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MODERN ELECTRONICS

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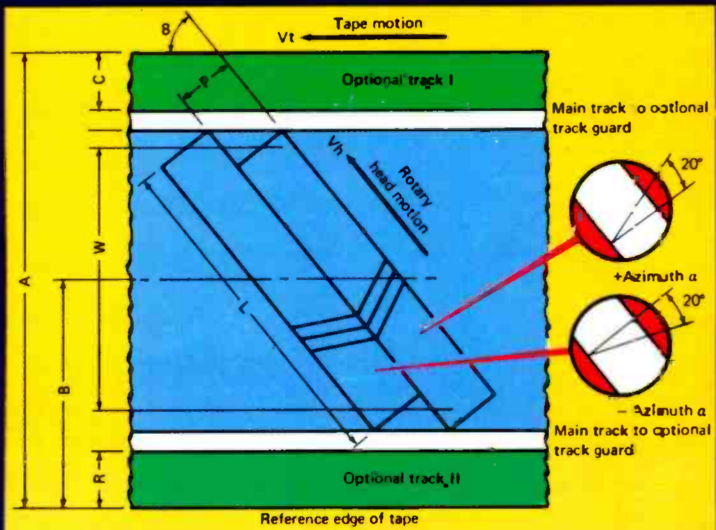
THE MAGAZINE FOR ELECTRONICS & COMPUTER ENTHUSIASTS

Commodore Amiga's Graphics-Oriented Computer

Audio Tape Decks— ey Work

Construction Plans:

- Timer for Air Conditioners
- o-on-a-Chip



Digital Audio Tape Decks on the horizon (p. 18)

- Phone-Controlled Nite Lite
- Hand-Held Ion Detector

One of Amiga's menu screens (p. 26)

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Plus: Forrest Mims on Relaxation Oscillators • Eric Grevstad looks at a new laptop computer, printer and graphics software package • Glenn Hauser Monitors Central America from Guatemala • Don Lancaster answers readers' questions • Electronics & Computer News . . . and more.

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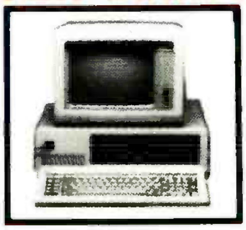

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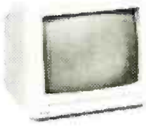

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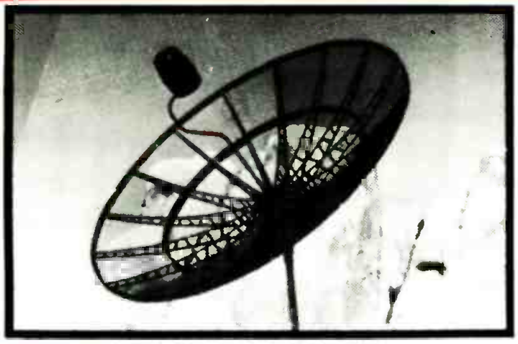

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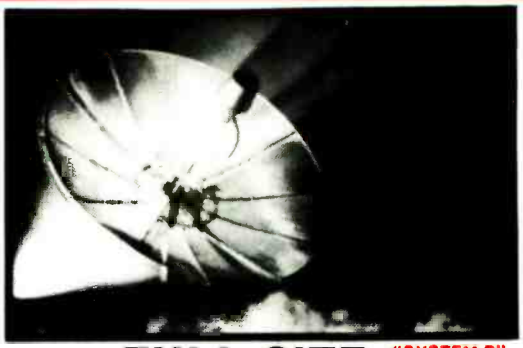

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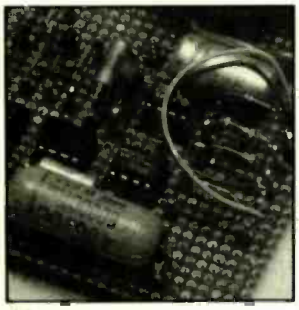
MODERN ELECTRONICS
THE MAGAZINE FOR ELECTRONICS & COMPUTER ENTHUSIASTS

JULY 1986

VOLUME 3, NUMBER 7



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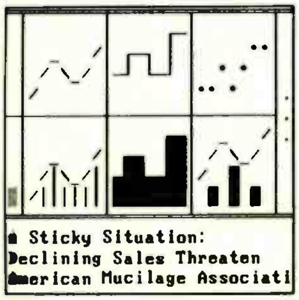

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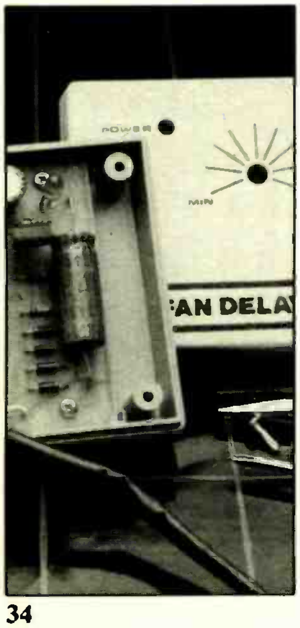

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FEATURES

COLUMNS

DEPARTMENTS

Offices: 76 North Broadway, Hicksville, NY 11801. Telephone: (516) 681-2922. Modern Electronics (ISSN 0748-9889) is published monthly by Modern Electronics, Inc. Application to mail at second class rates pending at Hicksville, NY and other points. Subscription prices (payable in US Dollars only): Domestic - one year $16.97, two years $31.00, three years $45.00; Canada/Mexico - one year $19.00, two years $35.00, three years $51.00; Foreign - one year $21.00, two years $39.00, three years $57.00. Foreign Air Mail - one year $74.00, two years $145.00, three years $216.00.

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NEW! Lower Price Scanners

Communications Electronics™, the world's largest distributor of radio scanners, introduces new lower prices to celebrate our 15th anniversary.

Regency‡ MX7000-EA

List price $699.95/**CE price $399.95/SPECIAL**
10-Band, 20 Channel • Crystalless • AC/DC
Frequency range: 25-550 MHz. continuous coverage and 800 MHz. to 1.3 GHz. continuous coverage.
The *Regency* MX7000 scanner lets you monitor military, F.B.I., Space Satellites, Police and Fire Departments, Drug Enforcement Agencies, Defense Department, Aeronautical AM band, Aero Navigation Band, Fish & Game, Immigration, Paramedics, Amateur Radio, Justice Department, State Department, plus thousands of other radio frequencies most scanners can't pick up. The *Regency* MX7000 is the perfect scanner for intelligence agencies that need to monitor the new 800 MHz. cellular telephone band. The MX7000, now at a special price from CE.

Regency® Z60-EA

List price $299.95/**CE price $179.95/SPECIAL**
8-Band, 60 Channel • No-crystal scanner
Bands: 30-50, 88-108, 118-136, 144-174, 440-512 MHz.
The *Regency* Z60 covers all the public service bands plus aircraft and FM music for a total of eight bands. The Z60 also features an alarm clock and priority control as well as AC/DC operation. Order today.

Regency® Z45-EA

List price $259.95/**CE price $159.95/SPECIAL**
7-Band, 45 Channel • No-crystal scanner
Bands: 30-50, 118-136, 144-174, 440-512 MHz.
The *Regency* Z45 is very similar to the Z60 model listed above however it does not have the commercial FM broadcast band. The Z45, now at a special price from Communications Electronics.

Regency® RH250B-EA

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10 Channel • 25 Watt Transceiver • Priority
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NEW! Bearcat® 50XL-EA

List price $199.95/**CE price $114.95/SPECIAL**
10-Band, 10 Channel • Handheld scanner
Bands: 29.7-54, 136-174, 406-512 MHz.
The Uniden Bearcat 50XL is an economical, hand-held scanner with 10 channels covering ten frequency bands. It features a keyboard lock switch to prevent accidental entry and more. Also order part # **BP50** which is a rechargeable battery pack for $14.95, a plug-in wall charger, part # **AD100** for $14.95, a carrying case part # **VC001** for $14.95 and also order optional cigarette lighter cable part # **PS001** for $14.95.

NEW! Regency® XL156-EA

List price $239.95/**CE price $129.95/SPECIAL**
6-Band, 10 Channel • No-crystal Scanner
Search • Lockout • Priority • AC/DC
Bands: 30-50, 144-174, 440-512 MHz.
Cover your choice of over 15,000 frequencies on 10 channels at the touch of your finger. Display messages. External speaker jack. Telescoping antenna. External antenna jack. AC/DC.

NEW! Regency® R1060-EA

List price $149.95/**CE price $92.95/SPECIAL**
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Bands: 30-50, 144-174, 440-512 MHz.
Now you can enjoy computerized scanner versatility at a price that's less than some crystal units. The *Regency* R1060 lets you in on all the action of police, fire, weather, and emergency calls. You'll even hear mobile telephones.

