described as "a new option, not a replacement" for standard 8mm, with "premium performance for those willing to pay a premium price." JVC and other members of the VHS group have forecast that S-VHS eventually will replace standard VHS. The first Sony Hi8 products are indeed premium priced—$2,200 for an editing camcorder and $2,000 for a deck loaded with editing features. They should be on the market by the time you read this.

• **"SmarTV."** That's the name of a new television system, based on artificial intelligence, being tested in a few homes in southern California. SmarTV is connected to the home telephone. Once a week it dials an 800 number, linking it to a central computer that contains the week's TV schedule and a profile of the specific viewer's personal tastes in programming. Any time something that the set owner might want to see is on the air, it's recorded. An on-screen listing tells the viewer what the options are. Thus, SmarTV lets viewers watch what they want when they want without the bother of having to tune the TV or set the VCR. The first model, which can store 32 cassettes, costs about $6,000. The company promises that it also will have cheaper models with less memory.

• **Stereo TV heats up.** One out of four color-TV sets sold last year had built-in multichannel TV sound (MTS), according to EIA figures, which showed that the total of MTS sets sold exceeded 5 million, or 25.2% of the 20 million color sets sold. It's estimated that some 14.8 million U.S. households now have MTS sets, representing 16.4% of the nation's homes. In addition, more than 6 million MTS-stereo VCR's have been sold. If there was no duplication—stereo VCR's in homes with stereo TV's—as many as 23.5% of all U.S. homes could be equipped to receive MTS. **R-E**

ASK R-E

WRITE TO:

ASK R-E
Radio-Electronics
500-B Bi-County Blvd.
Farmingdale, NY 11735

PULSE SHORTENER

I'm building a circuit that's triggered on by a high and triggered off by a low. I'm having a problem because the pulses are lasting too long. I know about pulse stretchers but I need a pulse shortener. Any ideas?—G. Fischer, New York, NY.

I have to agree with you. I've heard about pulse stretchers *and* I've never heard about pulse shorteners. The details in your letter are sketchy but I think your problem is that you're looking at the problem incorrectly.

Rather than trying to shorten the trigger pulse that is being sent to your circuit, you should be using it to generate a pulse of the correct length. That's right, you're really looking for an edge detector that will put out a pulse of the appropriate width whenever the trigger line changes state. Admittedly you won't be triggering your final circuit with your original trigger pulse but, as they say, a pulse is a pulse is a pulse.

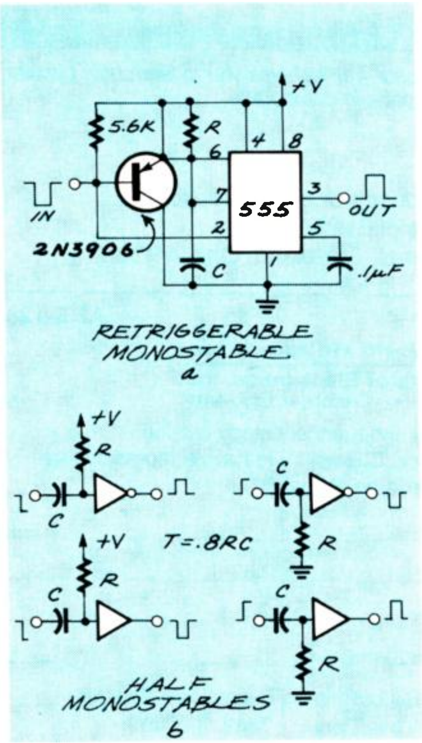


FIG. 1

Now that we know what we're looking for, the problem is to design an edge detector—and that's a piece of cake. You can add circuitry to the board to get the job done, but if you've got some spare gates around you may be able to get by with just adding a few passive components. Both types of circuits are shown in Fig. 1 and you can take your pick. Just plug the numbers you need into the formula and your problem is solved.

The 555 in Fig. 1-*a* is set up as a monostable that wants a negative-going trigger. If the pulse you're feeding it with is positive-going, you can run it through an inverter made up of either an inverting gate or, if you're tight on space, a single transistor. Both ways are shown in the drawing. A monostable built around a 555 is a reliable circuit that isn't at all picky about the shape of an incoming trigger pulse. If you need two of those circuits, you get a 556 dual timer and build both of them with that.

If you're lucky enough to have some spare gates around, you can use the circuits shown in Fig. 1-*b*. They are edge detectors as well, and are usually referred to as half monostables since they can't be used in every application. As you can see, the width of the output pulse is determined by the RC value, but there are a few rules governing their use.

- The input pulse has to be wider than the output pulse.
- The input pulse can't be glitchy.
- The circuit can't be retriggered faster than the RC time.

Since you're looking for a pulse shortener, the first rule's not much of a problem. The second one can be handled by debouncing the input. The third one, however, may cause some grief since you didn't indicate the rate at which you want the circuit triggered.

VIDEOS IN GERMANY

I have some friends living in West Germany, and I'd like to send them some of my family video tapes. Is that possible and, if not, what kind of an image will they see?—R. Doering, Camp Verde, AZ.

FIG. 2

The easiest thing to do is to go out and buy a VCR that can play PAL and SECAM video formats, as well as NTSC. Figure 2 shows one such VCR. It is the *Multiplay TL-1000*, manufactured by Ten-Lab Multisystem Video Products, 11064 Mississippi Ave., Los Angeles, CA 90025 (213) 473-6551. The unit lists for $795. Other than buying one of those VCR's, there's not much you can do. A video signal is extremely complex and, consequently, the timing parameters are really tight. The picture and control signals have to be in the right place at the right time, or all you'll be looking at on the screen is modern art.

There are three basic video standards—NTSC, SECAM, and PAL—and just about the only thing they have in common is that they live in the electromagnetic spectrum. The first is used both here and Japan, the second is used in France, and the third is used pretty much everywhere else.

You don't have to understand the difference between them to know that circuitry designed to make sense out of one is going to have a hard time making sense out of the others. That is particularly true with VCR's because they're dealing with signals recorded on tape rather than pulling them from the air. A VCR designed to handle NTSC is going to assume that there are certain control signals recorded on a particular part of the tape and, if they're not there or not just right, it won't be able to properly process the video-image signals. The result won't exactly be something you'd want to watch on a rainy afternoon.

If you really want your friends to be able to see the tapes you have, you'll have to get them converted to the correct video format. A brief trip through the yellow pages should yield a service that does that. If you can't find anything there, check with your local videotape rental store. They usually know where to get it done.

GUITAR EQUALIZER

I'm a guitarist and I like to use somewhat non-standard audio equipment rather than the ones made specifically for an electric guitar. That usually works well but the output of the graphic equalizer that I'm using is not enough to drive my power amp. Is there some small amplifier I could build that runs off a nine-volt battery that also has a volume control?—K. LaDow, Milwaukee, WI.

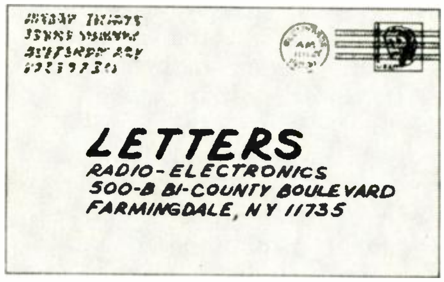
There used to be no such thing as a small amplifier. You might have had small amplification, but there were no small amplifiers. Fortunately for you, there's a whole slew of circuits you can use and two basic ones are shown in Fig. 3. Both of those amps have all the good things you'd expect from IC's. They are easy to assemble, very tolerant of component values, they require simple layouts, and while you can't feed them every frequency from DC to daylight, they're flat all across the audio spectrum. Each, however, has its own pluses and minuses.

The 741 circuit (3-*a*) is nice because it's truly a one-chip line amp. It uses very little current so your nine-volt batteries will last a long time. The disadvantage is that it needs a bipolar supply. That can easily be handled by using two nine-volt batteries but if you've got a space problem, that could be a pain in the neck. It's possible to run the circuit off a single supply but the op-amp won't perform as well. In general, when an IC wants a bipolar supply, you should give it one.

You can use other op-amps that

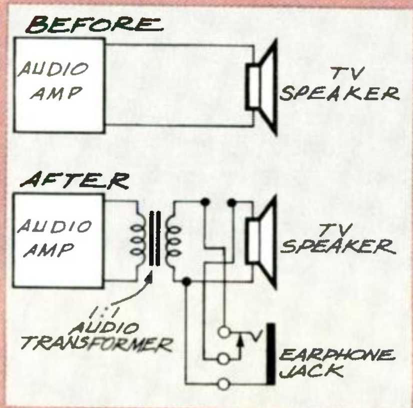
continued on page 77

LETTERS



CAUTION

It has come to our attention that the advice given in "Ask R-E" (**Radio-Electronics**, April 1989, page 89) concerning adding an earphone jack to a TV set is potentially dangerous. It is a fact that, in many modern TV sets, the chassis is actually at 60- to 80-volts AC with respect to ground. A 1:1 audio transformer, installed between the chassis and the speaker/earphone jack, as shown in Fig. 1, will provide enough isolation to be safe. We apologize for the error.—*Editor*



DESK-TOP VIDEO PRODUCTION

As the manufacturers of what we feel is the premier "genlock" for the Amiga 2000, we were pleased to see the attention given to the many video applications of the Amiga in the article "Computer Aided Video" (**Radio-Electronics**, March 1989, page 93). However, we'd like to comment on some common misconceptions—reinforced, we fear, by that piece—on what a genlock is and does.

The process of "genlocking"—interconnecting various pieces of video equipment so as to ensure that they are running in agreement with one another—does not, in and of itself, guarantee a video output that meets broadcast standards. Signal components like correct sync, blanking, and SC-H phasing are critical for an accurate NTSC signal to be produced. Most Amiga genlocks rely on that information to be provided by whatever equipment the computer is "genlocked" to. If the adjustment of that equipment does not meet correct broadcast standards, your Amiga-produced signals won't meet them either, genlock or not.

That dependence of genlocks like Supergen on external sources also explains the "snow and other garbage" appearing on the screen, solved by the authors with a video feed demodulated from the source VCR. With the source VCR not operating, the information has to be provided for the Amiga from somewhere, or the external-reliant genlock becomes useless.

The *4004* Genlockable Video Graphics Encoder does not depend on external sources. Correct sync, burst, and blanking are provided as on-board elements of the encoder card, which is installed in the Amiga, so the computer effectively becomes a free-running broadcast-video source. Complete features for keying and fading are also included. EILEEN TUURI, Marketing Communications Manager
MAGNI SYSTEMS, INC.
Beaverton, OR 97005

ACTIVE ANTENNA

I have two minor comments on Rodney Kreuter's "Active Antenna" article (**Radio-Electronics**, February 1989, page 51). It's a good article, and I'm sure the antenna works fine. However, if memory serves me right, the MPF102 is a *junction field-effect device* (JFET), rather than a *metal-oxide-semiconductor* FED (MOSFET). I don't think JFET's require any more electrostatic protection than MOSFET's 2N3904's, although JFET's do have another failure mode that requires a little caution. They will not tolerate much current flow through a forward-biased gate. Fortunately, Mr. Kreuter's design puts a 1 megohm "grid-leak" resistor (R1) in series with the gate, and the antenna is isolated with a capacitor. Similar designs that don't isolate the antenna, or that provide a DC path to ground (through the inductor in a tuned circuit, for example), are likely to quit working if the battery is hooked up backwards or if the antenna is inadvertently shorted to a circuit component at a voltage around 2 volts.

The second point—and I'm going from memory again—is that the MPF102 and similar devices have rather broad specifications. Because a short antenna can deliver surprisingly high signal voltages (at minute currents), and because the untuned input allows strong local signals to get into the active circuitry even though the receiver isn't tuned to them, the critical parameter in that application is the voltage range over which the device will respond linearly. If that range is exceeded, the input amplifier becomes a just-dandy mixer. Note that here the MPF102 has no voltage gain, but actually alternates, due to the low $R_2 = 22\ \Omega$. If spurious signals are encountered in the output, it may be a good idea to substitute another MPF102 (or whatever), for a wider linear range. Of course, the culprit could be Q3, which can also act as a mixer if it's ovedriven into its non-linear operating range.

DONALD KENNEY
San Diego, CA

CABLE CAPER

The subject of *Monster Cable* provides a lot of "yuks" here at the plant. Usually we just grin and move on, because the testimonials normally skip over the facts and concentrate on faith.

However, in the "Letters" column of the March 1989 issue of **Radio-Electronics**, Leland Faber describes the testing of equal lengths (50 feet) of *Monster Cable* and a variety of other wires including zip cord and house wiring. He says that with a matched 8-ohm source and load, and a frequency range of 20 Hz to 20 kHz, *Monster Cable* was "within ±3dB," whereas all other wire was not "within 9 to 10 dB's at the upper end."

Any audio professional can tell you that under those conditions, *Monster Cable*, zip cord, house wire, or just about anything you might find lying around, will have a virtually flat response from 20 Hz to 20 kHz. If Mr. Faber really got the results he said he did, there was something wrong with his test setup.

JOHN WILSON
CAPITAL CITIES/ABC, INC.
Hollywood, CA

ENGINEERING REWARDS

Anyone who agrees with Mr. Lancaster's hang-up ("Hardware Hacker," **Radio-Electronics**, March 1989) with the fact that "...[technicians] often do all the work and engineers get all the credit, all of the pay, and all of the promotions..." should realize that anyone who can survive 3 years of Engineering Calculus *should* be placed on a pedestal.

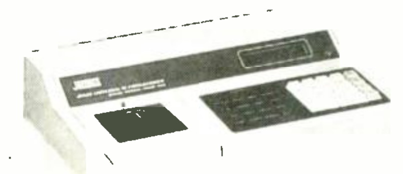
JOHN SAWKA
Engineering Student
Milwaukee, WI

R-E

EQUIPMENT REPORTS

Jameco Electronics JE680 Universal IC Programmer

Program virtually any programmable logic or memory device.



CIRCLE 28 ON FREE INFORMATION CARD

CAN YOU IMAGINE THE WORLD OF electronics without EPROM's, PAL's and other programmable memory and logic? Of course not! But if you don't have access to a programmer, you are effectively isolated from using those versatile devices in your designs.

We recently got a chance to examine a sophisticated programmer, the *JE680 Universal IC Programmer* from Jameco Electronics (1355 Shoreway Road, Belmont, CA 94002). The *JE680* can handle PAL, GAL, RAL, PLD, EPLD, EEPLD, and FPLD logic devices. It can also process PROM, Bipolar PROM, MOS/CMOS EPROM and EEPROM memory devices from 16K to 512K. The programmer can act as a stand-alone device or it can be controlled from the serial port of a personal computer.

The *JE680* is packaged in a sturdy metal and plastic case that measures about 15 × 12 × 3½ inches. The top panel features a 2-line by 20-character LCD readout, a ZIF (*Z*ero *I*nsertion *F*orce) socket, 16 LED function indicators, and a 20-key keypad. Rear-panel connectors include a Centronics-type printer port and a DB-25 connector for serial communications.

The programmer has three operating modes. First is the Local mode, where all operations are controlled by keypad entries, and all outputs are displayed on the LCD. Second is the Computer mode, where an IBM PC or compatible computer takes control of all but the editing functions of the programmer. (The control software is provided with the programmer.) Third is the Terminal mode, where any dumb terminal (or a computer running communications software) can control the programmer.

We preferred the Computer mode because of the online help provided by the software. However, in production environments, we can see the Local mode being favored. An especially useful feature in such environments is *Auto-Sense*, in which IC insertions and removals are automatically detected.

Putting it to work

The *JE680* offers numerous functions. A BLANK function performs a check to ensure that EPROM's are fully erased, or that logic devices are unprogrammed. Using *Auto-Sense*, it becomes as easy as setting up the function, and inserting devices one after the other. The programmer senses when the IC is in place and performs the test. If your IC is inserted backward, or is not recognized, the *JE680* immediately reports it—without damaging the chip—and even suggests a solution.

All communication with the programmer takes place via the programmer's RAM buffer. If a device is to be programmed, the buffer must first be loaded with the proper programming data. Then the PROG function programs the data from the RAM buffer into the IC. If a programmable device is to be read, the data of an IC is first loaded into the RAM buffer, where it can be accessed via the READ function.

A COPY function allows a master IC to be read into the programmer's RAM buffer so that the contents can be rapidly programmed into other devices. If changes need to be made, the EDIT function can be used. Along with normal editing functions, it is possible to split code into more than one device, or to reconstruct code from multiple chips.

A CHECKSUM function calculates and displays the checksum of the RAM buffer. For logic devices, the programmer reports the number of blown fuses along with the hex JEDEC (*J*oint *E*lectronic *D*evice *E*ngineering *C*ouncil) checksum.

Once a function has been executed, it can be re-executed by using the REPEAT function. That can help speed some operations considerably.

Other functions include IN and OUT for downloading and uploading files to and from the programmer's RAM buffer; VERIFY, which is used to double check that the data in a programmed device matches the RAM buffer; and PRINT, which outputs data to the Centronics port.

Software option

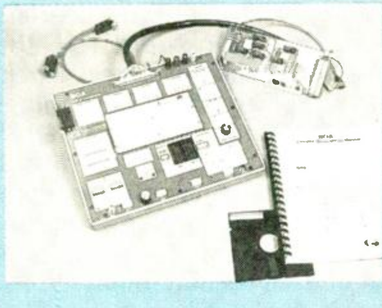
A $30 software option package, the *JE680AP*, is available for logic-design applications. It runs on an IBM PC or a close compatible and offers Boolean conversion, auto compilation, and fuse-map generation.

The software includes four independent modules. A parser module analyzes the syntax of Boolean equations. A fusemap module creates the JEDEC format file for downloading to the programmer. A Document module generates report records (such as IC pinouts, symbol tables, PLD fuse maps, and test vector tables), and a SGUP module downloads and burns in the JDEC file created by the fusemap module. SGUP can also read the IC pattern from the programmer.

While the *JE680* is sophisticated enough to handle any programming task you're likely to come up with, it's also easy to use—despite a somewhat frustrating operating manual.

The programmer's multiple operating modes mean that it will be at home in either an engineering laboratory or in a production environment. Such features don't come cheap—the *JE680* is priced at $1799.95. But if you're serious about programmable devices, it's certainly worth a serious look. **R-E**

Global Specialties BOA Microcomputer Applications Workstation



A "box of applications" for your PC

CIRCLE 29 ON FREE INFORMATION CARD

COMPUTERS HAVE BECOME UBIQUITOUS. You'll find them in electronics labs, in schools, even in many homes. Unfortunately computers have, for most people, become nothing more than appliances. Even young hobbyists don't have much opportunity to "get their hands dirty" with computer hardware. We recently discovered a device that could change that by turning any PC into a microcomputer applications workstation. It's called the *BOA* (an acronym for *Box Of* Applications) and is sold by a division of Interplex Electronics, Global Specialties (70 Fulton Terrace. P.O. Box 1942, New Haven, CT 06509).

The *BOA* is housed in a metal slope-front cabinet that measures roughly 13 × 11 × 4 inches. It connects to the computer's bus through a buffer card and cables, and offers access to the computer's bus through a solderless connector block which, along with a solderless breadboard, dominates the unit's top panel.

More than two dozen solderless connector blocks encircle the breadboard and bus-access block. They offer tie points to such things as output ports, input ports, DMA latches, A/D and D/A converters, a digitally programmable amplifier, a function generator, an audio amplifier, and so on. A brief description of each section follows

Circuit sections

Two output ports use two 74LS75 4-bit bistable latches to capture buffered data-bus signals. Each port has LED logic indicators and TTL-level interface outputs. As with all sections, all signals are accessible via tie points on solderless connectors.

Two 8-bit input ports provide the means to input data to the PC's bus. Top-panel DIP switches can be used to input data. Alternately, TTL-level signals can be sent through tie points. Data latching is available on both input ports.

A MEMORY section provides two 28-pin sockets to accept up to 16K of EPROM or RAM memory. (EPROM and static RAM can be mixed). A SEGMENT SELECT DIP switch is used to set the position of the memory in the computer's memory map.

An I/O DECODE section provides I/O device-select signals, which are decoded from the address bus. An 8-position DIP switch is used to set the address of the I/O decoder. It is used in combination with READ, WRITE, and SELECT tie points to provide I/O write, I/O read, and I/O select signals for other sections.

A DMA LATCH section allows breadboarded circuits and the other sections of the *BOA* to interface to the computer's bus under DMA (Direct Memory Access) control. Two DMA latches are provided for you.

A D/A CONVERTER section provides two digital-to-analog converters, an op-amp circuit, and a precision voltage source. Two A/D CONVERTER sections are provided as well.

An EXTERNAL INTERFACE section provides a convenient method of attaching peripheral modules to the side of the *BOA*. A DB-25 connector is connected in parallel with solderless tie points, which can then be connected to the various other sections of the *BOA*.

A PULSER section provides D-type latches and push-button switches to provide pulses to other circuits. Pulses can either be provided under circuit control, or by physically pushing the pushbuttons.

A FUNCTION GENERATOR section provides sine-wave and TTL-level pulse outputs. The amplitude and frequency of the function generator are controlled via AM and FM inputs.

A DIGITAL GAIN section can control the amplitude of an analog input signal under computer control, while an AUDIO AMPLIFIER section with a speaker provides a convenient way to hear an analog output signal. A MICROPHONE AMPLIFIER section is provided to amplify low-level inputs for use by other sections.

Hooking the *BOA* to the computer consists of inserting a card into a slot, and plugging a 50-conductor cable into the card's output and into the *BOA*'s top panel. The card "steals" power from the bus and outputs +5-, +12-, and −12-volt power on a 9-pin connector. If your computer doesn't have a 9-pin knockout, your can use an adapter plate to mount the power connector in an unused slot. The only tricky thing about installing the card is that you must be sure to disable any interrupts that are used by any other cards that are presently installed in your machine. Jumper pads make that operation a simple matter.

While each section of the *BOA* is interesting in its own right, things don't really get exciting until the sections are connected together. The excellent manual supplied with the *BOA* provides numerous example experiments, and step-by-step instructions on setting things up. It also provides many suggestions for additional experiments you can do.

Among the suggested projects is a DC volt meter, which can be assembled using the I/O DECODE, BUS INTERFACE, and A/D CONVERTER sections along with a top-panel potentiometer and some supplied BASIC software. Another experiment suggests how to build a frequency counter using interrupts. Experiments in digital audio recording and playback—even an experimental echo machine—are also suggested.

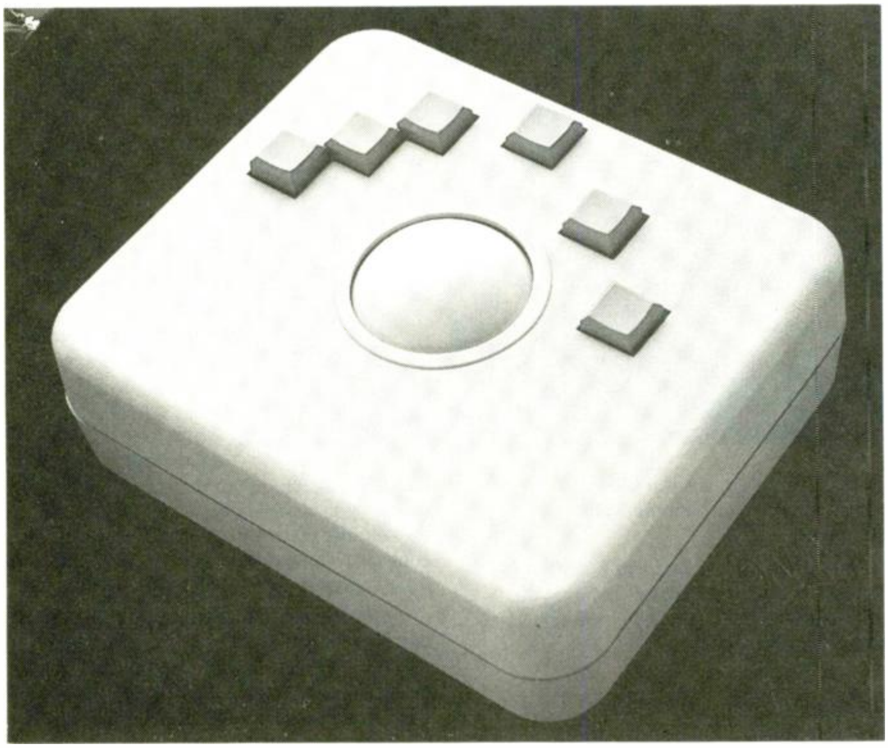
The *BOA* is a great tool, and would be at home in an engineering lab or a microprocessor lab course. Because it encourages experimentation, it also makes an excellent self-teaching tool for anyone who wants to learn about computer interfacing. We'd be hard pressed to think of a better way to breadboard prototypes for computer add-on cards. The *BOA* is priced at $1088. We recommend it to anyone who believes that computers are meant to do more than just run software. **R-E**

READER HELP READER

We often receive letters from readers who have searched, in vain, for schematic drawings and other documentation, or for discontinued parts. Unfortunately, we don't usually have this information at our fingertips, and don't have the time to mount our own searches for it. However, there is one invaluable source that we can easily tap—**Radio-Electronics**' readers! Here's your chance to get some assistance, or to help out a fellow electronics enthusiast.

- If you have service literature for a Garrard "Music Recovery Module" model *MRM 101*, MARK DESZCZ will gladly cover the shipping costs to send it to *P. O. Box 1168, Williamsville, NY 14221.*
- MICHAEL CARTER is trying to find a transformer for a Zenith radio, model *7S363*, that dates back to the late 1930's or early 1940's. The transformer number is C95-526N. He can be reached at *M.A.C. Electronics, RR4, Box 110, Hutchinson, MN 55350.*
- Can you help DONALD A. NEWELL JR. obtain an RCA Data Manual *SSD-245*? He's also seeking a source for RCA Bulletin Files and Application Notes. Write to him at *P. O. Box 181, Bruce, WI 54819.*

NEW PRODUCTS



CIRCLE 10 ON FREE INFORMATION CARD

POINTING DEVICE. *Fulcrum's Trackball Plus*, featuring trackball-pointing technology, is a versatile and easy-to-use alternative to—and requires less desk space and less frequent cleaning than—the mouse. Ball motion is detected optically and transformed to one of many formats by a local microprocessor before being sent to the host. The pointing device is easily interfaced to IBM compatibles with a standard RS-232 serial port, and offers an ALTERNATE CURSOR switch for CAD/CAM applications.

Trackball Plus emulates Microsoft Mouse and Mouse Systems Mouse, and comes with software drivers for both. It also emulates 8 popular pointing devices, and several digitizers. It supports a dozen commonly used programs—including Lotus 1-2-3, dBASE III Plus, MS-DOS, and WordPerfect—and offers "Point-n-Shoot Pop-Up" menus, which make it unnecessary for users to memorize the extensive codes that accompany software. The pointing device's MENUKEY provides arrow-key emulation for programs that don't normally accept pointing devices.

The *Trackball Plus*, complete with a comprehensive user's manual and an extended 6-month warranty, has a retail price of $99.00.—**Fulcrum Computer Products**, 459 Allan Court, Healdsburg, CA 95448.

MULTI-SPEED TURNTABLE. For collectors of "antique" phonograph records, *Esoteric Sound's Vintage* phonographic-disc player features a variety of speeds, providing convenient listening at the correct pitch. Because many so-called "78's" were actually recorded at other speeds, the 6-speed turntable plays at 71.29 rpm (the speed of the original *Berliner Gramophone* record), 76.59 rpm (many acoustic *Victors*), 78.26 rpm (modern 78's), and 80 rpm (*Edison*, vertical *Pathe*, and acoustic *Columbia* and *Okeh*, most vertical). The modern, high-fidelity turntable also offers 33 and 45 rpm for today's recordings. An optional accessory adapts the unit for vertical play, and Stanton pickup features 2 separate styli, one for LP's and one for 78's.

CIRCLE 11 ON FREE INFORMATION CARD

The *Vintage* 6-speed turntable is now available at a special introductory price is $225.00 (including the Stanton pickup and both styli) plus $4.00 shipping east of the Mississippi or $6.00 shipping west of the Mississippi. (C.O.D. orders add $2.25.) The optional vertical/lateral switch costs $22.50.—**Esoteric Sound**, 4813 Wallbank Ave., Downers Grove, IL 60515.

TEST LEAD ADAPTER KIT. *Pomona Electronics' Multimeter Test-Lead Adapter Kit* is offered in four models: *5592* to fits almost all Beckman and Amprobe; *5593*, Simpson; *5594*, Triplett; and *5543*, B&K and Fluke multimeters. The kit's modu-

CIRCLE 12 ON FREE INFORMATION CARD

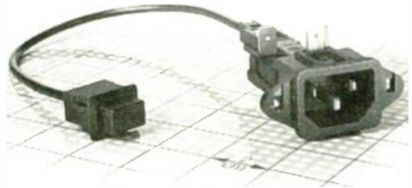
lar construction allows the use of a conventional test probe, a spade lug, a Minigrabber test clip, or an alligator clip, through interconnects of sheathed banana plugs. The test-lead wire used in the kit is made with heat- and chemical-resistant silicone insulation.

The user simply connects the test lead to the multimeter with the right-angled sheath plug, and then fits his choice of test-contact device to the sheathed banana plug on the other end. The banana-plug interconnects can withstand over 5 pounds of separation force.

The Multimeter Test Lead Adapter Kits each have a suggested retail price of $27.50.—**Pomona Electronics Division**, ITT Corporation, 1500 East Ninth St., P.O. Box 2767, Pomona, CA 91769-2767.

3-PIN POWER RECEPTACLE. The *NE20B* from *ITT Schadow* combines an IEC 3-pin receptacle, a power switch, and a remote actuator in one user-friendly package. It allows equipment manufacturers to put the ON/OFF switch on the front panel, where the status is clearly apparent, while leaving the power circuit at the back panel. A flexible cable connects the power module and the actuator, eliminating the need for more costly wiring. Switching power at the back panel increases safety and decreases EMI/RFI. The *NE20B* is easily mounted with a clip. Cable length is made to order.

The *NE20B* 3-pin power receptacle costs between $5.00 and $10.00, depending on options and quantity ordered.—**ITT Schadow, Inc.**, 8081 Wallace Road, Eden Prairie, MN 55344.



CIRCLE 13 ON FREE INFORMATION CARD

BENCH MULTIMETER. The *Fluke 45* has a multi-function dual display that allows more measurements to be taken from a single connection and a single instrument setup. The 5-digit, 100,000-counts digital multimeter has additional selectable resolutions of 30,000 and 3,000 counts, and includes a built-in

RS-232 interface for PC instrument applications. An optional IEEE-488 interface and QuickStart 45 software are available separately.

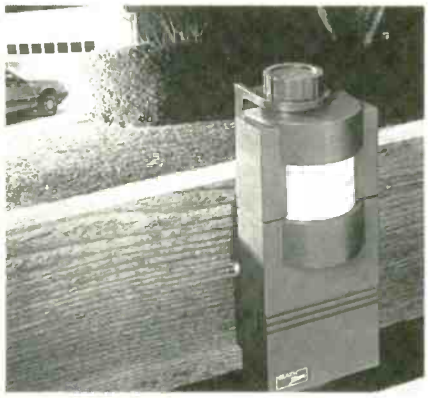
Using the bright, vacuum-fluorescent primary and secondary displays, a wide variety of different measurement combinations can be viewed. Other features include true RMS AC and DC measurement for voltage or current, MIN MAX, relative reference, and auto-ranging. The unit also has a compare function for easy in-tolerance testing, a frequency-counter function to 1 MHz, a dB-function with 25 reference impedances, audio power, diode test, and continuity.

CIRCLE 14 ON FREE INFORMATION CARD

The *Fluke 45* bench multimeter has a suggested list price of $595.00.—**John Fluke Mfg. Co., Inc.**, P.O. Box C9090, Everett, WA 98206; 800-443-5853, ext. 33.

SECURITY LIGHT CONTROL. *Heath Zenith's Model SL5420* wireless motion-sensor light control is designed to deter burglars by combining illumination with an element of surprise, as the light flashes on as soon as a person enters the detection field.

The wireless control consists of a battery-operated motion sensor and a receiver, which replaces any existing wall switch to control the light. The fully-adjustable motion sensor can be placed up to 150 feet from the receiver; by adding extra receivers, multiple lights can be controlled. The *SL5420* uses pulse-count technology, which reduces the chance of false alarms.



CIRCLE 15 ON FREE INFORMATION CARD

The control can be easily mounted indoors or outdoors on any surface, including lamp posts, walls,and fences. Packaged in a dark, weather-resistant case, it is difficult for an intruder to detect at night. The user can set the duration that lights remain on, or an adjustable photo cell can change the times the lights turn on at night.

The *SL5420* wireless motion-sensor light control, which is compatible with Heath Zenith wireless security systems, retails for under $100.00.—**Heath Zenith**, Consumer Products Group, Hilltop Road, St. Joseph, MI 49085.

continued on page 26

TELEPHONE DIALER/DIRECTORY. *Texas Instrument's TI-3100 Pocket Dialer* also acts as a telephone directory, an appointment schedule, a calculator, and a clock with alarm. The compact unit weighs only 5 ounces, runs on one lithium battery (included), and comes with a protective slide case that doesn't interfere with the dial function. It offers the convenience of completely portable, one-handed, one-button telephone dialing, with keyboard graphics that are color-coded by function.

As a dialer, users hold the unit against a phone with one hand, leaving the other hand free for writing. It has one-button redial, pause, slow-dialing, and local-dialing features. The *TI-3100's* directory function provides storage of up to 125 two-line entries, which are stored alphabetically and can be retrieved by scrolling or, more quickly, by typing the first word or letter and then scrolling. A secret password can be used to protect sensitive entries. Information about appointments is stored by

CIRCLE 16 ON FREE INFORMATION CARD

date, in chronological order; the alarm can be used as a reminder.

The *TI-3100 Pocket Dialer* has a suggested retail price of $65.00.—**Texas Instruments**, Consumer Relations, P.O. Box 53, Lubbock, TX 79408; 806-747-1882.

TOOL CASE. *Vaco's Tool Bux #70470* is a rugged Cordura nylon case that contains a convenient assortment of 20 popular tools, including screwdrivers, nutdrivers, electrical tools, and specialty tools. Strong elastic holders keep each tool in place, for well-organized ease of selection. The water-resistant case has sturdy webbed handles and three expandable pockets. It measures 15 × 11 × 2¼ inches.

CIRCLE 17 ON FREE INFORMATION CARD

The *Tool Bux #70470* tool case costs $222.04.—**Vaco Products.**, 7200 McCormick Blvd., Chicago, IL 60645. **R-E**

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FEATURES	222	223
Audible Readout		•
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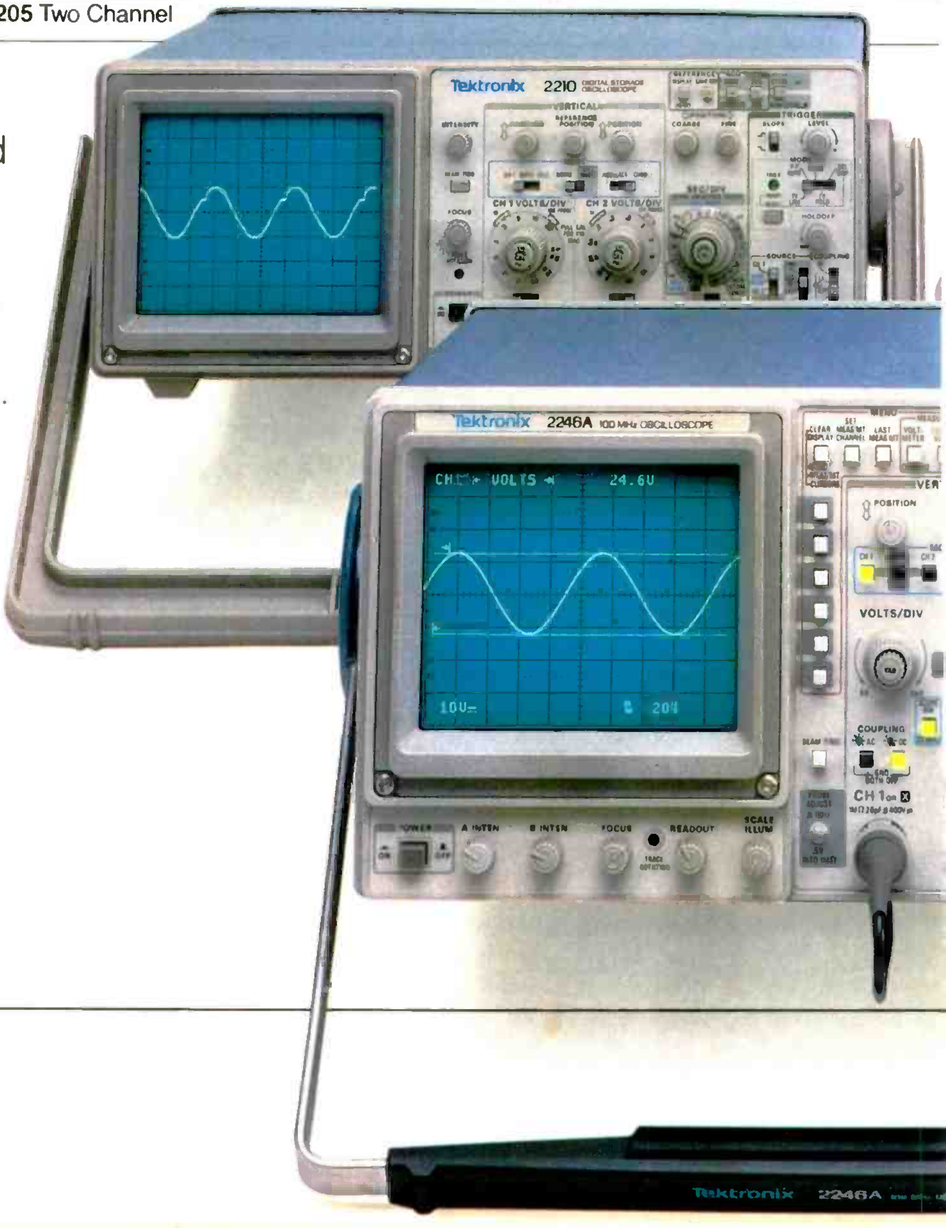
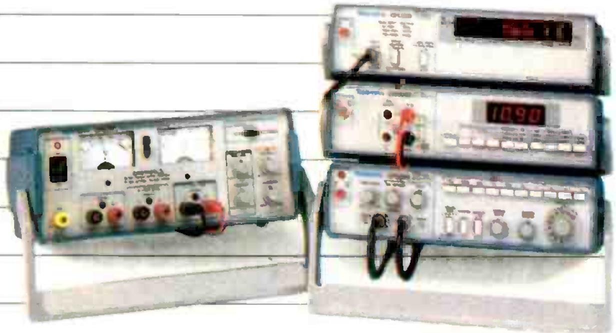


; right within your range.



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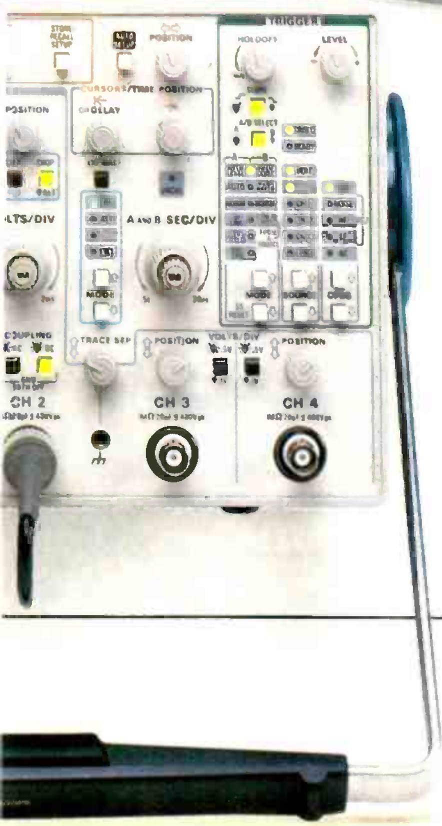

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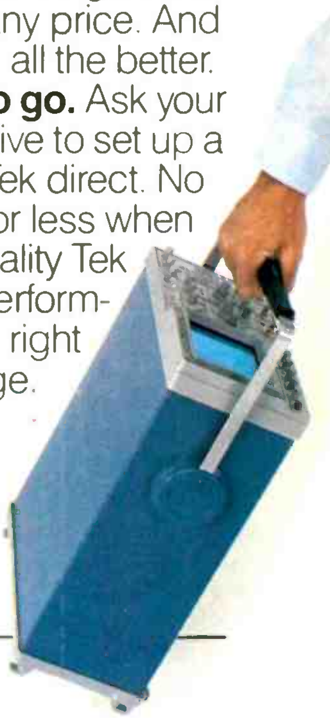

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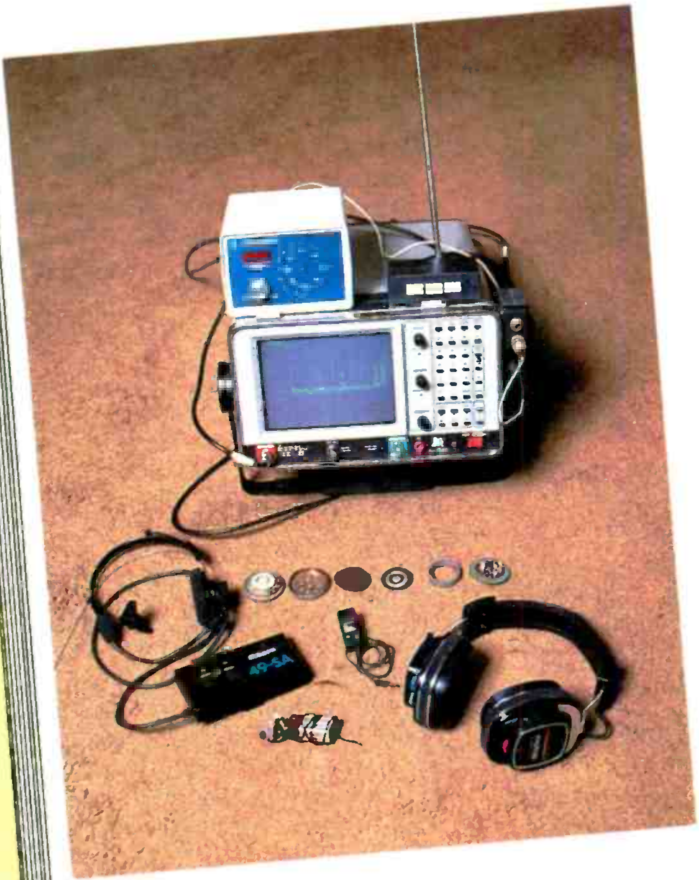

TRACKING DOWN BUGS USING A SPECTRUM ANALYZER

Are you being bugged? Here's how to find RF bugging devivces that are invading your privacy.

RICHARD A. BOWEN

BEING WIRETAPPED IS NO JOKE. TODAY'S micro-miniaturized electronics have made it easy for anyone with a little know-how and willful attitude to tap your phone and invade your privacy. Whether you call it eavesdropping, phone tapping, radio interception, or covert operations, we'll show you how to hunt down those tiny bugs.

Although there are many advertised gadgets that claim to locate clandestine transmitters, licensed private investigators, with few exceptions, have neither the technical expertise nor background to properly use them. Consequently, more and more investigators are turning to radio technicians who are knowledgeable in counter-surveillance technology.

That's why a competent radio technician with an inquisitive mind and the proper equipment can make a supplemental income (perhaps $100 + per hour) by availing himself, his equipment, and his expertise to investigators who are trying to locate clandestine transmitters.

Tools of the trade

The first order of business is to have the right tools. But what are the right tools for detecting bugs that are positioned by persons good at hiding them? Bar none, the most invaluable tool is a *spec*trum *an*alyzer (spec-an). The one used by the author is an IFR model *A7550*, which becomes portable when using its built-in Nickel Cadmium (Ni-Cd) battery—an essential convenience.

You'll also need a good receiver to scan the RF spectrum looking for the bug's frequency. Many spec-ans have radio-scanner options (receivers) that are designed to be hooked up without modification. Now admittedly, $500 dollars for that option might sound like a lot of money; but when you're talking about a $10,000 investment, it's not really that much. After all, you're trying to discern what type of intelligence is contained in a detected signal, you need a good receiver. Of tremendous benefit would be some kind of mixer, down converter, or prescaler to extend the receiver's frequency range.

For obvious reasons, it's paramount to tape-record the bugged audio; also, a first-rate direction-finder is necessary so you can track down and locate clandestine, or spurious emissions.