Bearcat® DX1000-EA

List price $649.95/**CE price $349.95/SPECIAL**
Frequency range 10 KHz. to 30 MHz.
The *Bearcat* DX1000 shortwave radio makes tuning in London as easy as dialing a phone. It features PLL synthesized accuracy, two time zone 24-hour digital quartz clock and a built-in timer to wake you to your favorite shortwave station. It can be programmed to activate peripheral equipment like a tape recorder to record up to five different broadcasts, any frequency, any mode, while you are asleep or at work. It will receive AM, LSB, USB, CW and FM broadcasts.

There's never been an easier way to hear what the world has to say. With the *Bearcat* DX1000 shortwave receiver, you now have direct access to the world.

NEW! Regency® HX1200-EA

List price $369.95/**CE price $214.95/SPECIAL**
8-Band, 45 Channel • No Crystal scanner
Search • Lockout • Priority • Scan delay
Sidelit liquid crystal display • EAROM Memory
New Direct Channel Access Feature
Bands: 30-50, 118-136, 144-174, 406-420, 440-512 MHz.
The new handheld *Regency* HX1200 scanner is fully keyboard programmable for the ultimate in versatility. You can scan up to 45 channels at the same time including the AM aircraft band. The LCD display is even sidelit for night use. Order **MA-256-EA** rapid charge drop-in battery charger for $84.95 plus $3.00 shipping/handling. Includes wall charger, carrying case, belt clip, flexible antenna and nicad battery.

NEW! Bearcat® 100XL-EA

List price $349.95/**CE price $203.95/SPECIAL**
9-Band, 16 Channel • Priority • Scan Delay
Search • Limit • Hold • Lockout • AC/DC
Frequency range: 30-50, 118-174, 406-512 MHz.
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Bearcat® 210XW-EA

List price $339.95/**CE price $209.95/SPECIAL**
8-Band, 20 Channel • No-crystal scanner
Automatic Weather • Search/Scan • AC/DC
Frequency range: 30-50, 136-174, 406-512 MHz.
The new Bearcat 210XW is an advanced third generation scanner with great performance at a low CE price.

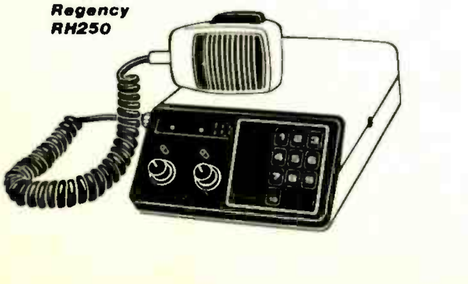
NEW! Bearcat® 145XL-EA

List price $179.95/**CE price $102.95/SPECIAL**
10 Band, 16 channel • AC/DC • Instant Weather
Frequency range: 29-54, 136-174, 420-512 MHz.
The *Bearcat* 145XL makes a great first scanner. Its low cost and high performance lets you hear all the action with the touch of a key. Order your scanner from CE today.

TEST ANY SCANNER

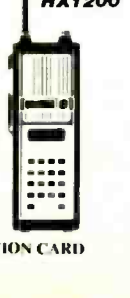
Test any scanner purchased from **Communications Electronics™** for 31 days before you decide to keep it. If for any reason you are not completely satisfied, return it in original condition with all parts in 31 days, for a prompt refund (less shipping/handling charges and rebate credits).

Regency RH250



Regency MX7000

Regency HX1200



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NEW! Bearcat® 800XLT-EA

List price $499.95/**CE price $317.95**
12-Band, 40 Channel • No-crystal scanner
Priority control • Search/Scan • AC/DC
Bands: 29-54, 118-174, 406-512, 806-912 MHz.
The Uniden 800XLT receives 40 channels in two banks. Scans 15 channels per second. Size 9¼" x 4½" x 12½."

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Add $3.00 shipping for all *accessories* ordered at the same time.
Add $12.00 shipping per shortwave receiver.
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EDITORIAL

More Survey Gleanings

Last month I promised to provide you with more information about the results of our 1986 subscriber study. Beyond the demographics outlined in our June issue, here is some insight to other aspects we covered.

We asked the subscribers surveyed what subjects they were interested in reading about and were not surprised to find that core electronics matter headed the list: Electronic Experimenting, Electronic Theory and New Developments ran neck and neck with an average of 97.8% expressing an interest in those areas, with 93.3% noting a high interest.

Test Instruments and Uses were right up there with the foregoing, with tabulations showing 95.9% of respondents indicating an interest in this category and 83.2% observing a high interest. Microcomputer hardware ranked near the top, too, with 91% noting an interest and 76.3% a high interest. Remaining subjects listed among a total of 16 indicated that MODERN ELECTRONICS subscribers have strong multiple interests.

We were impressed by the high number of respondents who indicated they build or enhance electronic devices from their own plans—61.3%—as compared to building from construction project plans (69.2%) or from electronic kit plans (61.4%). A total of 16.0% of the respondents noted that they only repair.

It was interesting to learn where you buy your equipment, parts and supplies. Our questionnaire broke this down into three categories: Computers, Electronic Products and Parts/ Supplies. In every category, Mail Order placed second as the source from among five sources listed. For Parts/Supplies, for example, Mail Order was noted by 69.4% of respondents, while Electronics Retailer led with 70.9%. Clearly, MODERN ELECTRONICS readers use mail order as a major channel for purchases.

On Test Equipment Ownership, Power Supplies ranked first with 81.5% indicating they own this equipment. Single-Trace and Dual-Trace Oscilloscope ownership was divided equally, with 34.8% and 34.3%, respectively. On a Plan-To-Buy basis, however, Dual-Trace Oscilloscopes swamped Single-Trace with 15.6% indicating planned purchase of one or more within the next 12 months, while Single-Trace Scopes fell to 3.1%. High Bandwidth, too, rose dramatically in purchasing plans to 45.4% for 20 MHz or higher as compared to only 8.7% for under-20-MHz scopes. (The remaining percentage did not reply in this instance.) Extrapolating the total buying plans for test instruments across our whole readership, MODERN ELECTRONICS readers plan to spend approximately $17.9-million on basic test gear in the next 12 months, excluding specialized equipment such as video test analyzers, transistor checkers, etc.

For Stereo Component Buying Plans, the Compact Disc Player was an easy winner, with 16.8% of respondents noting they plan to buy one this year. In contrast, standard record players accounted for only 2.7% in respondent's buying plans.

Video Cassette Recorders are owned by 64.7% of subscribers, according to survey results, with the VHS format leading by far. There is already significant multiple VCR ownership, amounting to an average of 1.2 VCRs per respondent-owner. Among the 22.4% of respondents who plan to buy a new VCR during the year, 7.1% already own one! Thus, 31.7% of anticipated buyers responding to our survey will be second-time buyers, exceeding industry estimates of 25% of VCR buyers in 1986 becoming two-VCR families. In Buying Plans, the VHS format extended its large lead over the Beta format, and 8-mm Camcorders take over a far-behind second slot.

Fully 74.2% of MODERN ELECTRONICS respondents said they own a computer. In fact, the total number on a brand basis exceeds 100% because there is a multiple computer ownership of 1.4 computers per owner. Commodore led with 35.2% brand ownership, followed by Radio Shack/ Tandy with 23.1%, IBM or Compatible with 18.2%, Apple with 16.8%, Atari with 8.5%, Heath/Zenith with 5.1%, Kaypro with 2.6% and Macintosh with 1.9%. (Note that some Tandy, Heath/Zenith and Kaypro computers were likely checked off as IBM or Compatible since these companies also market this type of computer.) Among "Other" computers, which required filling in the name by hand, were Texas Instruments with 9.0%, Timex/ Sinclair with 6.1%, Hewlett-Packard with 1.9%, and other computer brands noted with less than 1.9% each accounted for 13.4% ownership.

Equally important is what they said they plan to buy in the next 12 months. That's you! Based on survey results, MS-DOS machines are first in the hearts and minds of respondents since IBM or Compatibles easily outdistance other computer types with 10.9% planning to buy one or more in the next 12 months. Commodore ranked next with 6.3%. Among the 27% of respondents who indicated they plan to buy a computer this year, IBM-type machines

(Continued on page 87)

Some Praise

•I just picked up my first copy of *Modern Electronics* and am totally impressed with what I see. Your articles are superb, your reviews are great and your build-it-yourself sections are fantastic! Thanks.

Scott J. Keller
Waukesha, MI

•I just had to write to say thank you for renewing my interest in "hobby" electronics! Your provide a much-needed bridge that's overlooked by many of us in the field for the past few decades—that of keeping youngsters interested enough to pursue electronics when they advance to higher education. I wouldn't be writing software, building my own micros and doing field service repair work today if my engineer neighbor hadn't helped me build a crystal radio when I was 12. Magazines like *Modern Electronics* are that "neighbor" for many kids today who might develop something revolutionary tomorrow.

Tim Hinseth
Rexburg, ID

•Love your magazine. I especially enjoy Forrest Mims and Don Lancaster, as I am a "hands-on" electronics buff.