Another option that is extremely useful is a *G*eneral *P*urpose *I*nterface *B*us (GPIB) interface with a plotter, which will allow you to make hard-copy two-color printouts of the suspect frequencies that you have discovered, or wish to document. The GPIB will interface the spec-an's output to the plotter.

There are a lot of gizmos that are advertised on the market as so-called "counter-intelligence devices." The author is compelled to warn you that most of the equipment will not perform as advertised, and the equipment that *will* perform is often unethically sold for 3 to 5 times the list price—*caveat emptor!*

If you think that you're being bugged, you may be desperate for anything that advertises to solve your problem quickly. The false promise of those gizmos seems like a good risk. But wait a minute: That's exactly what those unethical companies are depending on to motivate a sale! Don't fall into their trap. There's no short-cut gizmo that can replace the proper test equipment in the hands of a qualified radio technician.

Sleuthing

Technicians make some of the best detectives in the world—no kidding! They have to investigate why something doesn't work and trace down the fault; that takes an inquisitive mind. And if one has a good sense of business, there's plenty of work in counter-surveillance. That's because private citizens are being illegally bugged every day; not to mention all the industrial and foreign espionage that seems so prevalent in today's world. Yes, indeed, when word gets around that a technician knows how to ferret out phone-taps, that person's skills will be in demand.

Most people just aren't aware of all the inexpensive devices that can be legally purchased to invade their privacy. Figure 1 shows three tiny bugs that can hear everything you say. Although clandestine bugs can come in small packages, a willful intruder will use what's handy and what works. Bugs range from sugar-cube sized "wireless microphones" for $20, to candy-box sized "wireless intercoms," and handhelds, that will allow anyone within a half-mile radius to listen to every spoken word in your home. And you can bet that there are many more sophisticated and much more expensive devices, too! Let's face it; not just anyone can find one of those cleverly hidden bugs in your home or office. It takes someone like a technician with expert knowledge of radio transmissions, having the skills and equipment needed to track down tiny radio bugs.

Did you know that a perfectly legal

FIG. 1—THESE ARE CLANDESTINE radio bugs. In *(a)*, a parasitic phone-tap is shown disassembled. In *(b)*, a Radio Shack FM-transmitter (part No. 33-1076) can be conveniently dropped behind the cushion of a chair. In *(c)*, this tiny FM transmitter can be hidden in a kitchen cabinet.

(FCC registered) phone tap is available from many companies for only $25? That's because there's a big market for bugging *your own* phone. Just think for a moment: At one time or another haven't you called some big-time attorney, or doctor, or insurance company, only to hear strange beep-tones or clicks. That's right, you're being recorded—and it's all legal!

Most people are under the impression that intercepting *your own* telephone conversation, or recording the conversion without beep tones, is illegal. That simply isn't true! You don't have to notify anyone that you're tapping *your own* phone. How about that! And if you can buy a simple phone-tap, so can a criminal out to victimize the average Joe.

Bug frequency

Let's suppose a client suspects a radio bug has been planted in his telephone. However, the client might lack the know-how to either disassemble the phone, or even tell the difference between a wiretap and the normal telephone's circuitry. It's possible that the client has found a wiretap, but dosen't know what to do. A common wiretap is shown in Fig 1-*a*. It's a "parasitic telephone transmitter" (not to be confused with parasitic or spurious emissions from a legal RF transmitter).

The nomenclature "parasitic" was derived from the fact that the bug steals power (as a parasite feeds on others) from the telephone company and, consequently, needs no external battery or antenna. Those devices use the telephone's own headset coil-cord and associated wiring as the antenna, and the 48-volt central-station battery for power (which drops to about 10 volts when the handset is off hook).

Depending upon how the tiny phone-bug is designed and where it's located, it can be received on an FM radio, or other receiver, up to one-half mile away. The beauty of that bug is that it can't be detected unless it's actually operating, which means the phone must be off-hook. And although able to operate on virtually any frequency, it's common to sandwich the transmissions between high-powered FM-broadcast stations; that's so they won't create radio interference that would tip off the authorities. Besides, an FM transmission can be received by any inexpensive FM car radio—usually sitting in front of, or nearby, the victim's house or business.

Here's a step-by-step procedure using a spec-an to make any bug stand out like a sore thumb:

Step 1: Set scan-width for the 88 MHz to 108 MHz FM broadcast spectrum.
Step 2: Set bandwidth resolution to 3 kHz. You will now have a factual display of all electromagnetic radiations occurring in the 88 MHz to 108 MHz frequency range.
Step 3: Set the "peak hold" to capture and store all legitimate signals that are on the air (see Fig. 2-*a*).
Step 4: Digitally invert all stored information (see Fig. 2-*b*).
Step 5: Pick up the suspected telephone (off hook) and you'll notice that the signal previously not present is now displayed (see Fig. 2-*c*).

What we have accomplished is a digital cancellation of everything that should be on the air against a brand new signal that was not there prior to our picking up the phone, but which now sticks out like a *sore thumb*.

Incidentally, for evidence in court (and customer records) the plots that are reproduced can be made at the actual scene of the crime with the GPIB option (also known as IEEE-488). One GPIB is available from IFR to connect their spec-an to a Hewlett Packard *7470A* Plotter. Whatever spectrum analyzer and plotter you're using, contact the manufacturer's representative for interfacing suggestions.

Bug locating

If you are sharp enough to find a bug, the last thing in the world that you want is the bug to hear itself! (If the bug is active, it is logical to assume that someone is listening.) If you have a receiver tuned to the bug with speaker audio, and you get too close, you'll get audio feedback, which will immediately tip off the spy that you're on to him! No good! Here's what to do.

Once the bug's frequency is found, use headphones with a long, long, extension cord (maybe 50-100 feet or so) to listen to the audio. Now walk around the house tapping the walls, rattling objects, or talking in a normal voice, while listening for an increase in volume level. Make your rattling sounds appear as natural as possible, so that the "bad guys" don't become suspicious. If the bug is in the kitchen, then as you move from the living room into the kitchen, the bug will pick up more audio thereby transmitting a higher-amplitude signal. You'll hear that over your headphones.

The receiver option of your spec-an will undoubtedly have a speaker output. Figure 3 shows how to convert the speaker output to a headphone output only. Although by no means any engineering marvel, the modification is extremely effective and retains the integrity of the receiver! The audio is re-directed (using shielded coaxial-cable) from the speaker to a set of headphones. Figure 4 shows the author's home-built adaptor box. Alternatively, a set of cordless infrared headphones, such as Maxon's model *49-SA* can be used, which would not only eliminate the possibility of tripping over a long headphone cord; but they are also useful in detecting infrared bugs—yes, those exist, too!

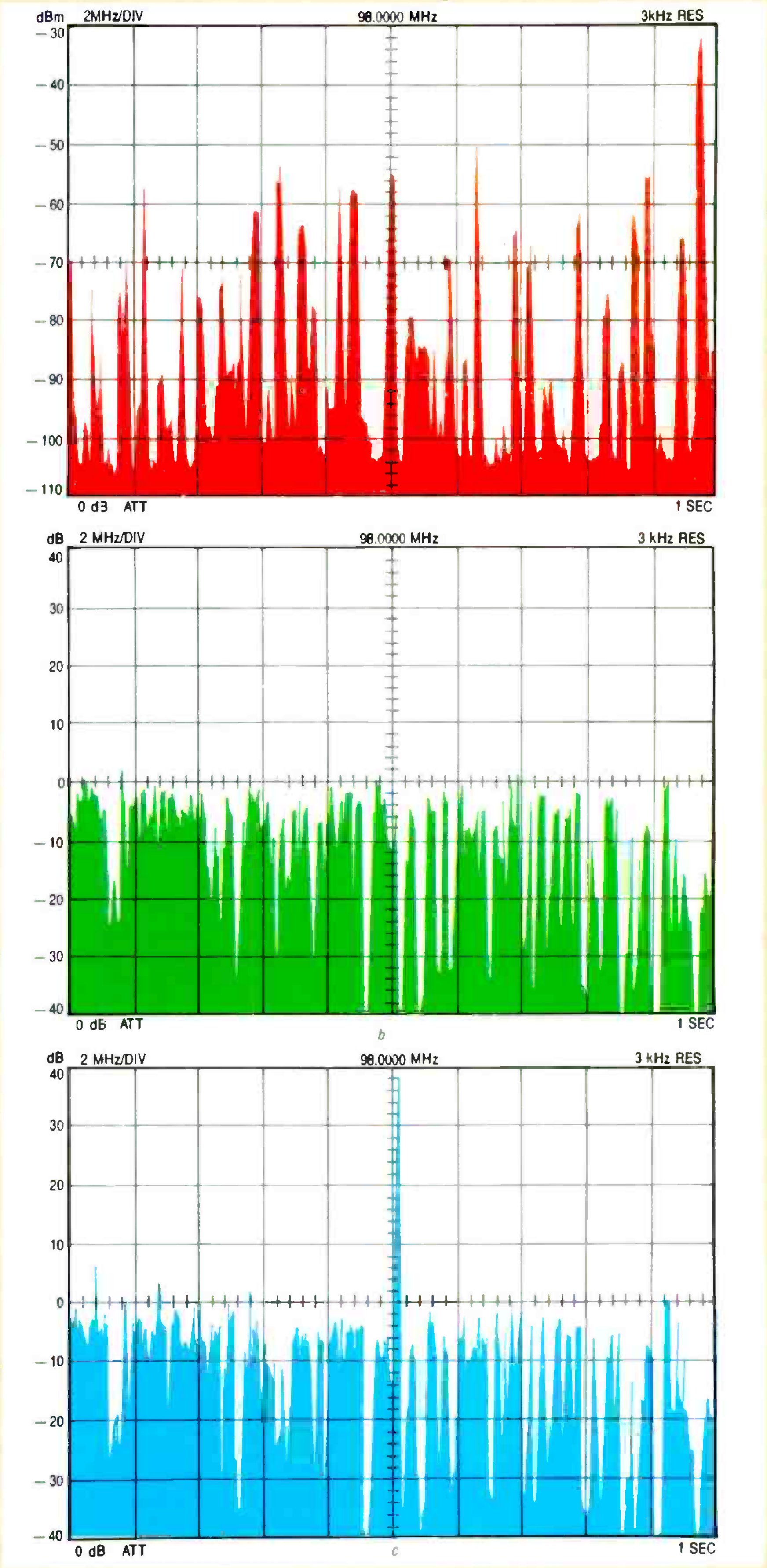

FIG. 2—A SPECTRUM ANALYZER WILL INTERCEPT THE BUGS FREQUENCY. In *(a)*, the broadcast (88-108MHz) FM spectrum is scanned and stored. In *(b)*, the stored spectrum is digitally inverted. In *(c)*, the bugs frequency sticks out like a sore thumb when the phone-tap begins transmitting.

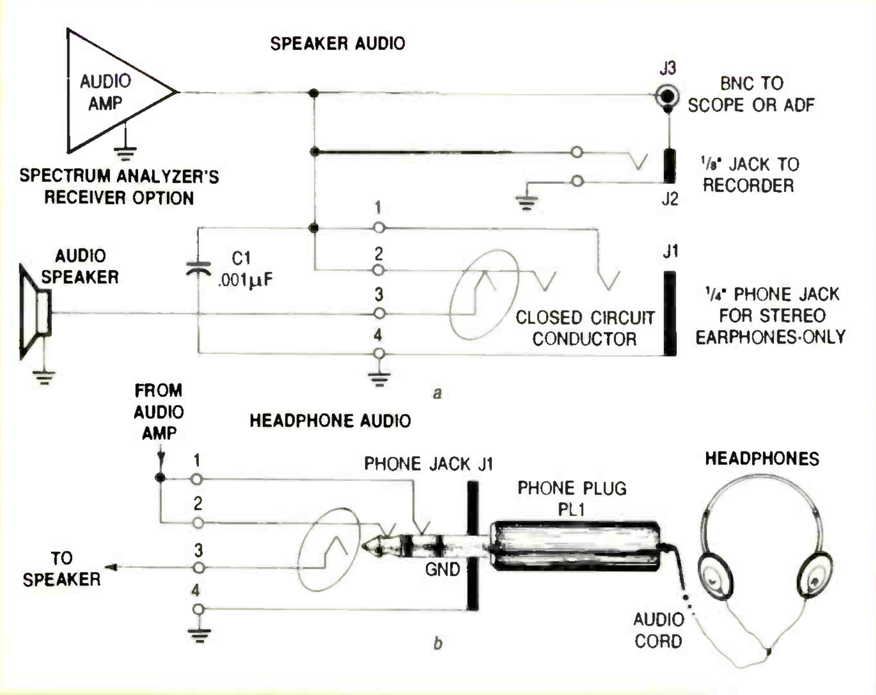

FIG. 3—USE HEADPHONES FOR LISTENING TO THE BUG'S TRANSMISSIONS. In *(a)*, this circuit will modify your receiver's speaker output for headphone use only. As shown in *(b)*, when the phone plug is inserted, the closed-circuit spring opens, thereby cutting off the speakers while re-directing the audio to the headphones.

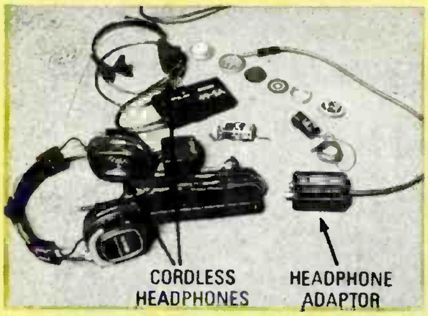

FIG. 4—USE THE AUTHOR'S home-built adaptor box with either a pair of stereo headphones, or a cordless infrared transmitter and receiver.

FIG. 5—HERE'S YOUR PERFECT sleuthing setup: a spectrum analyzer, automatic direction-finder, antenna switching box, and headphone audio-adaptor to listen privately to clandestine transmissions.

The headphone adaptor box can be attached with *Velcro* tape to the side of the spec-an. In addition to providing headphone-only audio, J2 can input to a *V*oice *O*perated *T*ransmit (VOX) actuated tape-recorder, J3 can input to an oscilloscope, *A*utomatic *D*irection *F*inder (ADF), or whatever else is required. Note: Use only a 1/4" *stereo* phone-plug for audio-jack J1; that's because if a monophonic phone-plug is inserted, it will short-circuit the audio amplifier.

An actual bust

As a case in point, the author's services were requested by an out-of-state detective agency. They had a client who quite honestly thought she was losing her mind.

Separated from her husband and having their two children in her custody, the children stood to inherit close to three million dollars, which would be administered by their legal guardian as a trustee. (Not a bad situation for the legal guardian.) To her, it seemed that every single word she said inside her home, or over the phone, was somehow being overheard. No one could find any clandestine listening device, and her suspicions seemed to be getting the best of her. She thought, "Is my ex-husband trying to collect evidence to prove that I'm an unfit mother, and then use that as a tactic in court to remove my guardianship?" The husband would then stand to become the trustee to three-million smackers.

The author and out-of-state detective set up a spectrum analyzer, and proceeded to search for a radio signal that shouldn't be there. After an hour or so, an intermittent signal kept popping up in the middle of the FM-broadcast band that didn't correlate with any known or published local radio-stations in the area. Without going into detail, it was established that a *frequency-hopping transmitter* was operating, and was remotely controlled by an AC line-current carrier transmitter.

In other words, that was a bug that selectively transmitted information on numerous frequencies. The purpose was to make it much more difficult for someone, to locate the bug because it would continually "hop" to a new frequency. If such a signal is monitored on a single frequency, all that is heard is gibberish.

The control of that device was discovered to be an AC line-current carrier transmitter that could activate or disable the bug from a convenient location in the neighborhood. Now that you have found something as insidious as that, what do you do? Psychology is always the best weapon. If we were to rip the bug out, the "bad guys" would instantly know that it was found.

The author made a hand-written note, showed it to the parties involved, and instructed them to walk outside onto the patio where their conversation could not be overheard. There he informed the victim that she was neither paranoid nor insane, and she immediately fell into the author's arms, crying in relief. The author advised that if they tore apart the kitchen cabinets, (where the bug was located) that the perpetrator would be aware that the bug had been discovered.

So "what now?" The author suggested that she make a tape recording (at another residence) of the kids screaming and carrying on, as if something terrible was happening. The next step of the plan was to take the children and place them in someone else's custody, whose testimony and verification could not be disputed in a court of law.

Having done that, she should stay in her house alone, play back the tape as loud as possible, grab a few pots and pans and make as much noise as possible (portraying a scene of total chaos and child abuse). The whole purpose of that action was to find out who would show up.

Well, it worked! It was the in-laws (outlaws) that showed up, and not the husband, much to the surprise of everyone. I can only presume that they cared more about the three-million dollar inheritance than they did about the welfare of their grandchildren.

Spec-an modifications

Unfortunately, the IFR *A7550*, along with other spectrum analyzers, has one fault in common: There is an unacceptable amount of leakage from the internal oscillators that cause alarming and inaccurate readings with an antenna placed as far as 20 to 30 feet away. The problem is caused by RF case leakage that can easily be corrected. But if you don't correct it, that leakage will ruin your day!

Spectrum analyzer RF leakage can be cured by making sure that the front and rear mounting bezels make good contact with the case. Dissimilar metals should not be used, because oxides caused by the bi-metallic contact will form a resistive film that isolates the bezel from the chassis. That turns the bezel and aluminum case into an antenna which, in turn, radiates all of the internal RF of the spec-an's circuitry. Also make sure that your plotter is line-filtered so that RF energy emitted by its microprocessor circuitry is not radiated into the power line.

RF direction-finding

Sometimes clandestine, spurious or overbearing emissions can be so powerful that they cause problems many miles from their source. Enter the *automatic direction-finding system* manufactured by Doppler Systems Inc., PO Box 31819, Phoenix, AZ. 85046, (602) 488-9755. Figure 5 shows the Doppler direction-finder attached by *Velcro* to the right top of the spec-an. The circle of LEDs indicates the bearing to the RF source, while a 7-segment LED-display indicates the bearing in large numerals. The Doppler system has a frequency range of 27 MHz to 500 MHz, and can be connected to any standard VHF or UHF FM-receiver. No receiver modifications are required—simply plug the Doppler electronics into the receiver's antenna and external speaker jacks.

As shown in Fig. 6, four ¼-wave whip antennas can be mounted on a car's roof for mobile operation, or on the roof of a house. The antennas can electronically simulate a rotating directional-antenna. As the antenna moves toward the RF source, the apparent signal frequency increases; as the antenna moves away from the source, the apparent signal frequency decreases. That up-down (Doppler) frequency shift is detected by the FM receiver as a 300-Hz audio tone. The phase of the tone is related to the bearing angle and is used by the direction-finder electronics to compute and display the bearing.

a b

FIG. 6—DIRECTION FINDING using Doppler System's four matched quarter-wave whips, shown in *(a)*, are supported on magnetically mounted bases for mobile operation. In *(b)*, four collapsible antennas are mounted on a sturdy platform, on top of the author's roof.

The purpose of the direction-finding platform is to get an initial bearing to the desired signal, and the relative signal strength. The ¼-wave whip antennas must be tuned to the exact frequency of the clandestine transmissions. You know the exact frequency by using the spectrum analyzer. The antennas are collapsible and will allow tuning by extension-retraction, and spacing the bases by sliding them along the platform. To work properly, the antennas must be spaced approximately ¼-wavelength apart.

One of the capabilities of a spectrum analyzer is the ability to identify the frequency of the offending radio-emission. That includes spurious emissions that are common in areas where multiple transmitters are placed in close proximity with each other. Besides the non-linear mixing that occurs in a transmitter's final-amplifier (called intermodulation) that create strong spurious signals, other far more exotic kinds of heterodyning also occur.

One time the author found a "difference" frequency coming from an oxidized dome of a town hall. There were two AM-broadcast stations less than a mile away; one was on 1590 kHz and the other on 900 kHz. Within a half mile of the town hall, everyone in town could hear one of the stations at 690 kHz! That was caused by rectification from the dome's copper-oxide layer.

When "DF-ing" a spurious signal in a moving vehicle, it is absolutely imperative that you have an assistant, or navigator to read a road map and give directions, or more important—to prevent you from kissing a telephone pole. Using Doppler System's *A*utomatic *D*irection *F*inder (ADF), the author has been able to track down signals to a specific section of a house—from the road out front!

Proximity signals

If you narrow down a suspected transmitter to within a given area, here's one method of determining its proximity. Place three identical antenna's having identical lengths (and types) of coaxial cable connected to a coaxial-switch box. Use the best coax, like RG 223-U coaxial cable, which is double-shielded (98% each) silver-plated (both shields and center-conductor) cable to ensure total integrity of the received signal. That may sound like overkill, but if you're going to do something, why not do it right?

Separate the three antennas by about 30 feet. A low-powered bug will show a marked change in signal strength on the spec-an, when antennas are independently selected. The stronger signal will indicate the relative bearing of the transmitter's location. Transmissions from far away will indicate almost identical signal strength. **R-E**

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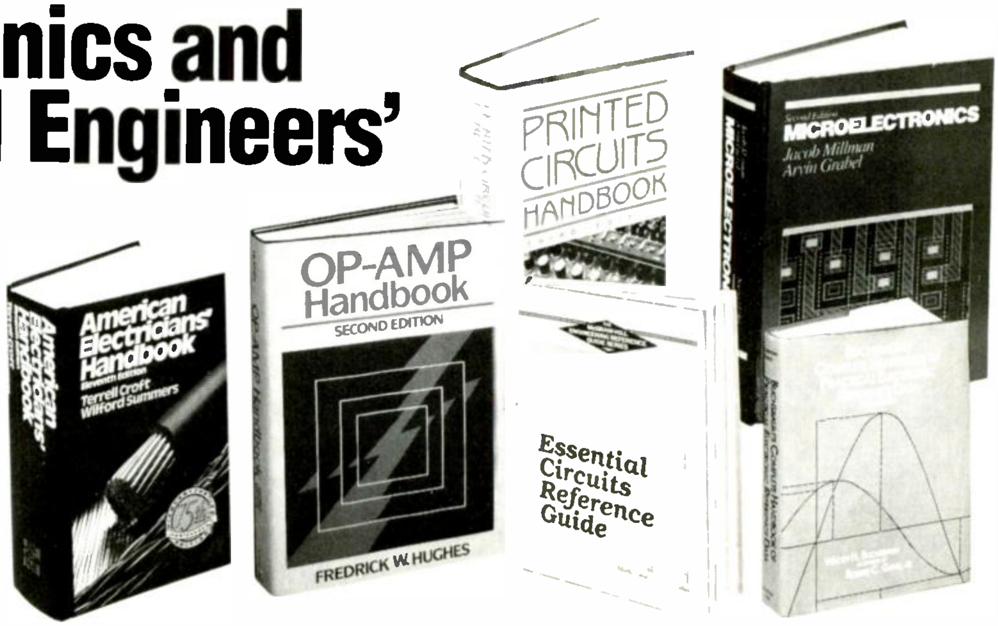

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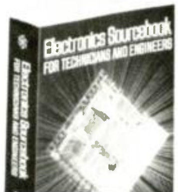

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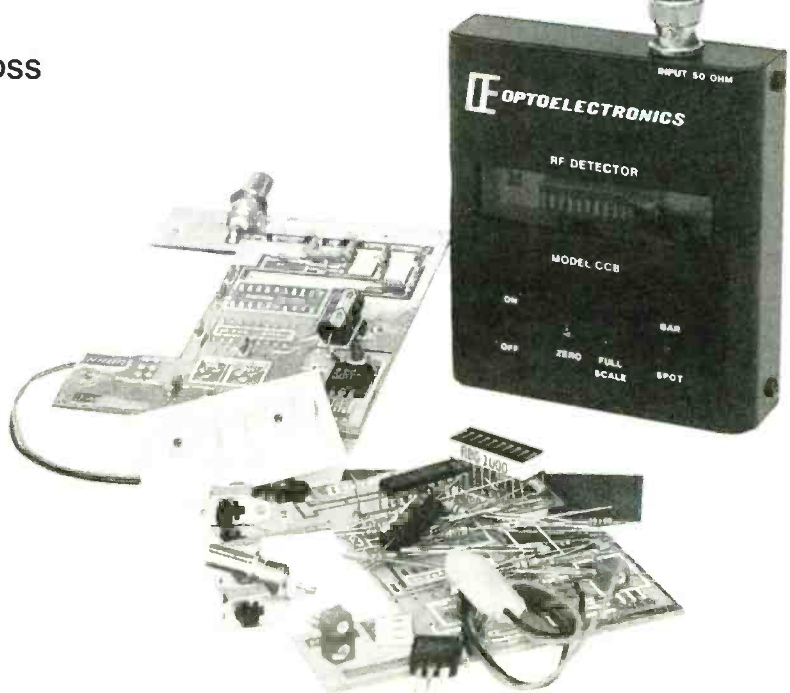
E34053

BUG DETECTOR

Our hand-held "bug" buster can sniff-the-airways like a trained bloodhound.

L. K. ROSS



IF YOU'VE EVER HAD THE FEELING THAT someone was illegally bugging your conversations, you were probably at a loss at how to find out for sure. Signal-detection equipment is expensive, and paying a professional to sniff out bugs is even more so. Here we show you how to build an RF detector that can locate low-power transmitters (bugs) that are hidden from sight. It can sense the presence of a 1-mW transmitter at 20 feet, which is sensitive enough to detect the tiniest bug.

As you bring the RF detector closer to the bug, more and more segments of its LED bargraph display light, which aids in direction finding. Furthermore, our bug buster costs less than $60 to construct, and is more effective than most high-priced gadgets to be found in flashy mail-order catalogs.

Little-known ability

Enter the cloak and dagger world of counter-surveillance electronics. Frequency counters have been used for years by the federal government, and police agencies for security work. You see, counters have the little-known ability to pick up and display the frequency of a hidden transmitter.

Our bug buster was developed to solve a problem that law-enforcement personnel were having when using frequency counters to locate bugs. A sensitive frequency-counter with an antenna input will continuously display random numbers caused by the counter's own oscillating circuitry. Nontechnical users tend to stare into the meaningless display, attempting to interpret the constantly changing numbers. Of course, the counter locks in solid when a real signal is present.

The bug buster is a frequency counter that doesn't self-oscillate, and is useful when knowing the bug's transmitter frequency is unimportant. As a field-strength meter, it will respond as the distance to the RF transmitter changes, allowing any bug to be precisely located.

Circuit theory

As shown in Fig. 1, the front end has a two-stage wideband RF amplifier, and a forward-biased hot-carrier diode for a detector. After detection, the signal is filtered and fed to IC1, a LM3915N bar-graph driver having a logarithmic (log) output; that means each successive LED segment represents a 3-dB step, which helps display the wide dynamic-range signals that the bug buster will encounter.

The front-end RF amplifiers are wideband *M*onolithic *M*icrowave *I*ntegrated *C*ircuit (MMIC) devices from Mini-Circuits, PO Box 350166, Brooklyn, NY 11235-0003: (718) 934-4500. They have 50-ohm input and output impedances from DC to 2000 MHz. The gain is 20 dB through 500 MHz, dropping to 11 dB at 2000 MHz. The amplifiers are surface mounted on a .1" wide microstrip lead. Surrounding the amplifiers are surface-mounted coupling capacitors, standard (current limiting) resistors, decoupling capacitors, and chokes. Chip components were selected based on information supplied in the Mini-Circuits Publication entitled, *A handy "how-to-use" guide for MAR monolithic drop-in amplifiers*. The amplifiers perform exactly as described by the manufacturer; the agreement with specifications is really quite good.

The input-sensitivity plot is shown in Fig. 2. Up to five amplifiers were connected in series in an attempt to increase the front-end sensitivity down to the level of a few microvolts. Although using more amplifiers does, in fact, increase apparent sensitivity when tested by a signal generator, the effective transmitter detection range does not increase. That's because the amplifiers are wideband, and have no tuning; therefore, increased amplification is applied across the entire RF spectrum. The signal being measured in the real world must appear larger than the RF noise background in order to be detected. In conclusion, a gain of about 40 dB was found to work best for detecting hidden transmitters.

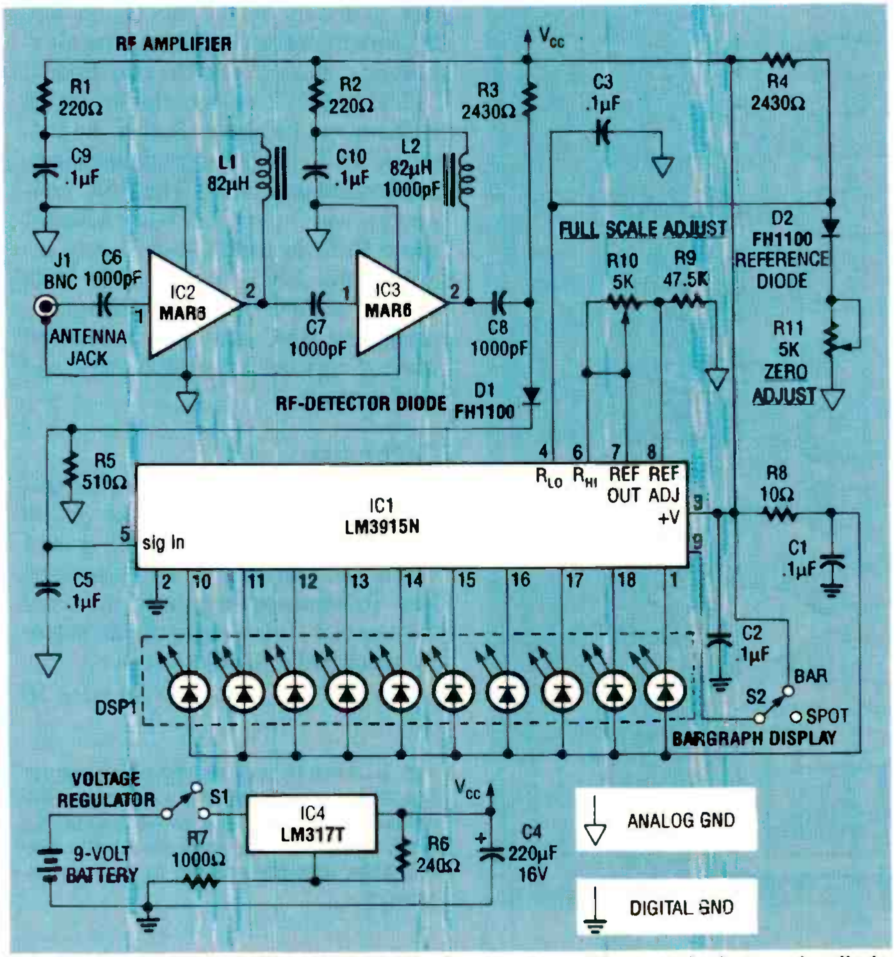


FIG. 1—THE RF FRONT-END USES MMIC wide-band amplifiers, and a hot-carrier diode detector.

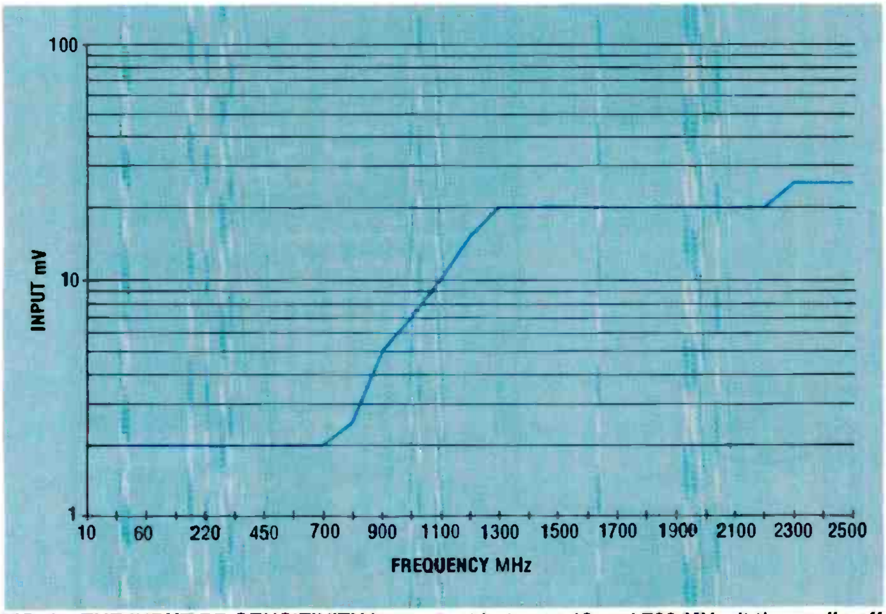


FIG. 2—THE INPUT RF-SENSITIVITY is greatest between 10 and 700 MHz. It then rolls off between 700 MHz and 1300 MHz, and remains almost constant out to 2500 MHz.

To ensure stable operation without having to constantly re-adjust the full-scale or zero-adjust potentiometers, voltage regulator IC4, an LM317T, is programmed for approximately 6 volts by R6 and R7. A 9-volt alkaline battery supplies the regulator.

Figure 3 shows the block diagram of the LM3915, consisting of a resistor-divider network and a chain of op-amp comparators. The output of each comparator is open (no current in or out) when the noninverting input is higher than the inverting input; the output goes low (sinking current) when the inverting input is higher. Each comparator controls a single LED segment, which lights when the comparator's output is low.

The noninverting inputs can be considered as reference inputs. The resistor string has log-weighted values, so that the current flowing from pin 6 to pin 4 generates the appropriate reference voltages at each of the ten comparator inputs. Those ten voltages always maintain the same relative relationship even when the reference voltage changes. The signal input is buffered (amplified with a voltage gain of 1) to prevent loading the source. As the signal input increases between the reference low and reference high voltages, each comparator will change state as its noninverting voltage is exceeded.

The LM3915 has an internal 1.25-volt reference source. Trimmer R10 will adjust the reference voltage according to this formula:

$$V_{REF\ HI} = 1.25\,(1 + {}^{R9}/_{R10}) + R2\,I_{ADJ}$$

The I_{ADJ} current is internally set to be less than 120 µA, while the LED brightness is controlled by the reference current out of pin 7. The current through each LED segment is equal to ten times the current through R9 and R10; therefore, changing R9 and or R10 will change the LED brightness.

Switch S2 programs the LM3915 for either a bar or a spot display. The spot display conserves battery life because only one segment is on at any given time; however, the bar display is more pleasing visually.

The SIG IN voltage is the sum of the bias voltage on detector diode D1, plus any rectified and filtered RF from the input amplifiers IC2 and IC3. To offset the bias voltage, a low-voltage reference is generated by R4, D2, and R11; it should track the bias voltage

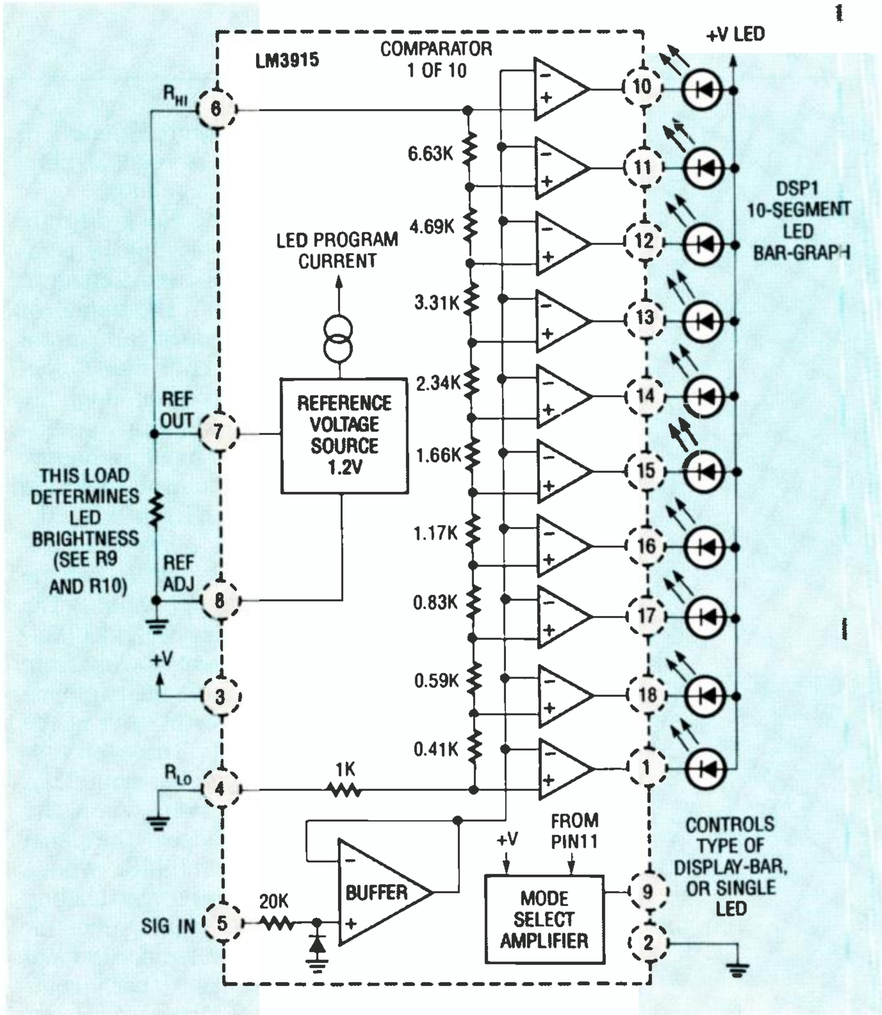


FIG. 3—INSIDE THE BARGRAPH DRIVER is a series of op-amp comparators driving a LED bargraph.

despite temperature changes, while capacitor C3 bypasses any RF to ground.

Construction

Figure 4 shows the parts placement for the bug buster's double-sided PC board. A plated-through silk-screened G10 glass-epoxy board is available from the source listed in the parts list, or you can etch your own using the artwork provided in "PC Service."

In Fig. 5, the MMIC surface-mounted amplifiers and chip capacitors require a little extra care during installation. They can be hand-soldered with a small-tipped iron, but must not be overheated—and watch out for solder bridges. The LM3915 bargraph-driver IC (IC1), the two trimmer potentiometers (R10, R11), and the two slide switches (S1, S2), all install on the solder side (also referred to as the far side) of the PC board. All remaining components install on the silk-screen printed side of the PC board. Holes are not provided in the microstrip for component leads; just solder the leads directly on top. Be sure to check polarity on the electrolytic capacitor, and the two diodes.

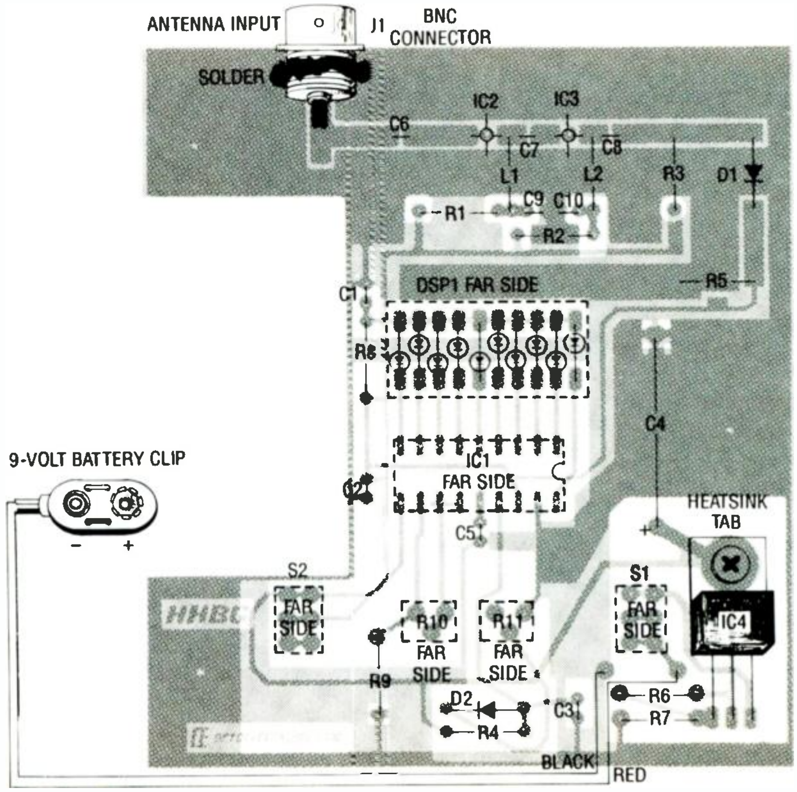
The LM317T bolts to the PC board without any insulator. Solder the battery leads to the appropriate locations labeled red and black. The BNC connector was modified with a 0.06" grove to fit in the PC-board cut out. Solder the BNC connector to both sides of the PC board as well as soldering the BNC center-pin to the foil trace. Snap on a 9-volt battery and you're ready.

Calibration

The BNC-mounted telescoping-antenna is convenient and works well in the 100-MHz to 470-MHz range where the majority of all bugs operate. To increase sensitivity to other frequencies, you have to use an antenna specifically for that service.

continued on page 50

FIG. 4—THIS IS THE PARTS-PLACEMENT DIAGRAM. Opposite the side that's silk screened is the solder side—called the far side. Install the components on the correct side, with the polarity in the right direction.



AMATEUR TV TRANSMITTER

Add TV transmission to your radio shack.

RUDOLF F. GRAF and WILLIAM SHEETS

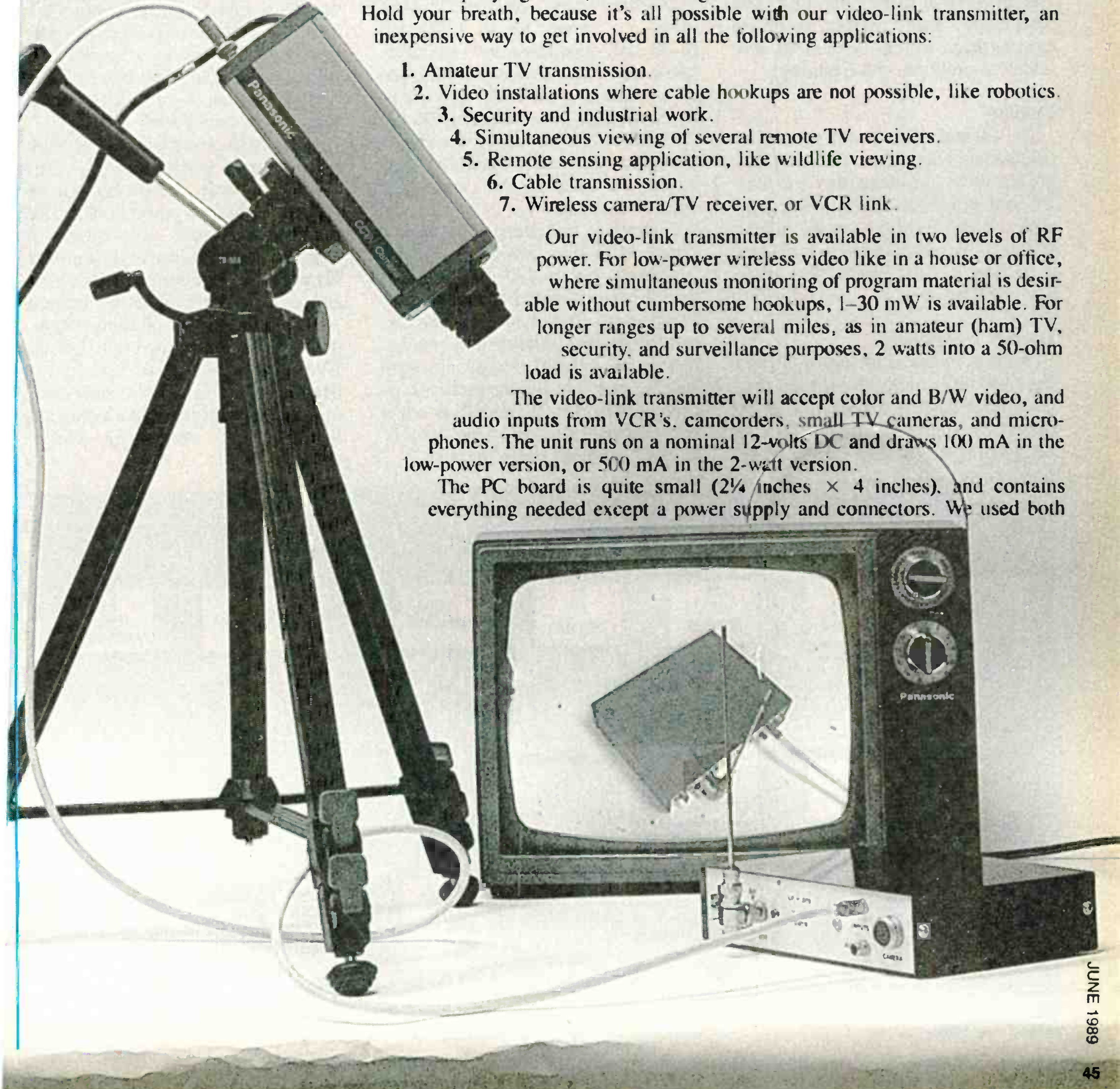
HOW WOULD YOU LIKE TO TRANSMIT COMPLETE VIDEO, EITHER COLOR OR BLACK-AND-WHITE, with accompanying audio, either through coaxial cable, or to a remote receiver? Hold your breath, because it's all possible with our video-link transmitter, an inexpensive way to get involved in all the following applications:

1. Amateur TV transmission.
2. Video installations where cable hookups are not possible, like robotics.
3. Security and industrial work.
4. Simultaneous viewing of several remote TV receivers.
5. Remote sensing application, like wildlife viewing.
6. Cable transmission.
7. Wireless camera/TV receiver, or VCR link.