Peet Robison
Santa Fe, NM

•"The Ni-Cd Battery" (March '86) is another great article by Anthony J. Caristi! The article is a treasure trove of obviously carefully researched information that cuts like a scythe through the conflicting data in my bulging file on the care and feeding of nickel-cadmium cells. This article with its simple projects that can be embellished with convenience modifications is by itself worth the subscription price. Sign me on for two years.

Porter Holman
New York, NY

Optical Scanning

•Re: "Reading by Computer" April 1986, you state, " . . . the OCR font, which is specially designed for optical scanning (it's the typeface usually used to imprint your account number on personal and business checks)." The typeface used to imprint the information (bank number, account number, check number, transaction type, and amount) at the bottom of a check is MICR, or Magnetic Ink Character Recognition. This typeface along with the use of a special magnetic ink allows the information to be read by a magnetic head, similar to the magnetic head in a tape recorder.

I believe that the MICR font predates the OCR fonts, of which there are two.

Lowell Ray Anderson, C.D.P.
Cody, WY

Rockets Away

•Many of Forrest Mims' articles mention his involvement with model rocketry—your own article about his book, "The Siliconnection," in the November 1985 issue of ME shows him preparing to launch one. It would be interesting to see articles about these model rocket experiments in his "Electronics Notebook" column. Please encourage Mr. Mims to write experimenter articles on these subjects.

Bill Tuleja
Newark, NJ

He's encouraged by your interest—Ed.

NYNEX TAKES OVER IBM STORES. IBM's Computer Product Centers, a group of 81 stores, has been taken over by Nynex Corp. and combined with the latter's 21 Datago chain outlets. Makes sense. What IBM dealer ever wanted the manufacturer to compete with them in the first place? This makes NYNEX Business Centers the fourth largest computer retail chain in the country, behind Tandy, Sears and Businessland.

AN UNDERSTANDING DOLL. Audec Corp. (Saddle Brook, NJ) announced it will be marketing a plush panda talking toy that has speech-recognition facilities built into it. Called Sing-Sing, the toy recognizes pre-determined questions at random and locates the appropriate response stored in RAM. The 18"-tall toy has a suggested retail of $79.95.

THE SOURCE EXPANDS OFFERINGS. Source Telecomputing Corp., a major on-line information service owned by The Reader's Digest, announced low competitive (compared to CompuServe) services that include an IBM SIG (Special Interest Group) for a one-time $49.95 fee. The new SIG has nine databases, including a bulletin board system directory, reviews, hardware, software and services. Software downloading is possible with the Kermit/Super Kermit protocol, which is part of a communication software package available through the SIG, with XMODEM said to soon be possible.

AM-STEREO EMBROILMENT. Kahn Communications attacks Motorola again with a complaint to the FCC that its C-QUAM exciter violates technical rules, especially with regard to channel interference. Motorola says it doesn't and that it falls within its type-acceptance report. Like the Iran-Iraq war, the battle goes on and on.

STEPPING UP TO DIGITAL TV. A growing number of affluent hi-tech enthusiasts are moving to digital TV sets. Pioneered by ITT Corp. in Europe with special chips, users can enjoy a second picture within the main TV picture to see what's happening on another TV (or VCR or closed-circuit camera) channel. In Europe, it's reported that an enhancement of the digital receivers allows a technician to service or adjust the sets by manipulating keys on the remote-control unit to speed up and simplify adjustments.

NEW AC VOLTS DETECTOR. Fisher Research Labs (Los Banos, CA), best known for its metal detectors, debuted an interesting AC volts detector recently that can check out whether or not there's dangerous voltage hidden behind walls or wherever without touching the wires or even breaking a portion of the wall to get at the wires. Morever, the switch doesn't have to be on. It detects the voltage potential through picking up the electrostatic field around an unshielded cable, emitting a steady battery-powered beep when it does. The device, which, among other applications, indicates where electrical wires are running behind walls, sells for $65.

Learn robotics and you build this robot

New NRI home training prepares you for a rewarding career in America's newest high-technology field.

The wave of the future is here. Already, advanced robotic systems are producing everything from precision electronic circuits to automobiles and giant locomotives. By 1990, over 100,000 "smart" robots will be in use.

Over 25,000 New Jobs

Keeping this robot army running calls for well-trained technicians . . . people who understand advanced systems and controls. By the end of the decade, conservative estimates call for more than 25,000 new technical jobs. These are the kind of careers that pay $25,000 to $35,000 a year right now. And as demand continues to grow, salaries have no place to go but up!

Build Your Own Robot As You Train at Home

Now, you can train for an exciting, rewarding career in robotics and industrial control right at home in your spare time. NRI, with 70 years of experience in technology training, offers a new world of opportunity in one of the most fascinating growth fields since the computer.

You need no experience, no special education. NRI starts you at the beginning, takes you in easy-to-follow, bite-size lessons from basic electronics right on through key subjects like instrumentation, digital and computer controls, servomotors and feedback systems, fluidics, lasers, and optoelectronics. And it's all reinforced with practical, hands-on experience to give you a priceless confidence as you build a programmable, mobile robot.

You get and keep Hero 1 robot with gripper arm and speech synthesizer, NRI Discovery Lab for electronic experimentation, professional multimeter with 3½-digit LCD readout, 51 fast-track training lessons.

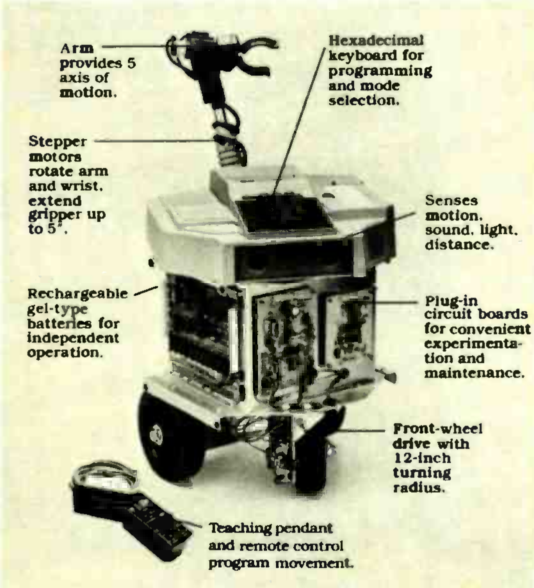
Program Arm and Body Movement, Even Speech

Designed expecially for training, your robot duplicates all the key elements of industrial robotics. You learn to operate, program, service, and troubleshoot using the same techniques you'll use in the field. It's on-the-job training at home!

industrial control as

Building this exciting robot will take you beyond the state of the art into the next generation of industrial robotics.

You'll learn how your completely self-powered robot interacts with its environment to sense light, sound, and motion. You program it to travel over a set course, avoid obstacles using its sonar ranging capability. Program in complex arm and body movements using its special teaching pendant. Build a wireless remote control device demonstrating independent robot control in hazardous environments. You'll even learn to synthesize speech using the top-mounted hexadecimal keyboard.



Your mobile robot duplicates functions of state-of-the-art industrial units.

Training to Build a Career On

NRI training uniquely incorporates hands-on building experience to reinforce your learning on a real-world basis. You get professional instruments, including a digital multimeter you'll use in experiments and demonstrations, use later in your work. And you get the exclusive NRI Discovery Lab®, where you examine and prove out theory from basic electrical concepts to the most advanced solid-state digital electronics and microprocessor technology. Devised by an experienced team of engineers and educators, your experiments, demonstrations, and equipment are carefully integrated with 51 clear and concise lessons to give you complete confidence as you progress. Step-by-step, NRI takes you from the beginning, through today, and into an amazing tomorrow.

Send for Free Catalog Now

Send for NRI's big free catalog describing Robotics and Industrial Control plus over a dozen other high-technology courses. You'll see all the equipment you get in detail, get complete descriptions of every lesson, find out more about career opportunities for trained technicians. There's no cost or obligation, so send today. Your action today could mean your future tomorrow. If the card has been removed, please write us today.

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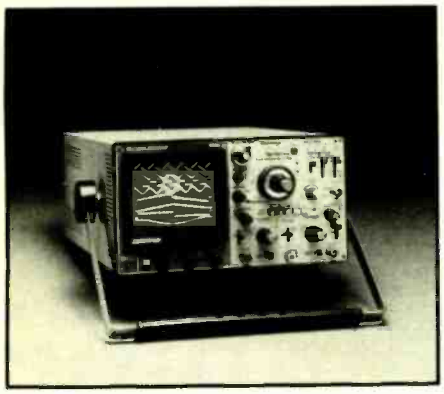
McGraw-Hill Continuing Education Center
3939 Wisconsin Ave.
Washington, DC 20016

WE'LL GIVE YOU TOMORROW.

For more information on products described, please circle the appropriate number on the Free Information Card bound into this issue or write to the manufacturer.

60-MHz Oscilloscope

New from Beckman is the Model 9060, a 60-MHz oscilloscope that offers three input channels, eight traces and a dual timebase with delayed sweep. The oscilloscope features a 6″ rectangular, high-brightness CRT display area and an illuminated internal parallax-free graticule. Other features include a unique Linear



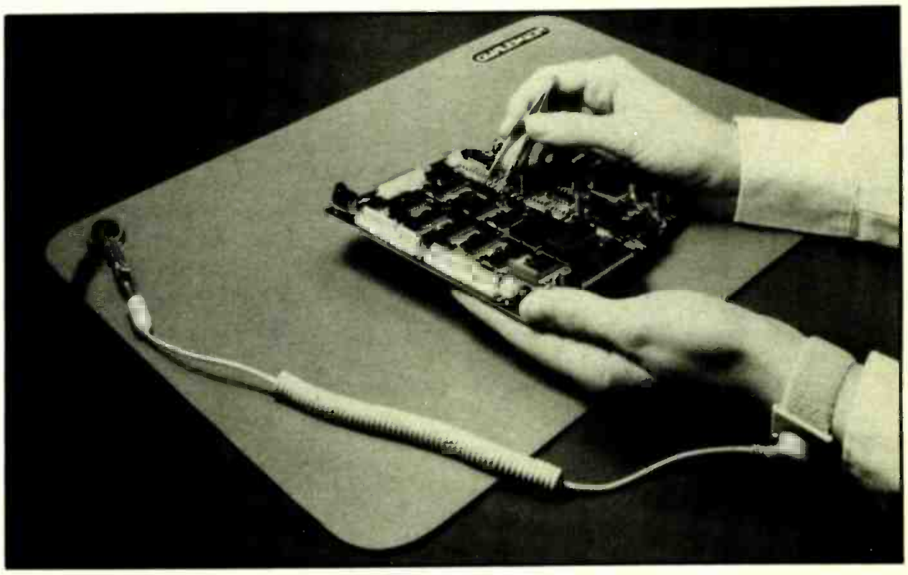
Focus control, Trigger Level Lock control, and dynamic bias circuitry. Among the functions available are: CH 1 output, TV sync separator, high-frequency reject and vertical mode triggers.

Sensitivity at 20-MHz bandwidth is up to 1 millivolt per division with ×5 magnifier on. Horizontal timebases range from 0.5 second to 50 nanoseconds per division, and a ×10 magnifier extends this range to 50 nanoseconds per division. The benchtop/transportable oscilloscope has a carrying handle/tilt stand. $1,195.

CIRCLE NO. 151 ON FREE INFORMATION CARD

Antistatic Work Surface

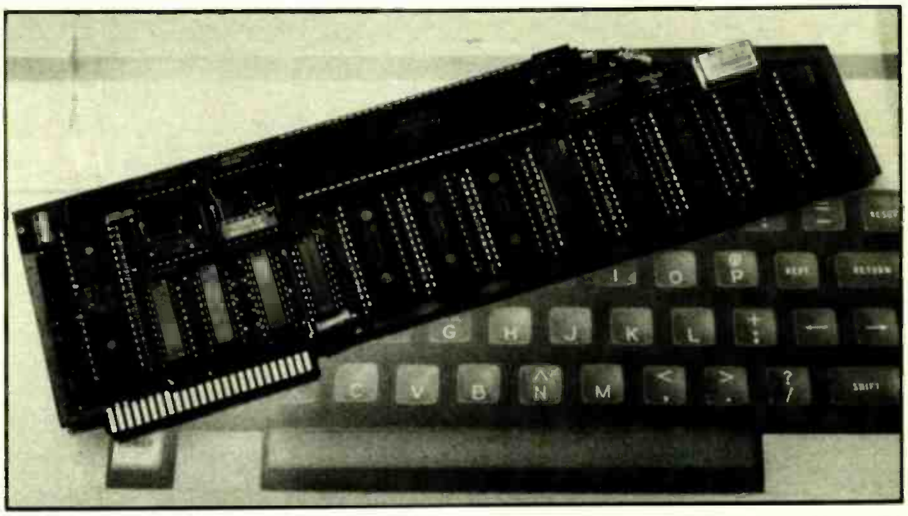
A portable, conductive hard laminate work surface that is said to provide rapid, nonsparking charge dissipation and exceeds NEMA standards for abrasion resistance is available from



Charleswater Products (W. Newton, MA). The Micastat Portable Pad features zero voltage suppression and dissipates a 5000-volt static charge to zero in less than 0.05 second. Supplied with a pressure-sensitive adhesive on the underside for fast, secure installation, the pad is clean-room safe and can be used on nonconductive workbenches.

Micastat Portable Pads are available in seven colors and 24″ × 36″ and 24″ × 48″ sizes. Each is equipped with a ground cord and dual snap fastener for attaching conductive wrist straps. From $42.

CIRCLE NO. 152 ON FREE INFORMATION CARD



A 68000 For Apple Computers

Apple II, II+ and IIe users can have 68000 power with Rapid Systems' (Seattle, WA) new R-68 System single-board 68000-based computer and software development package. It runs stand-alone after startup and provides independent coprocessing. (The Apple computer can be rebooted and any other program reportedly can be run without affecting the board or a program currently being executed.)

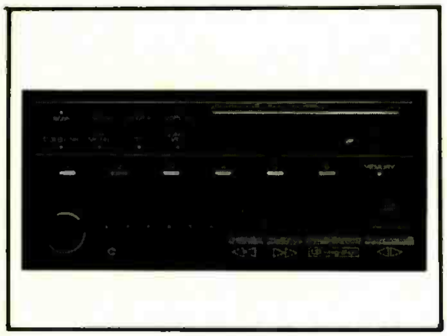
An open hardware and software design provides fast transfers between the computer and 8-MHz (optionally 10- or 12-MHz) 68000. Memory can be expanded to 256K. Eight levels of priority and two levels computer-to-68000 interrupts are provided. The four 8-bit computer-to-68000 interface ports, two 8-bit directional I/O ports and one serial data ports are interrupt driven.

Full monitor functions, user task and interrupt handlers are in ROM, along with 26 commands that can be used in Apple programs. Applesoft support provides communications and software development commands for writing and testing programs. A fast macro assembler with program editor is also provided. $499.

CIRCLE NO. 153 ON FREE INFORMATION CARD

Powerful Car Stereo

Two high-power in-dash cassette receiver systems designed to fit more than 90 percent of recent GM cars have been unveiled by Mitsubishi. The Models JX-3 and JX-2 provide 100 and 60 watts rms maximum total power, respectively. Proprietary tuner circuitry automatically opti-



mizes FM stereo reception and monitors and suppresses interference from strong local signals. Stereo Reception Control (SRC) provides automatic and gradual phasing on monaural broadcasting as FM stereo signals weaken.

Both systems feature AM-stereo and FM-stereo reception; LCD frequency/time display; switchable display/clock priority; electronic programmability for up to 18 station presets (12 FM and 6 AM); a six-band graphic equalizer (Model JX-3) or separate bass and treble controls (Model JX-2); auto-loudness; fader/balance controls; and CD-100 Compact Disc player compatibility.

The auto-reverse cassette player features Dolby B noise reduction, locking fast forward and rewind controls, and tape direction indicators. $349.95 for the Model JX-3; $279.95 for the Model JX-3.

CIRCLE NO. 154 ON FREE INFORMATION CARD

Pocket Calculator With Address Book & Memo Pad

Little Black Book is a pocket calculator with handy built-in phone book and memo-pad features. This Model EL-6150 calculator has 4K of RAM that can store up to 200 names and telephone numbers and features a

2-line LCD display. Additionally, the Little Black Book can store company names and addresses. Finding a phone number or address is fast and easy. All you need do is set the calculator to automatically search for it simply by feeding in the name of the person whose phone number or name of the company whose phone number or address you want to find.

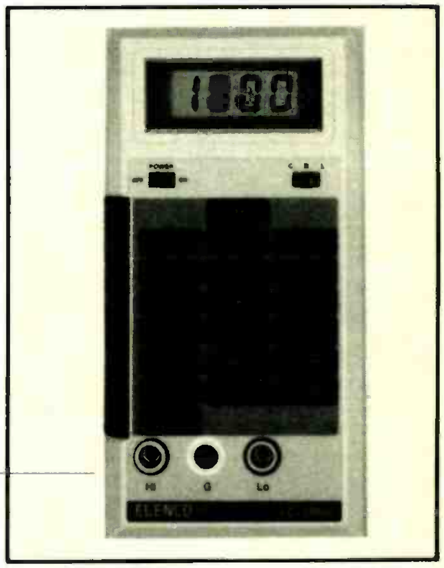
Enough extra memory is provided for an electronic memo pad that you can use to keep track of appointments, shopping lists or notes you have stored in memory. Any entry can be almost instantly retrieved with a key letter, number or word, or by category.

The calculator portion of the Little Black Book includes all standard arithmetic functions and percent and can calculate from data in memory. $69.95.