Our video-link transmitter is available in two levels of RF power. For low-power wireless video like in a house or office, where simultaneous monitoring of program material is desirable without cumbersome hookups, 1–30 mW is available. For longer ranges up to several miles, as in amateur (ham) TV, security, and surveillance purposes, 2 watts into a 50-ohm load is available.

The video-link transmitter will accept color and B/W video, and audio inputs from VCR's, camcorders, small TV cameras, and microphones. The unit runs on a nominal 12-volts DC and draws 100 mA in the low-power version, or 500 mA in the 2-watt version.

The PC board is quite small (2¼ inches × 4 inches), and contains everything needed except a power supply and connectors. We used both



subminiature and surface-mount components because they perform well at RF, requiring simple tuneup without complex test equipment. In fact, a good tuneup can be achieved with only a VOM and a TV receiver.

Readers may be familiar with the author's previous article on an RF video-link (February, 1986, **Radio-Electronics**). Since then, many improvements have been made. The new transmitter is easier to tune, uses three slug-tuned coils instead of air-wound, and has a double-sided PC board for better shielding and grounding. Additionally, better transistors were substituted in the new design, which also has an integral power amplifier, and audio/video gain controls for easier interfacing. Linearity control was added to optimize video quality.

Liability

Be warned: The 2-watt version is intended for educational purposes, legitimate TV broadcasting, amateur TV, and industrial, and scientific purposes. It can transmit several miles, so those intending to use our design must have a Technician-class amateur-radio license.

Carrier frequency

As Fig. 1 shows, transistor Q1 and the surrounding circuitry is a crystal-controlled oscillator operating at ⅛ the video frequency, from 52.5 to 62.5 MHz. After being multiplied by four through frequency-doublers Q2 and Q3, the output covers 420–500 MHz, overlapping the 430-MHz ham TV band and the lower UHF (300 MHz–3 GHz) TV channels.

First, the frequency is doubled to 105–125 MHz by Q2, and then to 210–240 MHz by Q3. With some modifications, higher or lower frequencies are possible, but with lower power above 500 MHz, and higher power below 420 MHz. Double-tuned interstage networks suppress unwanted harmonics. Then, Q4 doubles Q3's output to the final carrier frequency, which is injected into transistor Q5.

In the low-power version, Q5 modulates the carrier by V_{cc}. The RF (1–30 mW, depending on coupling) is taken from Q5's collector and fed to either a cable or a 6–inch whip antenna. In the high-power version, Q6 and Q7 form a high-gain RF power amplifier, and adjustable matching networks are used in the circuit for optimum tuneup.

Instead of matching networks, a tuned strip-line design was contemplated, but at 420–500 MHz, it would have occupied too much PC-board area. Broadband RF chokes, surface-mount (tantalum chip) capacitors, and careful design strategy avoided possible low-frequency spurious oscillations. We ended up with a very stable, efficient, reproducible circuit having no UHF "horrors."

Modulator

The audio input at J1 will accept a wide range of voltage levels; 10 mV (typical microphone output) to 1 V (line input) is fed to audio-amplifier Q8. The audio-gain control adjusts for optimum modulation of Q9, a Colpitts *V*ariable *C*ontrol *O*scillator (VCO) producing 4.5-MHz FM audio subcarrier, which is fed to video amplifier Q10, where it is then combined with the video from J3.

The video input at J3 may be 0.5– to 1.5-volts peak-to-peak, negative sync, while the video-gain control prevents Q10 and Q11 from video overload. Current-source Q10 and amplifier Q11 feed modulator Q12, which is capable of producing video having a 12-volt swing, and can drive a load up to 1 amp. Its bandwidth at −3 dB is in excess of 10 MHz, assuring crisp picture detail.

In the high-power version, Q12 is a power supply to Q6 and Q7, effectively amplitude modulating the RF carrier. In the low-power version, Q5 is modulated in the same manner. A linearity control adjusts Q12's operating point for optimum modulation linearity. The Q-point must be properly set; otherwise, video clipping will occur, producing "burned-out" picture highlights (white areas) and loss of detail. Other Q-point problems could include sync "buzz" in the audio, and loss of picture stability in extreme cases.

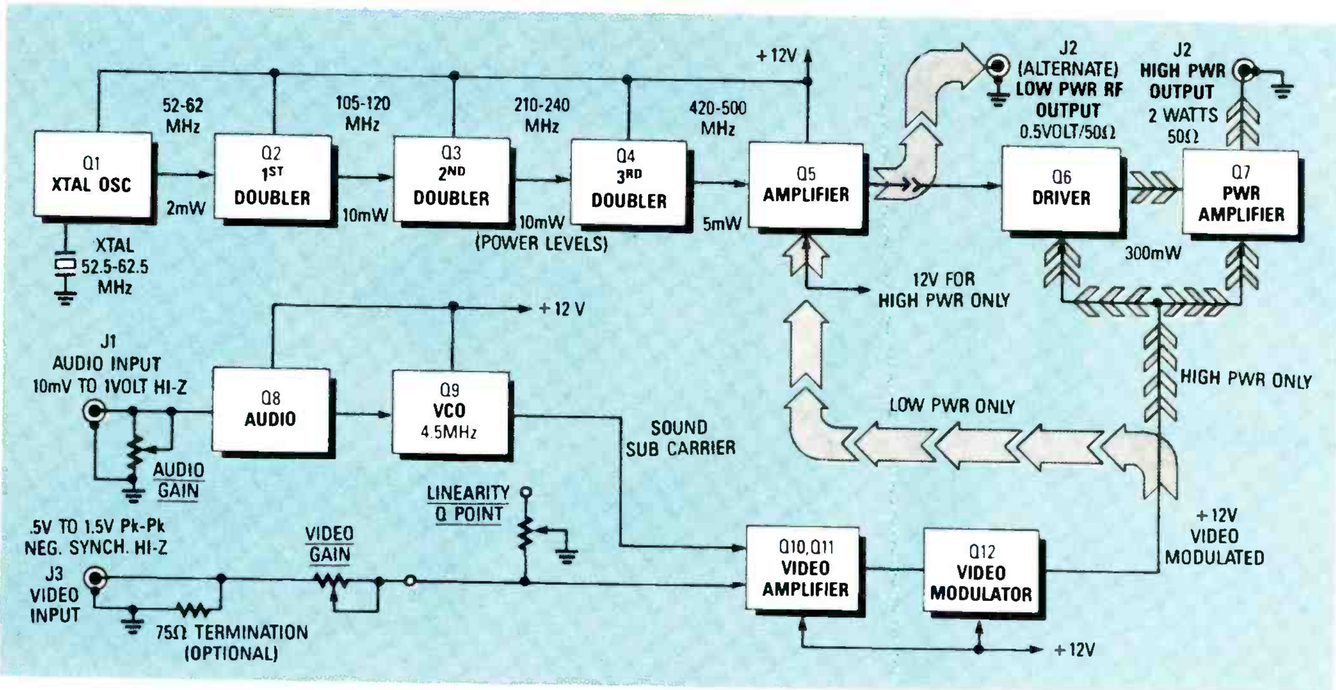


FIG. 1—VIDEO-LINK TRANSMITTER CAN BE CONFIGURED for either low-power, or high-power operation.

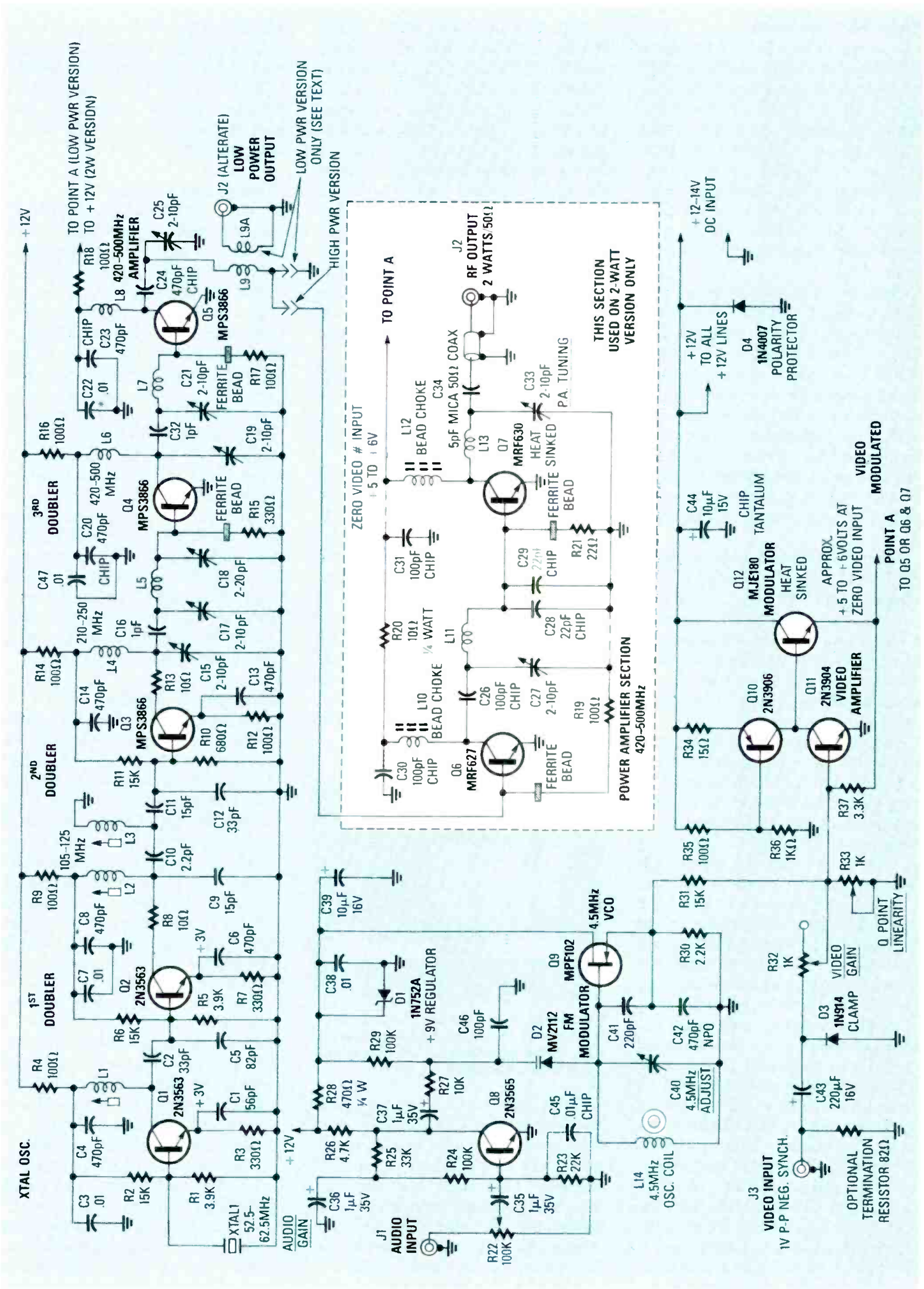


FIG. 2—HIGH POWER, 2-WATT Video-link Transmitter.

Frequency doublers

Referring to Fig. 2, VHF transistor Q1 is biased at 10 volts and 5 mA, with the Q-point set by resistors R1, R2, and R3. Crystal XTAL1 is series-resonant, "bypassed" to ground. At the crystal's resonant frequency (between 52.5 and 62.5 MHz), Q1 is a common-base amplifier. Tank (tuned circuit) L1/C2, in series with C5, together with about 1–2 pF of stray capacitance, form a load for the collector of Q1.

Once Q1 starts oscillating, its collector current is typically 5–10 mA, and depends on the tuning of L1. Here, C3 and C4 bypass the "cold" end of L1 solidly to ground for AC. Internal collector-to-emitter (C-E) feedback occurs in Q1 via the intrinsic 2-pF C-E capacitance. Here, C1 forms a voltage divider to feed the collector back to the emitter. Note that C1 is not for emitter bypass, but is part of the feedback network of oscillator Q1.

A portion of the voltage across tank L1/C2, and C5, is fed to Q2 by the voltage division between C2 and C5. Next, Q2 and its associated circuitry is a frequency doubler, where a large drive signal from Q1 causes rectification in Q2's emitter-to-base (E-B) junction, which produces considerable harmonic generation.

At twice the oscillator frequency, C5 has low impedance; keeping the impedance low in Q2's E-B circuit by using a large value (82 pF) for C5 also helps produce efficient harmonic generation. Biasing for Q2 is the same as Q1, via R5, R6, and R7. Bypass C6 adds stabilization, as does C7 and C8.

Tank L2/C9 is tuned to twice the crystal frequency. R9 supplies DC to Q2. A slug in L2 tunes the tank, while C10 couples RF energy at 2 times the crystal frequency to a second tank L3/C11/C12, also tuned to twice the crystal frequency. Using dual tanks assures good selectivity, and improved rejection of unwanted frequencies; that's important for a clean transmitter signal. Next, R8 in Q2's collector suppresses any self-oscillation tendencies at unwanted, parasitic UHF.

Frequency doubler Q3 (MPS3866, 400-MHz, medium power, 1-W, plastic) is fed at 105–125 MHz from the junction of C11 and C12. Here, R10, R11, and R12 bias Q3. The RF level at Q3's base is quite high, and that affects Q3's biasing, while the collector current runs at 10–15 mA.

Note that Q3 offers better performance at 250 MHz than the 2N3563's used for Q1 and Q2; Q3 doubles the frequency to between 210 and 250 MHz. Except for frequency, Q3 operates similarly to Q2. Then, R13 suppresses UHF parasitics, and L4/C15 form a bandpass filter tuned to twice the input frequency. At 250 MHz, C1 (for Q1) and C3 (for Q2) are ineffective, whereas C14 is sufficient. Finally, R14 feeds DC to Q3.

Note in tank L4/C15 that C15 is variable and L4 is fixed. Slug tuning is no longer practical because L4 has too few turns. Energy is coupled through C16 to tank L5/C17/C18, which forms a double-tuned bandpass filter at 210–250 MHz. Then, C17 is for RF tuning, while C18 will optimize matching into Q4, the last (third) doubler.

Figure 3 shows how a ferrite bead is slipped over one lead of R15, which causes a high series-impedance at RF, yet passes DC without attenuation, thereby completing the base circuit DC path for Q4. The bias is now supplied entirely by the drive signal; no extra DC bias is applied. The emitter of frequency-doubler Q4 is directly grounded, because bypassing emitter circuits at 420–500 MHz is difficult without some loss of RF gain; however, a low value of R15 keeps DC stability adequate.

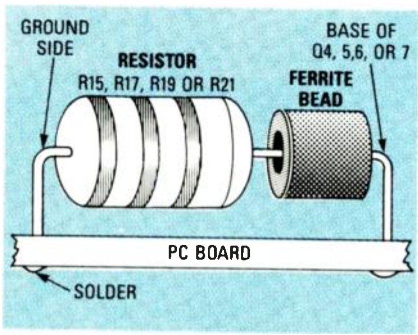


FIG. 3—SLIP RESISTOR LEAD through ferrite bead. The bead inductor causes a high series impedance at RF, yet passes DC without attenuation.

Tank L6/C19 (a short length of wire) operates at 420-500 MHz. Both C19 and C20 provide low-frequency video and RF bypassing, while C29 bypasses UHF; they also stop any stray low-frequency gain in Q4. Tantalum-chip C20 is the only type effective at 420 MHz, and provides a solid RF ground for the "cold" end of L6.

The 420–500-MHz at Q4's collector is fed to tank L7/C21, via C32, which matches Q4's collector circuit to Q5's low base impedance; together with L6/C19 they form a double-tuned UHF circuit. The ferrite bead and R17 provide a low DC impedance, but a high RF impedance to the base of amplifier Q5.

Low-power version

The UHF signal is amplified to about 30 mW by Q5. Choke L8 keeps RF energy out of the DC power supply. C22 and C23 bypass video and UHF, respectively. Note that if Q5 is video modulated (the low-power version) then C22 must be deleted, because it would cause loss of high-frequency video components; moreover, R18, which limits the supply current to Q5, must be returned to Q12's emitter. Tantalum-chip C24 couples RF output, yet blocks DC (and video, if applicable) from the tank circuit L9/C25.

In the 1–30-mW version, L9 couples the RF output to the secondary link of wire L9A, which then transfers the RF to output jack J2A (*Alternate*). Note that J2A and L9A are not used in the 2-watt version. Output power is limited depending on the proximity of the link L9A to L9.

High-power version

In the 2-watt version, L9 matches to the base of driver Q6, and Q5 is fed straight, unmodulated +12-V DC. The full 30-mW drive from Q5 drives Q6. The ferrite bead and R19 provide a high RF impedance, and low DC resistance at Q6's base. Since a ferrite bead looks more like a high resistance rather than a reactance at high frequencies, the effective Q is very low. That prevents the possibility of parasitic oscillations that could occur if a conventional-type solenoid-wound RF choke were used.

Here, C27, L11, and tantalum-chips C28 and C29 match Q6's collector impedance to Q7. RF-choke L10 is made with three turns of wire wound through a ferrite bead, in a toroidal fashion. That results in a low Q, about 1000 ohms resistance, and again avoids possible parasitics.

Tantalum-chip C26 is used to minimize stray inductance, and couples RF energy from Q6 to Q7. Now, C30 and C31 bypass UHF to ground while looking like a high impedance at 20 MHz or lower, so the video component of the modulating power supply voltage is relatively unaffected. Note

PARTS LIST

Resistors; all are ⅛ or 1/10-W, 5%
R1, R5—3900 ohms
R2, R6, R11, R31—15,000 ohms
R3, R7, R15—330 ohms
R4, R9, R12, R14, R16–R19, R35—100 ohms
R8, R13—10 ohms
R10—680 ohms
R20—10 ohms, ¼-W
R21—22 ohms
R22—100K-ohms potentiometer
R23—22,000 ohms
R24, R29—100K ohms
R25—33,000 ohms
R26—4700 ohms
R28—470 ohms, ¼-W
R30—2200 ohms
R32, R33—1000-ohm potentiometer
R34—15 ohm
R36—1000 ohms
R37—3300 ohms

Capacitors
C1—56 pF, NPO, ceramic disc
C2, C12—33 pF, NPO, ceramic disc
C3, C7, C19, C22, C38, C47—0.01µF, ceramic disc
C4, C6, C8, C13, C14—470 pF, NPO, ceramic disc
C5—82 pF, NPO, ceramic disc
C9, C11—15 pF, NPO, ceramic disc
C10—2.2 pF, NPO, ceramic disc
C15, C17, C19, C21, C25, C27, C33—2-10-pF, trimmer
C16, C32—1 pF, NPO, ceramic disc
C18—2-18 pF, or 2-20-pF-trimmer
C20, C23, C24, C45—470 pF, ceramic chip
C26, C30, C31—100 pF, ceramic chip
C28, C29—22 pF, ceramic chip
C34—5 pF, silver mica
C35–C37—1 µF, 50 V, electrolytic
C39—10 µF, 16 V, electrolytic
C40—3-40 pF, trimmer
C41—220 pF,NPO, ceramic disc
C42—470 pF, NPO, ceramic disc
C43—220 µF, 16 V, electrolytic
C44—10 µF, 16 V, tantalum chip
C45—0.01 µF, ceramic chip
C46—100 pF, NPO, ceramic disk

Semiconductors
Q1, Q2—2N3563, transistor
Q3–Q5—MPS3866, transistor
Q6—MRF559, or MRF627 transistor
Q7—MRF630, transistor
Q8—2N3565, transistor
Q9—MPF102, transistor
Q10—2N3906, transistor
Q11—2N3904, transistor
Q12—MJE180, transistor
D1—1N757A, diode
D2—MV2112, varactor diode
D3—1N914, diode
D4—1N4007, diode

Inductors
L1–L14—See table 1.

Other components
XTAL1—52.5-62.5 MHz

Note: Kits for this project are available from North Country Radio, PO Box 53, Wykagyl Station, New Rochelle, NY 10804. Two different kits are available; one is a low-power, the other is a high-power version. Those kits include the PC board and everything on it, except jacks, connectors, batteries, power-supply components, and case. Those are not included, because individual hobbyists may have their own preferences and interface requirements. The author recommends that those components be obtained at another supplier.
The Low-Power Kit w/ATV crystal for operation on 439.25 MHz costs $79.95, plus $2.50 for shipping and handling; the 2-W Kit w/ATV crystal for operation on 439.25 MHz costs $104.95, plus $2.50 for shipping and handling. Extra crystals for CH14/CH15 operation are $6.50, plus $1.50 for shipping and handling. The PC board only, plus cores, chip capacitors, and D2 (a partial kit) cost $49.95, plus $2.50 shipping and handling. The Video-Link transmitter, Radio-Electronics, February, 1986, plus a reprint of the article, costs $69.95, plus $2.50 shipping and handling. Crystals can be purchased separately from Crystek Corporation, PO Box 06135, Fort Myers, FL 33906.

that Q6 draws about 130 mA at modulation peaks (sync tips).

Also, Q6 supplies between 300- and 500-mW drive to Q7, an MRF630 (Q6 and Q7 are similar in their operation). RF-choke L12 functions exactly the same as L10. Collector matching-network L13/C33, together with mica C34 match the 50-ohm load impedance to the optimum collector load-impedance needed by Q7. Note that a 50-ohm load must always be present at J2, otherwise Q7 may be damaged. A tolerance of ±50% (25–100 ohms) is permissible here; however, optimum performance is obtained with a 50-ohm load.

Suitable 50-ohm coax must be connected from C34 (on the PC board) and J2, with short connections (a ¼-inch or so). Any length of coax can be used, but for the best results, keep it short. We used RG174/V PVC type, but teflon coax (RG188/U) would be better. From J2, a standard coax (RG8U, RG58/U, etc.) will do. Remember, feedline loss must be avoided as it can be very high at 420 MHz and up.

Video feed

Input video from J3 (standard 1-V p-p negative sync.) is fed through C43 to clamp-diode D3. Note that C43 is apparently incorrectly polarized; that is to allow for video equipment that may have a DC component of up to 16 volts at the video output. If you do not expect to encounter that, you can reverse the polarity of C43—if you wish. When turned around, the low reverse voltage (0.6 V) appearing across it doesn't seem to do any harm. Diode D3 clamps the maximum negative input level to −0.7 V, and avoids serious over-modulation at the sync tip levels. If you wish, you can DC couple from J3 directly into R32, the video-gain control, if your equipment interface permits. Also, note the optional 82-ohm termination (R32A) is not on the PC board, but is soldered across J2. Use it unless you're in a situation where loop-through (several other video loads in parallel) is required. It was not placed on the PC board so that possibility would not be compromised.

Video-gain control R32 feeds the base of video-amplifier Q11. Video-amplifier Q11's collector is fed by current-source Q10, which is biased by R34, R35, and R36 to about 50-mA of collector current. That permits Q11's collector to supply plenty of drive to modulator Q12, and eliminates the need for a low-value decoupling resistor from Q11's collector to the power-supply rail (+12V); therefore, Q12's base can approach V_{cc}, and allows a higher positive swing of Q12's emitter than a resistor from Q11 to +12V would permit, due to Q12's base-drive needs.

Modulator Q12, an MJE180, is configured as an emitter follower. It must supply all the current to Q6, Q7 (or Q5), have a low supply impedance, and high slew rate. The low impedance is necessary for both full RF power output, and to control the parasitic-oscillation tendencies in power amplifiers Q6 and Q7. The load tends to be capacitive due to the bypassing from C26 (somewhat), C30, and C31.

In tests, Q12 can supply nearly 12 volts of video into a 10-ohm load, at 1.2 amps; therefore, Q12 must be heat sinked. To establish both Q-point, video gain, and bandwidth, R37 provides feedback around the modulator; however, R33 sets the exact Q-point (voltage seen at point A, Q12's emitter), under zero-drive conditions at about 5- to 6-volts DC, to Q6 and Q7. R33 is adjusted for maximum undistorted symmetrical video at point A, while R32 controls video drive to Q11. Supply bypassing must be effective at Q12's collector due to the high current and fast waveforms handled. The main supply bypass, C44, a 10-µF, 15-volt, tantalum chip was used because standard electrolytics are somewhat less effective.

Power feed

DC power is fed to the transmitter at J4. Diode D4, a 1N4007, is provided to serve as reverse-polarity protection. It's cheap insurance against inadvertent damage to Q6, Q7, Q10, Q11, and Q12, should the negative and positive leads of the power supply be reversed by accident. Diode D1 is connected directly across J4. The 12-volt supply (11–14 V is OK) may come from Nickel-Cadmium batteries, an auto's electrical system, or any kind of AC-operated power supply.

Audio feed

Audio is fed to gain control R22 from jack J3. Input level should be between 10 mV and 1 volt at high impedance, allowing direct interfacing with most microphones, or other audio sources. From R22 the audio is coupled through C35 to Q8, which is biased from R23, R24, and R25. Bypass C36 will prevent audio degenerative feedback, and loss of gain. Collector-load R26 supplies DC to Q8, while C37 blocks DC and couples audio through R27 to the frequency modulator.

Note that no pre-emphasis (high-frequency boost) has been used. If you want to use it, for better high-frequency audio response, change C37 to 0.001 µF, and set the gain-control R22 up higher to compensate for loss. The author found that pre-emphasis was unnecessary for most applications.

Audio is coupled to the varactor-diode D2, an MV2112, where R29 biases D2 at 9 V. The varactor diode varies its capacitance at an audio rate from 56 pF at 4 V, to about 33 pF at 9 V. The capacitance of D2 appears across 4.5-MHz oscillator coil L14. Then, Q9, an MPF102 FET, together with C41, C42, C40, and L14 form a Colpitts RF oscillator operating at 4.5 MHz. Trimmer C40 is used to set the frequency to exactly 4.5 MHz, while toroidal coil L14 is used to minimize stray magnetic field generation.

The audio voltage on the DC bias causes D2 to change capacitance, which shifts the oscillator frequency causing frequency modulation (FM) of the 4.5-MHz generated in Q9, the Colpitts oscillator. Bias for Q9 is provided by R30, while R31 couples the audio subcarrier (4.5-MHz FM) into the video amplifier, which modulates it and the video onto the RF.

Zener-diode D1, R28, and C38 and C39 (which provide bypass) supply a regulated 9-V DC voltage to Q9, and varactor D2. The regulation prevents oscillator drift if the supply voltage were to vary. A frequency counter can be connected to point A to set C40 to exactly the value needed for 4.5-MHz audio subcarrier.

Looks like we've run out of space. Next month we'll focus on construction techniques, like how to wind coils, how to solder tantalum-chip capacitors, and circuit modifications. **R-E**

BUG DETECTOR

continued from page 44

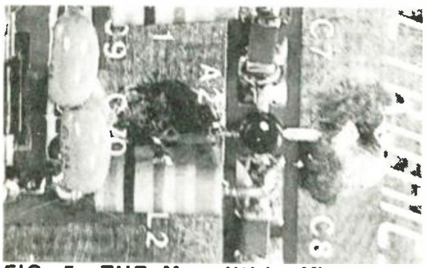


FIG. 5—THE *M*onolithic *M*icrowave *I*ntegrated *C*ircuit (MMIC) looks like a tiny dot with microstrip leads.

Put the PC board into its cabinet, and install the antenna before making any adjustments. Start with the zero-adjust set counter-clockwise, and the full-scale adjust set clockwise.

To properly calibrate our bug buster, a low-power transmitter is needed. A cordless-telephone handset is ideal. (Cordless phones are in the 40-MHz to 60-MHz region, and radiate less than most bugs!) Set the zero adjust until the left-most segment is about to come on. Set the full-scale adjust until all segments are lit when placed next to the cordless phone.

PARTS LIST

All resistors are ¼-watt, 5%, unless otherwise noted
R1, R2—220 ohms, ⅛-watt
R3, R4—2430 ohms, 1%
R5—510 ohms
R6—240 ohms
R7—1000 ohms
R8—10 ohms
R9—47,500 ohms, 1%
R10, R11—5000-ohm trimmer potentiometer

Capacitors
C1–C3, C5, C9, C10—0.1 µF, 50 volt, monolithic ceramic
C6–C8—1000 pF, ceramic chip
C4—220 µF, 16 volt, electrolytic

Semiconductors
IC1—LM3915N, log-bargraph display driver
IC2, IC3—Mini-Circuits, Inc., MAR6, MMIC
IC4—LM317T, voltage regulator
D1, D2—FH1100, hot-carrier diode

Inductors
L1, L2—82 µH RF choke

Other components
DSP1—RGB 1000, 10-segment bargraph display
J1—CP1094 modified, BNC connector

Miscellaneous
Cabiner assembly, cable, and battery clip.

Notes: A complete set of all parts except cabinet for $59.95; cabinet is $20; telescoping BNC antenna $12; lined zipper carrying-case $10; PC board only $25; all IC's and bargraph $30. Order from Optoelectronics, Inc. 5821 N.W. 14th Avenue, Fort Lauderdale, FL 33334; phone (800) 327-5912, in FL (305) 771-2050. Add $3.50 for shipping; FL address include 6% state sales tax. Master card and Visa orders must be over $20.

Some hints

You are now ready to put your bug buster to work. To effectively sweep a room, you need to get familiar with your bug buster's operating characteristics in as many situations as possible. Be sure to leave the power switch off when not in use. **R-E**

RADIATION MONITOR UPDATE

The Radalert and your PC: a great combination!

JOE JAFFE and DAN SYTHE

IT'S BEEN A YEAR SINCE WE PUBLISHED our article (with Steve Weiss) on building the Radalert radiation monitor. Since then we've heard from over a thousand **Radio-Electronics** readers who are interested in radiation detection. Hundreds have built the Radalert kit, and many breadboarded their own adaptations of the circuit. Hundreds more purchased an assembled version of the Radalert.

Those of you with whom we have spoken are interested in radiation detection for a variety of reasons. A nuclear-medicine class at a large midwestern university had each student build a Radalert as part of the course material. Many kits were also assembled by college, high-school, and vocational-school students. Some people built the Radalert because they work around radioactive materials; others built it for fun.

We heard from doctors and welders, students and scientists—it's surprising to see the wide variety of people who read **Radio-Electronics**. NASA is using Radalerts, as well as nuclear power-plant designers, operators, and employees, and environmental groups are monitoring plant perimeters to make sure they are safe.

The use of the Radalert to collect and disseminate radiation data over the past year has contributed to a better understanding of radiation, as events of the past year have indicated. One such event was the disclosure last September by the Department of Energy that thousands of residents near nuclear-weapons plants in Ohio, South Carolina, Colorado, and Washington have been exposed for decades to excessive radiation as a result of emissions from those facilities. One Radalert user living near the Fernald, Ohio plant noted a doubling of background radiation at certain times when the wind blew from the plant. Documenting such readings can be an important way to encourage plant operators to improve their safety measures and precautions.

A computer interface

This is the first of a series of articles on radiation monitoring, in which we will present samples of interesting experiments that **Radio-Electronics** readers have performed, and the results they have obtained. We will also describe a few simple interface circuits that can be built to increase the usefulness of the Radalert.

With the help of a computer, interested individuals and groups can now

This story began last Spring when I built the radiation monitor described in the June 1988 **Radio-Electronics** article by Joe Jaffe, Dan Sythe, and Steve Weiss. I have always had a natural curiosity about radiation. I'm interested in knowing the levels of radiation in the environment, and what the radon level is in my home.

Some of my interest relates to my experiences when I lived in Southern Utah in the Sixties. Radioactive fallout from the bomb tests in Nevada used to blow across the small desert communities there. People there are still very concerned about their exposure and the health effects from it.

When I built the kit version of the Radalert, I had a small problem with it. Several telephone conversations with Dan Sythe isolated the problem, and everything worked fine. During our conversations, I became friends with Dan and Joe Jaffe. We had several discussions about the need for a low-cost way to record and store radiation-level data, and to process the data into a useful form.

As an Electronics Engineer I do a lot of microprocessor programming, and I enjoy doing it—so I decided to create a program and interface that allows the Radalert to send information to an IBM-compatible personal computer through the RS-232 port. The program can collect, process, and plot data. With a modem, it enables a network of monitoring stations to communicate and share data. A monitoring station can be configured to automatically notify a central computer if a preset radiation level is exceeded.

I chose PC compatibles for this project because they are so inexpensive now. A recent browse through a computer publication shows a computer with all the necessary hardware selling for as little as $359 (without the printer, modem or monitor). Another ad offers, for less than $700, a portable computer that can run on battery power and has two disk drives and an internal modem.

The designers of the Radalert provided an output jack which furnishes a positive-going 5-volt signal, approximately 120 microseconds long, for each ionizing radiation event in the Geiger tube. The output signal can be coupled to a computer using the cable described here.

The software performs the following functions:

(1) It collects radiation data for a user-selectable number of samples. The computer can calculate the standard deviation for that data. (This mode is called the "survey" mode.)

(2) It collects and records radiation data, sounds an alert if a pre-set alert level is exceeded, and automatically dials another computer if a pre-set emergency-alert level is exceeded. (This mode is called the "monitor mode".)

(3) It saves the data collected (in either the survey or monitor mode) to a disk file.

(4) It prints or graphs the data stored in the alert mode on the disk.

(5) It sets up an automatic data-collection station, which can be used to manually poll a number of monitoring computers each hour and collect their data. The data-collection station can receive emergency-alert messages from the monitoring stations. It can also reset the monitoring computer's alert levels and other settings remotely from the collection station.

The hardware requirements for this system are a Radalert, an interface cable, and an IBM or compatible PC, XT, or AT computer with an RS-232 serial input, clock/calender, at least 256K memory, and MS DOS 2.1 or later. A printer is needed to print or plot the radiation data, and a modem is needed to send data or alert messages to a remote radiation-data collection station. (The hardware requirements for the data-collection station are the same as for the monitoring station.)

The two programs I wrote demonstrate the capabilities of a computer for data collection, display, and automatic transmission, using the Radalert as the source of data. The first is written in GW BASIC, and the code for it is shown in Listing 1. You can enter it from the keyboard, or download it from the **Radio-Electronics** BBS Radalert conference. The program has the two modes mentioned, monitor and survey. In the survey mode, it collects, stores, and prints data for the statistical survey, but does not do any data analysis. In the monitor mode, it collects, stores, and plots data, and sounds an alert if the pre-set alert level is exceeded, but does not communicate with another computer.

The second program, a compiled version of the first program, written in Microsoft Quick Basic 4.5, is available from the author. In addition to what the first program does, it does standard-deviation analysis in the survey mode, and uses the modem for automatic data transmission in the monitor mode. It can participate in a data-collection network via modem and can automatically dial a data-collection station if the emergency-alert level is exceeded.

CABLE INTERFACE

To construct the cable interface, note whether your RS-232 serial-input connector has 25 or 9 pins, and obtain the corresponding female connector for one end of the cable. For the other end of the cable, use a miniature stereo plug to mate with the jack on the Radalert. Use a convenient length of coaxial cable or shielded microphone cable (it is important to

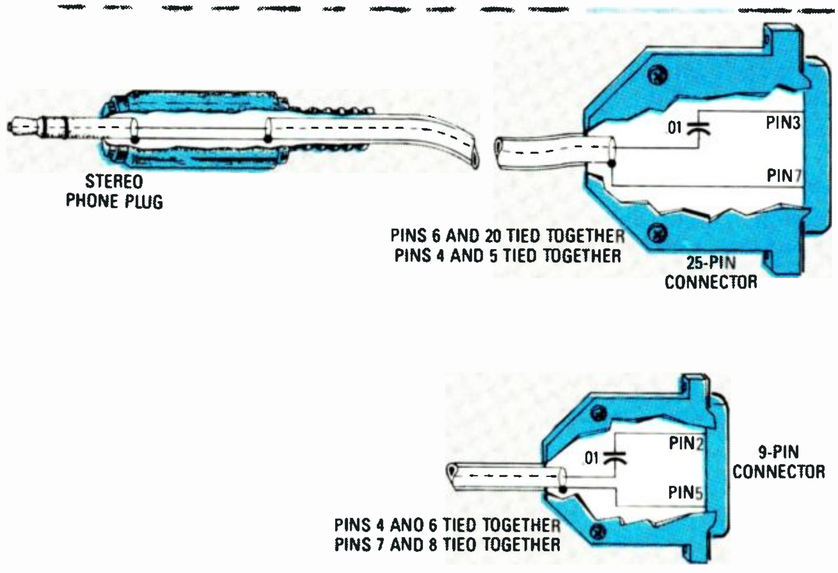


FIG. 1

```
:M RLGW.BAS   by: Harold (Bud) Cole
RADALERT Interface: 25 pin:
short pins 6 to 20 and 4 to 5
pin 3 through 0.01ufd cap. to Tip of output jack on RADALERT
pin 7 (ground) to sleeve of output jack on RADALERT
) pin:
Jumper 4 and 6 together and 7 to 8
Pin 2 through 0.01ufd cap to tip and pin 5 to sleeve
Start Program as follows: [BASIC RLGW.BAS/C:20000]
'this allows up to 20000 counts during any sampling period
CLEAR , , 45000: ' experiment with this value for best results with
'the basic you are using.
DIM READINGS(51)
TIMER OFF
CLS
'Most computers use port 1 (COM1)
IF T$ = "" THEN INPUT "Enter Serial Port Used:", T$
IF P$ = "" THEN INPUT "Do you want to print/plot results? Y/N", P$
IF P$ = "Y" OR P$ = "y" THEN P$ = "ON"
IF P$ = "ON" THEN LPRINT CHR$(27) + "@"
IF P$ = "ON" THEN INPUT "Enter dot row feed for plotting=", D
'Construct serial port file Name
C$ = "COM" + T$ + ":9600,E,7,1"
CLOSE 1: OPEN C$ FOR OUTPUT AS 1
CLS : LOCATE 10, 20: PRINT "Select Function:"
LOCATE 11, 20: PRINT "       (1) Radiation Survey"
LOCATE 12, 20: PRINT "       (2) Monitor Radiation Level/Min with Alarm"
K$ = INKEY$
IF K$ = "1" THEN GOTO 330
IF K$ = "2" THEN CLS : GOTO 710
IF K$ = CHR$(27) THEN CLOSE 1: CLS : END
GOTO 270
'***************************** S U R V E Y ************************************
CLS
'Input "No of samples to take for survey & sampling period
INPUT "Enter Samples to take(50 max.)=", S
IF S = 0 THEN S = 30
IF S > 50 THEN S = 50
CLS
LOCATE 1, 60: PRINT "Running count="
LOCATE 4, 60: PRINT "Interval=" + STR$(I) + " sec/s"
R = 0
LOCATE 5, 60: PRINT "# Rdgs to take"; S;
LOCATE 23, 60: PRINT "Start:";
LOCATE 24, 60: PRINT TIME$ + " " + DATE$;
IF P$ = "ON" THEN LPRINT "Interval=" + STR$(I) + " sec/s"
IF P$ = "ON" THEN LPRINT "# Rdgs to take"; S
IF P$ = "ON" THEN LPRINT "Start:"; TIME$ + " " + DATE$
'Set TIMER to I (Sampling period)
TIMER ON: R = R + 1
ON TIMER(60) GOSUB 620
LOCATE 6, 60: PRINT "to go="; S + 1 - R;
'Empty serial buffer to clear out and reopen LOC(1)=0
CLOSE 1: OPEN C$ FOR OUTPUT AS 1
'Start a Time loop = to Sampling Period
K$ = INKEY$
LOCATE 25, 60: PRINT TIME$;
LOCATE 1, 74: PRINT LOC(1);
IF K$ = CHR$(27) THEN LOCATE 2, 60: PRINT "Total Count="; LOC(1): TIMER OFF:
O 130
GOTO 570
TIMER OFF
'Save readings in an array set to S
READINGS(R) = LOC(1)
IF R > S THEN GOTO 1290
IF R > 25 THEN W = R - 25: COL = 26 ELSE W = R: COL = 1
LOCATE W, COL: PRINT "Rdg at "; TIME$: "="; READINGS(R);
IF P$ = "ON" THEN LPRINT "Rdg at "; TIME$: "=": READINGS(R)
GOTO 510
'***************************** M O N I T O R **********************************
'See RADALERT instructions pages 7 & 8.
IF a = 0 THEN INPUT "Enter Alarm Level:", a
LOCATE 24, 40: PRINT "Start:" + TIME$ + " " + DATE$;
LOCATE 12, 25: PRINT "Minutes before Hourly CPM update= 60";
750 M = 0: H = 0
760 IF P$ = "ON" THEN GOSUB 1190
770 'Set TIMER to 60 seconds for a one minute count period
780 TIMER ON: ON TIMER(60) GOSUB 960
790 LOCATE 8, 25: PRINT "Monitoring Nuclear Radiation Level"
800 LOCATE 9, 25: PRINT "                    Alarm Level/Min="; a
810 M = M + 1
820 'Empty com Buffer
830 CLOSE 1: OPEN C$ FOR OUTPUT AS 1
840 'Start a new or initial Interval = to 1 minute
850 K$ = INKEY$
860 IF MID$(TIME$, 4, 2) = "01" THEN P = 0
870 IF P$ = "ON" AND MID$(TIME$, 4, 2) = "00" AND P = 0 THEN GOSUB 1140
880 IF K$ = CHR$(27) THEN TIMER OFF: CLOSE 1: GOTO 1100
890 LOCATE 25, 46: PRINT TIME$;
900 LOCATE 10, 25: PRINT "Current Level this minute="; LOC(1);
910 IF LOC(1) >= a THEN LOCATE 4, 25: PRINT " R A D I A T I O N   A L E R T ";
920 IF LOC(1) >= a THEN SOUND 3000, 10: SOUND 2000, 5
930 IF LOC(1) >= a THEN LOCATE 4, 25: PRINT SPACE$(32);
940  'Loop for one minute
950 GOTO 850
960 TIMER OFF
970 LOCATE 25, 55: PRINT DATE$;
980 MINCOUNT = MINCOUNT + 1'acumulate LOC(1) for 60 minutes
990 C = LOC(1)
1000 GOSUB 1370 'Go check # minutes left to hourly CPM update
1010 IF M = 60 THEN CPM = (INT((H / 60) * 100)) / 100 ELSE : GOTO 1050
1020 M = 0: H = 0
1030 LOCATE 13, 25: PRINT "Last Hour average/minute="; CPM;
1040 IF P$ = "ON" THEN LPRINT CHR$(27) + "3" + CHR$(0): TAB(90): "CPM=": CPM:
LPRINT CHR$(27) + "3" + CHR$(D):
1050 LOCATE 10, 25: PRINT SPACE$(45);
1060 LOCATE 11, 25: PRINT SPACE$(45);
1070 IF P$ = "ON" THEN LPRINT STRING$(C + 1, "-")
1075 IF C > a AND P$ = "ON" THEN LPRINT " *"
1080 LOCATE 11, 25: PRINT "Previous minute count="; C;
1090 GOTO 770 'start another 1 minute loop
1100 a = 0: BEEP
1110 LOCATE 20, 30: PRINT "(Hit C to (C)ontinue)";
1120 K$ = INKEY$
1130 IF K$ = "C" OR K$ = "c" THEN GOTO 130 ELSE GOTO 1120 'wait for a C
1140 LPRINT CHR$(27) + "3" + CHR$(0): 'Zero LineFeed
1150 LPRINT "+         +         +         +         +         +         +
+         +  " + TIME$ + "/" + DATE$
1160 P = 1
1170 LPRINT CHR$(27) + "3" + CHR$(D): 'set line feed to nn/218 (varies
w/printers)
1180 RETURN
1190 WIDTH LPRINT 150
1200 LPRINT "Start:" + TIME$ + " " + DATE$
1210 LPRINT "Monitoring Nuclear Radiation Level"
1220 LPRINT "                    Alarm Level/Min="; a
1230 LPRINT CHR$(15) 'sets for compressed print
1240 LPRINT "0        10        20        30        40        50        60
70        80"
1250 LPRINT "+         +         +         +         +         +         +
+         +"
1260 LPRINT CHR$(27) + "3" + CHR$(0):
1270 RECORDNO = 1: LPRINT CHR$(27) + "3" + CHR$(D) 'sets #dot row feed
1280 RETURN
1290 IF P$ = "ON" THEN LPRINT "Survey Done": LPRINT TIME$ + " " + DATE$
1300 LOCATE 15, 60: PRINT "Survey Done"
1310 LOCATE 16, 60: PRINT TIME$ + " " + DATE$
1320 LOCATE 17, 60: PRINT "(Hit C to (C)ontinue)":
1330 BEEP
1340 K$ = INKEY$
1350 IF K$ = "C" OR K$ = "c" THEN GOTO 130
1360 GOTO 1340
1370 IF M < 61 THEN H = H + C
1380 B = 60 - M
1390 IF B = 0 THEN B = 60
1400 LOCATE 12, 25: PRINT "Minutes left before Hourly CPM update="; B;
1410 RETURN
```

e shielded cable).