CIRCLE NO. 155 ON FREE INFORMATION CARD

Digital LCR Meter

Elenco Electronics, Inc's (Wheeling, IL) Model LC-1800 is a digital hand-held instrument that measures values of coils, transformers and chokes;



capacitors; and resistors. It measures inductance from 0.1 μH to 200 H in seven ranges, capacitance from 0.1 pF to 200 μF in seven ranges, and resistance from 0.1 ohm to 20 megohms in six ranges. Rated accuracy is ± 1% of reading basic accuracy at resolutions of 0.1 μH, 0.1 pF and 0.1 ohm.

Slide switches are provided for turning on/off power and selecting between capacitance, resistance and inductance. Range selection is via locking pushbutton-type switches on the side of the case. All values are displayed in a large 3½-digit LCD window. A single 9-volt alkaline battery is said to provide up to 200 hours of operation. The meter measures 6.8"H × 3.5"W × 1.4"D. $199.

CIRCLE NO. 156 ON FREE INFORMATION CARD

VHS Hi-Fi VCR

Panasonic's new Model PV-1545 VHS Hi-Fi videocassette recorder of-

NEW PRODUCTS ...

fers the company's Tech-4 video head design for improved special effects and two extra audio heads to permit hi-fi signals to be recorded on the same portion of tape with video. The VCR also is equipped to accommodate the optional Model TUG-3010S MTS stereo sound adapter. Designed for flexibility, the VCR has an electronic clock/timer that allows you to program up to four different programs on the same or different channels over a two-week period. One-touch recording lets you key in 30-minute recording segments up to a total of four hours. And the 99-position voltage synthesizer tuner can access up to 107 vhf, uhf and cable channels.

Supplied with the Model PV-1545 is a 21-function infrared wireless remote-control system with a direct-access keypad that controls main power, channel up/down selection and double-speed play, as well as power on/off and TV volume up/down from the VCR's remote controller, even if your TV receiver does not have remote-control capabilities.

When operated in the VHS Hi-Fi mode, the VCR has a dynamic range greater than 80 dB, wow and flutter of 0.005% and stereo separation of greater than 60 dB. $875.

CIRCLE NO. 140 ON FREE INFORMATION CARD

Color Printer

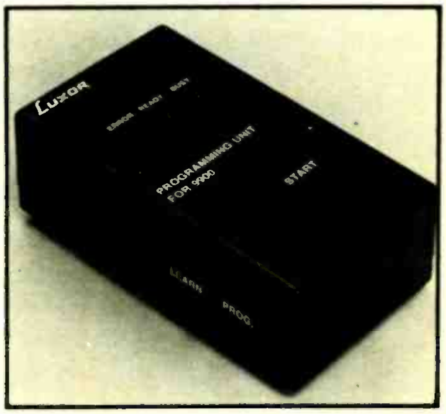
New from Juki is the Model 5510-Color dot-matrix printer that gives computer users 7-color print capability with a 4-color ribbon. Employing a bidirectional, logic-seeking system, the printer's speed is rated at 180 cps in the draft mode, 30 cps in the near-letter-quality mode. It provides 96 each ASCII and italic characters and 11 international character sets (eight internal character sets are switch-changeable) and features several printing modes. Its print matrix is user-definable for 9 × 9 to 21 × 27 or 11 × 9.

Among the printer's other features are a built-in tractor, a 3K buffer (expandable to 15K), a Centronics 8-bit parallel interface (an optional RS-232C serial interface is available), and either IBM or Epson software compatibility. The 19.8-lb. printer measures 17.5"W × 14.3"D × 4.9"H. $650.

CIRCLE NO. 141 ON FREE INFORMATION CARD

Automatic Programmer for Satellite TV Receiver

A new device from Luxor enables installers to quickly and automatically program the company's Model 9900 block satellite TV receiver. The hand-held, microprocessor-based "Fast Programmer," does a complete programming job that usually



takes 30 to 60 minutes in just 15 to 20 seconds. Once a single 9900 installation is made and transponder data is stored in the Fast Programmer, new systems within a 100-mile radius can automatically be programmed. All functions are operated by pushbutton from the 9900's wireless remote controller.

In addition to significantly reducing programming time of new installations, the Fast Programmer can save time in updating customer systems as new satellites are launched or transponder (channels) are changed. The device can also be used in servicing systems that are not working properly by rapidly transferring the program from the down system's receiver into a replacement receiver.

CIRCLE NO. 142 ON FREE INFORMATION CARD

PC-Board Repair Kits

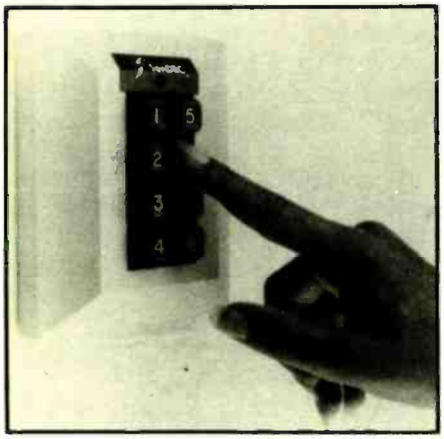
A.P.E.'s (Medford, NY) Model SRS 050 Track Repair kits contain all the materials needed to make the majority of printed-circuit board repairs. They come with the tools needed and a variety of copper foil strips and pads

that complement existing board circuitry. Plated-through hole repairs are made by swaging eyelets and funnelets into the board. Four versions of the kit are available: Standard, Service Technician's, Basic and Deluxe. Each kit differs in the types of tools supplied. $18 to $129.

CIRCLE NO. 143 ON FREE INFORMATION CARD

Door Access System

Mountain West (Phoenix, AZ) offers a self-contained electronic door access system that can be fitted to most existing wood doors and includes everything needed for installation and

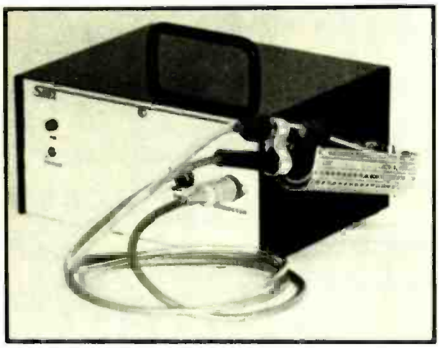


operation. The correct 4-digit code combination chosen from among 8 pushbuttons unlocks the door for 3 to 5 seconds. The system automatically locks when the door on which it is installed closes. The lock's 4-digit code can be changed at any time. $99.95.

CIRCLE NO. 150 ON FREE INFORMATION CARD

Desoldering Tool

Sibex's new Model S-1 desoldering tool features a combination heating element/vacuum nozzle handpiece with a conveniently located switch button that activates the vacuum pump for one-hand operation. An electrical cable and a hose from the



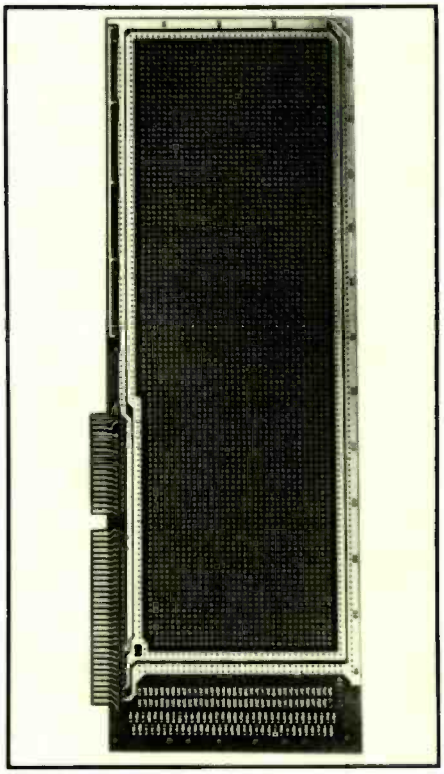
handpiece plug into the power supply and vacuum pump located in a separate workbench-top box. The handpiece is designed for easy cleaning while in use. The tool is said to provide static-free operation and is suited for printed-circuit board repair work. $189.95.

CIRCLE NO. 144 ON FREE INFORMATION CARD

Prototyping Card For PCs

Designed to be used with IBM PC and AT computers, Vector Electronics's new 0.062″-thick epoxy-fiberglass No. 4617-3 prototyping card has 0.042″ holes on 0.1″ centers to accommodate circuits with high component densities. Its pads and buses are 2-oz. copper with reflowed solder plating, and the edge connector contacts are gold plated over nickel.

Plated-through holes accept any width DIP device and Vector's Wire Wrap terminals. Power and ground



buses are located on each side around the edges of the card and terminate at connectors. Connector pads on the board and accompanying bracket accept DB-9, DB-15, DB-25, and 37-pin I/O connectors. The 13.25″ × 4.80″ card plugs into any open IBM PC/AT slot. $43.43.

CIRCLE NO. 145 ON FREE INFORMATION CARD

Compact Disc Player

Yamaha reports that it uses special VLSI control devices and a double-resolution filter to achieve superior tracking and signal processing in its full-width, easy-stacking Model CD-700 compact disc player. An infrared unit provides remote control of all playback, search and programming functions and display modes. Among the player's features are: a 12-selection programmable random-access playback; 10-key direct selection; 6-

digit display; three-way music search; three-way repeat play; index search; a headphone jack with level control, and a subcode output for still-image video playback.