CAUTION: DO NOT USE A MONO PLUG. If an alert signal is generated in the Radalert it will be shorted by a mono plug.

you have a 25-pin connector, short pin 6 to pin 20 and pin 4 to pin 5. Connect pin 3 to the center wire of the cable through a 0.01-μF capacitor and connect pin 7 to the cable shield (ground). If you have a 9-pin connector, connect pin 4 to pin 6 and pin 7 to pin 8. Connect pin 2 to the center wire through a 0.01-μF capacitor and connect pin 5 to the shield.

At the other end of the cable, connect the tip of the stereo plug to the center wire of the cable. Connect the cable shield to the plug sleeve (the conductor closest to the grip).

SOFTWARE

Type in the program or download it as shown in Listing 1. Line 90 says to start the program by typing BASIC RLGW.BAS/C:20000. That is correct for many computers, but you may need to modify it for your version of BASIC (for example, GWBASIC RLGW.BAS/C:20000).

Line 160 asks which serial port the Radalert is connected to. If you do not know, type "1." If you select the wrong port, no counts will be transferred from the Radalert to the computer when you run the program. In that case, start the program again and type "2" for the serial port used.

Line 200 asks for the dot-row feed for plotting in the monitor mode. Most printers allow you to set a programmable line spacing, for example 216 dot rows/inch. Standard line feed is 6 lines per inch. The radiation level is plotted once every minute, one line for each minute. Set a line spacing that will conserve paper, but still show the minute-by-minute variation. A dot-row feed of 2 will allow you to plot about 20 hours of data on one 11-inch sheet of paper, depending on your printer's programmable single-line spacing parameter. You can experiment with the setting to adjust the appearance of the plot.

If the alert level you set at the start of the program is exceeded, an asterisk (*) is printed on the chart to show where it occurred.

The program should be useful to anyone interested in experimenting with radiation detection. It is ideal for detecting and documenting low-level sources of radiation such as radiation from color TV's and monitors or radon gas. If you have a radon-gas problem in your home, plot your radiation levels for a long period of time, and keep track of barometric pressure over the same time period. You may find that radiation levels go up in your home when the pressure readings are low. Low barometric pressure tends to suck the radon gas out of the ground.

Experiments with natural and man-made radioactivity make good demonstrations for elementary- and high-school science classes. Using the computer to graphically illustrate radiation emissions and fluctuations will introduce the students to technological computer applications, and de-mystify radioactivity.

A kit to build the interface cable, or a completed interface cable is available from the source mentioned in the Sources Box. The compiled version of the software is available, as well.—*BUD COLE, WB5ONF* store and chart their radiation readings. Bud Cole, an Electronic Engineer from Albuquerque, NM, wrote a very useful program that collects data from the Radalert output jack (J2) and processes it using an IBM-compatible personal computer (see sidebar).

Figure 1 is an 8-hour graph of radiation levels, taken in Bud Cole's home using his computer program. The average level for that period was over 50 counts per minute, about four times normal. The previously unknown radiation source turned out to be an optical lens in Bud's desk drawer, intended for a future telescope project. The radiation level at the surface of the lens was over 2000 counts per minute. Fortunately, that discovery prevented the use of the lens in a telescope, where it could have caused serious eye damage. According to an International Atomic Energy Agency publication in 1974, some optical lenses contain up to 30%, by weight, of uranium or thorium. Those materials are selected for lens coatings in some applications because of their optical properties.

One interesting experiment involved a computer that used the Radalert to monitor its own monitor's radiation levels. The computer was used to plot about 10 hours of data collected while monitoring the radiation levels at the surface of the monitor's screen. The average counts-per-minute was 14.41, with a high reading of 18. When the same test was performed with the Radalert about 12 inches away from the monitor, the average reading was 10.26 cpm, with a high of 13 cpm. At 18 inches away from the CRT, the average reading was 9.8 cpm, with a high reading of 12 cpm.

Radon

Last September the EPA and Public Health Service announced that "Radon-induced lung cancer is one of today's most serious public health issues." We stated in the July, 1988 article that the Radalert does not specifically measure radon gas, but our experiments indicated that the average counts per minute did rise and fall with radon concentration.

Robert Vivian, a **Radio-Electronics** reader and Radalert kitbuilder from Provo, Utah, did some experiments. Robert operates a small radon-testing company called Radon Testing Services. His radon-test results were within 2% of the EPA's in the EPA Radon Measurement Proficiency program. That is unusually good, with 20% accuracy considered acceptable. He put his Radalert in his basement, side by side with the standard charcoal canister radon-detection package, with the Radalert in the "total count" mode.

To get accurate results with the carbon canister he had to run the test for a 48-hour period. To prevent the Radalert counter from overflowing during that period he recorded his count every 12 hours, and then reset the Radalert to count for another 12-hour period. He converted his counts

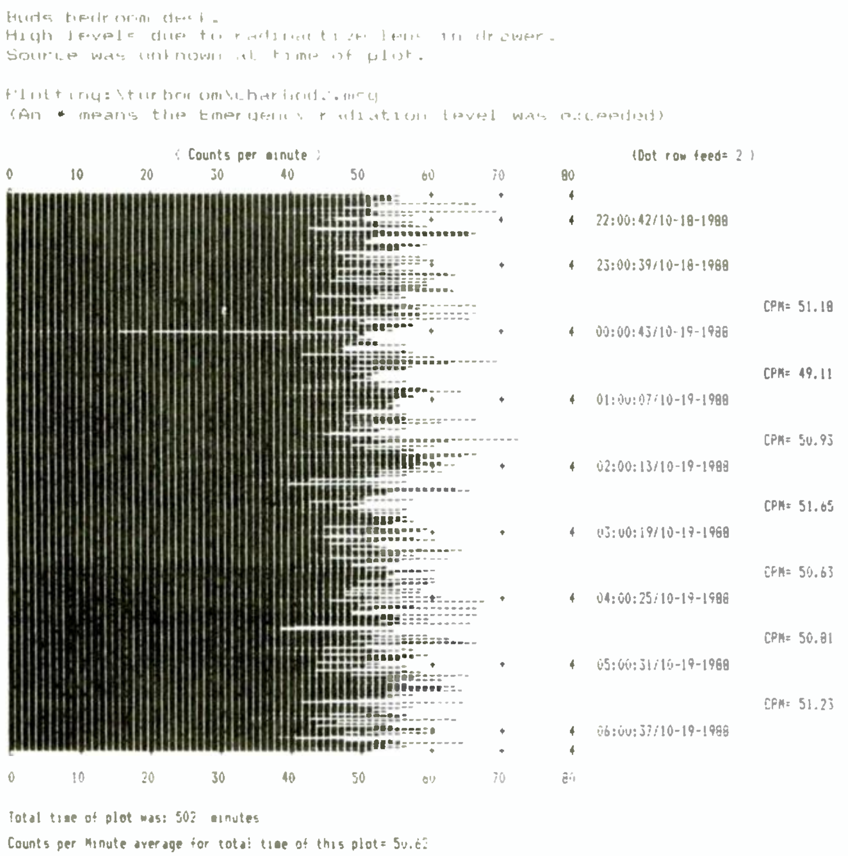


FIG. 1—AN 8-HOUR COMPUTER-GENERATED GRAPH of the radiation levels that were measured in Bud Cole's home.

ORDERING INFORMATION

A kit to build the Radalert is available from International Medcom, 7497 Kennedy Road, Sebastopol, CA 95472, for $185. An assembled Radalert, ready to use, is $275. To order a kit, or an assembled Radalert, and charge to your VISA or MasterCard, call toll free 1-800-257-3825 Nationwide, 1-800-255-3825 in California. To order from outside the U.S., call (707) 823-0336, or you can FAX International Medcom at (707) 823-7207. Add $4.00 for shipping/handling (in U.S.) for each unit. California residents please add 6% sales tax.

For EPA-approved Radon test kits contact: Robert Vivian at Radon Testing Services, 4096 Scenic Drive, Provo, Utah 84604, 1-800-777-2320.

Back issues of the June and July 1988 **Radio-Electronics** are available from the RE Reprint Bookstore for $3.75 each plus shipping and handling ($1.25 for one issue or $2.00 for two). Send check or money order, payable to Gernsback Publications, to: **Radio-Electronics** Reprint Bookstore, P.O. Box 4079, Farmingdale, NY 11735. Indicate the issue(s) you want, and allow 4–5 weeks for delivery.

The following items are available from Harold (Bud) Cole, 614 Cedar Hill Road North East, Albuquerque, NM 87122 (505) 296-2632. A kit for the interface cable containing the connectors and 10 feet of cable is $11, and an assembled 10-foot interface cable is $20. Specify 9-pin or 25-pin for the RS-232 connector. The compiled version of the software, with documentation on disk, is available for $49. All prices include postage. New Mexico residents add 5¼% sales tax.

for the ‹ ıour period into average counts pı ıinute and obtained 18.11 for the avı ːe. (By using Bud Cole's computer gram, he could have recorded thı ›unts per minute for as long as a ۱ ‹ and let computer calculate the a ıge cpm for the period).

The avera ·adon concentration as measured by carbon canister was 8 picoCuries pε er of air. He also did a 48-hour cou ›utdoors and determined that his ı 'oor radiation level was 14.75 couı ›er minute. That count was subtraı ' from his indoor count, as outlined he July article. (Outdoor air is conı ·ed to average about 0.2 picoCuriı f radon per liter).

The difference betweı 's average indoor and outdoor co ۹, 3.36 counts per minute for a rı ۹ concentration of 8 pCi/l, showı sensitivity of 0.42 cpm for 1 ı 1, assuming there was no other sourı of radioactivity in the basement. The EPA considers the risk of radon concentration of 4 pCi/l to be equivalent to the risk of 200 chest X-rays per year. At that level or higher, they recommend follow-up testing to determine if remedial action is necessary.

One Radalert kitbuilder, from Harrisburg, Pennsylvania, has a radon level of 55 picoCuries per liter (pCi/l) in his home. He also has an electrostatic air cleaner. Using the Radalert, he discovered that the dust collected by the filter is quite radioactive due to the radon daughter elements; he has gotten readings of over 400 counts per minute next to the filter.

Those experiments and others indicate that the Radalert can be useful in screening for radon levels of about 4 pCi/l or higher. Levels below 4 pCi/l may be difficult to detect reliably.

Use of the Radalert for radon testing should be considered experimental, as the EPA has not approved Geiger counters for that purpose, and your results should be confirmed by EPA-approved test methods. For example, you can use the Radalert to locate the area in a basement or other part of the building with the highest radiation level. Then you can place a testing device that is specific for radon, such as a carbon canister, in that location to confirm whether or not the increased radiation is due to radon. In the case of Bud Cole's house, the carbon canister test showed the high radiation level was not due to radon, and continued investigation located the radioactive optical lens.

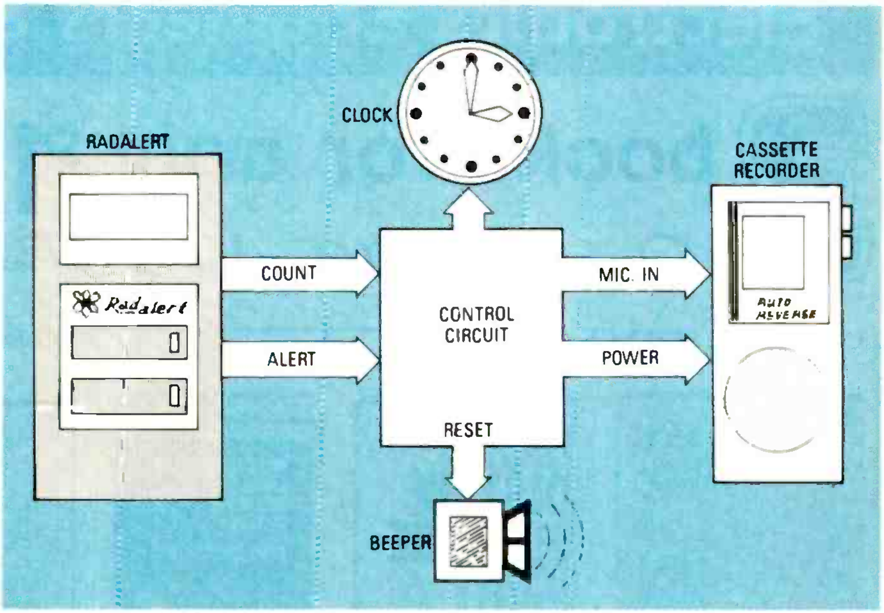


FIG 2—THE CONTROL CIRCUIT stops the clock and starts the recorder.

Radioactive sources

Radalert users have added to our list of radioactive materials that people work and live with. In addition to the optical lens described earlier in this article, we have reports on the following items: an optical prism which measured over 11,000 counts per minute, a thoriated filament on a 4-1000A power transmitting tube, some welding rods, and wood ash (where soil was contaminated with radioactive isotopes). If you have found any interesting and/or previously unknown radioactive sources, contact **Radio-Electronics** and share your story.

Networking/BBS

Radalert users are starting to network regionally to compare their readings, share information, and exchange application ideas. The RE BBS, (516) 293-2283, is available for readers who wish to contribute information on their experiences or learn more about radiation. Other national and international forums and on-line conferences seem to be developing, so check in on the bulletin board to stay up to date.

Monitoring nuclear plants

Dr. Donald Muirhead, a pediatrician, and David Quaid, an independent film maker, of Duxbury, Massachusetts, have put together a radiation-monitoring network of 23 Radalerts, around the Pilgrim nuclear plant. Dr. Muirhead was concerned about safety problems at the plant, and about a Massachusetts Department of Public Health allegation of increased leukemia and other cancers downwind from the plant. By collecting radiation data and sharing the information, their group hopes to increase the community's peace of mind, and encourage safe operation at the facility. Keep watching **Radio-Electronics** for an update on that monitoring network and the data they are collecting.

Budget monitoring

In 1978 a group of people living near the Maine Yankee nuclear power plant decided they would like to monitor emissions from the plant, so they would be aware of releases. An engineer in the group, Will Byers, developed an inexpensive build-it-yourself Geiger counter with an alarm. The counter was connected to a clock, so that when a pre-set radiation level was reached the clock would be stopped. That let the user know when the radiation increase was recorded. Will also built the Radalert kit, and has added it to their Citizen's Monitoring Network.

Bud Cole's program (with its real-time clock signature on radiation plots) is perfect for that type of application. Bud's program can also dial a telephone number to report high radiation levels to other computers in the network. But what if you want to

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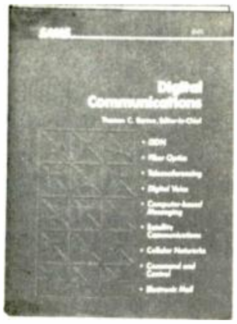

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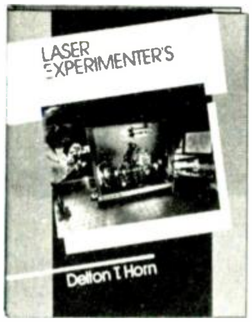

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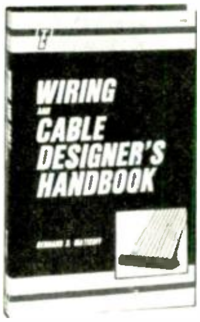

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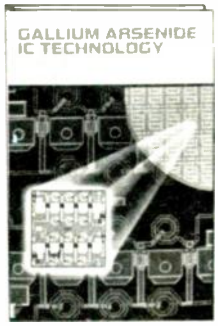

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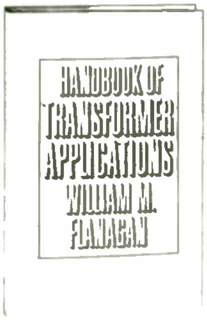

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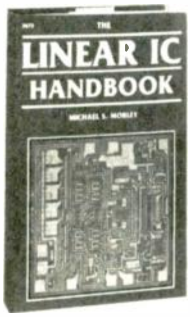

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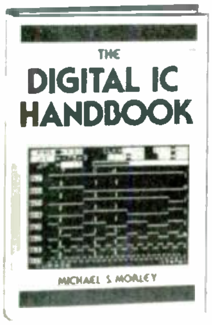

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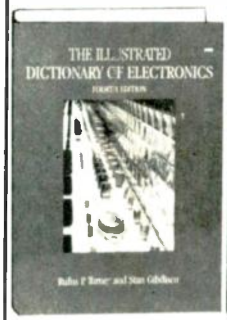

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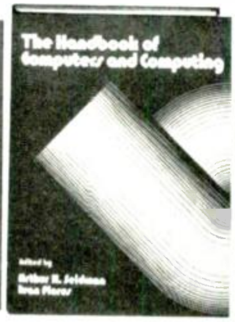

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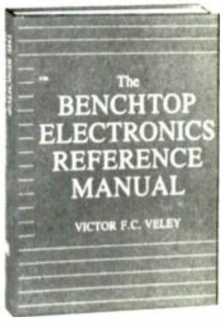

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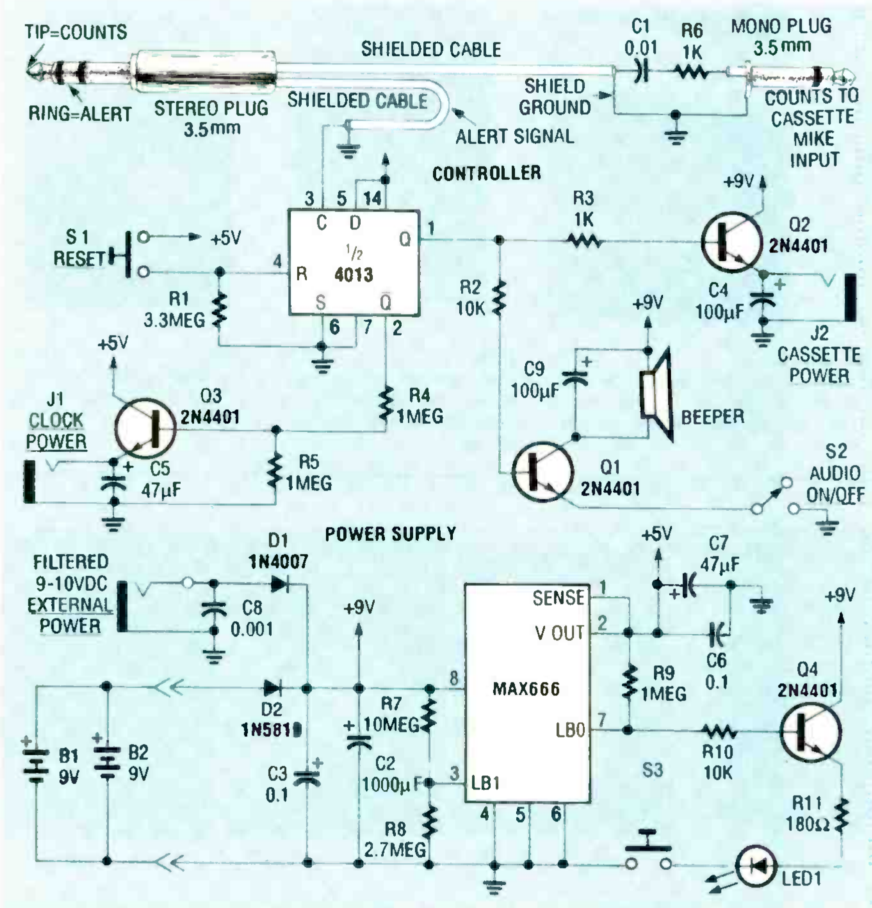


FIG. 3—CONTROL-CIRCUIT SCHEMATIC. The clock must run on 1.5-volts.

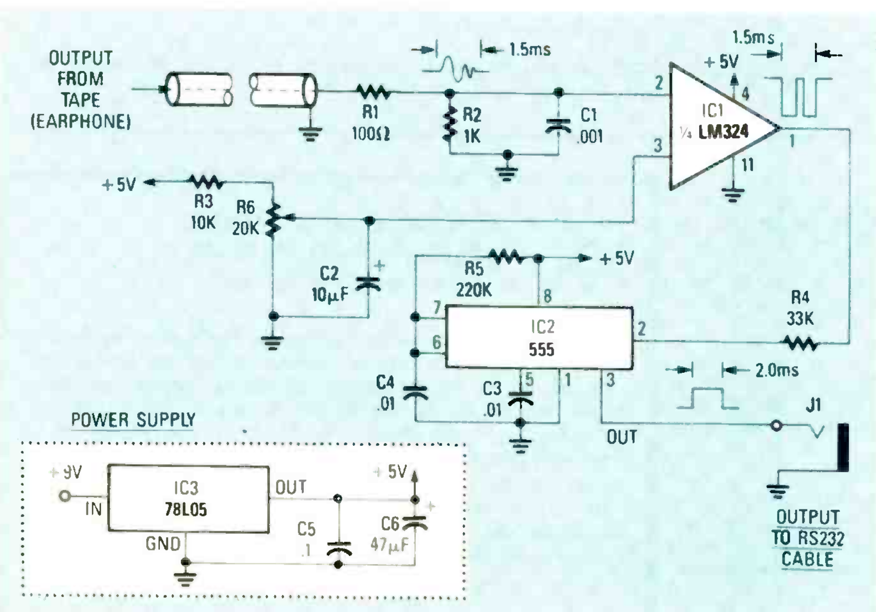


FIG. 4—DEMODULATOR CIRCUIT extracts the recorded data from the tape.

use your computer to do something else? Or what if every station in your monitoring network cannot afford to dedicate a computer for the task?

A simple and inexpensive data logger can be built to use with the Radalert. It takes Will Byers' "clock stopper" one step further by recording radiation levels on magnetic media, when an alert signal is generated. The technique is similar to those used in medicine, especially cardiology, to record information only when something abnormal happens. The "event" recorder stores radiation data on a standard microcassette recorder for a 60-minute period when "abnormal" radiation levels are detected. The data can be stored and processed on a computer by playing it back through the tape recorder's earphone jack into a demodulator which feeds the data into Bud Cole's interface cable. Then Bud's software can recreate the event and plot the results.

The block diagram for the device is shown in Fig. 2. When the radiation level exceeds the alert setting on the Radalert, the control circuit stops the clock, documenting the time that the incident occurred. At the same instant, the circuit turns on the tape recorder to record the level of radioactivity, and sounds a beeper. Each radiation event is detected as a "click" on the magnetic tape. While this method of storing data has limitations, particularly at high radiation levels where accuracy is reduced, it does allow important information to be recorded at low cost.

Figure 3 is the schematic for the control circuit. All parts are readily available. The clock cost $7.50 at a discount hardware store—just make sure that the clock you get can run on a 1.5-volt battery. That way, it can be turned on and off via J1, the clock-power output.

Here's how the circuit in Fig. 3 works: A 3.5-mm *stereo* phone plug is inserted into the Radalert's COUNT output jack. The tip of the plug picks up the Radalert's count pulses whenever a radioactive particle or photon is detected by the Geiger tube (see **Radio-Electronics**, June 1988, for a more detailed explanation). The ring of the plug (the middle conductor of the plug) is connected to the Radalert's ALERT output, which goes high when the alert level has been exceeded. Use a shielded two-conductor cable to connect the plug to the control-circuit board (one that has two conductors in addition to the shield). Remember never to put a mono plug into the Radalert's COUNT output jack, or else its alert output buffer could be damaged.

When the Radalert's ALERT output goes high, the flip-flop IC1 (½ of a 4013) is toggled, turning on the beeper switch, Q1, and the cassette-power switch, Q2. (Just make sure that the cassette recorder you use can run on the voltage provided by J2.

continued on page 66

BUILD THIS

ISDN PROTOTYPING TELEPHONE

DOUG TOUSIGNANT and KEN SLIGER

WHEN WE LEFT OFF LAST TIME, WE had just finished preliminary testing of the tip-and-ring section. As we continue, you'll want to refer to Fig. 1 in last month's issue, and Fig. 7, the parts-placement diagram.

Install the socket for IC6, C9, C16, C17, R1, R11, JD, JE, J5, D3, and D5; then press IC6 into its socket. Connect a conventional handset to J5 and listen for a dial tone while powering the prototyping telephone from a 9-volt DC source, and having it plugged into the phone-line "T" adapter; you should *not* hear one. Take the regular phone off hook, listen for a dial tone, and then dial your local time number. While listening to the local-time recording, activate RY1 by connecting a test lead between pins 32 and 34 of IC1. If there are no problems, install RES1, C6, and J10.

Solder in the sockets for IC8 and IC4, XTAL2, R12, and C7, and then press IC8 and IC4 into the sockets. Next, install the socket for IC3, C1–C4, and the right-angle header for J2. Do *not* put IC3 in its socket just yet.

The next step is to wire up a serial cable for connection between J2 and your terminal or a PC running terminal-emulation software. Basically, we'll be using a three-wire cable between the TXD, RXD, and GND on J2 and your terminal. (Don't forget that your terminal's TXD must be connected to J2's RXD.)

Some terminals or computers will require that the DATA TERMINAL READY, DATA SET READY and CARRIER DETECT be wired together. (If your computer uses a DB-9 connector, those are pins 1,4,and 6; for a DB-25 connector, those are pins 20, 6, and 4.) Some terminals will also require that the REQUEST TO SEND and CLEAR TO SEND be jumpered together. (Pins 7 and 8 on a DB-9 connector; pins 4 and 5 on a DB-25.)

The transmission parameters of your terminal or PC are unimportant at this time, but, if you wish, you can set them as follows:

9600 baud
no parity
8 data bits
1 stop bit
echo disabled
XON/XOFF enabled

Hook the serial cable to your PC but don't hook the other end to J2. Strip both ends of a 1-inch piece of bell wire, and use it to jump TXD AND RXD on your serial cable. Type some characters on the terminal keyboard; they should appear on the screen because the jumper creates a loopback between the transmit and receive pins of the connector. Remove the jumper: there should be no characters on the screen. If you still have characters echoing, or a double set of them, make sure that echo is set to off (ATEO for Hayes-type modems). Now connect the adapter cable to J2, and jump pins 13 and 14 of the IC3 socket, and repeat the echo test. Using a logic probe (or an LED/10K resistor combination), make sure that pin 13 is receiving data from your terminal. Remove the jumper and disconnect the cable from the terminal or PC.

Now, insert IC3 in its socket, making sure that the power to the prototyping telephone is off *before* doing so. Apply power, and check for the following voltages on IC3: pin 1, +7.17; pin 2, +9.00; pin 3, +2.36; pin 4, 4.80; pin 5, −4.27; pins 6 and 7, −8.93; pins 8 and 15, ground; pins 9–13 and 16, +5.00; pin 14, ± 12.00.

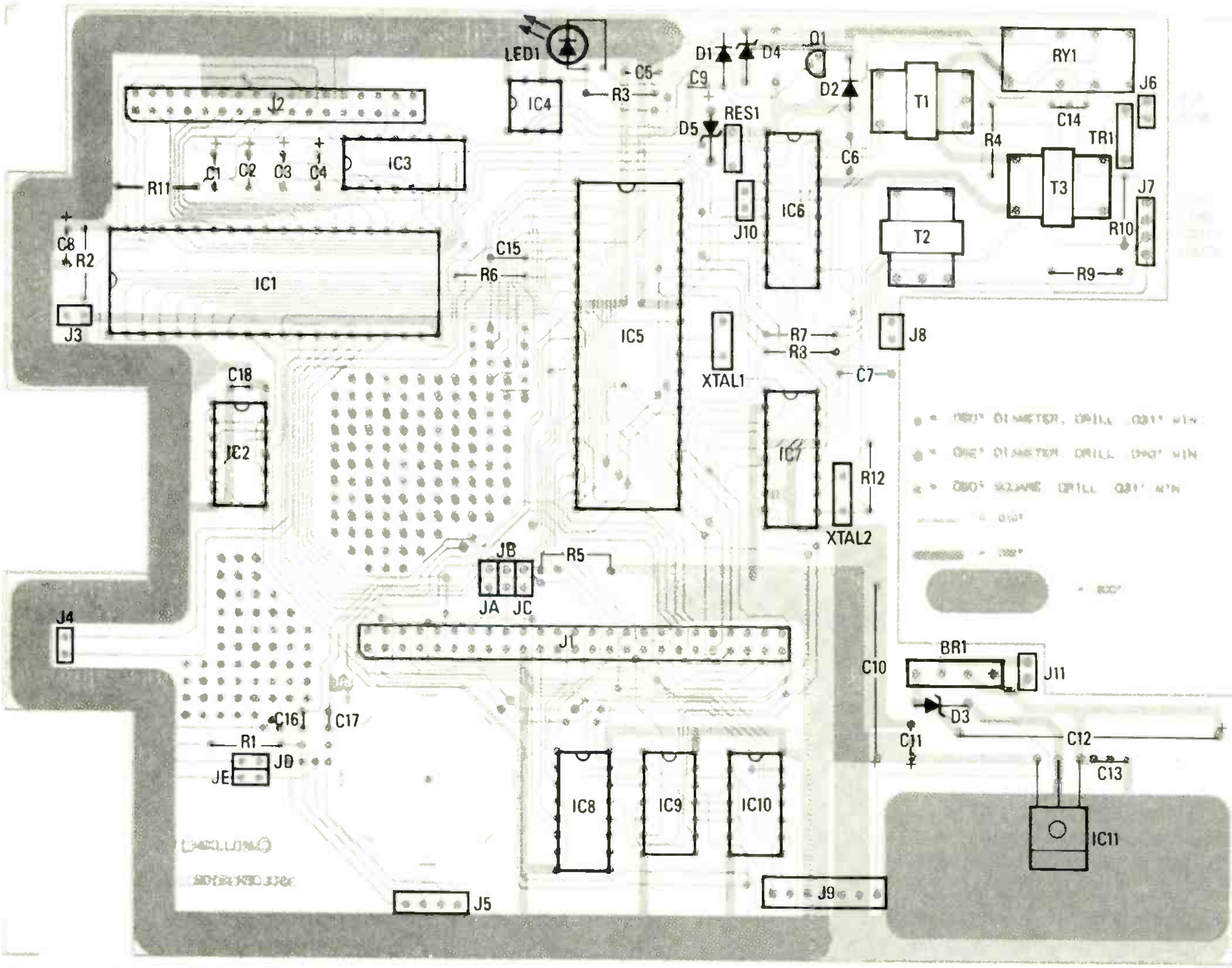


FIG. 7—PARTS-PLACEMENT DIAGRAM. The foil patterns for the double-sided PC board are provided in PC Service.

Jump pins 19 and 23 of IC1, and repeat the character echo test. Then go on and install any remaining parts on the PC board.

The ISDN alphabet soup

The ISDN is a service that is supplied by the telephone company that you subscribe to, in the same way that supplying a dial tone and completing telephone calls for you is a service. It is a digital data network. Voice data is digitized and sent as so many data bits, just like text, images, or video.

Figure 8 shows a typical ISDN configuration. The terms used are defined as follows:

NT 1 (Network Terminator 1)—Box containing 2-wire "U" loop to 4-wire "S"/"T" loop.

NT 2 (Network Terminator 2)—Intelligent box for data concentration, maintenance, or switching. Can be PBX.

"R"—Reference point between terminal equipment which is not compatible with ISDN (TE2) and a *T*erminal *A*dapter (TA).

"S"—Reference point between ISDN terminal equipment (TE1) and ISDN line.

TE1—ISDN-compatible terminal equipment.

TE2—Non-ISDN-compatible terminal equipment. Requires a terminal adapter.

"U"—Reference point between PSTN exchange and NT 1 on the customer's side.

From our perspective, we're interested in the "S" interface, which will be a modular RJ11-C wall socket; the class of device used on the "S" reference is a TE1. Non-ISDN equipment (TE2) such as PC's are used on the "R" reference point with a terminal adapter. The NT (*N*etwork *T*ermination) may be an existing PBX or on-premise switch, or it may reside at the central office. The telephone company takes care of the rest.

ISDN provides two types of service. 2B+D, or Basic Access Rate, which supplies two simultaneous, independent 64-kbit/s B-channels for transmitting and receiving data, and a 16-kbit/s D-channel for limited packet-data transfer and control functions.

The second service is 23B + D, the Primary Access Rate. 23B + D provides 23 B-channels multiplexed on a T1 (1.54 mbits/s) PCM (*P*ulse *C*rode *M*odulation) transmission highway and a D-channel for control.

Basic Access Rate is for individual devices, and the Primary Access Rate collects the Basic Rate B-channels and sends them outside.

Basically, here's how it works. Somebody picks up the handset of an ISDN TE1 that happens to be a telephone. On the D-channel, a packet is prepared and sent from the TE1 to the switching equipment, which might be

Take the completed prototyping telephone configured for ISDN, plug it into an ISDN "S" reference and pick up the handset. There is no dial tone and you can't make a simple phone call. Why is it that a high-tech ISDN-technology telephone won't even do what a $15 telephone can do?

The fundamental difference between the analog, tip-and-ring telephone and an ISDN TE1 is that tip-and-ring telephones work on a specific analog network designed and engineered to transmit and receive voice via a simple base-band transport. ISDN is a complete digital network designed and engineered as a data network, whether the data is text, FAX, music, CATV, or voice. ISDN has protocols, or rules, for using the network. Before a TE1 can use ISDN, those rules must be implemented with software.

Figure 1 shows the relationship between the CCITT (*I*nternational *T*elegraph and *T*elephone *C*onsultative *C*ommittee—a United Nations organization headquartered in Geneva, Switzerland) recommendations for ISDN and how they fit with the ISO (*I*nternational *S*tandards *O*rganization) seven-layer model for OSI (*O*pen *S*ystems *I*nterconnect) architecture. It is a hierarchical design, with the layer above providing control functions for the one below. That sounds like a mouthful, but it is an international agreement about how networks should be engineered.

Though it looks complex, The ISO seven-layer model is designed to make data communications between disparate equipment and different countries easier. By following those recommendations, you should be able to communicate with any device, in any country.

The good stuff comes in at the bottom (layer 1), rises through the other layers as far as the application requires, and then goes back down and out. ISDN is an international standard for a digital network, and it is defined for the first three layers of the seven-layer model.

In layer 1, the physical layer, analog-to-digital conversion takes place, and some time-division multiplexing to break out B-channel and D-channel information is done. In addition, CSMAR (*C*arrier-*S*ense *M*ultiple *A*ccess with *C*ollision *R*ejection) is used if the D-channel is accessed by multiple terminals—almost like a LAN (*L*ocal *A*rea *N*etwork) so far. The control functions are handled by the line-interface and the data-link controller sections of the AM79C30A digital subscriber controller. Those are the I.430 and I.431 CCITT ISDN recommendations.

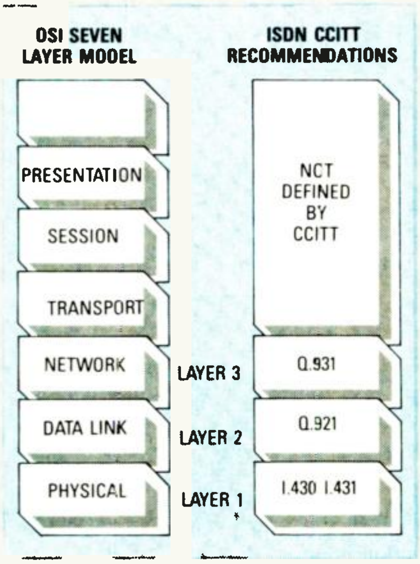


FIG. 1

Layer 2 of the ISO model, the data-link layer, connects the D-channel and B-channels to actual devices in layer 3. Layer 2 uses statistical multiplexing to send D-channel information up to layer 3, and also imposes further error controls on the data coming from the layer 1. Some of those functions are implemented for D-channel information in the data-link control section of the AM79C30A. The rest of layer 2 is done with software called LAPD (*L*ink *A*ccess *P*rotocol for the *D*-channel) and LAPB (*L*ink-*A*ccess *P*rotocol for the *B*-channels). This is the CCITT Q.921 ISDN recommendation.

Layer 1 can be considered the electron level, because it processes voltages, timing, and pin configurations. Any A/D conversion is done and the D-channel information and B-channel information has been identified, multiplexed, and checked. Layer 2 might be defined as the bit level, because bit patterns are recognized. In layer 2, D-channel data is processed (what is to be done, who is it for) and the data from layer 1 is checked again for errors. With the LAPD and LAPB software in place, the TE1 is doing everything the ISDN network requires for layer 1 and layer 2. But there's still one more layer between you and the simple phone call.

Layer 3 of the ISO model, the network layer, is where the devices reside. It might be called the byte level. Now we process characters and numbers. From layer 2, the devices are informed of what action to take by D-channel data which has been formed into packets, and those devices are allowed to use the network to transmit and receive packet data on one or more B-channels. Those devices are the ISDN telephones (TE1's) and other terminal equipment, as well as the digital switching equipment at the telephone company's central office.

In layer 3, meaningful packets of D-channel information are sent and received to and from the digital switch. A TE1 that happens to be a telephone is identified to the ISDN switching equipment by the SAPI (*S*ervice *A*ccess *P*oint *I*dentifier) and TEI (*T*erminal *E*ndpoint *I*dentifier), sent via the D-channel. Once the TE1 tells the switching equipment its SAPI and TEI, the equipment can allocate a B-channel and connects you to the outside world. It is the use of the CCITT Q.931 recommendation that makes the D-channel packets mean something to another layer-3 device. Q.931 is generally software implemented.

A TE1 that works on an AT&T 5ESS ISDN digital switch probably won't work when connected to a Northern Telecom DMS-100 ISDN digital switch. Each company implements Q.931 differently, so a TE1 must have different Q.931 software for each vendor's switch.

Before you throw your hands up in disgust and roundly curse the manufacturers for their duplicity, and before you lose hope of ever making a phone call with your ISDN-compatible, prototyping telephone, remember that a station set designed to work on a Northern Telecom DL-1 digital switch won't work on an AT&T S-75 digital switch. Vendor-specific equipment isn't new with ISDN.

To see what a Q.931 interface looks like, you may want to examine the *DMS-100 Family ISDN Basic Rate Access User-Network Interface Specifications*, published by Northern Telecom for their DMS-100 digital switching equipment.

A copy can be ordered by calling 1 800 422-6373, and ordering publication number BRA-NIS-S208-3. It explains in detail how the Q.931 recommendation is implemented on the Northern Telecom DMS-100.

The Q.931 interface that you use depends on which big digital switch your local telephone company is using for ISDN. The Northern Telecom DMS-100 and the AT&T 5ESS seem to be widely used.

If you are a programmer who likes to really grovel in the bits, writing a Q.931 interface is a very elegant project. If not, you should contact the switch manufacturer or the IC manufacturer and see if they offer the LAPB, LAPD, and Q.931 software for your particular configuration. **R-E**

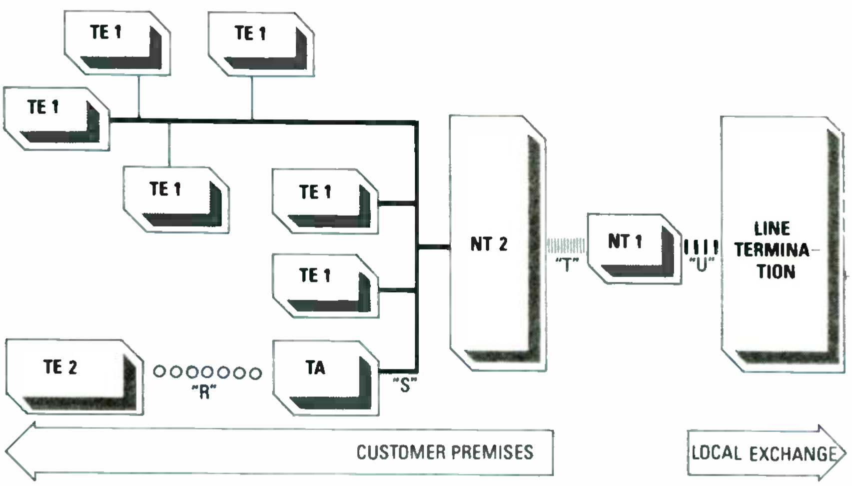


FIG. 8—SHOWN HERE IS A TYPICAL ISDN configuration.

an NT2. The switch will supply the dial tone, identify the device, and signal back. The user types in *Touch Tone* digits to make a phone call. Those are decoded and put into another D-channel data packet and sent to the switch. The switch then allocates Basic Access B-channel and switches the call.

Now the TEI has been allocated a B-channel back to the switch. The switch takes the B-channel information and puts it on the 23B + D PCM data highway to wherever the data is going. You might think of the 23B channels as 23 trunks or central-office lines. As always, the D-channel lurks in the background.

Your call has been switched (you're talking to someone), but let's assume the ISDN TEI is both a telephone and a video monitor/camera. Your voice uses one B-channel, and the video uses the other. The D-channel can be used to tell you that you have another incoming call or, if you have an ISDN security system in your house, the D-channel can inform you of a break-in.

And you thought a telephone was a bunch of wire and a big bell. In the contemporary office, a handwritten letter has become an E-mail packet or a fax. A photograph is a digitized image stored on a laser disk. Typewriters are hard to find. Telephone communication is part of the information age, and the prototyping telephone, like the personal computer, is a development tool. With high-speed digital networks like ISDN handling text, video, imaging, and voice, the telephone has become a computer.

Scratching the surface

While the concepts of ISDN are exciting, things don't really start cooking until you actually start *applying* ISDN capability to the Millcom ISDN prototyping telephone.

By 1992 enough ISDN technology will be in use that it should be easy to market applications programs and products that are TEI-compatible. Such software might provide a TEI with capabilities such as accepting, rejecting, rerouting, recording, calling back, or ignoring any incoming call based on its D-channel packet.

What can you do before 1992? Lots. You have ISDN users to share your applications ideas with. Your government will be one of ISDN's biggest users and is helping them voice their application ideas and needs. Congress appropriated funds to the National Institute of Standards and Technology (formerly the National Bureau of Standards) to establish the North American ISDN Users Forum (NIU). NIU is a users group with quarterly meetings and an electronic bulletin board (301 869-7281) to support and promote ISDN-related application profiles and ideas. The bulletin board is for NIU members only, but it's easy to join. They want and need application ideas. This new

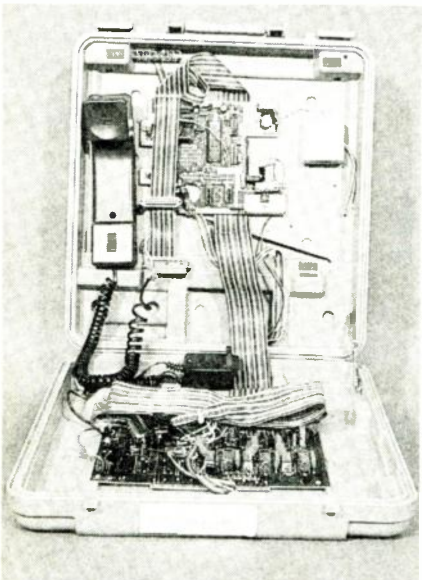


FIG. 9—THE MILLCOM BOARD is installed in the case along with a multi-purpose single-board computer.

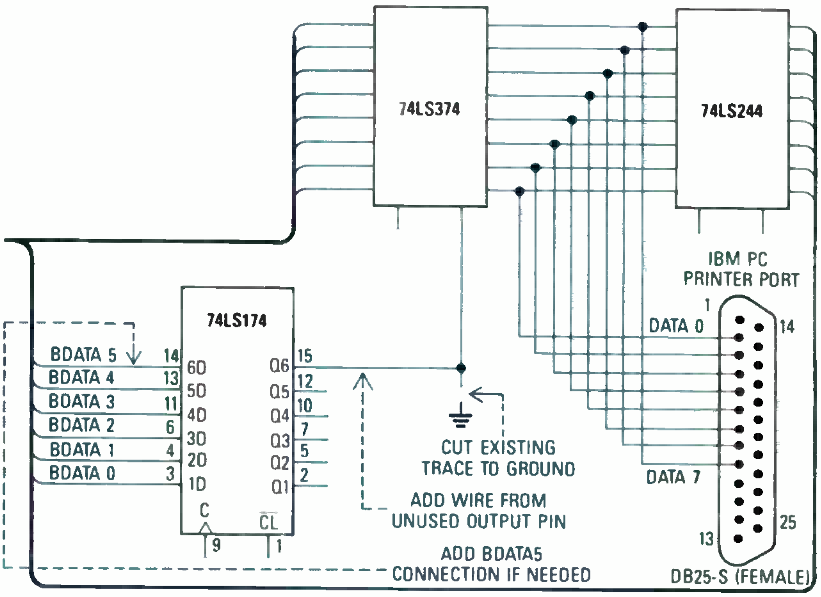


FIG. 10—THE MODIFICATION requires a single trace to be cut, and one or two jumpers to be installed.

industry *needs* ISDN-knowledgeable programmers and hardware designers. Therefore, the knowledge you gain from building the Millcom kit may benefit your career.

You may not be able to order ISDN BRI service yet, but you can get on a waiting list for future subscribers. You can build the Millcom ISDN Kit and experiment with ISDN's D-channel applications, and begin to study ISDN protocols with simulators and protocol analyzers. Teleos, Progressive Computing, Hard Engineering, Intel, AMD, Mitel, Hayes, and others have developed ISDN PC boards and development software.

Sometimes unwanted calls can result in missing an important call. And with an analog telephone system, there is no effective way to filter out unwanted calls, or to have the system interrupt an unimportant one for one that is important.

The prototyping telephone lets you simulate *C*alling *P*arty *ID*entification (CPID). Of course, since there's no D-channel to detect, the caller has to be prompted by an answering machine to enter his phone number, while the prototyping telephone, which is connected to the same phone line, listens to the caller's number (the DTMF data) and determines whether or not the call should be put through. If the caller's number matches one that has been programmed into memory as one that should be put through, the prototyping telephone will then ring to alert you.

Incoming callers will hear: "You have reached the offices of so and so. I'm sorry but no human is available to take your call right now. If your are calling from a *touch tone* phone please enter *your* area code now (pause 3 seconds)...Please enter the remaining seven digits of your phone number now (pause 7 seconds)...You may now leave a voice or fax message after the beep.

The prototyping telephone can collect the area code and, if it is different, closes the contact on the beeper which immediately informs you that you have a long-distance call. If you pick up an extension phone you can intercept the call.

On local calls the prototyping telephone collects and compares the seven-digit phone number to the allowed-calls list downloaded from the PC. If it finds a match it beeps twice. That lets you know that you are receiving an expected call: you can intercept it or let the machine get it.

Another experiment would be to design an *I*ntelligent *P*roximity *D*etector, or IPD. Such a device would be able to detect whether or not you are within a certain distance from your telephone. And, depending upon where you are, it could put the caller on hold, transfer the call to another extension, take a message, or whatever. The action would be up to you.

Phoneless ISDN

We have mentioned that the Millcom experimenter's kit can be used without the Telenova station set. All that you need is a PC, or some other kind of computer that can communicate with the kit board through its parallel port. Figure 9 shows the board installed in a case, along with a

TABLE 1

(1) 2000h - 3FFFh	8K unused and unreferenced for user expansion.
(2) 4000h - 40FFh	256 bytes for monitor variables
(3) 4100h - 41FFh	Interrupt and utility vectors. User access and interception of ROM-based functions can be achieved via the defined vectors in this block of ram.
(4) 4200h - 43FFh	Command function pointers. This block contains the jump table for all serial commands. User additions to, and interception of the basic monitor commands can be accessed here.
(5) 4400h - 46FFh	700-byte free area. Can be used by applications code for variables or as an image of 4100h - 43FFh.
(6) 4700h - 5FFFh	6K Free area. Applications code should be originated here. The "g/G" command calls address 4730 for execution. The stack pointer is initialized to 5FFFh.

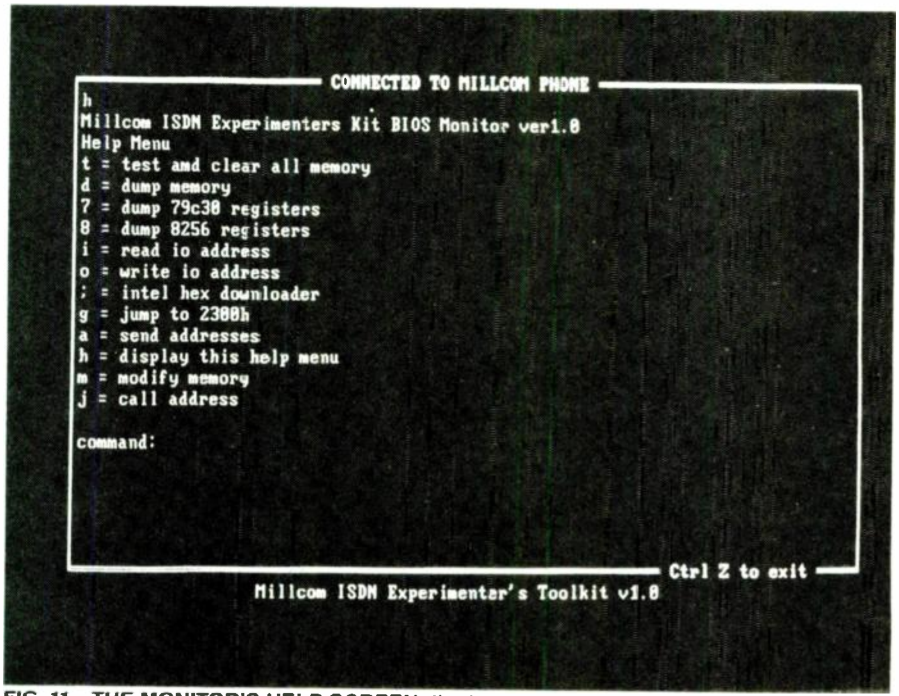


FIG. 11—THE MONITOR'S HELP SCREEN displays the monitor's basic commands.

SOURCES

Note: The following are available from Millcom, 3014 Pershall, Saint Louis, MO 63136 (314-524-0804): Prototyping Telephone Kit board and all parts, $239. Refurbished Telenova station set with Millcom PROM BIOS monitor, $260. PC board, $39. Flat-rate repair, $100. The monitor ROM and the source code are $35 apiece.

multi-purpose single-board computer that can be used to control the Millcom board.

In order to communicate with the Millcom board, you do need a bi-directional parallel port. Unfortunately the parallel printer port on IBM PC's is capable of outputting data only. (Most—but not all—clones and compatibles have a bi-directional port, though.)

As discussed by Steve Ciarcia in the September 1988 Byte magazine, the following printer-port modification will provide bi-directional communication to PC's that don't already have it. It seems that all of the hardware that was needed to read or write 8 bits of data is already on board. The modification, as shown in Fig. 10, requires a single trace to be cut, and one or two jumpers to be installed. Be warned, though, that not all boards have the same traces, IC numbers, or bit assignments. So be sure that you have the correct documentation for your card, and that you know what you are doing *before* you begin to cut traces. (You can always buy a bi-directional clone printer-port card for

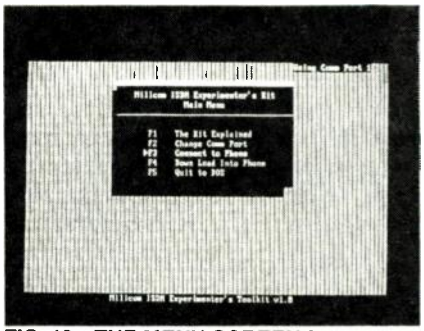


FIG. 12—THE MENU SCREEN from MILLCOM.EXE.

around $50.)

Now that you have the board communicating through a parallel port, the board has to know *how* to communicate through the port. And that's where the Millcom Monitor ROM comes in. Basically, the monitor ROM is the "bios" of the kit board. Without it, the board knows nothing. The ROM contains the basic set of commands that are used to control the phone's operations. Figure 11 shows a menu of basic commands that are available to a user when connected to the phone thru the serial port. The Monitor allows the user to access and program the Millcom board from a variety of terminals and computers.

The monitor occupies about 4K of code space. That allows the user to access the upper 4K for special applications. Also, the first 8K is not used by the Monitor to provide an additional 8K of user ROM. 16K of RAM is divided into 2 contiguous blocks which are allocated as shown in Table 1.

On the free side, a "tool kit" containing an executable program called MILLCOM.EXE, hex files, and communications software, is available on the R-E BBS (516) 293-2283; the tool kit is called MILLCOM.ARC. The hex files can be downloaded into the Millcom board, using the executable file. The main menu screen from MILLCOM.EXE is shown in Fig. 12.

We've only scratched the surface of ISDN and how it will change the way we use telephones. The prototyping telephone we've described is not the end—it's the beginning. We hope that the readers of **Radio-Electronics** become the developers of the best ISDN applications. Let us know about your successes. **R-E**

RADALERT

continued from page 60

Otherwise you may have to slightly alter the circuit so that it can turn the cassette recorder on and off via its "remote" jack, if it has one.) At the same time, Q3 is turned off, stopping the clock by cutting the power to the clock-power jack, J1. The beeper sounds a pulsating beep until S1 is depressed, resetting the system. The count pulses from the Radalert are fed to the microphone input of the cassette player, through C1, which provides DC isolation.

To begin operation, set the clock to the correct time, and put the cassette recorder in its record mode with a tape installed. You'll have to make sure that nobody disturbs any of the equipment, so it is advisable to choose an out-of-the-way location for the setup. Also remember that if your setup is outdoors, the equipment must be shielded from nature's elements. Test the system and check the batteries periodically. Use good-quality tapes and record at the normal speed for best results.

Figure 4 shows the demodulator circuit for extracting the data from the tape. Use a 3.5-mm *mono* phono plug and shielded cable to connect to the earphone jack of the tape recorder. The pulses that were recorded before are easily detected by IC1, an op-amp (¼ of an LM324) configured as a comparator. R6 must be adjusted so that the output of IC1 does not trigger on noise. Remember not to change the volume level on the cassette player once R6 has been set. The output pulse, which may have some ringing, should not be longer than 1.5 ms. That pulse is fed into IC2, a 555 timer configured as a one-shot with a 2-ms output pulse. The 2-ms pulse width decreases the resolution at high radiation levels, but it is necessary so that the ringing is not detected as more than one pulse.

The output is coupled to the tip connector of J1, a 3.5-mm stereo jack, which can be connected to the mini-plug end of the RS232 cable described in the sidebar. If you connect the other end of that cable to the RS232 port on a computer running the Radalert program, you can process and plot the data on the data logger. Using Bud Cole's software, you can recreate and plot the "event" previously recorded.

The control circuit we have described can also be used for doing long-time-period counting (described in detail in the July 1988 article). Set the alert level on the Radalert to 9990 counts, reset the control circuit, and log the time on the clock. Put the Radalert in the total-count mode and begin counting. When the count reaches 9990 the clock will stop and the beeper will let you know. Then you can calculate the counts per minute for that time period.

The Radalert, and other similar devices, are making radiation information more available to more people. Now, people living near nuclear plants can independently monitor radiation levels and gain peace of mind—or alert themselves to danger. We cannot eliminate radiation from our lives, but if we can detect and measure its level, we can take appropriate action. **R-E**

HARDWARE HACKER

Soup cans full of chips
Digital audio front ends
Sensors and transducers
Starting your tech venture
Delta-Sigma A/D conversion

Soup cans full of chips

DON LANCASTER

THERE SURE WAS A LOT OF READER RE-sponse to our big HDTV contest we ran a few issues back. As expected, most of you strongly supported the flushing of NTSC compatibility at the earliest possible opportunity.

Fortunately, there is a new HDTV consortium starting up that includes such outfits as *IBM, Apple, Hewlett Packard, Compac, Tektronix*, and a few others. Together that crew should have enough clout to spank both the FCC and the networks and send them all off to bed without any supper, if they continue to insist on all of their pathetically limiting and mindlessly short-sighted substitutes for genuine digital HDTV.

Here, more or less at random, are several of the more interesting HDTV points that many of you made:

"The concept that HDTV will only be good for the 40-inch and higher screens is not only totally absurd but completely misses the point. The key to the future of HDTV lies in closing the gap between computing and home-video displays. Any time that HDTV text is involved, all of the differences will be obvious on a two-inch screen, let alone a larger one..."

"Twelve years ago, a video-display device in the home was used only to watch network TV. Today it can do a dozen major functions, the most important of which include personal computing, video games, those cable services, and for watching videotape rentals. And, twelve years from now, there will likely be hundreds of possible uses, the most significant of which will probably be a fax-mail delivery service..."

"The phone company should be a big player here. They recently got approval for a total fiber-optic phone network, which ultimately just might make them the primary broker for home-HDTV material. The obvious advantage here is that you have a full-bandwidth, two-way comm setup in which each customer's needs can be individually provided for..."

"There *already* are several million HDTV display devices in consumer's homes today. They are called *NEC Multi-Sync Monitors*, and there will probably be ten or fifteen million of them around by the time the first of the real HDTV receivers roll off the production line. To simply ignore them is sheer lunacy..."

Once again, many thanks for your input. One interesting way of getting a good handle on any major technological change is to look into another from long ago and far away. To that end, you might find *The Electric Interurban Railways In America*, by George Hilton and John Due, to have an awful lot more to say about HDTV than you'd first expect. Stanford University Press, 1964.

Once again, this is your column and you can get technical help and off-the-wall networking per the *Need Help?* sidebar.

Our real biggies this month include some ready-to-use, sanely priced, and rather hacker-friendly digital audio front ends. But first...

NEED HELP?

Phone or write your **Hardware Hacker** questions directly to:
Don Lancaster
Synergetics
Box 809
Thatcher, AZ 85552
(602) 428-4073

Starting a tech business

Step number one of any serious hardware hacking is to create your own tech venture having all its own letterheads, business cards, mailing address, answering machine, and a bank account. There are simply too many doors that get slammed in your face if you omit that essential step.

Among zillions of other benefits, it is far easier and ridiculously cheaper to get the free trade-journal subscriptions, samples, data books, and application notes if you appear to be professionally competent.

These days, it can be very fast and cheap to form your own tech venture. What you do is to set up a new business entity called a *simple proprietorship*.

To start, pick a name and register it with your state's Secretary of State as a trade name. The name must not be in use, must not be deceptive, and must not be obscene. Beyond that, anything usually goes. Stay a tad on the "vague-but-unusual" side, so that you can use the same name for different purposes and are unlikely to become confused with anyone else. The cost of tradename registration out here in Arizona is around $15 for five years. The price varies with the state, but usually it is no big deal.

Next, rent yourself a post-office box and on the "Who uses this box?" form, put in your name and the name or names of your venture. Open up a new bank account and fill out the bank's alias card the same way. Get a *for deposit only* rubber stamp with both your own name and the company name.

For stationary, simply use a PostScript speaking laser printer to work up all your own letterheads, business cards, logos, invoices, and shipping labels. It's fast and cheap. You'll find more details on all this in my other column that's over in *Computer Shopper* magazine, as well as in my *Ask the Guru* reprints.

With a proprietorship, many of your hardware-hacking expenses can easily become fully tax deductible, provided that a few common-sense rules are followed.

SENSOR AND TRANSDUCER RESOURCES

Amperex
230 Duffy Avenue
Hicksville, NY 11802
(516) 931-6200

General Eastern
50 Hunt Street
Watertown, MA 02172
(617) 923-2386

Hewlett-Packard
PO Box 10301
Palo Alto, CA 94304
(415) 857-1501

IC Sensors
1701 McCarthy Blvd
Milpitas, CA 95035
(408) 432-1800

Intech
57 Alexander Drive
Research Triangle, NC 27709
(919) 549-8411

Measurement & Control
2994 West Liberty Avenue
Pittsburgh, PA 15216
(412) 343-9666

Micro Switch
11 West Spring Street
Freeport, IL 61032
(815) 235-6600

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

Motorola
5005 E Mcdowell Road
Phoenix, AZ 85008
(602) 244-6900

Nova Sensor
1055 Mission Court
Fremont, CA 94539
(415) 490-9100

Omega Engineering
Box 4047
Stamford, CT 06907
(203) 359-1660

Pollution Equipment News
8650 Babcock Blvd
Pittsburgh, PA 15237
(412) 364-5366

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

SenSym
1255 Reamwood Avenue
Sunnyvale, CA 94089
(408) 744-1500

Weathertronix
1165 National Drive
Sacramento, CA 95834
(800) 824-5873

Yellow Springs Instrument
Box 279
Yellow Springs, OH 45387
(513) 767-7241

Your business is expected to show a profit two years out of five. It is expected to be conducted as a business as opposed to a hobby. Any home office or lab space must be clearly and exclusively dedicated totally and absolutely to the goals of your intended venture.

All of the deduction rules on home office space have been tightened up considerably, owing to previous abuses. But if your home space is the *exclusive* and *primary* place where all business activities take place, and is in no way for the convenience of you or your employer, you should rightfully claim a tax deduction.

The primary goals of your venture also have to be legal and must *not* be centered on the management of your investments. Above all, accurate and professional records must be kept, consistent in detail with what others would do in a similar enterprise.

With careful records, you can also tap other major tax benefits such as depreciation, investment tax credit, minority and female business credits, and even research and development tax credits. The obvious way to start is with one each of *every* free tax booklet from the IRS.

Lots more info on that sort of thing appears in my *Incredible Secret Money Machine* book.

Digital audio A/D front ends

There is a spunky little integrated-circuit house way down in Texas by the name of *Crystal Semiconductor*, and they are totally upsetting the entire A/D-converter industry. What they produce are some totally revolutionary and yet moderately priced single-chip A/D conversion systems and "plug and go" evaluation boards. What that means is that at long last there are some instant and professional-quality digital stereo audio front ends that are hacker-friendly and sanely priced.

As we've seen in previous issues, it is real hard for your typical hacker lashup to yield even 9 bits of A/D resolution, let alone 16. The new evaluation boards eliminate all of that black magic involved in proper shielding, grounding, and guarding. While by no means a beginner project, those boards will

NAMES AND NUMBERS

All Electronics
PO Box 5167
Van Nuys, CA 91408 (800) 826-5432

BCD Electro
PO Box 830119
Richardson, TX 75083
(800) 456-2233

Computer Shopper
Box F
Titusville, FL 32781
(407) 269-3211

Crystal Semiconductor
4210 S. Industrial Drive
Austin, TX 78744
(512) 445-7222

Fiberoptic Product News
301 Gibraltar Drive
Morris Plains, NJ 07950
(201) 292-5100

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

National Semiconductor
2900 Semiconductor Drive
Santa Clara, CA 95051
(408) 721-5000

NEC Electronics
401 Elis Street
Mountain View, CA 94039
(800) 632-3531

Newark Electronics
228 East Lake Street
Addison, IL 60101
(312) 941-7200

Precision Decisions/PMI
1500 Space Park Drive
Santa Clara, CA 95052
(408) 727-9222

SGS-Thompson
1000 East Bell Road
Phoenix, AZ 85022
(602) 867-6259

Solid State Music/PMI
2076-B Walsh Avenue
Santa Clara, CA 95050
(408) 727-0917

Stanford University Press
Stanford University
Stanford, CA 94305
(415) 723-9434

Stick II Products
Box 670
Easthampton, MA 01027
(800) 356-3572

Texas Instruments
PO Box 809066
Dallas, TX 75380
(800) 232-3200

Time Line
1490 W Artesia Blvd
Gardena, CA 90248
(800) 872-8878

Ultimate Technology
5955 Jimmy Carter Blvd #20
Norcross, GA 30071
(404) 242-0125

Unette
26 Eastmans Road
Parsippany, NJ 07054
(201) 884-0010

let an advanced hacker quickly digitize first-quality stereo audio to 16 bits and beyond. For just about any use at all.

Figure 1 summarizes three of their more interesting chips and their supporting evaluation boards. The chips are typically priced in the $16 to $50 range, while their ready-to-use evaluation boards run around $150 or so, including the needed A/D chip.

The oldest of the three chips is called the CSZ5126, and is included in the CDB5126 evaluation board. A simplified block diagram of the board is shown in Fig. 2, and a simplified pictorial appears in Fig 3.

What you have is basically a 16-bit and 100-kHz Analog-to-Digital converter. It uses the traditional successive-approximation method, but uses capacitors, rather than resistors, in a *charge rebalancing* scheme. The circuit provides for its own internal sample-and-hold. On any reset, it automatically self-recalibrates itself. You can also force a recalibration at any time you care to.

For stereo-audio operation, a left-channel sample and a right-channel sample are alternated, using an input multiplexer. Each channel is sampled at 44 kilohertz for CD digital audio, or any sample rate from DC up to 50 kHz for special uses. The channel separation and signal-to-noise ratio are both a respectable 92 decibels. Distortion is around 0.001 percent.

Your usual output is a serial data stream consisting of alternating 16-bit words of left- and right-channel data. While that is ideal for recording, it is rather fast and awkward

The **CSZ5126** is an older 16-bit and 50 kHz two-channel successive approximation A/D conversion chip. It is self-calibrating and needs no sample-and-hold, but still requires an input anti-aliasing filter.

The companion evaluation board is model **CDB5126/5101**, and can be used as a nearly complete stereo audio front end. Both serial and parallel digital outputs are available, with a choice of internal or external clocking easily selected.

The **CS5501** is a 16-bit and 10 Hertz single channel Delta-Sigma A/D conversion chip intended for precision DC measurements. It is a total conversion subsystem that includes a powerful internal anti-aliasing filter, sample and hold, and auto calibration.

The companion evaluation board is model **CDB5501**, and can be used as a complete precision instrumentation front end. The output serial data is easy to interface to most any modem or computer.

The **CSZ5326** is a new 16-bit and 50 kHz two-channel Delta-Sigma A/D conversion chip. It is a total conversion subsystem that includes a powerful internal anti-aliasing filter, sample and hold, and features auto calibration. The impressive specs include a dynamic range of 95 decibels, signal-to-noise of 106 decibels, 0.001 decibels of passband ripple, and 0.0015 percent of total harmonic distortion.

The companion evaluation board is model **CDB5326**, and can be used as a complete high performance stereo audio front end. Both serial and parallel digital outputs are available, with a choice of internal or external clocking.

FIG. 1—CRYSTAL SEMICONDUCTOR has all of these very impressive new A/D converter chips and evaluation boards out. They can be used as stereo digital-audio or precision instrumentation and measurement front ends.

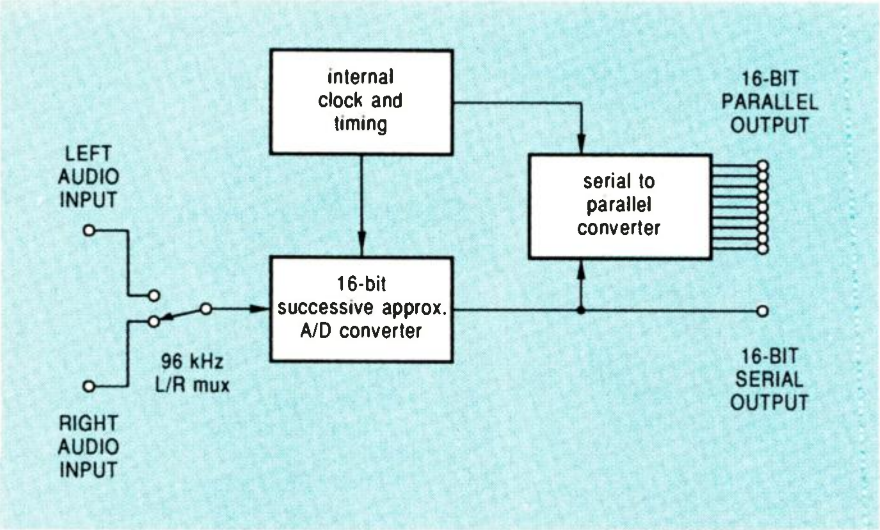


FIG. 2—A SIMPLIFIED BLOCK DIAGRAM of the CDB5126 stereo-audio A/D front-end board. Because of a factory-tested layout, nearly all of the usual black magic involving ground noise, shielding, and guarding has been done for you.

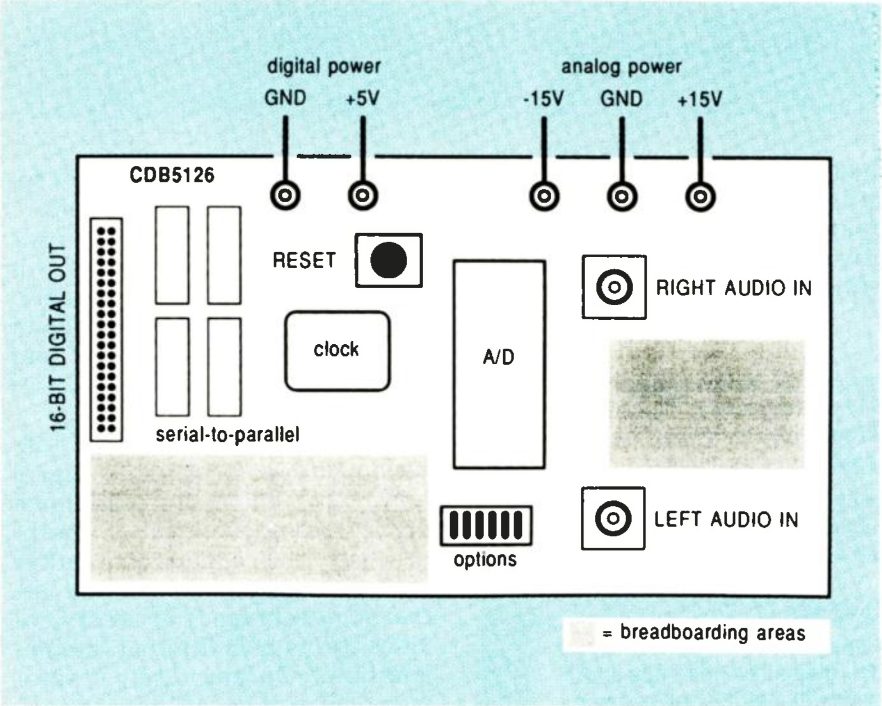


FIG. 3—THE LAYOUT OF THE CDB5126 stereo-audio front end. You literally squirt your stereo audio into the right side connectors, and 16-bit digital bits and bytes pour out the left. Note that the digital +5-volt supply power must be applied AFTER the analog power or serious damage can result.

for personal-computer use. What's also nice is a serial-to-parallel converter that is included; it directly gives you the separate left- and right-channel parallel 16-bit digital words at speeds that most personal computers can accept and use.

What you do is simply squirt in the left- and right-channel hi-fi audio, and the 16-bit digital words will fall off the other end of the board. It is that fast and simple.

Since it's more or less a traditional converter circuit, you still need analog anti-alias filtering on your input. Figure 4 shows you a simple input driver and filter that should be good for test purposes. For your final circuit, though, a rather high-quality anti-aliasing filter must be provided at each input. *Linear Technology* is the unique source for single-chip stereo CD audio anti-aliasing filters.

As a review, any A/D conversion scheme must limit its input frequencies to less than *one-half* of the clock frequency or quite serious aliasing will result. For a 44-kHz CD audio, a very high-quality 22-kHz low-pass filter is needed.

There are all sorts of jumper and dip-switch options on the CDB5126 board for clocking sources, selecting the output codes, and such. Do be sure to read *all* the ap-notes and data sheets carefully before you use any of the evaluation boards. Although they're essentially plug-and-go systems, a 25-MHz oscilloscope is absolutely essential for most of your initial testing and debugging. Do not even think of hacking those boards without having such a scope on hand.

One major gotcha on the CDB5126 evaluation board: Always apply your analog power *before* you apply your +5-volt digital power. Should digital power be applied without analog power, the chip can be destroyed. The simplest way to handle everything is to derive your digital +5 volts off the analog +5-volt source. By the way, the A/D chip draws only a quarter of a watt, so it is usable for portable applications. There's also a standby mode.

Naturally, there is no reason why you have to run the 5126 at full tilt. Drop down to a 7-kHz sample rate, and you can handle voice-grade audio, with far less memory-storage needed inside your personal computer.

Exciting as the chip-and-board combo sounds, the other two are even more impressive. Before we can understand them, though, we have to take a look at...

Oversampling

It sure would be nice to do everything on a single chip. The CSZ5126 comes close, but it still needs a high-performance anti-aliasing filter at its input for serious applications. And its specs are useful but not outstanding. Can we either eliminate the need for the filter or substitute a simpler one?

Crystal reasoned that an entirely new approach to A/D conversion was needed. So, they went back to the drawing board.

Well, the simplest A/D converter

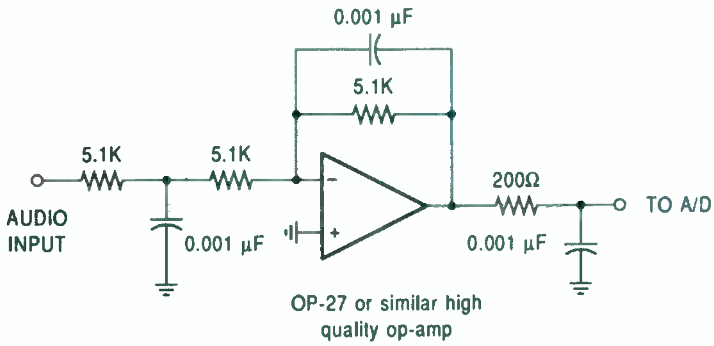


FIG. 4—A RECOMMENDED INPUT DRIVER CIRCUIT. Additional anti-alias filtering is likely to be needed for your final CSZ5126 application.

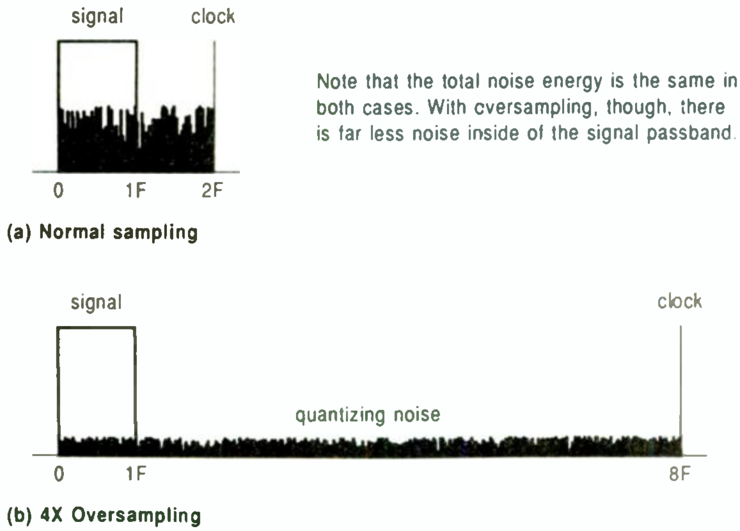


FIG. 5—THE QUANTIZATION NOISE of an A/D converter is often distributed from DC on up to the sampling frequency. By oversampling and then digital low-pass filtering, a 1-bit A/D converter can actually end up with far less noise than a 16-bit one! That is one of the key secrets to Crystal's Delta-Sigma conversion and post decimation digital filtering scheme.

is a one-bit converter. You can build one of those by using nothing but a comparator or even an op-amp. And it turns out that there is only one tiny thing wrong with a one-bit A/D converter: The signal-to-quantizing-noise ratio is a miserable seven decibels. Most people would instantly flush a one-bit converter as being uselessly noisy, especially for high-quality services.

But wait. Crystal decided to ask just where all the quantization noise came from and just how all the noise was distributed. Well, it turns out that the quantization noise is pretty near uniformly distributed from DC clear on up to your actual sampling frequency.

So what happens if we dramatically *raise* that sampling frequency? As Fig. 5 shows us, most of the noise ends up *outside* the passband of your intended input frequencies. If you now *digitally* filter your output, you can literally throw away most of your quantization noise, and might ultimately get as much as 16 or even 20 bits of signal-to-noise ratio out of a one-bit converter!

That newer process is known as *oversampling*, and one way of

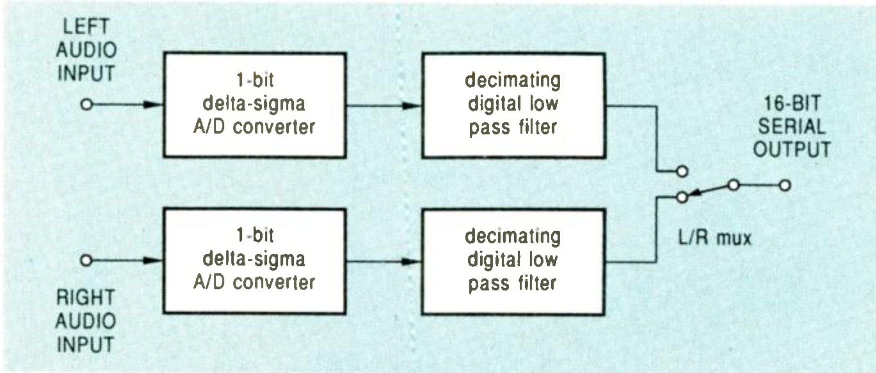


FIG. 6—A SIMPLIFIED BLOCK DIAGRAM of the CSZ5326 A/D converter. The mind-blowing specs include a 95-decibel dynamic range, 106 decibels of signal/noise ratio, 0.001 decibels of passband ripple, and 0.0015 percent harmonic distortion for both 44-kHz stereo channels. The input anti-alias filtering is also trivial.

doing the one-bit A/D conversion is called *Delta-Sigma* conversion. One hairy but easily done process that greatly simplifies digital filtering is a digital signal-processing scam called *decimation*, where high clock frequencies are progressively *folded over* back into lower and lower ones.

That is the route that Crystal chose to take on their newer chips. Besides being elegant, powerful, and cheap, the new method has another big plus—the sampling frequency is now so remote that your input anti-aliasing filter becomes utterly trivial. Even a single resistor and a capacitor can often do the job and, for example, the input driver of Fig. 4 is more than adequate.

Crystal chose two different routes for their first delta-sigma A/D products. The first is the CS5501 and its companion CDB5501 evaluation board. That chip is optimized for precision instrumentation-measurement at sampling rates of 10 Hz or less. Totally useless for audio, of course, but it's just what you need for precision electronic measurements. There's no point in updating digital displays faster than you can read them. And locking to a submultiple of the power-line frequency might dramatically reduce hum, noise, and digit bobbles.

A high-performance anti-aliasing filter is included internally; that filter lets you preselect your system bandwidth. The output is optimized for serial communications to a personal computer or over a modem. The linearity error is an absurdly low 0.0015 percent of full scale, or a little over one part in ten thousand.

And if that's not good enough for you, there's a 20-bit version in the works that should be able to handle such ultra-precise needs as an auto-counting weighing scale.

Their final chip boggles the mind. It is the CS5326 and its CDB5326 companion board. A full 16-bit delta-sigma oversampling stereo audio A/D processor with a 96-decibel signal-to-noise ratio, a passband ripple of 0.001 decibels, and a total harmonic distortion of 0.0015 percent. Another plus: Only a trivial anti-aliasing filter is needed at the input.

There's actually two separate chips inside the package, one analog and one digital, since there's no way to get enough noise isolation on a single chip. The analog half still uses loose design rules and is continually being improved. Figure 6 shows you a simplified block diagram.

For our first contest this month, just tell me what you would do with a stereo audio front end or a precision analog instrumentation input circuit. There will be all the usual *Incredible Secret Money Machine* book prizes for the best dozen or so entries, with an all-expense-paid (FOB Thatcher, AZ) *tinaja quest* for two going to the very best of all.

As usual, send your entries directly to me per the *Need Help* box, and not to the **Radio-Electronics** editorial offices.

Sensors and transducers

I sure do get a lot of helpline calls from **Radio-Electronics** readers after humidity sensors, strain gauges, pressure transducers, shaft encoders, and such. As with any other field, you start off with the trade journals and major-supplier catalogs, and build up your personal data base from there. The *Sensor and Transducer Resources* sidebar shows you a few of my favorite information sources.

I guess I do like the free *Measurements and Control* trade journal best, with Carl Helmer's *Sensors* coming in a close second.

While it sounds a tad off-the-wall, *Pollution Equipment News* does have plenty of useful transducer and sensor info in it. I happened into that trade journal after I got rather tired of paying $2 per ounce for the hot-tub clarifier that the sewage-plant people were paying $2 a gallon for.

Omega Engineering probably has the widest selection of the sensors for pressure, temperature, humidity, pH, conductivity, strain, and whatever else is available, along with lots of fine technical books, excellent application notes, and ready-to-use instruments. Unfortunately, those folks are often very expensive.

Some very low-cost temperature and pyroelectric people-detector sensors are now available from *Amperex*, while the traditional source of very linear thermistor temperature sensors has been *Yellow Springs Instrument*.

While there still is no stable and wide-ranging $5 humidity sensor yet available, two useful supply sources include *Omega* and *General Eastern*.

For pressure transducers, *Motorola* and *MicroSwitch* were the traditional biggies, but they have now gotten totally eclipsed by the "gang of three," that includes *SenSym, IC Sensors*, and *NovaSensor*. Start with SenSyms outstanding data book, slide rule, and ap-note package.

Shaft encoders and their low-cost encoder-conditioning integrated circuits are now readily available from *Hewlett-Packard*, while some other competing sources will often run ads in *Motion* magazine. Be sure and let me know if you have any other favorites that belong in our list.

Discrete soup cans

All of the good folks at SGS have recently run a free "soup can" promotion. On your letterhead request, they will send you a can full of a dozen mainstream discrete semiconductors. And nearly every one of them is an outstanding hacker component.

There's a Zener diode, an AC power-line controlling triac, a fast-recovery diode, and a transient zapper. Fancier chips here include a medium-power bipolar power transistor and a high-power MOS transistor, a 5-volt regulator, and the obligatory 555 timer. From various logic families, you will find an actual latch, a hex inverter, a quad AND gate, and a dual AND-OR-INVERT gate. That is an all around "must have" good deal. Let's start with the soup can and go a step further.

What are the *real* top forty hacker components? As a second contest this month, send me a list of a dozen or so of all your favorite electronics parts, tell me why you like them, and why they belong in the top forty. Later on, we'll work up a master list of all the good stuff.

New tech literature

Newark Electronics has just come out with their free, monster 1106 page Catalog #110. Although *Newark* was among the oldest of those "old line" distributors, they do stock everything in depth, have a tolerable minimum order, and are not nearly as hacker vicious as most of their competitors.

Some of the more interesting new surplus flyers this month include *BCD Electro, All Electronics,* and *Time Line.* The latter has 256-element CCD line-image video scanners for an unbelievable $5 each.

The old *Solid State Music* analog integrated circuits has been taken over by PMI. Ask for their *SSM Audio Products Catalog.*

You'll find a brand-new free trade journal known as *Fiberoptic Product News.* It's chock full of infrared lasers and similar goodies. The free demo disks this month include *Precision Decisions* from *PMI*, and *UltiBoard PCB Design* from all of the people at *Ultimate Technology.*

Switching to the mechanical stuff, *Stick II Products* has a free sample flyer on many of their pressure-sensitive foam tapes, while *Unette* has a free sample packet of their miniature liquid-dispensing packages.

There's a rash of free samples on all of those new fifth-generation op-amps floating around. Check out *Texas Instruments* for a freebie on their *Enhanced JFET* technology, or *National Semiconductor* for their *VIP Process* high-speed op-amps and video buffer circuits.

Turning to my own products, yes, we are now shipping the *Hardware Hacker II* reprints of everything you have seen here in **Radio-Electronics,** along with my *Ask the Guru*, volumes I and II from the sister column to this one over in *Computer Shopper* magazine. And, yes, I do stock autographed copies of five of my classics—*TTL Cookbook, CMOS Cookbook, Active Filter Cookbook,* and *Micro Cookbook,* volumes I and II. **R-E**

SHORTWAVE RADIO

STANLEY LEINWOLL

Jamming: the end of an era?

ONE OF THE MOST MOMENTOUS events in the history of shortwave broadcasting took place at 2100 UTC on November 29, 1988, when the Soviet Union abruptly stopped jamming the broadcasts of Radio Liberty after thirty six years of uninterrupted, intentional, harmful interference.

In all, twelve Radio-Liberty languages to the USSR, including Russian, are no longer jammed. In addition, the Soviets also stopped jamming *R*adio *F*ree *E*urope (RFE) broadcasts in Latvian, Lithuanian and Estonian, Deutsche Welle broadcasts in Russian, and Israeli broadcasts in Yiddish, Hebrew, Russian, Georgian, and Bukharic. In addition, the Dari and Pashto broadcasts of Radio Free Afghanistan were also cleared of jamming on November 29.

On December 16, jamming of RFE Czechoslovak broadcasts, which had continued uninterrupted since 1951, was terminated, and on December 23, RFE Bulgarian jamming ceased.

It is estimated that during this truly historic period the Soviet Union took about 2,500 jamming transmitters off the air.

Because of the importance of that event to shortwave broadcasting, we will devote our next several columns to jamming, in order to properly assess the event's impact on the high-frequency spectrum. The assessment will include a brief history of jamming, as well as a detailed look at the Soviet jamming system. Some of the technical consequences of the cessation of most jamming will be discussed. We will also try to analyze the motives behind such an important event, and conclude with a look at the future. Some of the material has not been published before in the West.

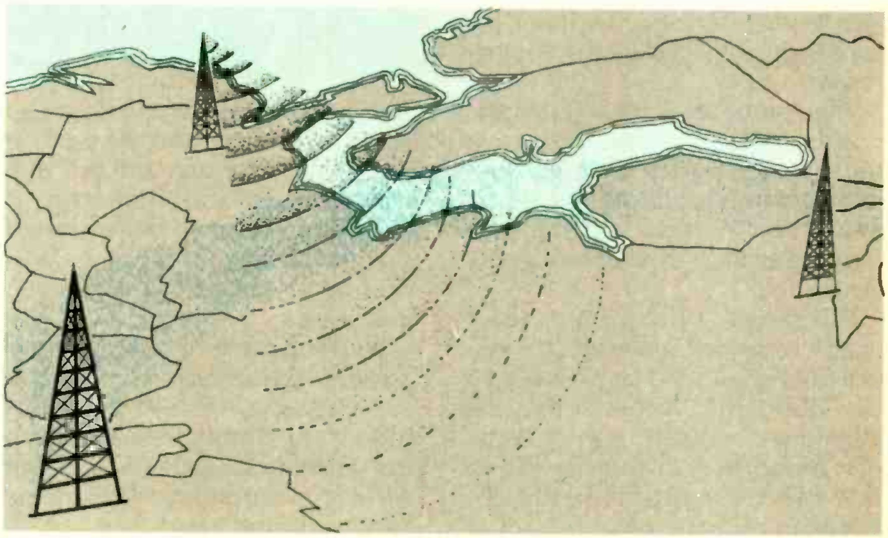


FIG. 1

Never before has an event of such broad impact occurred in shortwave broadcasting. Although the Soviets had periodically stopped jamming some broadcasters, only to resume at a later date, it has never involved virtually the entire USSR jamming system.

Jamming is well known to all shortwave listeners. It is the transmission of deliberate interference, in the form of white noise or other disruptive material, in order to make reception of a broadcast impossible. Jamming is intended not only to prevent reception, but to make listening so annoying that even repeated *attempts* to listen will be discouraged.

One of the more serious side effects of jamming is that, because of its broadband nature, it not only affects the program being jammed, it also affects reception on adjacent channels, as well. Thus, innocent bystanders have also suffered from the deleterious effects of jamming.

A history of jamming

Radio historians generally credit the Germans with the first use of jamming techniques. During World War I they transmitted random characters to disrupt radioteletype communication between Paris and St. Petersburg (now Leningrad) in Russia.

In the 1920's, before broadcasting in the United States was regulated, radio programs were often deliberately disrupted by competing broadcasters in attempts to drown out the competition.

Jamming became a political weapon in the 1930's. The first recorded instances of such jamming occurred in 1934, when Austria jammed Nazi German broadcasts, and in 1935, when the Nazis began jamming Radio Moscow.

World War II saw the continued development of jamming. Both sides used it extensively. The Germans used it as a means of censorship, jamming the broadcasts of the BBC regularly. It was also used as a military weapon. Perhaps the most notable example was the German naval coup which enabled the warships *Prinz Eugen*, *Scharnhorst*, and *Gneisenau* to race through the English Channel under the noses of British artillery because the Germans were able to successfully jam British radar installations overlooking the English channel.