Frequency response is rated at 4 Hz to 20 kHz +0.5/−1.0 dB, harmonic distortion plus noise at 0.003% (1 kHz); S/N at 100 dB; dynamic range at 96 dB; and channel separation at 95 dB at 1 kHz. Wow and flutter are said to be unmeasureable. Output levels are 2 volts rms into 600 ohms line and 370 mV into 8-ohm phones. The player measures 17⅛"W × 11⅜"D × 3¾"H. $549.

CIRCLE NO. 146 ON FREE INFORMATION CARD

Static Workstation Tester

Spectrascan/Monitor Electronics' Model SMU-101 Static Sentry contains all the test and alarm functions required to ensure that a static-control workstation is safe and fully

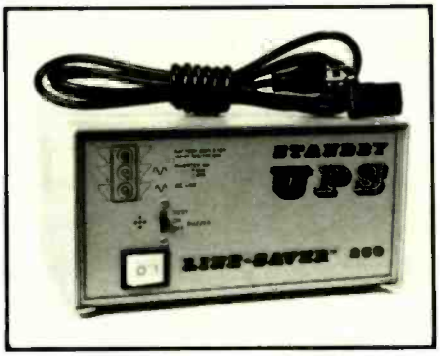
functional at all times. It checks wrist straps for shorts, opens and safe resistance; measures conductivity and proper grounding of bench and floor mats to 1000 megohms; detects ac signals in excess of 5 volts on the tip of a soldering iron; and continuously monitors earth and electrical grounds for continuity and low impedance.

Both an audible alarm and visible LEDs are used for clear test and alarm indication, and an alarm signal output is provided on the rear panel for remote monitoring or control. The tester can be used with a central monitor in a system containing up to 100 channels.

CIRCLE NO. 147 ON FREE INFORMATION CARD

Uninterruptible Power Supply

Kalglo's (Bethlehem, PA) new Model LS250 Line-Saver® standby uninterruptible power system is designed for use with home and small business

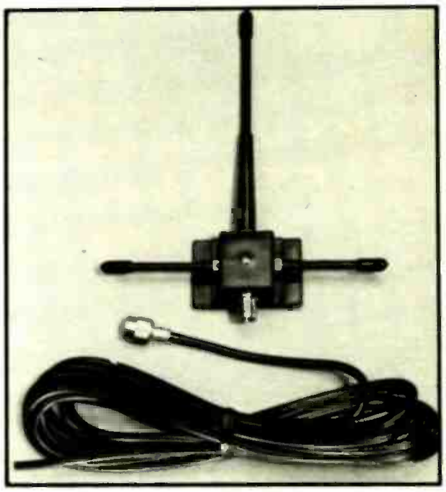


computers with up to 250-WVA loading at 120/240 volts, 50/60 Hz. Pulse-width modulation regulates the ac output voltage to 5 to 10 minutes back-up time under full load (20 to 25 minutes under 50-percent load). Features include: an internal 12-volt sealed rechargeable battery; two surge-protected and emi/rfi filtered ac outlets; audible and visible power-failure warning system; test mode indicator and switch; replaceable external fuses; external 12-volt battery connectors; and detachable 6-ft. 3-conductor line cord. $549.

CIRCLE NO. 148 ON FREE INFORMATION CARD

In-Vehicle Cellular Antenna

A cellular antenna designed to be mounted on a window inside a vehicle, claimed to be the first of its kind, is available from ORA Electronics (Chatsworth, CA). Inside installation provides two benefits: it deters thieves and protects the antenna from physical damage.



The Model CMR750 antenna requires no outside radial. Its "current-feeding" design is said to allow the antenna to operate with minimum signal loss or pattern distortion. Two "Rubber Duck" ¼-wave radials serve as a "ground plane" deflection system that provides a typical 1.5:1 VSWR and typical gain of 3.6 dBi over a ¼-wave design.

Although the antenna is pretuned at the factory for the U.S. cellular band, a trimmer is provided that permits adjustment in the field if necessary. The CMR750 comes with a 12-ft. RG-58XM/U low-loss cable and all connectors.

CIRCLE NO. 149 ON FREE INFORMATION CARD

214-234-8116 ELECTRONIC SURPLUS SPECIALS 214-234-8105

MACHINE PIN SOCKET

22 PIN GOLD PLATED SOCKET
5 pcs $1.00
Stk. #ICS-22M

CIRCUIT BOARD BONANZA

Soung generator boards removed from electronic pin-ball games. Contains oscillators, control circuits & 2 watt audio amp. Experimenters dream!!!
$2 ea — 10/$12.50 w/schematics

5V & 12V REGULATOR BOARD
Regulator board containing 5V & 12v TO 220 regulators, fuses, bridges, caps & I/O connectors. Size 2" x 4" w/heatsinks.
REG 512 .... $3.50

RECTIFIER BOARD
Contains (4) 10 Amp bridges, (3) large filter caps, & I/O conn. Size 4.5" x 8"
BRDG-4 .... $2.50ea or 10/$12.50

LINEAR & CMOS BONANZA
Circuit board removed from SINGER electronic calculators. Has 20 linear & cmos IC's & a wealth of other parts.
BD-20 .... $2.50 ea or 10/$12.50

POWER SUPPLY MFG. BY GENERAL INSTR.
INPUT: 110VAC
OUTPUT: +5VDC @ 5AMPS
+12VDC @ 2.5AMPS
−12VDC @ 3AMPS
PS-120 .... $24.50
Used is some Commodore comp.

LOW PROFILE SOCKETS (TIN)

# OF PINS	PRICE
8	$.08
14	$.10
16	$.12
18	$.15
20	$.18
22	$.18
24	$.20
28	$.25
40	$.30

ELECTRONIC PIEZO BEEP BUZZER
Special — 2/$1.00
7/8" Diameter element on plasting mounting. Originally used in Radio Shack telephone as the ringer.
Stk. #PZO-78 .... $.75

ULTRAVIOLET TUBES GOOD FOR EPROM ERASERS
110 VAC
$2.25 ea. — 10/$15.00

8" DRIVE POWER SUPPLIES $24.50

8" DISK DRIVE POWER SUPPLY
Heavy duty supply can run up to 4 drives. Enclosed frame. Iput 117VAC. Output 5VDC @ 7 Amps; +24VDC @ 6 Amps; −24VDC @ 6 Amps
Stk #PS-8 .... $24.50

BUILD YOUR OWN EPROM ERASER

115VAC BLACK LIGHT (ULTRA VIOLET)
115 volt ultra violet light with lamp ballast and in-line cord switch. Just build enclosure to finish.
Stk. #EPB-125 .... $12.50

$.75 ROCKER SWITCH
16 Amp On/Off
Used in Xerox 820 Computers

Full Wave Bridge
6AMP-300V
2/$1.00

MINI-TOGGLE SWITCH
5AMP DPDT
$.65 EA
10/$4.50

SNAP ACTION SWITCH
MICRO SWITCH
ASS'T OF 10
$2.50
STK #500-10M

DISK DRIVE MOUNTING SCREWS
20 for 50¢

WALL PLUG ADAPTERS
6VDC @ 300ma
$1.75 or 10/$12.50

ISOLATION TRANSFORMER
117VAC:
117VAC @ 125VAC
MFG BY SIGNAL TRANS
$3.00 Each 10/$20.00

RIGHT ANGLE HEADERS
40 Pin .... $.40
34 Pin .... $.50
10 Pin .... $.25

COMPUTER POWER CORDS
$1.25 EA — 10/$10

12 VDC TOY MOTOR
Stk. #MO-12 .. 2/$1.00

COMPUTER GRADE CAPACITORS
Ass't of 10
Stk#CCG-10 .... $2.50

CPM DISKETTE FOR USE WITH NEC V-20 PROCESSORS
$3.75

TRANSFORMERS

Stk #	PRI (VAC)	Secondary (VAC)	Price
TN-6.3	117	6.3 @ 300ma	$1.25
TN-12	117	12 @ 400ma	$1.35
TN-24A	117	24 @ 200ma	$1.25
TN-24B	117	24ct. @ 3.6 Amp	$3.50

HEAT SINK TO-3
$.25

LOAR RESISTOR FOR IBM POWER SUP.
5 Ohm @ 25 watts
$1.79
Stk# RIBM-5

POWER SUPPLY
General purpose compact power supply. 3 outputs: +5V @ 1 Amp, +12V @ 1 Amp, & +24V @ 1 Amp. Power Transistors mounted on a heat sink 2" x 4" w/transformer. Stk #PS-3P $4.49

RIBBON CABLE
9 conductor Spectrastrip with red market stripe. 250' per roll. 28ga. stranded wire.
WRIB-9 .... $10/Roll
20 conductor spectrastrip with red market stripe. 100' per roll. 28ga. Stranded wire.
WRIB-20 $.30/ft. or $25/roll
34 conductor spectrastrip with red marker stripe. 100' per roll 28 ga. stranded wire.
WRIB-34 $.45/ft. or $35/roll

VITEK CABLE CONVERTER
Model No. TC-1M converter. Both Mid Band & VHF frequencies. Has built in power supply. Units are new & in working cond.
Stk. #TC-1M $9.95

1000 PIECE RESISTOR ASS'T
ALL SIZES & VALUES
Stk. #RES-1000 .... $3.00

for robotics, precision movement application etc.
STEPPER MOTOR
(Unifilar Wound)
5 VDC 3½ Watts 7.5°X
48 Step/Rev. 28 RPM
Stk. #MO-5 .... $3.50

UNENCODED KEYBOARD
Full size kybd. w/number pad. 70 keys w/LED power indicator. Orig. from dumb terminals. New!!! Mfg by Hi Tek.
Stk. #Kybd-70 .... $9.95

XEROX 1810 Power Transf.
$6.95
Stk. # WTN-1810
Extremely Hard To Find!!!

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Digital Audio Tape Decks

Will DAT recorders soon challenge ordinary audio cassette recorders? Here is an overview of the state of audio tape recording today that might lead to an analog-vs.-digital battle

By Len Feldman

Onkyo's "Integra" R-DAT consumer digital audio cassette deck has all the controls and indicators usually found on analog cassette decks plus some unusual ones unique to digital recording. For example, it lets you choose between 44, 44.1 and 32 kHz sampling rate at the touch of a button.

At the most recently held Japan Audio Fair, held last October in Tokyo, everyone fully expected that manufacturers would proudly display prototype samples of digital audio tape recorders. Everyone was wrong! There wasn't a sign of a digital audio tape, or DAT, recorder in sight. Manufacturers admitted that they had working models of digital audio tape recorders "back in the lab," but none of them were ready to show their handiwork to the public. The reason: introducing yet another technology would confuse the buying public, who are just now getting used to the idea of digital audio on Compact Discs.

Nonetheless, new technology has a way of breaking through, despite those who would hold it back. At the more recent Winter Consumer Electronic Show, held earlier this year in Las Vegas, at least one leading manufacturer of audio equipment, Onkyo, "broke ranks" and did announce and show a sample of a DAT recorder. Now that one maker has displayed this product, it's pretty certain that others will follow suit; we should have DAT recorders available on audio dealers' shelves in late 1986 or, at the latest, in early 1987.

Advantages of DAT

Anyone who has listened to any of the new digital compact discs knows that the digital method of recording audio signals offers much wider and more realistic dynamic range, ruler-flat frequency response, low distortion and the total absence of any background noise or hiss. The same advantages apply to digital audio tape recording, with an added benefit—the ability to make your own digital recordings! That's something that you can't do with Compact Discs (at least not yet). Furthermore, tape recordings, whether analog or digital, can be erased and the tape can be used over and over.

Professional recording studios have been using digital tape recorders for many years to make the multi-track and master tapes from which both analog LPs and now the new Compact Discs or CDs are ultimately pressed. Those machines used in studios cost thousands, even hundreds of thousands of dollars. Those of us who like to record our own high-quality music at home have, in fact, also been able to realize the advantages of digital tape for nearly a decade, though very few people are aware of the technique. Some years ago, a set of standards were developed which enabled you to record digital audio signals on a video recorder. They are the so-called separate Digital Audio Processors, also known as PCM (Pulse Code Modulation) Processors, which convert analog audio signals into a video-compatible digital format.

The millions of digital pulses representing the audio signals are not unlike video signals. Both require a storage medium that can record such a high density of signals. The VCR is ideal for both purposes, thanks to its rapidly rotating head drum. Although the tape itself moves very slowly from reel to reel within its cassette housing, the rotating head drum spins across the surface of the tape at 1800 rpm. In effect, the relative tape-to-head speed is not one inch or less per second, but more nearly 35 to 40 feet per second! Given that tape "writing speed," the high pulse rate of digital audio (or the high-frequency content of video signals) is easily accommodated on video tape. Hence, the PCM processor adds these digital signals to a standard video signal format and the combination is recorded using a VCR. Instead of pictures, the tape stores digital "bits" or number samples that, during playback, are converted back into high-quality analog audio signals.

While this VCR/PCM processor approach works quite well, (and is quite expensive) engineers felt that a *dedicated* audio tape recording system would make more sense. Such a system would not need two separate pieces of equipment. The need to superimpose the digital data onto a video-format signal could be eliminated. (Right now, the digital data must be chopped into small blocks that fit the horizontal and vertical synchronizing pulses of a standard TV picture format.) A new and much more compact tape cassette package could be standardized for such a dedicated DAT system. Finally, the quality and dynamic range of a dedicated system could be improved. After all, the technology of PCM processor/VCR combination recording was introduced more than a decade ago, and a lot has happened in digital technology since then.

It's more than two and a half years since representatives from 81 companies sat down in Japan to try to establish new standards for home digital audio tape recorders. After the experience of having to live with multiple formats for video tape recording (Beta, VHS, and now 8 millimeter), no one wanted to see multiple DAT formats evolve.

Despite the need for a single DAT standard, at their most recent meeting, held last July, the members of the DAT Conference (including 60 Japanese companies and 21 companies from Europe, North America and elsewhere) decided to release specifications for *two* types of DAT recorders after all. But don't despair! One of the two systems, known as S-DAT (for Stationary head Digital Audio Tape) will more than likely be used only for professional or studio applications. The other one, known as R-DAT (for Rotating head Digital Audio Tape), is the one employed in the unit that I saw hidden behind that curtain at the Onkyo exhibit in Las Vegas. It's also the one that will most likely be adopted by other manufacturers as they enter the DAT race next year.

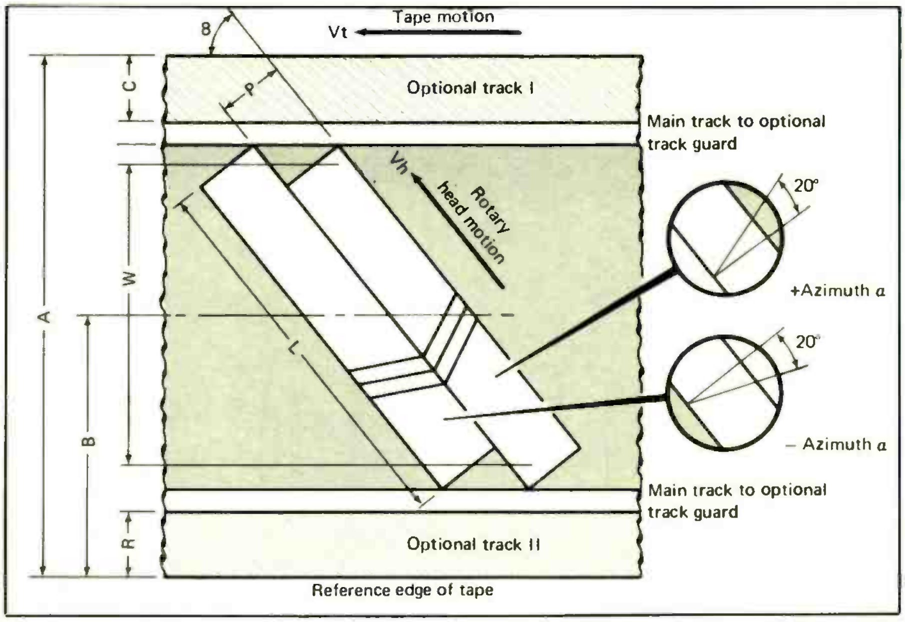

Fig. 1. R-DAT track layout and dimensions.

The Recommended R-Dat Standard

The Table presents a summary of the operating system specifications for the R-DAT digital audio tape recording format, while Fig. 1 shows the R-DAT track layout and dimensions. The 30-mm-diameter rotating drum, spinning at 2000 rpm, is equipped with a pair of record/playback heads. The "gap" of one of these heads is angled at + 20 degrees, while that of the other is angled at – 20 degrees. That way, adjacent "tracks" don't cause any crosstalk or interference with each other.

Several options and combinations of sampling frequency, digital quantization and recording or playback times are provided for in the standard. The mandatory record/play mode calls for a 48-kHz sampling rate, which means that frequency response could actually extend beyond the 20-kHz limit imposed by the 44.1 kHz sampling rate of Compact Discs. (Highest recorded frequency in any digital recording system can never exceed half the sampling rate.) In the playback-only mode (reserved for prerecorded cassettes that will be available some day), a recording time of 80 minutes will be available in addition to the longer 2-hour recording time.

Notice, too, that there are two playback modes for prerecorded tapes. The "Normal" mode is for tapes recorded in real-time with a 44.1-kHz sampling rate. The "Wide" mode is for tapes duplicated at high speed. The high-speed duplicating process fast-winds a blank tape together with a similarly fast winding master tape. At the point of contact, using specialized magnetic field focusing, the blank tape assumes the same magnetic pattern as the master tape. This makes it possible to duplicate tapes at about 200 times normal playback speed!