The end of World War II saw the continuation of jamming on a much more massive scale than had been dreamed of during the war. A new type of war, a Cold War, was being waged, and jamming really flourished.

In February 1948, Stalin made a major decision. In order to keep censorship as total as possible, it was decided to launch a massive jamming campaign against Western broadcasts. The purpose of that effort was two-fold. The obvious one was to keep control of the information monopoly that the Soviets enjoyed; the second, more subtle, but equally important, involved the military. It had been demonstrated in World War II that an effective jamming network, operating against military circuits, was a potent wartime weapon. Establishing an active network to jam radio broadcasts would also serve to keep the military jamming machine well-oiled.

The commitment was made with a dozen or so jammers commencing operations against the Russian-language broadcasts of the Voice of America. Within two years, over 450 jamming transmitters were in operation, during which time BBC Russian-language broadcasts joined the list of jammed services.

By the end of 1951, all languages beamed to East Europe from the West were jammed, and a total of over 1,000 jammers were in operation. In 1951, Radio Free Europe commenced operations from Germany with programs beamed to the East European block; they were immediately jammed. In 1953, Radio Liberty began broadcasts in the languages of the USSR. It, too, was severely jammed from the outset.

By 1956 between 2,500 and 3,000 Soviet bloc jammers were in operation against Western shortwave broadcasts. Then, the first break in the Electronic Curtain that had sprung up around the Communist bloc occurred.

Coincident with a series of riots in the city of Poznan, and the coming into power of a new Polish Communist Government, jamming of RFE Polish language programs was ended. The official date was November 24, 1956. There had been mounting outcries from the press about the jamming of foreign broadcasts, and at the onset of the Poznan rioting the local jamming station was destroyed.

RFE Polish-language programs continued unjammed for fourteen years, when food riots in Polish coastal cities broke out. In an apparent panic, Polish authorities deployed transmitters that had been used by Radio Warsaw's external service to jam the Polish transmissions of Radio Free Europe. The hierarchy had been caught off guard, with no spare jamming transmitters. Until they were available, Radio Warsaw international broadcasts were severely cut back. As jamming transmitters became available, Polish broadcast transmitters were put back into service.

The use of broadcast transmitters for jamming purposes was an indication of the high priority placed by bloc countries on obliterating news from the outside world. One of the counter-measures that have been attempted by Western nations over the years involves scheduling frequencies that are used by Soviet-bloc countries for their own international broadcasting efforts. Without exception, the frequencies have been jammed relentlessly within minutes, a sure sign that even if they had to jam themselves, they would do so to keep unwanted programs out.

Another major break in the jamming pattern occurred in June of 1963. Following an atomic-test ban treaty, BBC and Voice of America programs in the languages of the USSR were unjammed for the first time in almost 15 years. The following month, Rumania stopped jamming the broadcasts of Radio Free Europe, the Voice of America, and the BBC. In February 1964, Hungary followed suit. In April of 1964, Czechoslovakia stopped jamming VOA and BBC but continued its efforts against RFE.

But if anyone thought the situation was permanent, such persons were mistaken. Jamming can be turned on and off like a faucet, at the discretion of those doing the jamming. That became clear in 1968, with the invasion of Czechoslovakia on August 21, 1968 by 200,000 Warsaw-Pact troops. With the invasion, massive jamming of VOA, BBC, and Deutsche Welle resumed. Languages of the USSR were affected, as were Czechoslovak transmissions. The wheel of jamming had come full circle.

The situation did not change until 1973, when once again, Soviet jamming of the VOA, BBC, and Deutsche Welle Russian and minority languages of the USSR ended during a thaw in the cold war.

Those of us who are a little more cynical are of the opinion that the Russian jamming of some of the western broadcasts ceased because many of the jammers were needed for use against Peking transmissions to the USSR. Fur-

CONDITIONS, MAY AND JUNE 1989

A combination of lengthening hours of daylight and continued increases in sunspot activity will result in a trend toward higher usable frequencies during this period. Around-the-clock DX in the 19-meter band will be possible, and during the daylight hours 13, 16, and 19 meters will be open for DX. During the evening and nighttime periods all bands between 49 and 19 meters will be open, with some 16-meter openings probable as well.

During the period from about noontime to early evening, local time, openings in the Citizens' band and the Amateur 10-meter band will occur fairly regularly. **R-E** thermore, the Soviets were launching a massive jamming effort against the Voice of Israel, whose pleas for a more liberal emigre policy were not enthusiastically received in the Soviet Union.

The on-again, off-again nature of the Soviet jamming turned on-again in 1980, with the emergence of the Solidarity trade-union movement in Poland, as well as the growing world disenchantment with the Soviet invasion of Afghanistan. On August 20, 1980, the USSR resumed jamming VOA, BBC, and Deutsche Welle broadcasts to the Soviet Union. Inasmuch as that effort had no effect on the continuing jamming against RFE, RL and Radio Israel, it is clear that the 1970 cessation did not result in the dismantling of the Soviet jamming system. Evidently, great numbers of transmitters had been mothballed in 1970, in the event of future need. That need arose in 1980.

The situation remained essentially unchanged until 1987, when as part of the Gorbachev thaw, jamming of the BBC broadcasts to the USSR ended in January, with VOA jamming ending in May of the same year.

Next time we will discuss the Soviet jamming system, how it works, how much it costs, and the countermeasures that have been taken against jamming and the success of those countermeasures. We'll also assess the impact of the cessation of jamming, who is still jammed, and what the outlook is for the future. **R-E**

ASK R-E

continued from page 13

are designed to work off a single supply but the IC might not be as easy to find locally.

If you can use other amps—for stereo, or as the basis of a small distribution system—check out the LM324. It's a quad op-amp (four separate op-amps in one package) and you can use the same circuit that is shown for the 741 by tying −V and ground together. The LM324 was designed to work on a single-ended supply so you won't be making any compromises if you use it like that.

The circuit using the LM386 (3-*b*) runs off a single supply and has the advantage of being able to directly drive an 8-ohm speaker. Since you never get something for nothing (unless that's what it's worth), you have to pay a price to drive a speaker and the currency is milliamps. Your battery won't last very long. Power consumption, however, is directly related to output load, so if you're feeding the amp into a 50K line input, you won't have a battery problem.

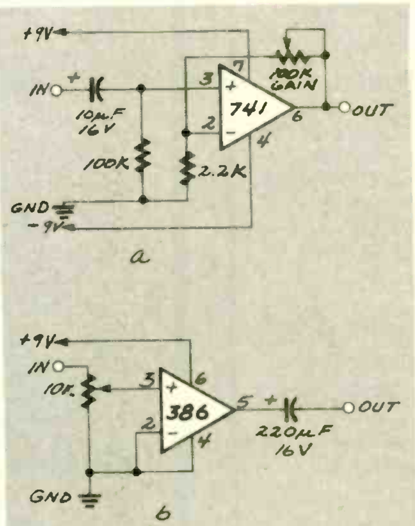
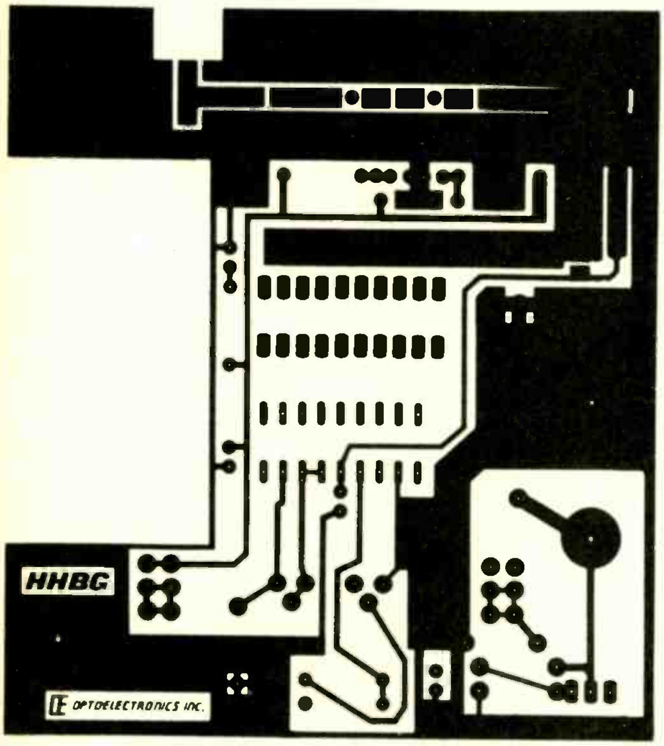


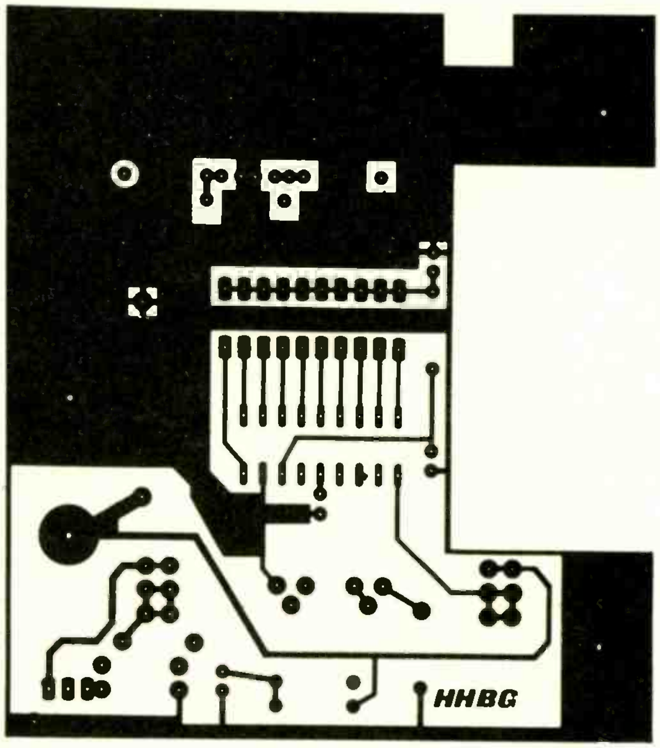
FIG. 3

The frequency response of the 386 is pretty flat but the specs just aren't as good as the 741 circuit. That is particularly true with harmonic distortion, since the 386 has over 1% THD when you get above 12 kHz or so. However, the 386 amp is easy to assemble and will give you a maximum gain of 200, so it's a handy circuit to keep in the back of your brain. **R-E**

PC SERVICE



"SILKSCREENED" side of the bug detector.



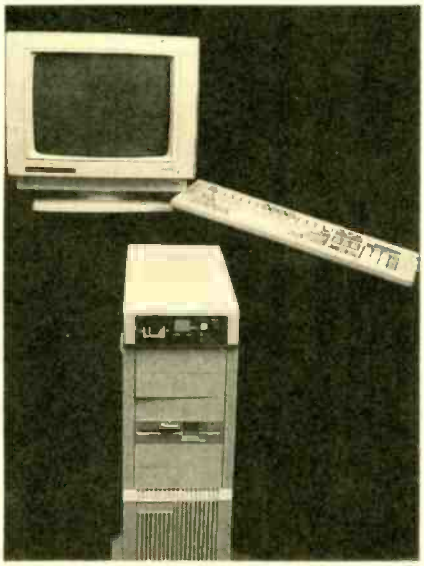
THE "FAR" SIDE of the bug detector.

PUT A 386SX TIGER IN YOUR TANK!

BERNARD A. McILHANY

You think that you don't *need* a 386. And maybe you're right—*today*. You'll be dead wrong tomorrow; but even today you can use 386MAX and OMNIVIEW (which we'll examine in detail next month) to make your computing under DOS much more efficient and much more fun. If a graphic environment is your bag, Windows/386 is light-years ahead of Windows/286. Tomorrow, of course, OS/2 (or OS/3 or OS/386 or whatever it will be called) will offer applications as far beyond what we use now as present applications are beyond CP/M.

But you feel like the kid with empty pockets staring into a candy shop? Not to worry—we've got the solution. For less than $700 (without memory) you can build a 386SX motherboard to upgrade your present AT clone or serve as the basis of a new system. Our board features up to five megabytes of memory, one parallel and two serial ports, and an on-board floppy-disk controller.



WE INSTALLED THE 386SX motherboard in a roomy tower case.

Actually, the 16-MHz motherboard is built around an 80286 CPU and a special VLSI chip set. What we've done is design an 80386SX daughtercard that plugs cleanly and neatly into the 80286 socket to make 386 power affordable to everyone. There are no traces to cut or jumpers to run; just plug in the card and go! If you're budget is extremely limited, you can build the motherboard with an 80286 (for $465); later, when you're ready, you can add the 386SX daughterboard.

The prices quoted don't include RAM. For absolute top performance (zero wait states), you can populate the board with fast (70-ns) RAM's; if your budget is restricted, 100-, 120-, and 150-ns IC's also work, at varying performance penalties. A good balance between price and performance is provided by 100-ns IC's, which run at about 0.7 wait states.

The secret is a special chip set designed by Chips & Technologies. The NEAT (*N*ew *E*nhanced *AT*) set consists of four VLSI components that reduce the number of parts required in a standard AT design by about one third (from 100 to 29). The NEAT chip set uses CMOS technology, so it consumes about 60 percent less power than conventional-design components. In addition, it comes in 12-, 16-, and 20-MHz versions. Our motherboard uses components rated for 20-MHz operation, so to upgrade from 16 to 20 MHz, you'd only have to change a few components (CPU, clock oscillator, and NEAT IC's).

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EDITOR'S WORKBENCH

JEFF HOLTZMAN

Teletek X-Bandit EMS 4.0 Memory Board

One of the biggest advantages of the 80386 is, with the proper software, its ability to emulate EMS 4.0 memory. Conversely, EMS 4.0 memory can bring a bit of 80386 power to users of 8088 and 80286 machines. Because of the high cost of RAM IC's, memory boards are not the most popular upgrade items these days. However, memory prices are dropping, and a memory-board upgrade may be a better solution for many users than scrapping a perfectly good system for a new 80386. Further, a memory-board upgrade may be more affordable (in the short run, anyway) than a motherboard upgrade, which requires memory of its own.

Several vendors offer boards claiming compatibility with the EMS 4.0 standard, but many are limited in that they emulate the hardware page-mapping registers in software, and that software emulation can cripple the effectiveness of multi-tasking software.

Other vendors offer extremely flexible memory-allocation schemes that let you perform 386-like tricks, such as back-filling system memory to the 640K limit, and "overfilling" system memory to B000:0000 (Hercules) or even B800:0000 (CGA), thus providing 64K or 96K more contiguous memory for DOS.

Teletek, a company that got its

start selling S-100 bus peripherals for CP/M machines, sells several memory boards for 8- and 16-bit PC systems; I looked at the 8-bit X-Bandit. The board can hold as much as two megabytes of RAM (in 41256 IC's); you can install as many as four boards in a single system, for a total of eight megabytes of RAM. The 8-bit board has one set of hardware memory-mapping registers, and an extremely versatile ability to re-map memory. It's also cheaper ($229) than any other true EMS 4.0 board on the market. The 16-bit version has 7 sets of hardware registers, which makes for even more efficient task swapping; it lists for $259.

I installed the board in a generic XT clone with a Hercules monochrome Graphics Card Plus video adapter. Originally, the machine had 640K on the motherboard, along with a Microsoft Mach 20 accelerator card with 1.5MB of EMS 4.0 memory. I was unsuccessful in getting the X-Bandit to run with the Mach 20; I suspect the Mach 20's memory-caching driver to be the culprit.

After determining that the X-Bandit wouldn't get along with the Mach 20, I removed the latter and stripped system-board memory to 256K. Then I let the X-Bandit fill in the gap all the way to B000:0000, which gave me a 704K DOS partition, of which a memory utility told me that 637,952 bytes were available after booting and loading the X-Bandit EMS driver. An XT with an EGA or VGA video system would have about 570K of memory after booting.

Why did I remove the system-board memory? Because the larger the chunk of memory that a multitasking environment (OMNIVIEW, for example) can control, the more efficiently it can operate. True, I lost 384K of memory, but I found the compromise worth it. In fact, I found it more efficient to use the XT with back filling and overfilling than with the Mach 20 and 640K installed on the motherboard. CPU-intensive tasks (like decompressing ARC files) ran slower, but task swapping under OMNIVIEW was faster and smoother.

Over the course of several months, I received several versions of the EMS software driver; all versions had trouble dealing with my 101-key enhanced keyboard under DESQview; however, I experienced no problems under OMNIVIEW.

The X-Bandit doesn't come with fancy packaging or documentation, but it does come with a RAM disk and a print spooler. If you're looking for a way to upgrade an XT, and have some spare 41256's, the X-Bandit's versatility and low price make it an extremely good buy. ♦CD♦

Get Organized With ViewLink

Hard disks fill up and files get lost; it's a fact of life with PC's. Of course, numerous utilities exist for locating files by name and by contents; but those types of utilities do nothing to solve the real problem: the fact that even DOS's two-dimensional directory structure does not allow proper organization.

You might, for example, organize your hard disk with separate subdirectories for each main program you use (Q&A Write, VP Planner, and PC-File, for example), one for all the little utility programs, and several data directories, say, for letters, spreadsheets, and databases.

But suppose you're working on a big project (possibly with several other people over a network), with several related files. It's a pain to keep track of all those files in the scheme previously outlined, so you create a special project subdirectory where all the letters, spreadsheets, graphics files, and whatever else has to do with that project are stored.

Six months down the road someone comes asking for a copy of the letter to Mr. Trimble. With

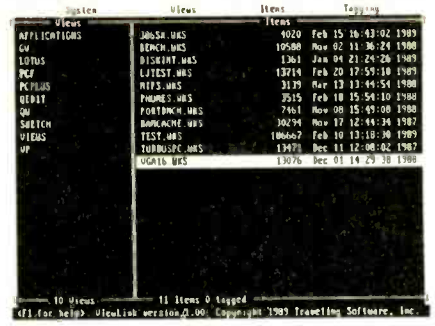


FIG. 1

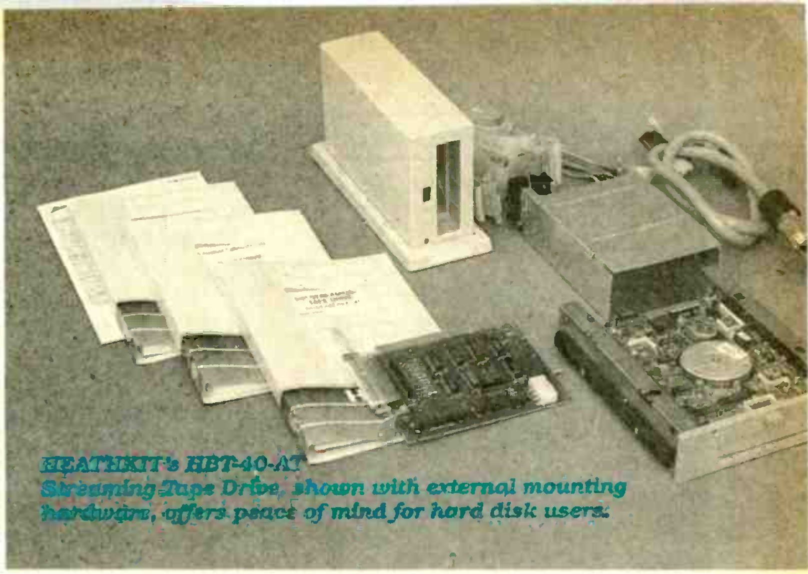
pride in your well-maintained directory structure, you immediately change to \LETTERS—but can't find anything to Trimble. It takes a few minutes, but eventually you remember that that's one of the files you stored in the special project directory.

ViewLink is Traveling Software's attempt to provide a tool that solves what is really a three- or four-dimensional organizational problem. The current version runs under DOS 2.0 or higher, and requires 384K of RAM, the company states that a version for the OS/2 Presentation Manager will be released by the end of the year. I examined version 1.0; version 1.1, which should be out by the time you read this, has support promised for EMS memory, a mouse, and more (see Fig. 1). Purchasers of 1.0 get a free upgrade to 1.1.

With ViewLink you create *views*, each of which is a list of items or other views; each *item* is a pointer to a file (either a data file or an application program). More than one view can refer to the same items. Thus, in the example above, one view might contain *all* letters; another might contain *all* files related to a particular project. Thus, letters to Trimble that are really part of the special project may be stored either in \LETTERS or the special directory; to ViewLink, the actual locations of the files in question are basically irrelevant.

ViewLink works by letting you get into an application program from an item. For example, you can bring up a spreadsheet view, scroll through the list of spreadsheet items (i.e., worksheets, each of which may have a descriptive annotation), and then run the spreadsheet pro-

HOW TO INSTALL A TAPE BACKUP UNIT



HEATHKIT's HBT-40-AT Streaming Tape Drive, shown with external mounting hardware, offers peace of mind for hard disk users.

Your hard disk is inevitably going to crash. A good backup system makes it an inconvenience instead of a disaster.

BRIAN FENTON

Just as most home-security systems aren't installed until *after* a house has been burglarized, most hard-disk backup systems aren't installed until *after* a disk crash has caused a disaster. In either case, the lesson is a painful one.

If you have important data on your hard disk, you're inviting catastrophe if you don't back it up regularly. If the inconvenience of floppy disks stops you from backing up your data as often as you should, it's time to install a tape-backup unit. We recently chose Heathkit's *HBT-40* streaming tape-drive kit to back up a 40-megabyte hard-disk drive in a AT clone to show how easy it can be. We got everything up and running in less time than we normally spend backing up to floppy.

Why tape backup?

Streaming tape drives aren't the only way to back up your hard disk. We all know that backups *can* be done with a floppy disk drive and DOS's BACKUP and RESTORE commands—if you're willing to spend an entire afternoon doing it. If you have about 30 megabytes worth of files on your hard disk, you're going to need about 90 360K floppy disks to complete a backup! While that inconvenience is bad enough, the result is even worse. Human nature being what it is, the prospect of swapping and labeling 90 floppies usually means that the task is put off—until it's too late.

Many software manufacturers have produced new programs that are miles ahead of DOS's BACKUP and RESTORE. Menu-driven programs make it easy to choose which files to backup, and they can be configured to operate almost automatically. But they are still no match for a streaming tape drive and tape cartridge.

The most popular tape-backup systems today use DC-2000 tape cartridges. The most popular tape format for PC's follows the QIC-40 standard (developed by the Quarter Inch Compatibility committee), which arranges 20 tracks across the width of the tape, each track holding about 2 MB. The result is that those smaller-than-shirtpocket-sized cartridges can hold up to 40 megabytes of data.

Heathkit's drive closely follows the standard. We should point out, however, that even with the QIC-40 standard, you may not be able to transfer tapes between QIC-40 drives from different manufacturers. The tape file structure is not specified by the standard, resulting in unpredictable transfers.

Heath offers two streaming tape drives: the *HBT-40-XT* and the *HBT-40-AT* for XT and AT computers, respectively. The difference between the two models is speed, and is brought about because QIC drives use the PC's standard floppy-disk controller for data transfer. AT-type controllers can transfer data at 500 kilobits per second (as opposed to the XT's rate of 250 kb/s), thus making the two versions necessary. Of course, it is possible to use the XT version in an AT, but it will run at half the speed. The converse is not true. Tapes produced by either of Heath's drive— regardless of which machine they're made in—are compatible with the other.

The heart of the Heathkit backup system is an XL5540 tape drive manufactured by Archive Corp. That rugged drive can mount in both 3½ or 5¼-inch drive bays, or, as we chose, an external case—a decided advantage if your drive slots are already full! Speaking of full drive bays, you may be wondering how a standard AT drive controller can support two floppies along with a third device. The answer is an adapter card that intercepts signals from the disk controller. For external systems, the card provides a rear connector for signals and power.

Although Heathkit's system is technically a kit, it's simple enough for anyone to build. Most of the work involves simply installing the drive in an external shielded case. Mounting the drive internally—if your computer can support it—is about as complicated as installing a new floppy-disk drive. As we'd expect from Heath, the manuals detail everything step-by-step, leaving no questions unanswered. The only problems we ran into were caused by an incompatible disk controller card in our AT clone.

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386SX MOTHERBOARD

continued from page 79

Neato!

The NEAT set has a plethora of features that are worth describing; one of the best is its extremely versatile ability to handle memory, including types of IC's and speed, how memory is allocated (conventional, extended, and EMS 4.0 are all supported), and whether RAM is used to "shadow" the ROM BIOS. (Shadowing involves copying the contents of a slow ROM or EPROM into RAM and then physically mapping the ROM out of its normal address space, and mapping the RAM in). All of that is under software control, as are all NEAT features, so system setup and maintenance is simple.

To get started, you can populate the PT-386-PLUS motherboard with 512K, 640K, or 1M of DRAM in standard DIP packages. In addition, the motherboard has four SIMM (*S*ingle *I*nline *M*emory *M*odule) sockets on the motherboard, into which you can install either two or four SIMM's. That means that you can install 512K, 640K, 1M, 3M, or 5M of memory directly on the motherboard; through the standard bus, you can expand the system to a full 16 megabytes of memory.

Paged/interleaved memory

For best performance, the PT-386-PLUS uses two of today's leading memory-design techniques; most systems use one or the other. First is page-mode memory access. In a computer *without* page-mode architecture, both a RAS strobe and a CAS strobe must be generated for each memory location that is accessed. In a page-mode system, however, first a row address is presented; then the RAS line is held low. Subsequently, any memory location in the current page may be accessed simply by generating a column address and a CAS strobe. (The page size for 256K DRAMS is 9 bits or 512 bytes; for 1024K DRAMS the page size is 10 bits or 1024 bytes.) Since a RAS strobe is not generated unless the memory request falls outside the current page, data can be accessed in about half the usual time.

However, if the required memory location is not within the current page, a new RAS address must be generated before data can be retrieved. The penalty when a RAS page boundary is crossed is that wait states will be generated. But programs typically access several addresses sequentially, so sustained operation on a single page is fairly common.

The second memory architecture used by the PT-386-PLUS is called interleaved memory, in which memory is divided into two (or sometimes four) banks, each of which is alternately accessed under most circumstances. Most interleaved memory designs require sequential memory accesses for no-wait-state operation, so that the RAS precharge time of one memory bank overlaps the access time of the other bank. That means that an access that is *not* sequential can cause a wait state.

The combination of page-mode and interleaved memory in the PT-386-PLUS results in RAS page boundaries occurring at 1K-byte intervals. That means that any access within the 1K-byte boundary can occur without a RAS cycle, which effectively cuts the memory access time in half. When a memory access crosses a 1K boundary there is a page miss, requiring that a new page be selected; in addition, a wait state will be generated for the first access to the new page.

The typical "hit rate" for standard interleaved memory designs is around 50 percent. Essentially, the higher the hit rate, the lower the average number of wait states. In page/interleaved-mode, a 100% hit rate can, in theory, never be achieved. However, when page/interleaving-mode memory access is used, as in the PT-386-PLUS, typical hit rates may exceed 80 percent.

What does page/interleaved memory operation mean in terms of performance and cost? When operating at a 16-MHz clock rate with zero-wait-state memory, 60- or 70-ns DRAM's are required. When page mode is combined with interleaving, near-zero-wait-state operation can be achieved with 100-ns DRAM's.

Bus synchronization

In the PT-386-PLUS the clock speed of the CPU and the speed of

Acknowledgements

Peripheral Technology would like to acknowledge the exceptional assistance and cooperation of Chuck Link of Chips and Technologies and Eric Koch of The Novus Group.

Harness that 386

The 80386 and 80386SX microprocessors are more than just fast 80286's. With the right software, you can maximize your DOS memory space, perform multitasking, or both.

386^{MAX} is a utility program that taps the microprocessor's ability to physically map memory. With it, you can fill out a 512K motherboard with extended memory; you can load TSR's (SideKick, disk caches, keyboard enhancers, etc.) into memory above the first 640K, leaving 600K or more of contiguous DOS memory; and other tricks.

OMNIVIEW is a multitasking environment that runs on all Intel 80xxx family processors. (Watch for a detailed feature article next month.) With OMNIVIEW you can download information from your favorite BBS while simultaneously typing in your word processor; you can also switch instantly among several tasks.

SunnyHill Software has arranged special 30% discounts off the list prices of OMNIVIEW and 386^{MAX} for readers of **Radio-Electronics.** OMNIVIEW normally lists for $89.95; the discount price is $62.95. 386^{MAX} normally lists for $74.95; the discount price is $52.45. Order both from SunnyHill Software, P.O. Box 33711, Seattle, WA 98133-3711. (800) 367-0651; (206) 367-0650. Be sure to mention this article.

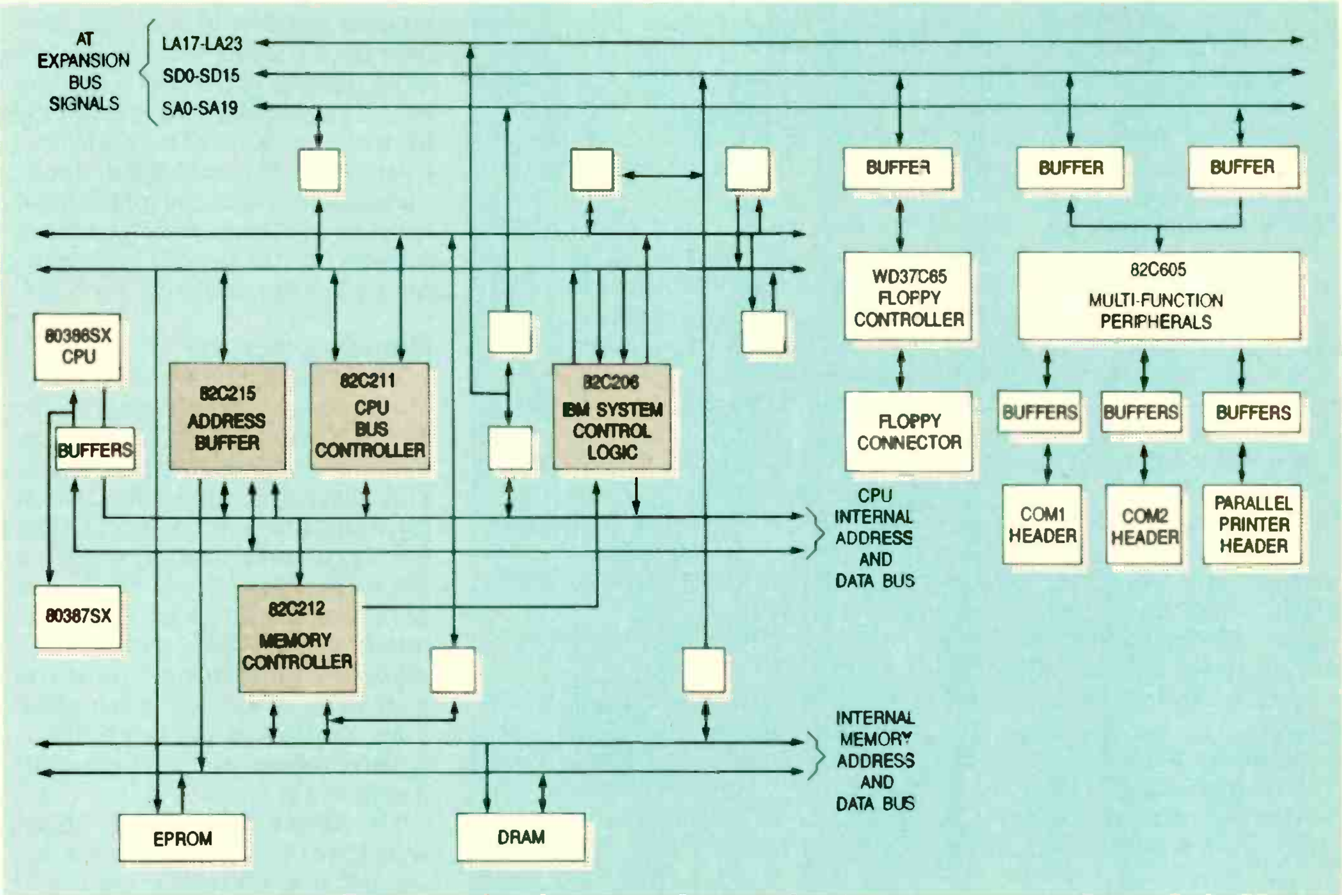


Fig. 1. *PT-386-PLUS BLOCK DIAGRAM. The system is built around Chips & Technologies' NEAT CHIPset, a single-chip floppy-disk controller, and a peripheral controller with two serial and one parallel ports. The complete 80386SX-based motherboard can be built for less than $700 (not counting RAM).*

the AT bus needn't be the same. If they were the same, and a CPU ran any faster than 8 MHz, then there could be problems with slow peripheral devices. (For that reason, it's advantageous to fill out the on-board SIMM memory before adding memory via the bus.) Further, the NEAT set supports fast switching between real and protected modes, which results in as much as 20% better performance under OS/2 than conventional designs. It also increases the performance of RAM disks and other DOS applications that use extended memory.

> **Editor's Note**
>
> I tested the 80386SX version of this board extensively and found no incompatibilities whatsoever. Test software included: Windows/386, 386^MAX, OMNIVIEW 4.12, Lotus 1-2-3, several word processors and database managers, and numerous small utility programs.
>
> The board's performance is approximately equal to that of the Compaq 386s, an 80386SX design that costs about $5000 with a fast 40-megabyte hard disk and VGA video system. With judicious purchasing, you should be able to put together a comparable system based on the PT-386-PLUS for about 60% of that amount, or even less if you go for a monochrome system and a slower hard disk.—*Jeff Holtzman*

Not part of the NEAT set, but equally important, are the on-board peripheral controllers, including: a floppy-disk controller (for 5.25-inch drives in both 360K and 1.2M formats, and for 3.5-inch drives in both 720K and 1.44M formats), a standard parallel printer port, two standard RS-232 serial ports, and a real-time clock, all of which are under software control.

As for the basics, the PT-386-PLUS board has the full-size AT format, two 8-bit (XT) slots, six 16-bit (AT) slots, and it accepts a 101-key or AT-style keyboard. It comes with a BIOS ROM with a built-in setup program and extensive diagnostics.

To put things in perspective, those features give you the ability to build a five-megabyte system, with a hard disk and video adapter, and still have six free expansion slots! On the other hand, to get a minimal system up and running, you have to add only a single floppy drive and cable, a video adapter and monitor, a keyboard, and a power supply.

System overview

The NEAT set consists of a CPU/bus controller (82C211), a memory controller (82C212), an address/data buffer (82C215), and system control logic (82C206). Figure 1 shows a block diagram of the system; the basic system-control devices are shown on the left and the peripheral devices on the right.

Let's discuss the NEAT devices

Price Information

Peripheral Technology (1710 Cumberland Point Drive, Suite 8, Marietta, GA 30067 (404) 984-0472) is selling parts kits, complete systems, and a variety of peripherals, as follows.

PT386-Starter-system
Includes the PT386-PLUS KIT, an AT-style cabinet, 200W power supply, 84-key (AT-style) keyboard, 1.2-MB 5.25-inch floppy-disk drive, Samsung amber monitor, Hercules-compatible monochrome text/graphics card with printer port, and MS-DOS 4.01: $1195

Starter system options
For EGA monitor and display adapter, add $400.00; for 20-MB hard-disk drive and controller, add $349; for 40-MB drive and controller, add $485.00; for assembled and tested unit, add $100.

Component prices

- PT386-PLUS-KIT (includes system board, daughterboard, BIOS, 16-MHz 80386SX, and support IC's. DRAM and the optional 8037SX math coprocessor not included), $695
- PT386-PLUS-ASM (assembled version of the PT386-PLUS), $795
- PT286-KIT (same as PT386-PLUS KIT but does not include 80386SX daughterboard. Includes 16-MHz 80286), $465
- PT286-ASM (assembled version of the PT286-KIT), $495
- CABINET (standard AT style with 3 drive openings), $65
- PS-200 (200W power supply for AT case), $70
- KEY (84-key AT-style keyboard), $60
- DOS (MS-DOS version 4.01), $80
- AT1003 (Hard/floppy disk controller), $139
- DISK 1.2 (1.2-MB 5.25-inch floppy-disk drive), $109
- 20MEG (20-MB hard disk drive), $230
- EGA (EGA display card), $189
- EGA MON (Samsung EGA monitor), $360
- DRAM, call for current prices
- Notes: Complete catalog of options is available upon request; PT386-PLUS kits add $7 for UPS ground shipping, systems add $22, other items additional. VISA/MC orders accepted without surcharge. Technical assistance and repair service available. Georgia residents add appropriate sales tax.

first. The PT-386-PLUS contains a local CPU bus, a 16-bit system memory bus, and the AT expansion bus. The 82C211 synchronizes and controls all buses; it also provides an independent AT bus clock speed that may be set by the user under software control. In addition, wait states and command delays to the AT bus may be programmed to allow for either fast or slow peripherals. The 82C211 also provides DMA control, refresh logic, numeric coprocessor interface logic, and configuration registers.

The 82C211 has two reset inputs and two reset outputs. RESET1 is the power-good indicator from the power supply. RESET2 is generated from the keyboard controller. The two outputs (RESET3 and RESET4) are activated in various combinations depending on the type of reset desired. For example, when a cold (power-on) reset is required, RESET3 and RESET4 are both activated. When a warm boot is required (Ctrl-Alt-Del) RESET3 is activated. RESET3 and RESET4 may be activated in other combinations when a shutdown sequence is detected by the processor.

The 82C211 is what sets processor and bus speeds. The IC has two clock inputs, CLK2IN and ATCLK, either of which may be directed to the processor bus and the expansion bus. The processor may be driven by CLK2IN directly, by (CLK2IN ÷ 2), or by ATCLK ; the bus can also be driven by any of those signals. The source is determined by a setup program. (Setup and operation will be discussed next time.)

There are three bytes of indexed configuration registers in the 82C211. I/O port 22h is used as an indexing register. To access a given register, first you write the register number to port 22h. You may then read or write to the desired register at I/O port 23h. The 82C211's three bytes are accessed by indexes 60h, 61h, and 62h. Chips and Technologies' documentation details the meaning of each bit in each configuration register; a full set of C&T documents is supplied with each kit.

Memory controller

The 82C212 performs the memory-control functions: EPROM and DRAM decoding, memory mapping, refresh logic, and clock generation for DRAM refresh. Like the 82C211, the 82C212's configuration registers are accessed at I/O ports 22h and 23h, but the 212's registers are indexed from 64h–6Fh. These registers determine where the boot ROM is located, where and how shadow RAM is enabled, types of memory IC's, whether interleaving is used, etc.

The EPROM and DRAM control logic in the 82C212 generates RAS, CAS and MWE signals for control of DRAM. The 212 also generates a ROMCS signal for enabling the BIOS EPROM. In addition, the control logic generates READY for indicating to the CPU when the current memory operation is complete; the appropriate number of wait states are inserted, according to how the 212's wait-state register has been programmed.

The 82C211 and 82C212 chips jointly handle the refresh chores. The timing for the refresh task is generated by an oscillator circuit in the 82C212. (A 14.31818-MHz crystal is connected to the 82C212; its output is divided by 12 to generate a 1.19381-MHz clock.) A separate counter is maintained for each RAM bank; when each counter times out (in about 9 clock cycles or 10 μs), a refresh request is generated.

Why is a separate counter maintained for each bank, rather than simply refreshing all banks simultaneously? When a DRAM chip is refreshed it draws hundreds of milliamps, albeit for only a very brief time. However, when refreshing a large number of DRAM's, several amps of current may be required from the power supply for a few nanoseconds. Most power supplies simply are not able to respond that quickly, and the result is spikes or noise on the power line. Staggering DRAM refresh reduces the noise generated by the power supply during refresh.

Data/address buffer

The 82C215 provides data and address buffers, bus conversion logic for 16-bit to 8-bit transfers, and parity generation and detection logic. Unlike the NEAT family members discussed so far, the 82C215 has no configuration registers. The IC's buffers isolate the CPU from the local and expansion buses.

Glue

The 82C206 contains the real-time clock and CMOS RAM that are standard parts of any AT system board. The 206 also handles interrupts and DMA requests, and it provides "glue" logic to tie the system together. The 82C206 requires a battery to power the CMOS RAM and real-time clock when the computer is turned off.

In addition to the four major IC's of the NEAT set, the PT-386-PLUS has two other major VLSI IC's: the WD37C65 and the 82C605, which provide onboard control of key peripheral devices.

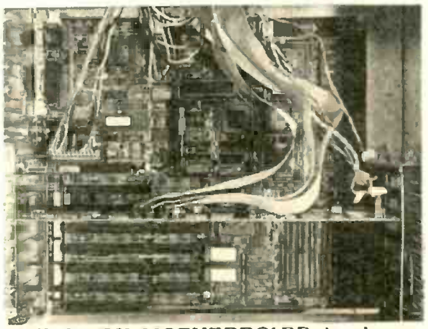
Floppy-disk controller

The WD37C65 is a single-IC floppy-disk controller that contains all circuitry necessary to control two floppy-disk drives. In older systems, a floppy-disk controller might require as many as 20 IC's; with the WD37C65, only three are required, including a data-bus buffer, an I/O port decoding PAL, and the WD37C65 itself.

Peripheral controller

The 82C605 contains one parallel printer port and two UART's (Universal Asynchronous Receiver/Transmitters) that are compatible with standard 6450 devices. A big advantage of the 82C605 over traditional devices are the configuration registers that allow peripherals to be disabled or re-assigned to other addresses in the event of conflict with some other device. Since these registers are configurable by a software program, the user doesn't have the hassle of opening up the case, hunting for the dip switches, fumbling for the correct page in the hardware manual, and so forth.

We'll present complete construction details next time. ◆CD◆



THE 386SX MOTHERBOARD is shown here. We'll talk about building it next time.

"Of course I haven't made a payment on the computer... your salesman said it'd pay for itself in no time!"

EDITOR'S WORKBENCH

continued from page 80

gram just by pressing the Enter key; up will pop 1-2-3 with the desired file loaded and ready.

Or you could bring up the Special Project view and run either your word processor or your spreadsheet, etc., depending on the type of the file you choose. ViewLink can learn what program to run for a given data file automatically by enabling the "autolink" feature. You can also set up links manually.

One real strong point is the ability to hot-link from one application to another, almost like a multitasking environment. For example, if you're in the middle of WordStar and need some information from a linked spreadsheet file, you can hot-key directly to 1-2-3, which will bring up the desired file automatically. You can then capture data from the screen, hot-link back to WordStar, and transfer the information into your document. Unlike a multitasker, however, ViewLink does not keep the switched-from program loaded in RAM (much less running); rather, it must close one and then open another application.

From the factory, the program supports many common applications (AskSam, dBASE, GrandView, Lotus 1-2-3, Microsoft Word and Works, most of the PFS series, Quattro, Sprint, SuperCalc 4, WordStar, XyWrite, among others); provision is made for adding your own.

One problem, as you might suspect, is that to use ViewLink effectively, you must use it religiously. Actually, Traveling Software provides a means of updating View lists after creating files outside the ViewLink domain, so you really needn't be obsessive about it. Even so, greatest efficiency will be gained by using ViewLink as a kind of "control center" for launching all your software applications.

ViewLink is a clever program; if you pride yourself on organization but have trouble maintaining a suitable structure, it could be a big help. A prime target is a manager responsible for maintaining multiple multi-file projects simultaneously. Just be aware that, like most personal information organizers, proper use of ViewLink will require some serious mental effort, and an ongoing commitment. ViewLink is a great hammer, but it won't drive the nails for you. ◆CD◆

PRODUCTS REVIEWED

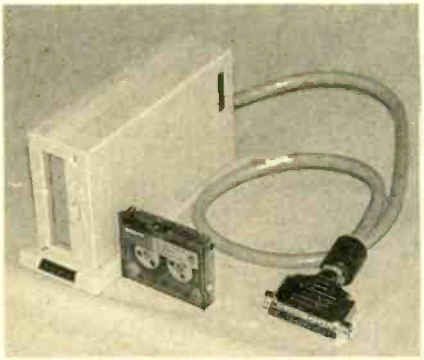
- X-Bandit-8 ($229), X-Bandit-16 ($259), Teletek Enterprises, Inc., 4600 Pell Drive, Sacramento, CA 95838, (916) 920-4600.
  CIRCLE 50 ON FREE INFORMATION CARD
- ViewLink ($149.95), Traveling Software, Inc., 18702 North Creek Parkway, Bothell, WA 98011. (206) 483-8088.
  CIRCLE 49 ON FREE INFORMATION CARD

TAPE BACKUP

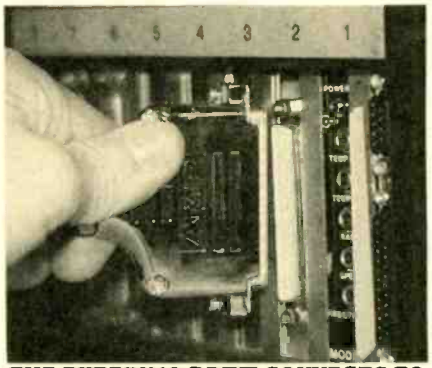
continued from page 81

Putting it to work

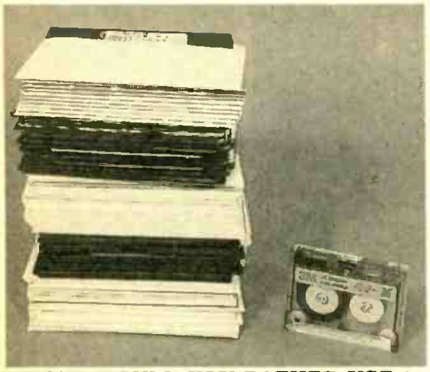
The *HBT-40* is supplied with menu-driven *HeathStream* software (which is evidently a renamed version of Archive's *QICstream* program. The main menu lets you back up to tape, restore from tape, display a tape's directory, change to a tape utility menu, and, perhaps most important, to create and schedule macros. The macros let you automatically perform backups, restores, and the like, unattended, at dates and times you schedule in advance. The *HBT-40* supports only file backups—support for image backups is not provided.



IF YOUR DRIVE BAYS are already full, you'll want to use an external case.



THE EXTERNAL DRIVE CONNECTS TO an adapter card which provides power, data, and control.



WHICH WOULD YOU RATHER USE to back up 30 megabytes of data? The stack of ninety disks on the left can do it, but the DC-2000 cartridge makes it more likely that you'll actually get it done.

Backing up 40 megabytes on the *HBT-40* isn't fast, but the same is true for any DC-2000 drive. HeathStream software keeps you informed of its progress as the tape winds seemingly endlessly back and forth. It even displays a time-line that reports the approximate length of time remaining for the selected operation. Since formatting a tape to hold 40 megabytes takes about 45 minutes—and actual backups seem only slightly faster—the time line and progress information, if nothing else, is comforting.

The *HBT-40* is available for $379 and $389 for the XT and AT versions respectively. For external mounting, the *HBT-40-SD* and *HBT-40-HZ* are $139 and $199 for XT's and AT's respectively. Are they worth it? When your hard disk suffers that inevitable crash, they're worth their weight in gold! ◆CD◆

AUDIO UPDATE

LARRY KLEIN,
AUDIO EDITOR

How Important is Slew Factor?

IN THE LAST DECADE OR SO, MOST JAPAnese and some U.S. audio-equipment manufacturers have devoted enormous amounts of effort to the discovery of previously unrecognized forms and sources of audible distortion. Their purpose, aside from a desire to advance the state of the audio art, was to promote their latest products that embodied their proprietary cures for the newly discovered diseases. The true seriousness of their concerns can best be judged by the rapidity with which each year's distortion and its cure is abandoned in favor of a new problem and its so-called solution.

One of the most durable of the "nouveau" distortions is *T*ransient *I*ntermodulation *D*istortion (TIM), which—despite my efforts during my service on the 1975 IHF Standards Committee—made its way into the current amplifier Standard (RS-490). Hailed by some manufacturers as a major source of audible distortion not revealed by conventional testing, the cause and cure of TIM was actually discussed in the early Fifties—although not by that name. Several articles dealing with feedback-induced slewing distortion in tube amplifiers are cited in the Fourth Edition (1952) of the classic *Radiotron Designer's Handbook* under the heading "Overloading of Feedback Amplifiers on Transients."

We seldom see figures for transient intermodulation distortion listed in amplifier spec sheets because there's no general agreement as to the best way of measuring it. However, Slew Factor, which relates to TIM, appears frequently. Exactly what is "slewing?" My dictionary of electronics describes slew rate as the rate at which the output of an electronic circuit or device can be driven to the limit of its dynamic range. When it appears in spec sheets, slew rate is given in volts per microsecond. In other words, the "speed" of the circuit's response enables it to go from zero to X volts in one millionth of a second. That sort of response is easily viewed on an oscilloscope. When an amplifier is unable to slew (change) its output rapidly over its full range, it is reflected by a high-frequency response that falls as the signal output level increases. That is the reason that amplifier spec sheets usually give a very wide frequency response at low power levels, and a somewhat reduced high-frequency response at full output power.

FIG. 1

When a transient reaches a high level very quickly—in other words, a fast rise-time—it (theoretically) can exceed the ability of an amplifier using overall negative feedback to "track" it. In such a case, the negative-feedback signal from the output of the amplifier returns to the input too slowly to prevent the input stages from being driven by the input transient into momentary overload. The overload is the cause of TIM.

On a theoretical level, there are several ways to minimize or eliminate TIM: (1) The response speed of the entire amplifier can be made fast enough (which is to say, its bandwidth wide enough) to prevent the time delay in negative feedback; (2) the amplifier can be designed without the negative feedback that produces the problem; or, (3) the bandwidth at the amplifier input can be limited so that the high-frequency components in the program are never faster than the frequency capabilities of the following stages. All of those techniques are effective, but in my view, option (3) represents the best engineering practice. Not only is it the least expensive way to go, but it also keeps ultrasonic and radio-frequency signals out of the amplifier circuitry where they could only cause trouble.

Testing TIM

Many manufacturers have devised complex and non-comparable tests to measure TIM and are pleased to tell you about them in their literature. The simplest and easiest one to interpret is the *Slew Factor* (SF) measurement found in the EIA amplifier standard mentioned earlier. The amplifier under test is driven to its full rated output with a 1,000-Hz test signal. Then, without changing the test signal's amplitude, its frequency is raised until the total harmonic distortion of the output signal hits 1 percent. The Slew Factor number is derived by dividing the highest frequency achieved before distortion by 20,000 (Hz). An amplifier that is able to deliver say, 40 kHz, before hitting 1 percent distortion, therefore has an SF of 2.

In practice, it's rarely necessary to actually measure THD during the SF test because: (1) the amplifier's output may decrease—not distort—as the frequency is raised; (2) the output waveform viewed on an oscilloscope may distort abruptly as slew limiting occurs; or, (3) the amplifier blows its fuses or output transistors. With an amplifier whose bandwidth is properly limited (as in the first case), the signal generator's highest available test frequency usually establishes the amplifier's Slew Factor. For example, if its highest frequency is 500 kHz, the SF is at least 25.

What is the minimum acceptable Slew Factor? Slew Factors commonly seem to range from a low of about 5 to a figure determined, as I said, by the upper frequency limit of the signal generator used. But, more important, it seems evident that no recorded or broadcast signal will have a fast enough rise-time (a wide enough bandwidth) to cause trouble with any competently designed amp.

To my mind, those designers and audiophiles hyperconcerned about slew rate, Slew Factor, or TIM as an insidious source of distortion are essentially chasing a wild goose up a blind alley. In short, if you hear some unpleasant sonic quality in the sound of any of today's amplifiers, you can be almost positive that TIM is not likely to be its source. **R-E**

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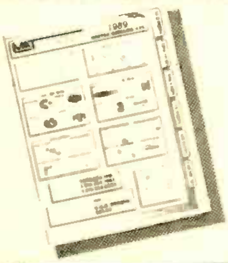

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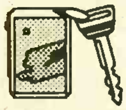

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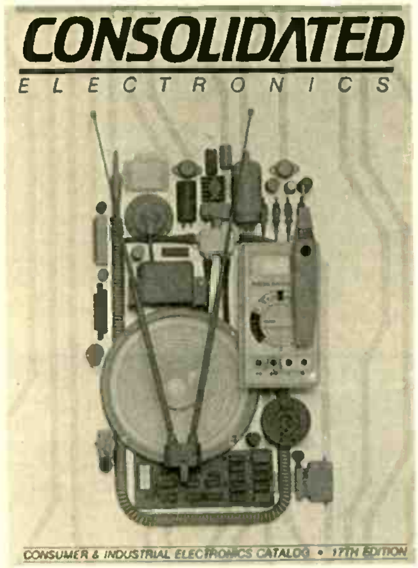

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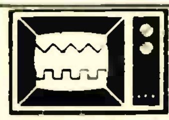

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8833	2.50
8834	2.00
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DIP SOCKETS

8 PIN	.10	22 PIN	.15
14 PIN	.11	24 PIN	.20
16 PIN	.12	28 PIN	.20
18 PIN	.15	40 PIN	.25
20 PIN	.18		

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3.000	8.000
3.12	10.000
3.579	17.32
4.000	18.000
5.000	20.000
6.000	34.550

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7403	.19	7486	.35	74177	.66
7404	.19	7489	1.90	74180	.75
7405	.25	7490	.39	74181	2.00
7406	.27	7491	.40	74182	.75
7407	.27	7492	.50	74184	1.50
7408	.24	7493	.35	74190	.80
7409	.18	7494	.60	74191	.80
7410	.18	7495	.55	74192	.75
7411	.25	7496	.60	74193	.75
7412	.25	74107	.30	74194	.80
7413	.35	74116	1.20	74195	.80
7414	.45	74121	.30	74196	.75
7416	.25	74122	.45	74197	.80
7417	.25	74123	.45	74199	1.25
7420	.20	74125	.45	74221	1.25
7425	.27	74126	.45	74273	1.00
7426	.30	74145	.60	74278	1.95
7427	.27	74148	1.20	74279	.70
7430	.20	74150	1.35	74298	.60
7432	.27	74151	.55	74365	.65
7437	.27	74153	.55	74367	.65
7438	.29	74154	1.25	74390	.90
7440	.20	74155	.55	75114	.90
7442	.45	74156	.75	75115	.90
7445	.65	74157	.55	75150	.60
7447	1.00	74158	.60	75325	1.50
7450	.20	74160	.85	75491	1.00
7472	.29	74161	.65	9602	.90
7473	.35	74162	.65	8T26	1.10
7474	.32	74163	.65	8T28	1.10
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7476	.50	74165	.85	8T98	1.10
		74166	1.00		

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74C04	.25	4001	.19	4028	.65	4076	.55
74C08	.25	4002	.20	4029	.65	4077	.28
74C10	.25	4006	.65	4030	.35	4081	.20
74C14	.55	4007	.20	4034	1.40	4082	.20
74C20	.25	4008	.85	4035	.65	4093	.45
74C32	.35	4009	.35	4040	.65	4099	1.40
74C42	1.10	4010	.35	4041	.75	4501	.95
74C74	.55	4011	.19	4042	.55	4503	.45
74C76	.60	4012	.25	4043	.85	4506	.75
74C85	1.25	4013	.35	4044	.65	4510	.65
74C86	.35	4014	.65	4045	.85	4511	.65
74C93	1.00	4015	.28	4046	.85	4512	.75
74C157	.95	4016	.28	4047	.65	4514	.95
74C161	.95	4017	.45	4049	.28	4515	1.60
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74C175	.95	4019	.35	4051	.65	4518	.85
74C193	1.25	4020	.55	4052	.65	4520	.75
74C245	1.75	4021	.65	4053	.65	4528	.75
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74C907	.75	4025	.25	4069	.19	4541B	1.20
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74HC10	.35	74HC139	.45	74HC354	.95
74HC11	.40	74HC153	.55	74HC373	.80
74HC20	.35	74HC154	1.75	74HC374	.80
74HC30	.35	74HC157	.50	74HC533	1.35
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74HC74	.40	74HC174	.60	74HC640	2.00
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74HC85	.70	74HC194	.70	74HC4020	1.10
74HC86	.40	74HC221	.90	74HC4066	.60
74HC107	.35	74HC240	.75	74HC4514	3.20
74HC109	.40	74HC242	.75	74HC4538	1.40
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74LS02	.17	74LS114	.33	74LS243	.65
74LS03	.17	74LS122	.70	74LS244	.65
74LS04	.17	74LS123	.45	74LS245	.75
74LS05	.17	74LS125	.35	74LS246	1.40
74LS08	.17	74LS126	.35	74LS247	.75
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74LS11	.20	74LS137	.90	74LS253	.45
74LS12	.27	74LS138	.39	74LS257	.39
74LS13	.25	74LS139	.39	74LS258	.45
74LS14	.36	74LS145	.70	74LS259	1.20
74LS15	.25	74LS147	1.00	74LS260	.45
74LS20	.17	74LS148	.90	74LS266	.55
74LS21	.22	74LS151	.39	74LS273	.75
74LS22	.22	74LS153	.39	74LS279	.39
74LS26	.23	74LS154	1.50	74LS280	1.70
74LS27	.23	74LS155	.55	74LS283	.55
74LS28	.26	74LS156	.45	74LS290	.80
74LS30	.17	74LS157	.35	74LS293	.80
74LS32	.17	74LS158	.20	74LS298	.65
74LS37	.26	74LS160	.29	74LS299	1.25
74LS38	.26	74LS161	.49	74LS320	2.00
74LS40	.17	74LS162	.49	74LS322	3.00
74LS42	.35	74LS163	.49	74LS323	2.40
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74LS51	.17	74LS165	.65	74LS366	.39
74LS54	.22	74LS166	.95	74LS367	.39
74LS73	.25	74LS169	.90	74LS368	.39
74LS74	.24	74LS170	.80	74LS373	.75
74LS75	.29	74LS173	.49	74LS374	.75
74LS76	.29	74LS174	.39	74LS377	.75
74LS83	.45	74LS175	.39	74LS386	.45
74LS85	.45	74LS181	1.40	74LS390	1.10
74LS86	.22	74LS190	.49	74LS393	.75
74LS90	.39	74LS191	.49	74LS398	2.50
74LS92	.45	74LS192	.65	74LS446	2.00
74LS93	.45	74LS193	.65	74LS541	1.40
74LS95	.48	74LS194	.65	74LS625	1.75
74LS96	.49	74LS195	.65	74LS645	.95
81LS98	1.40	74LS196	.55	74LS668	1.45
74LS107	.35	74LS197	.55	74LS670	.95
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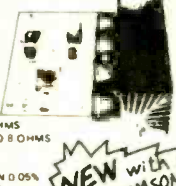

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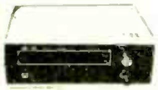

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Frequency Range 10Hz - 150MHz
Event Counter 0 to 99999999 counts (8 Digit)
Input Sensitivity KHz range 10Hz - 10MHz 50mVrms
MHz range 1MHz - 150MHz 40mVrms
Response time 0.2 second
Hold Function Hold the last input signal
Power Supply DC6V Battery or DC9V Adaptor
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DC FET SUPER CLASS "A" PRE-AMP TA-2200 NEW

The TA-2200 is a discrete transistor stereo pre-amplifier using FETs in the critical stages for ultra low noise linear operation. All amplifier stages operate in class A.

The circuit is devoid of all signal processing circuits such as tone controls, filters, etc., in order to closely approximate a 'straight wire with gain' configuration.

The power supply is heavily regulated to provide a low impedance constant voltage source.

SPECIFICATIONS:
Total Harmonic Distortion, Overall from AUX less than 0.01%
Frequency Response—
(at rated output) 10 to 100,000Hz +0.5dB −1dB
Input Sensitivity and Impedance—
Phono 47K ohms 2mV
Output Level—
Rated Output (0.01% Total Harmonic Distortion)
Preamplifier Output 1.3V
Recording Output 130mV
Power Requirements: AC 36V × 2 0.2A

KIT $47.70 ASSM & TESTED $58.24

100W+100W NEW CLASS 'A' DC STEREO PRE-MAIN AMP

TA-1500 200W POWERFUL AMP W/MIC MIXER!
KIT $73.70
METAL CABINET/X'FORMER $33/25

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TERMS: $10 min order ● $20 min charge card order ● Check, money order or phone order accepted ● We ship UPS Ground ● Add 10% of total order (min $2.5) for shipping, outside USA add 20% (min $5.00) ● Transit Insurance: add 5% of total (outside USA only) ● CA residents add sales tax ● All merchandise subject to prior sale ● Prices are subject to change without notice ● Any goods proved to be defective MUST BE RETURNED IN ORIGINAL FORM WITH A COPY OF YOUR INVOICE WITHIN 30 DAYS FOR REPLACEMENT.

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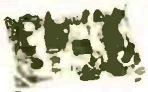
DIGITAL VOICE MEMO TA-28 MKII



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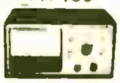
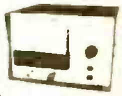
TR-100



SALE

TR-100A



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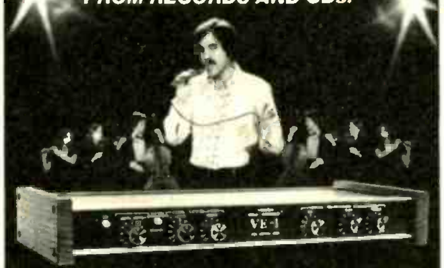

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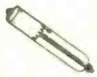

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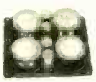

12 dB/octave rolloff. 800Hz, 5000Hz crossover points. 8 ohm. 100 watts RMS.

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#260-235 — $14.50 (1-5) — **$12.90** (6-up)

12" POLY WOOFER

Super duty, 40 oz. magnet. 100 watts RMS, 145 watts max. 4 and 8 ohm compatible (6 ohm). 2" voice coil. fs = 25 Hz. QTS = .166, VAS = 10.8 cu ft. Response: 25-1500 Hz. Net weight: 9 lbs. Pioneer #A30GU40-51D

#290-125 — $36.80 (1-3) — **$34.50** (4-up)

WALNUT SPEAKER CABINET KIT

Super quality, genuine walnut veneer cabinet. Kit includes: routed and mitred top, sides, and bottom in unfinished 3/4" walnut veneer. Cut your own custom holes in the front and rear to match your drivers. 15" x 24" x 11". Volume: 1.9 cubic feet.

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PIONEER HORN TWEETER

Mylar dome. 2.93 oz. barium ferrite magnet. 8 ohm. Response: 1800-20000 Hz. 35W RMS, 50W max. fs = 2000 Hz. SPL = 106 dB. Pioneer #AHE60-51F

#270-050 — $6.50 (1-9) — **$5.90** (10-up)

12" SUB WOOFER

Dual voice coil sub woofer. 30 oz. magnet, 2" voice coils. 100 watts RMS, 145 watts max. fs = 25 Hz. 6 ohm (4 and 8 ohm compatible). SPL = 89 dB 1W/1M. Response: 25-700 Hz. QTS = .31, VAS = 10.3 cu. ft.. Pioneer #A30GU30-55D. Net weight: 6 lbs.

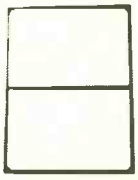
#290-145 — $39.80 (1-3) — **$36.80** (4-up)

15" THRUSTER WOOFER

Thruster by Eminence. Made in USA. Poly foam surround, 56 oz. magnet. 2-1/2", 2 layer voice coil. 150 watts RMS, 210 watts max. 4 ohm. fs = 23.5 Hz, QTS = .33, VAS = 17.9 cu ft. SPL = 94.8 dB 1W/1M. Net weight: 15 lbs.

#290-180 — $43.50 (1-3) — **$39.80** (4-up)

GRILL FRAME KIT



With this kit you can make speaker grill frames up to 30" x 40". Kit includes 4 corner pieces, 2 "T" brackets, and 7 frame bars. Grill mounting kit included.

#260-333 — $8.50 (1-9) — **$7.80** (10-up)

18" EMINENCE WOOFER

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100 oz. magnet, 3" voice coil. 250 watts RMS, 350 watts max. 8 ohm, 30 Hz resonant frequency. 22-2700 Hz response. Efficiency: 95 dB 1W/1M. Paper cone, treated accordian surround. Net weight: 29 lbs.

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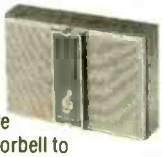
Program your doorbell with a favorite tune Arrange wire leads on one-octave keyboard inside doorbell to program any tune. Includes songbook with 50+ college, seasonal, Christmas and special occasion songs. Back door button activates a part-tune. Volume, tone, speed and delay adjustable. Two-evening kit. Takes standard 16 VAC, 50/60 Hz bell transformer.
Kit TD-1089 (3 lbs.) **$32.95**



Build your own Heathkit draft detector Easily detect heat loss areas. Turn it on, adjust for silence, then move sensor in areas where heating or cooling losses occur. Temperature changes set off beeping alarm and flashing LED. Used in temperatures from 59-95F. Takes a 9-volt battery (not included).
Kit NE-2112 (2 lbs.) **$14.95**

Heathkit Furnace Air Cleaner. Works with heating or A/C system to reduce the effects of pollen, dust and cigarette smoke. Power supply mounts onto a cold air duct, and turns on collecting cell when blower is running. 1" collecting cells below directly replace original furnace filter. 120VAC also works with GD-2196 2" filters. Kit GD-3196 (9 lbs.) **$79.95**
Accessory filters 4 sizes available.
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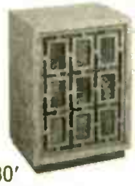
Kit GDS-1297 (59 lbs.) **$199.00**
Accessory: Replacement Charcoal Filter Assd. GDA-1297-2 (2 lbs.) **$9.95**



Charging system tester Diagnose faulty components in your car's charging system with accuracy and ease. A two-wire setup and three quick tests show you if the battery has sufficient charge to reliably start the engine, if the battery is being charged by the alternator, if the voltage regulator is faulty (causing the battery to become overcharged), or if the alternator stator windings and rectifier diodes are functioning properly. No external power or battery required. Dimensions are 5½" H x 2¾" W x ¾"D.
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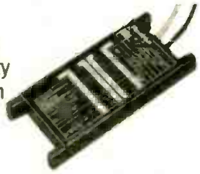

Noise generator kit To properly check out any stereo or sound system with a spectrum analyzer, you need a noise source with a nearly constant energy output. This one-evening Pink/White Noise Generator will do just that...and at a fraction of the cost of comparable noise generators.
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Assd. BC-100X-LT (3 lbs.) .. **$188.88**

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Part No.	1-9	10+	Part No.	1-9	10+
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7404	SALE	.15	7489	1.95	1.85
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7406	.39	.29	7493	.45	.35
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74LS85	.59	.49	74LS366	SALE	.35
74LS86	.29	.19	74LS367	SALE	.29
74LS90	SALE	.29	74LS368	SALE	.35
74LS93	SALE	.29	74LS373	SALE	.59
74LS123	SALE	.35	74LS374	SALE	.49
74LS125	.49	.39	74LS393	SALE	.69
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74LS163	SALE	.35	74LS670	SALE	.79
74LS164	SALE	.35	74LS688	2.39	2.29

74S/PROMS*

74S00	SALE	.19	74S188*		1.49
74S04	SALE	.19	74S189		1.49
74S08	SALE	.19	74S196	SALE	.99
74S10	SALE	.19	74S240		1.39
74S32	SALE	.19	74S244	SALE	.75
74S74	SALE	.19	74S253	SALE	.29
74S85	SALE	.49	74S287*		1.49
74S86	SALE	.19	74S288*		1.49
74S124	SALE	1.25	74S373	SALE	.99
74S174	SALE	.25	74S374	SALE	.99
74S175	SALE	.25	74S472*	SALE	2.49

CD—CMOS

CD4001	.19	CD4076	.59
CD4008	.59	CD4081	.22
CD4011	.19	CD4082	.22
CD4013	.29	CD4093	.35
CD4016	.29	CD4094	.89
CD4017	.49	CD40103	1.49
CD4018	.59	CD40107	.49
CD4020	.59	CD4510	.69
CD4024	.45	CD4511	.69
CD4027	.35	CD4520	.75
CD4030	.35	CD4522	.79
CD4040	.65	CD4538	.79
CD4049	.29	CD4541	.89
CD4050	.29	CD4543	.79
CD4051	.59	CD4553	3.95
CD4052	.59	CD4555	.79
CD4053	.59	CD4559	7.95
CD4063	1.49	CD4566	1.95
CD4066	.29	CD4583	.59
CD4067	1.49	CD4584	.49
CD4069	.19	CD4585	.69
CD4070	.29	MC14411P	7.95
CD4071	.22	MC14490P	4.49
CD4072	.22		

EEPROMS

2816A	2048x8	350ns (9V 15V) 5V Read/Write	5.25
2816A-25	2048x8	250ns (9V 15V) 5V Read/Write	5.49
2817A	2048x8	350ns 5V Read/Write	6.95
2864A	8192x8	250ns 5V Read/Write (Pin 1, No R/B̄)	13.95
2864A-30	8192x8	300ns 5V Read/Write (Pin 1, No R/B̄)	12.95
2865A-30	8192x8	300ns 5V Read/Write	9.95
52B13	2048x8	350ns (21V) 5V Read Only	1.49

MICROPROCESSOR COMPONENTS

MISCELLANEOUS CHIPS

Part No.	Price
D765AC	~~8.95~~ 2.95
WD9216	3.95

Z80, Z80A, Z80B SERIES

Z80	1.19
Z80-CTC	~~1.29~~ .99
Z80-PIO	~~1.29~~ .99
Z80A	1.29
Z80A-CTC	1.65
Z80A-DART	~~4.95~~ 3.95
Z80A-PIO	~~1.89~~ 1.49
Z80A-SIO/0	~~8.95~~ 2.95
Z80B	2.75
Z80B-CTC	~~9.95~~ 3.25
Z80B-PIO	3.95
Z8530	4.95
Z8671	7.95
Z8681B1	8.95

8000 SERIES

8031	~~8.95~~ 3.49
80C31	~~9.95~~ 8.95
8035	~~1.49~~ 1.25
8039	~~1.95~~ 1.59
8052AHBASIC	24.95
8080A	~~2.25~~ 1.49
8085A	2.49
8086	3.95
8086-2	~~6.95~~ 5.49

8000 SERIES Continued

Part No.	Price
8087 (5MHz)	99.95
8087-1 (10MHz)	194.95
8087-2 (8MHz)	139.95
8088 (5MHz)	~~4.95~~ 3.49
8088-2 (8MHz)	~~6.95~~ 5.95
8116	~~4.95~~ 3.95
8155	2.49
8155-2	3.49
8156	2.95
8212	2.29
8224	~~2.25~~ 1.95
8228	~~1.95~~ 1.49
8237-5	~~4.25~~ 3.95
8243	1.75
8250A	~~4.95~~ 3.95
8250B (For IBM)	~~5.95~~ 4.95
8251A	1.69
8253-5	1.95
8254	3.95
8255A-5	2.95
8259-5	~~2.25~~ 1.75
8272	~~8.95~~ 2.95
8279-5	~~2.95~~ 2.75
8741	9.95
8742	~~19.95~~ 17.95
8748 (25V)	7.95

8000 SERIES Continued

Part No.	Price
8748H (HMOS) (21V)	9.95
8749	9.95
8751 (3.5-8MHz)	37.95
8751H (3.5-12MHz)	39.95
8755	~~19.95~~ 12.95
80286-10 LCC	59.95
80287 (6MHz)	159.95
80287-8 (8MHz)	229.95
80287-10 (10MHz)	279.95
80386-16 PGA	309.95
80387-16 (16MHz)	439.95
80387-20 (20MHz)	499.95
80387-25 (25MHz)	599.95
80387-SX (16MHz)	399.95
82284 (8MHz)	9.49
82288 (8MHz)	9.95

DATA ACQUISITION

ADC0804LCN	2.79
ADC0808CCN	~~5.95~~ 5.49
ADC0809CCN	~~8.09~~ 3.29
ADC1205CCJ-1	19.95
DAC0808LCN	~~1.75~~ 1.49
DAC1008LCN	5.95
AY-3-1015D	~~4.95~~ 3.95
AY-5-1013A	1.95

STATIC RAMS

Part No.	Function		Price
2016-12	2048x8	120ns	~~4.95~~ 3.75
2018-45	2048x8	45ns 300MIL	6.95
2102	1024x1	350ns	.89
2114N	1024x4	450ns	~~.99~~ .79
2114N-2L	1024x4	200ns Low Power	1.49
21C14	1024x4	200ns (CMOS)	.49
5101	256x4	450ns (CMOS)	~~2.95~~ 2.49
6116P-1	2048x8	100ns (16K) CMOS	~~3.95~~ 3.19
6116P-3	2048x8	150ns (16K) CMOS	~~3.49~~ 2.79
6116LP-1	2048x8	100ns (16K) LP CMOS	~~4.39~~ 3.59
6116LP-3	2048x8	150ns (16K) LP CMOS	~~3.95~~ 3.09
6264P-10	8192x8	100ns (64K) CMOS	~~9.95~~ 9.49
6264P-15	8192x8	150ns (64K) CMOS	~~8.25~~ 7.49
6264LP-10	8192x8	100ns (64K) LP CMOS	~~10.95~~ 10.25
6264LP-12	8192x8	120ns (64K) LP CMOS	~~9.49~~ 8.95
6264LP-15	8192x8	150ns (64K) LP CMOS	~~10.25~~ 7.95
6514	1024x4	350ns (CMOS)	~~3.75~~ 3.49
43256-10L	32,768x8	100ns (256K) Low Power	23.95
43256-15L	32,768x8	150ns (256K) Low Power	22.95
62256LP-85	32,768x8	85ns (256K) LP CMOS	26.95
62256LP-10	32,768x8	100ns (256K) LP CMOS	24.95
62256LP-12	32,768x8	120ns (256K) LP CMOS	24.25

DYNAMIC RAMS

THM91000L-10	1,048,576x9	100ns 1Megx9 SIP	~~399.95~~ 329.95
THM91000S-10	1,048,576x9	100ns 1Megx9 SIM	~~399.95~~ 299.95
THM91000L-80	1,048,576x9	80ns 1Megx9 SIP	~~419.95~~ 349.95
THM91000S-80	1,048,576x9	80ns 1Megx9 SIM	~~419.95~~ 339.95
TMS4416-12	16,384x4	120ns	~~7.75~~ 6.75
TMS4416-15	16,384x4	150ns	~~7.25~~ 6.25
4116-15	16,384x1	150ns (MM5290N-2)	~~1.89~~ 1.25
4128-15	131,072x1	150ns (Piggyback)	5.29
4164-100	65,536x1	100ns	3.49
4164-120	65,536x1	120ns	2.95
4164-150	65,536x1	150ns	2.59
41256-60	262,144x1	60ns	~~14.49~~ 11.99
41256-80	262,144x1	80ns	~~13.49~~ 10.19
41256-100	262,144x1	100ns	~~12.49~~ 9.75
41256-120	262,144x1	120ns	~~11.95~~ 8.95
41256-150	262,144x1	150ns	~~11.49~~ 8.49
41264-12	64Kx4	120ns Video RAM	19.95
41464-10	65,536x4	100ns	~~14.49~~ 11.95
41464-12	65,536x4	120ns	~~11.95~~ 9.95
41464-15	65,536x4	150ns	~~10.95~~ 8.95
51258-10	262,144x1	100ns Static Column	~~13.95~~ 11.95
85227-10PL	262,144x9	100ns 256Kx9 SIP	~~149.95~~ 119.95
85227-10PS	262,144x9	100ns 256Kx9 SIM	~~149.95~~ 119.95
511000P-10	1,048,576x1	100ns (1 Meg)	~~29.95~~ 25.95
511000P-80	1,048,576x1	80ns (1 Meg)	~~42.95~~ 35.95
511000P-85	1,048,576x1	85ns (1 Meg)	~~41.95~~ 33.95
514256P-10	262,144x4	100ns (1 Meg)	~~34.95~~ 29.95

EPROMS

TMS2516	2048x8	450ns (25V)	~~6.95~~ 5.95
TMS2532	4096x8	450ns (25V)	~~5.95~~ 4.95
TMS2532A	4096x8	450ns (12.5V)	~~4.49~~ 3.25
TMS2564	8192x8	450ns (25V)	~~6.95~~ 4.95
TMS2716	2048x8	450ns (−5V, +5, +12V)	~~6.95~~ 6.49
1702A	256x8	(1µs)	4.95
2708	1024x8	450ns	6.95
2716	2048x8	450ns (25V)	3.75
2716-1	2048x8	350ns (25V)	~~4.25~~ 3.95
27C16	2048x8	450ns (25V) CMOS	~~4.25~~ 3.75
2732	4096x8	450ns (25V)	3.95
2732A-20	4096x8	200ns (21V)	4.25
2732A-25	4096x8	250ns (21V)	3.95
27C32	4096x8	450ns (25V) CMOS	~~4.95~~ 4.25
2764-20	8192x8	200ns (21V)	4.25
2764-25	8192x8	250ns (21V)	3.59
2764-45	8192x8	450ns (21V)	3.39
2764A-25	8192x8	250ns (12.5V)	3.69
27C64-15	8192x8	150ns (12.5V) CMOS	5.95
27128-20	16,384x8	200ns (21V)	~~6.95~~ 6.49
27128-25	16,384x8	250ns (21V)	5.95
27128A-15	16,384x8	150ns (12.5V)	7.75
27128A-20	16,384x8	200ns (12.5V)	~~5.75~~ 5.25
27128A-25	16,384x8	250ns (12.5V)	~~5.25~~ 4.95
27C128-25	16,384x8	250ns (21V) CMOS	5.95
27256-15	32,768x8	150ns (12.5V)	8.95
27256-20	32,768x8	200ns (12.5V)	~~6.95~~ 6.25
27256-25	32,768x8	250ns (12.5V)	5.49
27C256-15	32,768x8	150ns (12.5V) CMOS	7.95
27C256-25	32,768x8	250ns (12.5V) CMOS	~~6.25~~ 5.49
27512-20	65,536x8	200ns (12.5V)	10.95
27512-25	65,536x8	250ns (12.5V)	9.95
27C512-25	65,536x8	250ns (12.5V) CMOS	~~10.25~~ 9.49
27C1024	131,072x8	200ns (12.5V) CMOS (1 Meg)	27.95

6500/6800 68000 Series

Part No.	Price
6502	2.65
65C02 (CMOS)	7.75
6520	1.95
6522	2.95
6532	~~5.49~~ 4.95
6551	2.95
65C802 (CMOS)	~~15.95~~ 14.75
6800	~~1.95~~ 1.49
6802	2.95
6810	~~1.25~~ .99
6821	1.75
6840	~~8.49~~ 2.95
6845	~~2.75~~ 2.49
6850	~~1.95~~ 1.49
6852	~~.75~~ .59
6854	~~1.19~~ .99
MC68000L8	9.95
MC68000L10	~~11.95~~ 10.95
MC68010L10	~~49.95~~ 39.95
MC68020RC12B	99.95
MC68701	14.95
MC68705P3S	~~9.95~~ 8.95
MC68705U3L	10.95
MC68705U3S	10.95
MC68450L10	49.95
MC68881RC12A	129.95

Commodore

WD1770	~~8.95~~ 7.49
S13052P	~~1.25~~ .99
6504A	1.19
6507	2.95
6510	12.95
6522	2.95
6525	~~4.95~~ 3.95
6526	~~14.95~~ 13.95
6526A	15.95
6532	~~5.49~~ 4.95
6545-1	3.95
6560	~~10.95~~ 8.95
6567	24.95
6569	~~15.95~~ 13.95
6572	~~10.95~~ 7.95
6581 (12V)	~~12.95~~ 10.49
6582 (9V)	~~14.95~~ 12.95
8502	7.95
8564	~~4.95~~ 2.95
8566	~~9.95~~ 7.95
8701	9.95
8721	~~14.95~~ 9.95
8722	~~18.95~~ 10.95
310654-05	9.95
318018-03	~~12.95~~ 10.95
318019-03	~~12.95~~ 10.95
*82S100PLA**	15.95
901225-01	~~15.95~~ 13.95
901226-01	~~15.95~~ 13.95
901227-03	15.95
901229-05	15.95

*No specs. available
**Note: 82S100PLA = U17 (C-64)

74C/CMOS

74C00	Sale	.19	74C174	Sale	.39
74C02	Sale	.19	74C175	Sale	.59
74C04	Sale	.19	74C192	Sale	.99
74C08	Sale	.19	74C194	Sale	.49
74C10	Sale	.15	74C221		1.79
74C14		.49	74C240	Sale	.75
74C32	Sale	.19	74C244		1.79
74C74		.49	74C373	Sale	1.49
74C85		1.49	74C374	Sale	1.49
74C86	Sale	.19	74C911		6.95
74C89		2.95	74C912	Sale	7.95
74C90		.99	74C915	Sale	1.19
74C151	Sale	1.49	74C917	Sale	3.95
74C154	Sale	2.75	74C920	Sale	3.95
74C157	Sale	1.25	74C921	Sale	2.95
74C160	Sale	.49	74C922		3.95
74C161	Sale	.49	74C923		3.95
74C162	Sale	.49	74C925		5.49
74C173		.59	74C926		5.95

MISC. COMPONENTS

TANTALUM CAPACITORS

TM1/35	1µf @ 35V	.19	TM4.7/35	4.7µf @ 35V	.45
TM1/35	1µf @ 35V	.19	TM6.8/35	6.8µf @ 35V	.49
TM2.2/35	2.2µf @ 35V	.25	TM10/35	10µf @ 35V	.59

POTENTIOMETERS

Values available (insert ohms into space marked "XX"): 500Ω, 1K, 2K, 5K, 10K, 20K, 50K, 100K, 200K, 1MEG

43PXX	¾ Watt, 15 Turn	.99	63PXX	½ Watt, 1 Turn	.89

TRANSISTORS AND DIODES

PN2222	.13	PN2907	.13	1N4004	.12
2N2222A	.29	2N4401	.12	1N4148	.07
2N3055	.65	1N270	.25	1N4735	.29
2N3904	.12	1N751	.15	C106B1	.49

SWITCHES

JMT123	SPDT, On-On	1.19	206-8	SPST, 16-pin DIP	1.25
MPC121	SPDT, On-Off-On	1.19	MS102	SPST, Momentary	.39

D-SUB CONNECTORS

DB25P	Male, 25-pin	.69	DB25S	Female, 25-pin	.75

LEDS

XC556R	T1¾, Red	.13	XC556Y	T1¾, Yellow	.17
XC556G	T1¾, Green	.17	XC556C	T1¾, Clear/Red	.17

IC SOCKETS

Low Profile		Wire Wrap (Gold) Level #2	
8LP	.11	8WW	.59
14LP	.12	14WW	.65
16LP	.13	16WW	.69
24LP	.25	24WW	1.19
28LP	.27	28WW	1.39
40LP	.29	40WW	1.89

Soldertail Standard (Gold & Tin) & Header Plug Sockets Also Available

74HC HI-SPEED CMOS

Part No.		Price	Part No.		Price
74HC00	SALE	.17	74HC175		.59
74HC02	SALE	.17	74HC221	SALE	.69
74HC04	SALE	.17	74HC240	SALE	.59
74HC08	SALE	.17	74HC244		.79
74HC10	SALE	.19	74HC245	SALE	.69
74HC14		.29	74HC253	SALE	.39
74HC30	SALE	.19	74HC259		.49
74HC32	SALE	.25	74HC273	SALE	.49
74HC74	SALE	.29	74HC373		.69
74HC75	SALE	.29	74HC374	SALE	.59
74HC76	SALE	.29	74HC595		1.29
74HC85		.55	74HC688	SALE	1.25
74HC86	SALE	.25	74HC943	SALE	7.95
74HC123	SALE	.49	74HC4040	SALE	.79
74HC125		.49	74HC4049	SALE	.25
74HC132	SALE	.39	74HC4050	SALE	.25
74HC138		.45	74HC4060	SALE	.69
74HC139	SALE	.35	74HC4511	SALE	.99
74HC154		1.49	74HC4514		1.79
74HC163	SALE	.39	74HC4538	SALE	.99
74HC174		.59	74HC4543	SALE	.99

74HCT — CMOS TTL

74HCT00	SALE	.15	74HCT139	SALE	.29
74HCT02	SALE	.15	74HCT157	SALE	.19
74HCT04	SALE	.17	74HCT174	SALE	.25
74HCT08	SALE	.15	74HCT175	SALE	.25
74HCT10	SALE	.15	74HCT240	SALE	.59
74HCT32	SALE	.17	74HCT244	SALE	.49
74HCT74	SALE	.25	74HCT245	SALE	.49
74HCT86	SALE	.15	74HCT373	SALE	.45
74HCT138		.39	74HCT374	SALE	.45

LINEAR

DS0026CN	1.95	LM1458N	.35
TL074CN	.99	LM1488N	.45
TL084CN	.89	DS14C88N (CMOS)	1.19
AF100-1CN	8.95	LM1489N	.45
LM307N	.39	DS14C89N (CMOS)	1.19
LM309K	1.25	LM1496N	.69
LM311N	.39	MC1648P	2.95
LM317T	.65	LM1871N	1.95
LM318N	.99	LM1872N	1.95
LM319N	1.29	LM1896N-1	1.49
LM323K	3.49	ULN2003A	.75
LM324N	.35	XR2206	3.95
LM338K	4.49	XR2211	2.95
LM339N	.39	XR2243	1.95
LF347N	1.49	26LS29	2.95
LM348N	.69	26LS31	.99
LM350T	2.95	26LS32	.99
LF351N	.39	26LS33	1.49
LF353N	.49	LM2901N	.25
LF355N	.79	LM2907N	1.29
LF356N	.79	LM2917N (8 pin)	1.79
LF357N	.89	MC3446N	.99
LM358N	.49	MC3450P	.49
LM360N	1.95	MC3470P	1.19
LM361N	1.49	MC3471P	.99
LM380N-8	.99	MC3479P	3.95
LM386N-3	.89	MC3486P	1.19
LM387N	1.09	MC3487P	.99
LM393N	.39	LM3900N	.49
LM399H	3.49	LM3905N	1.19
LF411CN	.79	LM3909N	.89
TL497ACN	1.49	LM3914N	1.79
NE540H (C540H)	.99	LM3916N	1.49
NE555V	.29	NE5532	.69
XRL555	.59	NE5534	.69
LM556N	.45	7805K (LM340K-5)	1.29
NE558N	.79	7812K (LM340K-12)	1.29
LM565N	.89	7815K (LM340K-15)	1.29
LM567V	.75	7805T (LM340T-5)	.45
NE592N	.75	7812T (LM340T-12)	.45
LM741CN	.29	7815T (LM340T-15)	.45
LM747CN	.49	7905K (LM320K-5)	1.35
MC1350P	.89	7905T (LM320T-5)	.49
MC1377P	2.29	75472	.49
MC1398P	4.95	75477	.89
LM1414N	.99	MC145106P	1.95
		MC145406P	2.95

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TEST EQUIPMENT

Metex Digital Multimeters

Metex General Specs:
- Handheld, high accuracy
- AC/DC Voltage, AC/DC Current, Resistance, Diodes, Continuity, Transistor hFE
- Manual ranging w/overload protection

M3650/B & M4650 only:
- Also measures frequency and capacitance

M4650 only:
- Data Hold Switch
- 4.5 Digit

M4650 Pictured

M3610	3.5 Digit Multimeter	$49.95
M3650	3.5 Digit w/Freq. & Capacitance	$69.95
M3650B	Same as M3650 w/Bargraph	$79.95
M4650	4.5 Dig. w/Freq., Capacitance and Data Hold Switch	$99.95

Metex Autoranging Jumbo Readout DMM

- AC/DC Voltage, AC/DC Current, Resistance, Diodes, Continuity and Frequency
- 3.75 Digit (.8" High)
- Ruggedized, Water-resistant case
- Easy-to-use pushbutton switches

M80 .... $59.95

Logic Pulser and Logic Monitor

Ideal for inspecting and repair of Logic Circuits

Logic Pulser (LP540):
- Generates "one-shot" pulse or continuous 5Hz pulse train
- Pulse repetition rate: 0.5pps/400pps
- Audible tone
- Compatible with: TTL, DTL, RTL, HTL, HINIL, MOS and CMOS ICs

LM20 Pictured

Logic Monitor (LM20):
- Tests 14 through 20 pin ICs
- Detachable, heavy-duty spring clip
- LED on or off indicates high or low level

LP540	Logic Pulser	$19.95
LM20	Logic Monitor	$49.95

Oscilloscope Probes

- Attenuation: x1 / x10
- Capacitance (LF180): 180pF / 22pF; (LF210): 40pF / 17pF

LF180 Pictured

LF180	40MHz Oscilloscope Probe	$19.95
LF210	100MHz Oscilloscope Probe	$29.95

Digital Logic Probes

PRB20 Pictured

- High, low and pulse indication
- 20MHz and 50MHz versions available
- Circuit powered w/ over/undervoltage indicators

PRB20	20MHz Logic Probe	$26.95
PRB20A	20MHz Audible Logic Probe	$33.95
PRB50	50MHz Logic Probe	$47.95

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- Male to female DB25 pin connectors
- Includes device wiring chart

MLA1 .... $29.95

Jameco IBM PC/XT 8MHz Turbo Compatible Kit With 256K RAM

- *Free! QAPLUS Diagnostic Software Included!*
- *Free! PC Write Word Processing Software Included!*
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- *360K Disk Drive*
- *Parallel Printer Port*
- *84-Key Keyboard*
- *Monochrome Amber Monitor*

JE3002	IBM Compatible PC/XT 8MHz Turbo Kit	$499.95
EZDOS	Digital Research MS/PC-DOS Comp. Operating System	$49.95
EZDOSP	Same as above with TrueBASIC	$69.95

IBM COMPATIBLE DISPLAY MONITORS

AMBER	12" Amber Mono	$99.95
CTX2410	14" RGB 640x200	$279.95
TM5154	EGA 14" 720x350	$399.95
JE1059	EGA Monitor & Card	$519.95
TM5155	14" Multiscan 800x560	$499.95
QC1478	14" VGA 720x480	$449.95
JE2055	VGA Monitor & Card	$649.95

QC1478 Pictured

JAMECO IBM PC/XT/AT COMPATIBLE CARDS

JE1050	Monochrome Graphics Card w/Parallel Printer Port (PC/XT/AT)	$59.95
JE1052	Color Graphics Card w/Parallel Printer Port (PC/XT/AT)	$49.95
JE1055	EGA Card w/256K Video RAM (PC/XT/AT)	$159.95
JE1071	Multi I/O Card w/Controller & Monochrome Graphics (PC/XT)	$119.95
JE1060	I/O Card w/Serial, Game, Printer Port & Real Time Clock (PC/XT)	$59.95
JE1061	RS232 Serial Half Card (PC/XT)	$29.95
JE1062	RS232 Serial Half Card (AT)	$34.95
JE1065	I/O Card w/Serial, Game and Parallel Printer Port (AT)	$59.95
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JE1041	20/40MB Hard Disk Controller Card (PC/XT)	$79.95
JE1043	360K/720K/1.2MB/1.44MB Floppy Disk Controller Card (PC/XT/AT)	$49.95
JE1044	360K Floppy/Hard Disk Controller Card (PC/XT)	$129.95
JE1045	360K/720K/1.2MB/1.44MB Floppy/Hard Disk Controller Card (AT)	$149.95

SEAGATE HALF-HEIGHT HARD DISK DRIVES

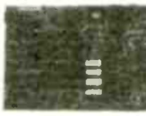
ST225	20MB Drive only (PC/XT/AT)	$224.95
ST225XT	20MB w/Controller (PC/XT)	$269.95
ST225AT	20MB w/Controller (AT)	$339.95
ST238	30MB Drive only (PC/XT/AT)	$249.95
ST238XT	30MB w/Controller (PC/XT)	$299.95
ST238AT	30MB w/Controller (AT)	$389.95

ST225XT Pictured

Seagate 40MB and 60MB Hard Disk Drives Also Available!

IBM PC/XT/AT COMPATIBLE MOTHERBOARDS

JE1001	4.77/8MHz (PC/XT)	$89.95
JE1002	4.77/10MHz (PC/XT)	$109.95
JE3005	Baby 8/12MHz (AT)	$329.95
JE3010	Baby 8/16MHz *NEAT* (AT)	$469.95
JE3020	Baby 16MHz 80386 (AT)	$1199.95
JE3025	Baby 20MHz 80386 (AT)	$1499.95
JE3026	Full-Size 25MHz 80386 (AT)	$2299.95



JE3025 Pictured

IBM PC/XT/AT COMPATIBLE 3.5"/5.25" DISK DRIVES

352KU	3.5" 720KB (PC/XT/AT)	$109.95
356KU	3.5" 1.44MB (PC/XT/AT)	$129.95
JE1020	5.25" 360KB (PC/XT/AT) Black	$89.95
JE1021	5.25" 360KB (PC/XT/AT) Beige	$89.95
JE1022	5.25" 1.2MB (PC/XT/AT) Beige	$99.95

JE1022 Pictured

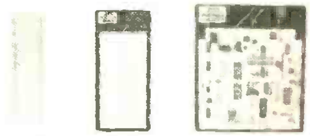
IBM PC/XT/AT COMPATIBLE INTERNAL MODEMS

1200H	1200/300 Baud Internal Modem w/MaxiMite Comm. Software (PC/XT/AT)	$69.95
2400H	2400/1200/300 Baud Internal Modem w/MaxiMite Comm. Stwr. (PC/XT/AT)	$129.95

External Modems and Pocket-Size Modem Also Available!

PROTOTYPING PRODUCTS

Jameco Solderless Breadboards



JE23 JE24 JE27

Part No.	Dim. L" x W"	Contact Points	Binding Posts	Price
JE20	6.5x.75	200	0	$1.95
JE21	3.25x2.125	400	0	$4.95
JE22	6.5x1.325	630	0	$5.95
JE23	6.5x2.125	830	0	$7.95
JE24	6.5x3.125	1,360	2	$12.95
JE25	6.5x4.25	1,660	3	$19.95
JE26	6.875x5.75	2,390	4	$24.95
JE27	7.25x7.5	3,220	4	$34.95

DATAK Photo Etch PCB Kit

Make your own circuit boards!

The ER4 photo etch kit contains all the chemicals necessary for any hobbyist, engineer or student to create professional circuit boards. Contains: Print frame, photo copy film, resist developer, etch resist, 2 copper circuit boards, concentrated etchant, film developer and fixer, resist patterns and complete instructions.

ER4 Photo Etch PCB Kit $34.95

Jameco Prototype PC Boards

Specs: Laminated glass epoxy .062" thick 2 oz. copper clad with solder tin finish. All holes are .042" dia. on .10" x .10" grid pattern

JE401 Pictured

JE401	4.5"x6.5" 1-sided 3-hole pad pattern	$9.95
JE403	4.5"x6.5" 1-sided pwr & gnd busses	$9.95
JE405	4.5"x6.5" 1-sided general purpose	$9.95
JE407	5"x13.25" 2-sided general purpose	$19.95
JE417	4.2"x6.5" PC/XT 1/2 card proto board	$19.95
JE421	4.75"x3.7" IBM PC/XT Card Extender	$19.95

ENGINEERING/DATA BOOKS

21035	Sams TTL Cookbook (88)	$14.95
21398	Sams CMOS Cookbook (88)	$19.95
22453	Sams Op-Amp Cookbook (88)	$21.95
270645	Intel 8-bit Controller Hndbk (89)	$19.95
270646	Intel 16-bit Controller Hndbk (89)	$19.95
270647	Intel 32-bit Controller Hndbk (89)	$19.95
400041	NSC Linear Data Book Vol 1 (88)	$14.95
400042	NSC Linear Data Book Vol 2 (88)	$9.95
400043	NSC Linear Data Book Vol 3 (88)	$9.95
ICM89	1989 IC Master (3 Volume Set)	$129.95

EDUCATIONAL KITS

JE310/315: Fiber optics kits demonstrate the principles of fiber optic system design. Complete step-by-step instructions, theory of operation and tutorial info. incl.

JE2206 Pictured

JE2206: Function generator kit provides three basic waveforms: sine, triangle and square wave. Frequency range: 1Hz to 100kHz

JE310	Fiber Optics Experimenter Kit	$19.95
JE315	Advanced Fiber Optics Kit	$29.95
JE2206	Function Generator Kit	$19.95

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EPROMS

PART	SIZE	SPEED	Vpp	PRICE
2708	1024x8	450ns	25V	4.95
2716	2048x8	450ns	25V	3.49
2716-1	2048x8	350ns	25V	3.95
2732	4096x8	450ns	25V	3.95
2732A	4096x8	250ns	21V	3.95
27C64	8192x8	250ns	12.5V	4.95
2764	8192x8	450ns	12.5V	3.49
2764-250	8192x8	250ns	12.5V	3.69
2764-200	8192x8	200ns	12.5V	4.25
27128	16384x8	250ns	12.5V	4.95
27128A-200	16384x8	200ns	12.5V	5.95
27C256	32768x8	250ns	12.5V	7.95
27256	32768x8	250ns	12.5V	5.95
27256-200	32768x8	200ns	12.5V	7.95
27512	65536x8	250ns	12.5V	11.95
27C512	65536x8	250ns	12.5V	12.95
27C101-20	131072x8	200ns	12.5V	34.95

■ CALL TO CONFIRM CURRENT PRICES ■

STATIC RAMS

PART	SIZE	SPEED	PRICE
2114	1024x4	450ns	.99
2114L-2	1024x4	200ns	1.49
TC5516	2048x8	250ns	3.95
TMM2016-200	2048x8	200ns	3.25
TMM2016-150	2048x8	150ns	3.29
TMM2016-100	2048x8	100ns	4.29
HM6116-4	2048x8	200ns	4.95
HM6116-3	2048x8	150ns	5.95
HM6116-2	2048x8	120ns	6.45
HM6116LP-4	2048x8	200ns	5.95
HM6116LP-3	2048x8	150ns	6.45
HM6116LP-2	2048x8	120ns	6.95
HM6264LP-15	8192x8	150ns	9.95
HM6264LP-12	8192x8	120ns	10.95
HM43256LP-15	32768x8	150ns	17.95
HM43256LP-12	32768x8	120ns	19.95
HM43256LP-10	32768x8	100ns	24.95

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DYNAMIC RAMS

PART	SIZE	SPEED	PRICE
4116-200	16384x1	200ns	.89
4116-150	16384x1	150ns	.99
4164-150	65536x1	150ns	2.89
4164-120	65536x1	120ns	3.19
4164-100	65536x1	100ns	3.95
TMS4416	16384x4	150ns	8.95
41128-150	131072x1	150ns	5.95
TMS4464-15	65536x4	150ns	14.95
TMS4464-12	65536x4	120ns	15.95
41256-150	262144x1	150ns	7.99
41256-120	262144x1	120ns	8.49
41256-100	262144x1	100ns	8.79
41256-80	262144x1	80ns	9.49
MK4332	32768x1	200ns	6.95
HM51258-100	262144x1	100ns	13.95
1 MB-120	1048576x1	120ns	24.95
1 MB-100	1048576x1	100ns	27.95

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CO-PROCESSORS

8087	5 MHz	97.95
8087-2	8 MHz	139.95
8087-1	10 MHz	189.95
80287	6 MHz	157.96
80287-8	8 MHz	219.95
80287-10	10 MHz	264.95
80387-16	16 MHz	397.95
80387-SX	16 MHz	389.95
80387-20	20 MHz	469.95
80387-25	25 MHz	589.95

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■ ERASES MOST EPROMS/EPLD'S IN 3 MINUTES ■ ALL SIZES UP TO 4 AT A TIME
DATARASE II

SPECTRONICS CORPORATION

Model	Timer	# of Chips	Intensity (uW/Cm²)	Unit Cost
PE-140	NO	9	8,000	$ 89
PE-140T	YES	9	8,000	$139
PE-240T	YES	12	9,600	$189
PL-265	YES	30	9,600	$255

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AN EXCELLENT VALUE! GIVE YOUR SYSTEM EXTRA SPEED AND STORAGE SPACE. THESE HIGH-QUALITY MAXTOR DRIVES ARE BUILT FOR YEARS OF DEPENDABLE SERVICE—THEY HAVE A FIELD-PROVEN MTBF (MEAN TIME BETWEEN FAILURES) OF NEARLY 8 YEARS.

MB	MODEL	AVG. SPEED	INTERFACE	PRICE
120MB	XT-1140	27MS	ST-506	$1595
160MB	XT-2190	29MS	ST-506	$1695
340MB	XT-4380S	18MS	SCSI	$2395

PARTIAL LISTINGS ONLY! CALL FOR COMPLETE CATALOG

74 SERIES LOGIC

7400

7400	.19
7402	.19
7404	.19
7405	.25
7406	.29
7407	.29
7408	.24
7410	.19
7411	.25
7414	.49
7416	.25
7417	.25
7420	.19
7432	.29
7447	.89
7473	.34
7474	.33
7475	.45
7476	.35
7586	.35
7489	2.15
7490	.39
7493	.35
74121	.29
74123	.49
74151	.55
74154	1.49
74157	.55
74166	1.00

74LS00

74LS00	.16
74LS02	.17
74LS03	.18
74LS04	.16
74LS05	.18
74LS08	.18
74LS10	.16
74LS11	.22
74LS14	.39
74LS20	.17
74LS21	.22
74LS27	.23
74LS30	.17
74LS32	.18
74LS38	.26
74LS42	.39
74LS47	.75
74LS51	.17
74LS73	.29
74LS74	.24
74LS75	.29
74LS76	.29
74LS83	.49
74LS85	.49
74LS86	.22
74LS90	.39
74LS92	.49
74LS93	.39
74LS109	.36
74LS112	.29
74LS123	.49
74LS125	.39
74LS132	.39
74LS138	.39
74LS139	.39
74LS151	.39
74LS153	.39
74LS154	1.49
74LS155	.59
74LS156	.49
74LS157	.35
74LS158	.29
74LS161	.39
74LS163	.39
74LS164	.49
74LS165	.65
74LS166	.95
74LS175	.39
74LS192	.69
74LS193	.69
74LS197	.59
74LS221	.59
74LS240	.69
74LS241	.69
74LS244	.69
74LS245	.79
74LS251	.49
74LS257	.39
74LS258	.49
74LS259	1.29
74LS260	.49
74LS273	.79
74LS279	.39
74LS322	3.95
74LS323	2.49
74LS367	.39
74LS373	.79
74LS374	.79
74LS377	.79
74LS393	.79
74LS541	1.49
74LS670	.89
74LS682	3.20
74LS688	2.40

74S

74S00	.29
74S02	.29
74S04	.29
74S74	.49
74S86	.35
74S112	.50
74S287	1.69
74S288	1.69
74S374	1.69
S32	.35
S138	.79
S240	1.49
S244	1.49
S373	1.69

74F

74F00	.35
74F04	.35
74F08	.35
74F32	.35
74F74	.39
74F138	.79
74F244	1.29

74HC

74HC00	.21
74HC04	.25
74HC08	.25
74HC14	.35
74HC32	.35
74HC74	.35
74HC138	.45
74HC139	.45
74HC154	1.09
74HC157	.55
74HC244	.85
74HC245	.85
74HC373	.69
74HC374	.69

74HCT

74HCT00	.25
74HCT04	.27
74HCT08	.25
74HCT32	.27
74HCT138	.35
74HCT240	.89
74HCT244	.89
74HCT245	.99
74HCT373	.99
74HCT374	.99

SIMM MODULES

41256A8B-15	256K x 8-BIT	FOR MAC	150ns	$89.00
41256A8B-12	256K x 8-BIT	FOR MAC	120ns	$95.00
41256A8B-10	256K x 8-BIT	FOR MAC	100ns	$99.00
41256A9B-15	256K x 9-BIT	FOR PC	150ns	$94.00
41256A9B-12	256K x 9-BIT	FOR PC	120ns	$99.00
41256A9B-10	256K x 9-BIT	FOR PC	100ns	$109.00
41256A9B-80	256K x 9-BIT	FOR PC	80ns	$119.00
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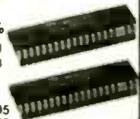

V20	5 MHz	6.95	V20	8 MHz	8.95
V20	10 MHz	11.95	V30	8 MHz	13.95

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16L8	$2.95	20R4	$4.95
16R8	2.95	20R6	4.95
16R6	2.95	20R8	4.95
16R4	2.95	20X8	4.95
20L8	4.95		

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6502	2.25
6502A	2.69
6502B	4.25
65C02*	7.95
6522	2.95
6526	13.95
6532	5.95
6551	2.95
6581	14.95

* CMOS

6800

6800	1.95
6802	2.95
68B02	3.95
6803	3.95
6809	2.95
68B09	5.99
6809E	2.95
68B09E	5.49
6808	2.49
6810	1.95
6821	1.25
68B21	1.85
6840	3.95
6845	2.75
6847	4.75
6850	1.95
68B50	1.75
6852	4.95
6883	22.95
68000	9.95
68020	189.95

8000

8031	3.95
8035	1.49
8039	1.95
8052AH BASIC	34.95
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8085	1.95
8085A-2	3.75
8088	5.99
8088-2	7.95
8155	2.49
8155-2	3.95
8156	2.95
8741	9.95
8748	7.95
8749	9.95
8755	14.95

8200

8205	3.29
8212	1.49
8216	1.49
8224	2.25
8228	2.25
8237	3.95
8237-5	4.75
8238	4.49
8243	1.95
8250	6.95
8251	1.29
8251A	1.69
8253	1.59
8253-5	1.95

8200

8254	2.79
8255	1.99
8255-5	2.49
8256	15.95
8259	1.95
8259-5	2.29
8272	4.39
8274	4.95
8275	16.95
8279	2.49
8279-5	2.95
8282	3.95
8283	3.95
8284	2.25
8286	3.95
8287	3.95
8288	4.95

Z-80

Z80-CPU	1.25
Z80A-CPU	1.29
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Z80B-CTC	4.25
Z80A-DART	5.95
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Z80A-DMA	5.95
Z80A-PIO	1.89
Z80B-PIO	4.25
Z80A-SIO/0	5.95
Z80A-SIO/1	5.95
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LINEAR COMPONENTS

TL071	.69	TL497	3.25	MC3487	2.95
TL072	1.09	NE555	.29	LM3900	.49
TL084	1.49	NE556	.49	LM3909	.98
LM301	.34	NE558	.79	LM3914	1.89
LM309K	1.25	LM565	.95	IC7760	1.99
LM311	.59	LM567	.79	7805T	.49
LM311K	3.49	NE570	2.95	7808T	.49
LM317T	.69	NE590	2.50	7812T	.49
LM318	1.49	LM723	.49	7815T	.49
LM319	1.25	LM741	.29	7905T	.59
LM323K	3.49	MC1330	1.69	7912T	.59
LM324	.34	MC1350	1.19	7915T	.59
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LM336	1.75	LM1488	.49	ICL8038	3.85
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LM358	.59	XR2211	2.95	75188	1.25
LM380	.89	CA3046	.89	75189	1.25
LM386	.89	CA3146	1.29	75451	.39
LM393	.45	MC3470	1.95	75452	.39

MISC.

ADC0804	2.99
ADC0809	3.85
DAC0800	3.29
DAC0808	1.95
1793	9.95
8272	4.39
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AY5-1013	3.95
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MM58167	9.95
MM58174	9.95
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IM6403	9.95
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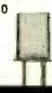
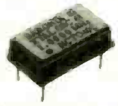
32.768 KHz	.95
1.0 MHz	2.95
1.8432	2.95
2.0	1.95
2.4576	1.95
3.579545	1.95
4.0	1.95
5.0688	1.95
6.0	1.95
8.0	1.95
10.0	1.95
12.0	1.95
14.31818	1.95
16.0	1.95
18.0	1.95
20.0	1.95
22.1184	1.95
24.0	1.95



CRYSTAL OSCILL.

1.0MHz	5.95
1.8432	5.95
2.0	5.95
2.4576	5.95
4.0	4.95
5.0688	4.95
8.0	4.95
10.0	4.95
14.31818	1.95
16.0	4.95
18.432	4.95
20.0	4.95
24.0	4.95

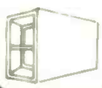


STD. CMOS LOGIC

4001	.19	4050	.29
4011	.19	4051	.69
4013	.35	4060	.69
4015	.29	4066	.29
4016	.29	4069	.19
4017	.49	4093	.49
4024	.49	14411	9.95
4040	.69	4511	.69
4046	.69	4538	.95
4049	.29	4702	9.95

SHORTING BLOCKS

5/$1.00



DISCRETE

1N751	.49	2N3904	.10
IN4004	10/1.00	2N3906	.10
IN4148	25/1.00	2N4401	.25
KBP02	.55	4N26	.69
2N2222	.10	4N35	.89
2N2907	.25	JMBO RED	.10
2N3055	.79	JMBO GRN	.14

BYPASS CAPS

CERAMIC DISC:
.01UF 100/5.00
.1UF 100/6.50
MONOLITHIC:
.01UF 100/10.00
.1UF 100/12.50

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CIRCLE 113 ON FREE INFORMATION CARD

POWER SUPPLIES

135 WATT POWER SUPPLY
- UL APPROVED
- +5V @15A, +12V @ 4.2A, -5V @ .5A, -12V @ .5A

PS-135 $59.95
PS-150 150W SUPPLY $69.95

200 WATT POWER SUPPLY
- UL APPROVED
- +5V @ 20A, +12V @ 7A, -5V @ .5A, -12V @ .5A

PS-200 $89.95

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- WITH APPLE CONNECTOR
- +5V @ 6A, +12V @ 3A, -5V @ 1A, -12V @ 1A

PS-A $49.95

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- +5V @2.5A, +12V @1.5A
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- SELECTABLE 110V-220V

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- OIL-FREE VACUUM PUMP
- TEMP ADJUSTS (212°F-900°F) & VACUUM (0-60 CM/HG)
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XY999D DESOLDER ONLY $349.99

DELUXE SOLDER STATION
- ROTARY SWITCH TEMP CONTROL (200°F-878°F RANGE)
- LED TEMPERATURE READOUTS
- INCLUDES COOLING TRAY

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- TIP TEMPERATURE READOUT
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FOR AT

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FOR PS/2

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- WIDE BAND WIDTH ■ VARIABLE HOLDOFF

MODEL-3500 (SHOWN) $499.95

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- TV SYNC FILTER ■ COMPONENTS TESTER

MODEL 2000 $389.95

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- AUTORANGING ■ AC/DC 2V - 500V, RESIS. 2K-2M

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3.5 DIGIT POCKET SIZE DMM
- BASIC DC ACCURACY ±0.5% ■ 14 RANGES

DMM-100 $29.95

3.5 DIGIT FULL FUNCTION DMM
- BASIC DC ACCURACY ±0.25% ■ 22 RANGES

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THE ULTIMATE 3.5 DIGIT DMM
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TYPE	# OF POS.	PARALL	SERIAL	PRICE
PUSHBTTN.	2-WAY	AB-P	AB-S	39.95
ROTARY	2-WAY	RSP-2	RSS-2	24.95
ROTARY	3-WAY	RSP-3	RSS-3	27.95
ROTARY	4-WAY	RSP-4	RSS-4	29.95

EXTENDER CARDS

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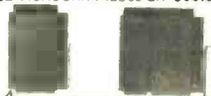
EXT-8088 XT COMPATIBLE $29.95
EXT-80286 AT COMPATIBLE $39.95
EXT-16 MICROCHANNEL 16-BIT $69.95
EXT-32 MICROCHANNEL 32-BIT $99.95



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CBL-PRINTER PC PRINTER CABLE 9.95
CBL-PRINTER-25 AS ABOVE 25 FT. 15.95
CBL-PRINTER-RA RT. ANGL. PRINTER 15.95
CBL-DB25-MM DB25 MALE-MALE 9.95
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CBL-9-SERIAL 9 PIN-25 PIN SERIAL 6.95
CBL-KBD-EXT KEYBOARD EXTEN. 7.95
CBL-CNT-MM 36 PIN CENTRON. M/M 14.95
CBL-HD-20 20 PIN HARD DISK 3.95
CBL-HD-34D 34 PIN DUAL HARD DISK 6.95
CBL-FDC-EXT 37 PIN EXT. FLOPPY 9.95
CBL-MNT-9 9 PIN MONITOR EXTEN. 6.95
CBL-MODEM DB25-DB25 FEMALE 7.95

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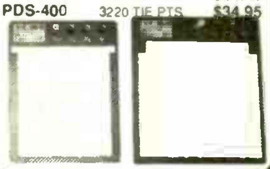
PDS-200 1660 TIE PTS $19.95
PDS-300 2390 TIE PTS $24.95
PDS-400 3220 TIE PTS $34.95



IDC CONNECTORS/RIBBON CABLE

DESCRIPTION	ORDER BY	CONTACTS					
		10	20	26	34	40	50
SOLDER HEADER	IDHxxS	.82	1.29	1.68	2.20	2.58	3.24
RIGHT ANGLE SOLDER HEADER	IDHxxSR	.85	1.35	1.76	2.31	2.72	3.39
WIREWRAP HEADER	IDHxxW	1.86	2.98	3.84	4.50	5.28	6.63
RIGHT ANGLE WIREWRAP HEADER	IDHxxWR	2.05	3.28	4.22	4.45	4.80	7.30
RIBBON HEADER SOCKET	IDSxx	.63	.89	.95	1.29	1.49	1.69
RIBBON HEADER	IDMxx	–	5.50	6.25	7.00	7.50	8.50
RIBBON EDGE CARD	IDExx	.85	1.25	1.35	1.75	2.05	2.45
10' RIBBON CABLE	RCxx	1.60	3.20	4.10	5.40	6.40	7.50

FOR ORDERING INSTRUCTIONS, SEE D-SUBMINIATURE CONNECTORS BELOW

RS-232 BREAKOUT BOX

FOR TROUBLESHOOTING SERIAL COMMUNICATIONS

- OPEN/CLOSE INDIVIDUAL CIRCUITS ■ 20 JUMPERS CROSS-CONNECT ANY TWO CIRCUITS ■ 10 CIRCUIT ACTIVITY LEDS

GENDER-BO $34.95

PC BREADBOARD

- 62 CLEARLY LABELLED BUS LINES
- ACCEPTS UP TO 24 14-PIN ICS
- 1940 TIE POINTS
- EXT FEMALE DB25 D-SUB CONNECT

PDS-604 $49.95

D-SUBMINIATURE CONNECTORS

DESCRIPTION		ORDER BY	CONTACTS					
			9	15	19	25	37	50
SOLDER CUP	MALE	DBxxP	.45	.59	.69	.69	1.35	1.85
	FEMALE	DBxxS	.49	.69	.75	.75	1.39	2.29
RIGHT ANGLE PC SOLDER	MALE	DBxxPR	.49	.69	–	.79	2.27	–
	FEMALE	DBxxSR	.65	.75	–	.85	2.49	–
WIREWRAP	MALE	DBxxPWW	1.69	2.56	–	3.89	5.60	–
	FEMALE	DBxxSWW	2.76	4.27	–	6.84	9.95	–
IDC RIBBON CABLE	MALE	IDBxxP	1.39	1.99	–	2.25	4.25	–
	FEMALE	IDBxxS	1.45	2.05	–	2.35	4.49	–
HOODS	METAL	MHOODxx	1.05	1.15	1.25	1.25	–	–
	PLASTIC	HOODxx	.39	.39	–	.39	.69	.75

ORDERING INSTRUCTIONS: INSERT THE NUMBER OF CONTACTS IN THE POSITION MARKED "xx" OF THE "ORDER BY" PART NUMBER LISTED. EXAMPLE : A 15 PIN RIGHT ANGLE MALE PC SOLDER WOULD BE DB15PR

MOUNTING HARDWARE .59

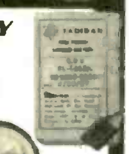
SURGE SUPPRESSOR

PROTECTS YOUR EQUIPMENT!

- SIX 3-PRONG AC OUTLETS
- 15 AMP CIRCUIT BREAKER
- 6' HEAVY DUTY CORD
- 15 AMP MAX LOAD, 1875 WATTS
- UL APPROVED

POWER-SURGE $12.95
POWER-STRIP W/O SURGE $9.95

LITHIUM BATTERY

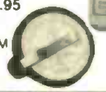


- 6V FOR 286 AND 386 PCS
- MOTHERBOARD CONNECTOR
- ADHESIVE VELCRO MOUNTING STRIP

LITHIUM6.6V $11.95

COIN TYPE BATTERY
LONG-LASTING 3V LITHIUM

3V-MHW $1.95
HOLDER $1.49



GENDER CHANGERS

GENDER-FF FEMALE-FEMALE $7.95
GENDER-MM MALE-MALE $7.95
GENDER-MF MALE-FEMALE $7.95
GENDER-NM NULL MODEM $8.95
GENDER-JB JUMPER BOX $8.95
GENDER-MT MINITESTER $14.95
GENDER-VGA DB9-DB15 $19.95
GENDER-9-25 DB9-DB25 $4.95

IC SOCKETS/DIP CONNECTORS

DESCRIPTION	ORDER BY	CONTACTS								
		8	14	16	18	20	22	24	28	40
SOLDERTAIL SOCKETS	xxST	.11	.11	.12	.15	.18	.15	.20	.22	.30
WIREWRAP SOCKETS	xxWW	.59	.69	.69	.99	1.09	1.39	1.49	1.69	1.99
ZIF SOCKETS	ZIFxx	–	4.95	4.95	–	5.95	–	5.95	6.95	9.95
TOOLED SOCKETS	AUGATxxST	.62	.79	.89	1.09	1.29	1.39	1.49	1.69	2.49
TOOLED WW SOCKETS	AUGATxxWW	1.30	1.90	2.10	2.40	2.50	2.90	3.15	3.70	5.40
COMPONENT CARRIERS	ICCxx	.49	.59	.69	.99	.99	.99	.99	1.09	1.49
DIP PLUGS (IDC)	IDPxx	.95	.49	.59	1.29	1.49	–	.85	1.49	1.59

FOR ORDERING INSTRUCTIONS SEE D-SUBMINIATURE CONNECTORS ABOVE

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FLOPPY DRIVE FOR APPLE II SERIES
AP-150 (W/CABLE, CONNECTOR) $99.95

REPLACEMENT KEYBOARD FOR APPLE II & II+
KEYBOARD-AP $59.95

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SNAP APART TO MAKE ANY SIZE HEADER, WITH .1" CENTERS

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2 X 40 RIGHT ANGLE LEAD $2.99

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- HAYES COMPATIBILITY ■ 1/2 CARD ■ AUTO DIAL/ANSWER
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- CALL PROGRESS MONITORING ■ ADJUSTABLE VOLUME

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INTERNAL MODEMS (MIRROR II SOFTWARE INCLUDED)

PRO-12I	1200 BAUD 1/2 CARD	$69.95
PRO-24M	2400 BAUD FOR PS/2	$249.95

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PRO-24E	2400 BAUD	$169.95
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400 DPI **$199.95**

- INSTANTLY SCANS UP TO 4.1" WIDE IMAGES ■ 100, 200, 300, 400 DPI BOTH DIRECTIONS ■ B&W & 3 HALF-TONE MODES ■ 32 LEVELS OF GRAY SCALE ■ HERCULES, CGA, EGA AND VGA COMPATIBLE
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HS-3000
OCR-SOFT SOFTWARE $99.95

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SPACESAVING DESIGN HOLDS ALL SIZES OF MOTHERBOARDS. INCLUDES
- 250W POWER SUPPLY ■ MOUNTS FOR 3 FLOPPY & 4 HARD DRIVES
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CASE-FLIP	FOR 8088 BOARDS	$39.95
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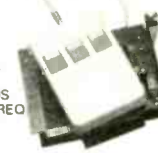

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- NO PAD, POWER SUPPLY OR PORT REQ

LMOUSE-BH

LOGITECH 3 BUTTON MOUSE

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LMOUSE-BP	BUS MOUSE W/LOGIPAINT	$89.95
LMOUSE-BPBL	BUS MOUSE W/PUBLISHER PKG	$129.95
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- 800 X 560 MAX. RESOLUTION ■ 640 X 480 IN 16 COLORS
- 320 X 200 IN 256 COLORS ■ IBM STYLE MONITOR
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NEW LOW PRICES!

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40MB	ST-251	40 MS	5-1/4"	$379
40MB	ST-251-1	28 MS	5-1/4"	$469
60MB RLL	ST-277	40 MS	5-1/4"	$449
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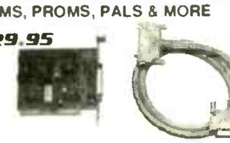

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- SELECTABLE ADDRESSES PREVENTS CONFLICTS
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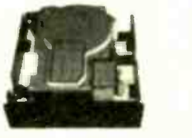

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With 60W power supply (fan cooled).
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2 floppy drives .... #10005/17171
1 hard drive .... #19704
& 1 floppy .... #10005
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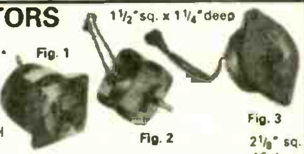

Fig. 1 — 2"L x 2 1/4" dia. x 2 1/4"H
Fig. 2 — 1 1/2" sq. x 1 1/4" deep
Fig. 3 — 2 1/8" sq. x 1" deep

Item No.	Step Angle	DC Voltage	Torque oz/in.	Type	Mfr. & Part No.	Fig.	Price
7630	1.8°	3.0	200	PM	Superior MO92-FT-402	1	$34.50 ea. 2 for $59.50
16410	1.8°	12.0	700*	PM	Applied Motion 4017-839	2	$9.95 ea. 2 for $14.95
16406	3.6°	12.0	700*	PM	Applied Motion 4017-838	2	$9.95 ea. 2 for $14.95
7014	7.5°	12.0	900*	PM	Mitsubishi 55SI-25DAYA	3	$10.95 ea. 2 for $19.95

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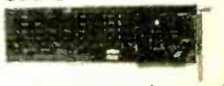

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Major Mfrs. Item #9307 *RFE* – **$1.50**

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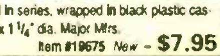

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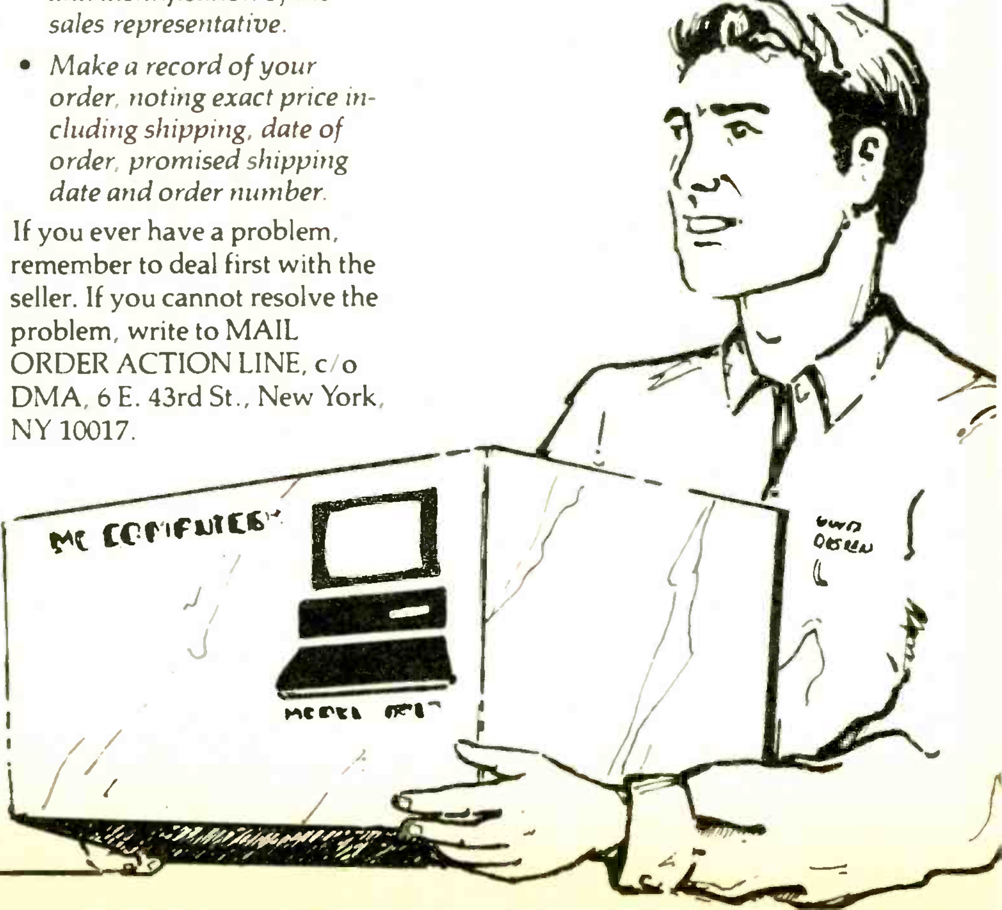

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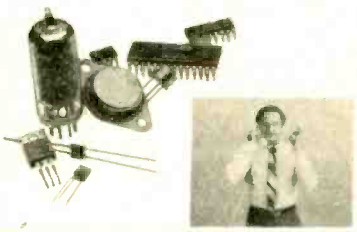

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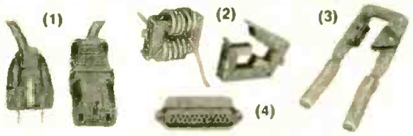

Fig.	Description	Cat. No.	Price
1	6-Ft. Grounded AC Power Cord	278-1257	3.99
2	"Snap" Toroid Choke Cores (2)	273-104	6.95
3	IDC Installation Tool	276-1596	12.95
4	Male D-Sub 25 Connector	276-1559	3.99
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—	36-Position IDC Male	276-1533	4.99
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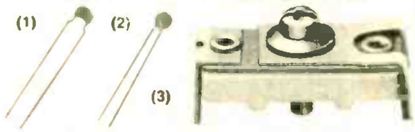
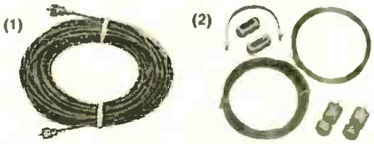


(1) **0.1 μF Monolithics.** 50 WVDC. High capacity in a tiny size—ideal for on-board noise cleanup. #272-109 .... Pkg. of 5/1.79
(2) **Low-pF Assortment.** 50 ceramic discs, hard-to-find values from 1 to 33 pF. 50 WVDC. #272-806 .... Pkg. of 50/2.99
(3) **95-420 pF Trimmer.** #272-1336 .... 1.69

Antenna Components



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(2) **Shortwave Antenna Kit.** 75 feet of copper antenna wire, 50 feet of lead-in, window feed-through and insulators. #278-758 .... 8.49

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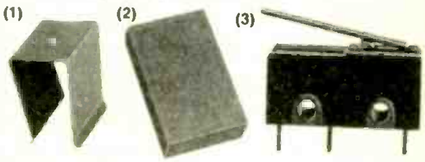
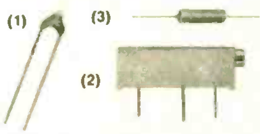


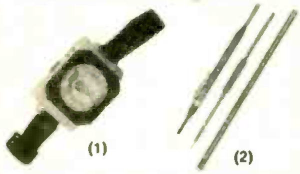
(1) **9V Battery Holders.** #270-326 .... 2/69¢
(2) **Case.** For a controller, beeper, small portable device. 3¾ x 2$\frac{5}{16}$ x 1". Removable end panel. #270-293 .... 3.99
(3) **SPDT Lever Switch.** #275-016 .... 1.69

Resistor Values



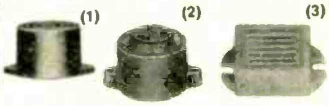
(1) **Precision Thermistor.** Range: −50 to +110° C. #271-110 .... 1.99
(2) **15-Turn Trimmer Pots.** Select from 1k, #271-342. 10k, #271-343. 20k, #271-340 .... Each 1.49
(3) **8-Ohm Non-Inductive Resistor.** 20W. #271-120 .... 1.39

Bench Helpers



(1) **Head Light.** Really handy—puts light where you look! Comfortable band. #61-2510 .... 3.99
(2) **Anti-Static TV/RF Alignment Tool Set.** #64-2230 .... 3.99

Chime and Buzzers



(1) **Electronic Chime.** Delivers pleasant "ding-dong" output. #273-071 .... 8.69
(2) **Two-Tone Piezo Alerter.** For 6 to 18VDC. Extra-loud. #273-070 .... 9.95
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12	273-055	1.99

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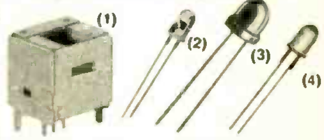
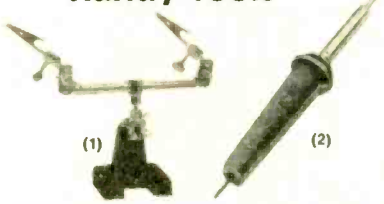


(1) **Infrared Detector Module.** Built-in amp. 5VDC. #276-137 .... 3.49
(2) **SEP8703-1 Infrared LED.** Low power and high output. #276-143 .... 1.69
(3) **Blinking Red LED.** Super indicator! #276-036 .... 1.29
(4) **Blinking Green LED.** 1 Hz flash rate. #276-030 .... 1.29

Handy Tools



(1) **Adjustable Project Holder.** For easier soldering, gluing and assembly. #64-2093 .... 7.99
(2) **Dual-Wattage Soldering Iron.** Go from 15 to 30 watts with the flick of a switch. Replaceable tip. 8¼" long. #64-2055 .... 8.95

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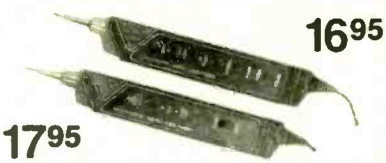

16.95

17.95

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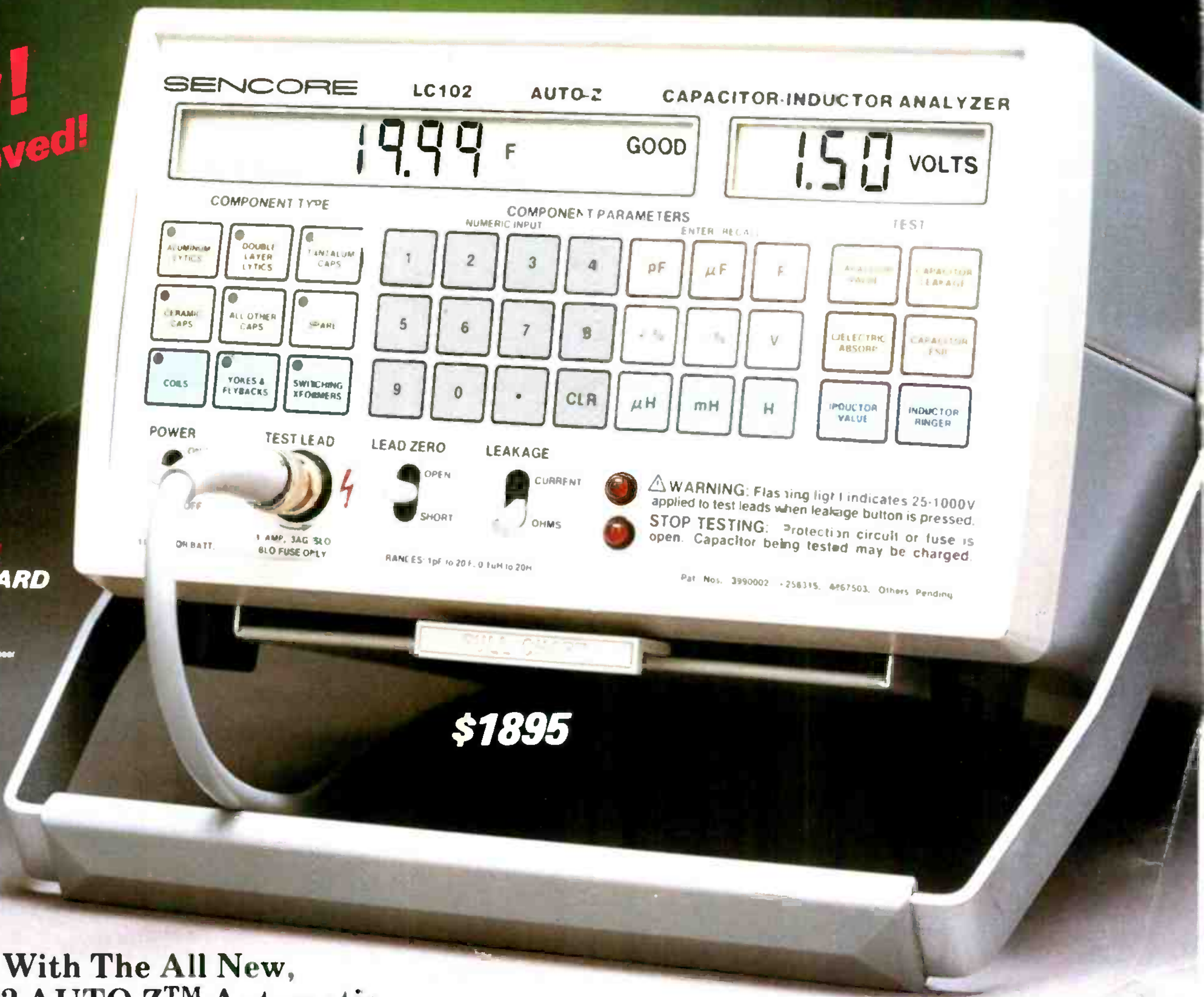

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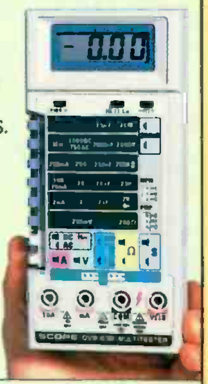

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