The resulting signal level using the

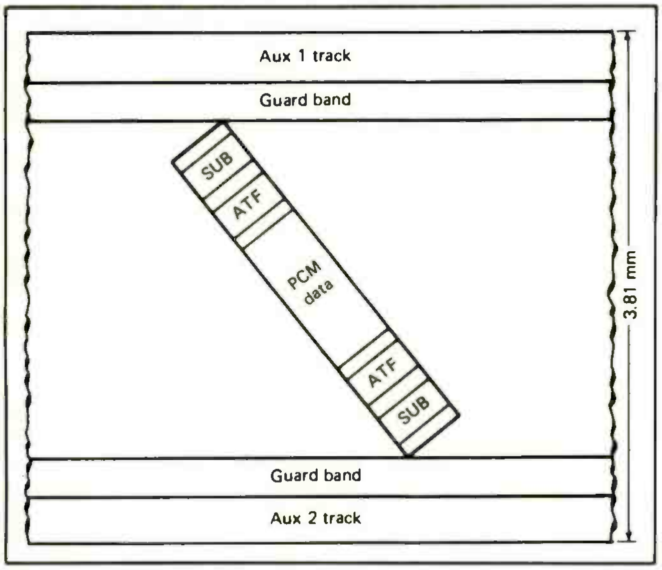

Fig. 2. Cross-section of R-DAT tape.

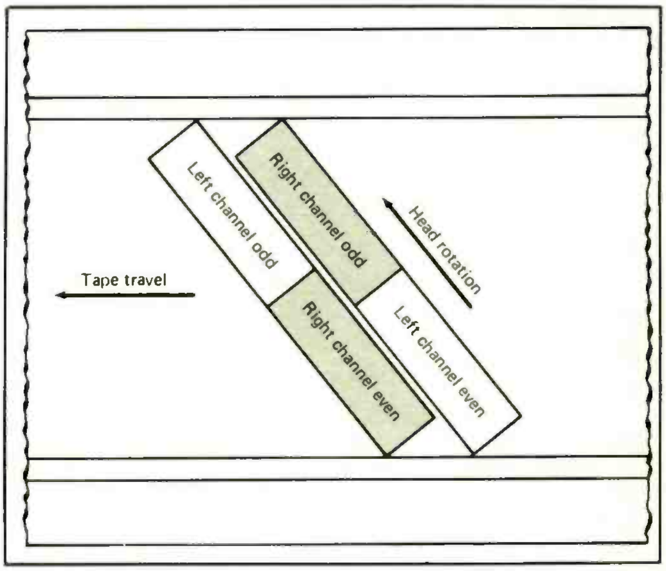

Fig. 4. Relationship between left- and right-channel odd and even data on R- DAT tracks.

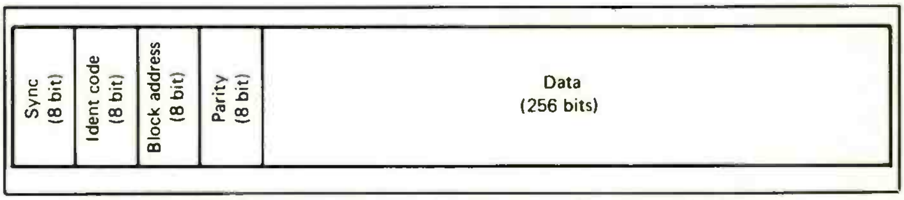

Fig. 3. PCM data arrangement on each track of an R-DAT tape.

contact method is not as great as that on a tape dubbed in real-time. Therefore, track width is made 1.5 times that of the normal mode to compensate for that decrease in output level. Since the track width is higher, the recording square density will be proportionately lower, allowing for the use of ferric-oxide tape, as opposed to the pure metal-particle tape that must be used for the other recording and playback modes.

On of the most important advantages of the R-DAT format is its high recording density. The system will use similar heads and tape as the 8-mm video systems. A new cassette package, measuring only 2⅞ inches in width by 2⅛ inches deep by less than 13/32 inches thick will be able to record up to two hours of digital audio program material (four hours if the optional lower sampling rate of 32 kHz is used). Tape thickness is the same as that of a C-90 analog audio cassette, and the same width as well.

Because the tape wraps around the head-drum only 90 degrees and the rotating drum has only two heads mounted in it, the signal must be time-compressed during recording. The recorded signal goes into a temporary buffer memory, and is released to the head in blocks when either of the two heads is in contact with the tape. During playback, a similar data buffer memory circuit stretches the data back into a continuous digital bit stream.

The R-DAT system has a dedicated tracking correction method. Figure 2 shows the cross-section of the tape indicating five basic data fields per track. The subcode portions (upper- and lower-most along each track) include data for tape time, music selection, indexing, etc. On either side of the main digital PCM data block are two additional portions, labeled ATF in the diagram. These are dedicated to head-to-tape positioning. During tracking, the head overscans the main track so that a small portion of the adjacent tracks is read. This overscan is detected by the ATF portion. The intensity of the signals on the two adjacent tracks is compared. If one is different from the other, a voltage is detected and the tracking mechanism adjusts the position of the head accordingly.

The digital audio data (PCM) portion of the track consists of 196 blocks of data, as shown in Fig. 3. Each track is split so that one half of the data portion is for the left stereo channel and the other half is for the right channel. The data for each channel is split into even and odd data blocks. If one is unable to read data for any reason (such as dirt or other foreign matter covering the heads), the other head will then read the reciprocal data, and interpolate the missing information. Figure 4 shows the relationship between left and right odd and even data on the tracks. This system was designed specifically for R-DAT, so the emphasis is entirely on integrity and fidelity of audio recording.

Unlike digital audio recording formats that are offshoots of video technology, R-DAT therefore makes optimum use of digital technology as it relates to sound recording.

Copying of CDs

Before you get your hopes up about using a DAT player in your car and being able to copy all your CDs onto digital tape, one point should be made clear. Of course, you will be able to copy CDs onto digital tape if you simply connect the analog outputs of your CD player to the analog inputs of future DAT recorders. What you *won't* be able to do (even if your CD player is equipped with a separate digital subcode output terminal) is direct digital-to-digital recording. Such direct digital-to-digital recording would, naturally, preclude any degradation of audio quality that might be caused by the analog steps in the process. If that's what you were hoping for, you'll be out of luck.

With all the fuss that audio recording companies have been making lately about private "pirating" of copyrighted music onto analog cassette tapes by individuals, the DAT committee probably wanted to ensure that owners of CD players would not be able to plug into their new R-DAT recorders and transcribe their CDs onto digital cassette tapes.

One way of preventing that is by using a different digital sampling rate for home DAT recorders. The rate chosen is 48 kHz as opposed to the 44.1 kHz used for Compact Discs. The committee also agreed upon an alternate sampling rate of 32 kHz where the ultimate in fidelity is not required. When this sampling rate is used along with a lower number of bits-per-sample (12 instead of 16), maximum recording time can be extended to 240 minutes as opposed to the 120 minutes available at the higher sampling and higher "bit" rate. Of course, using the lower sampling rate reduces the bandwidth or frequency response of the system to around 15 kHz; about the same cutoff frequency that the 8-mm video tape format provides when used for digital audio recording.

On the other hand, you can expect recording companies to begin to issue prerecorded digital audio tapes just as soon as there are a substantial number of DAT machines out there that can play them. For such prerecorded fare, the sampling rate will be 44.1 kHz, exactly the same as it is for Compact Discs. Owners of such tapes won't be able to copy them either (at least not digital-to-digital) because of the difference in sampling rate. Even if someone gets around the sampling rate disparity, there's further protection against illegal copying. The standard provides for copy-inhibit encoding which, when present in prerecorded source material, prevents tape-to-tape dubbing. This should make it impossible to copy material digitally.

DAT Operating Systems Specifications

	Recording and Playback Modes				Playback Modes	
	Standard	Option 1	Option 2	Option 3	Normal	Wide
Number of channels	2	2	2	4	2	2
Sampling frequency (kHz)	48	32	32	32	44.1	44.1
Quantization bit (Linear/Non-L)	16L	16L	12NL	12NL	16	16L
Recording line density(kB/in.)	61.0	61.0	61.0	61.0	61.0	61.1
Recording sq. density (MB/sq.in.)	114	114	114	114	114	76
Transfer rate (MB/second)	2.46	2.46	1.23	2.46	2.46	2.46
Subcode capacity (kB/second)	273.1	273.1	136.5	273.1	273.1	273.1
Modulation method	8- to 10-Bit Modulation					
Error correction	Double Encoded Reed Solomon Code					
Tracking	Divided Area Alternate Tracking Fields					
Cassette size (mm)	73 × 54 × 10.5					
Recording time (minutes)	120	120	240	120	120	80
•A-Tape width	3.81					
Tape material	Metal Particle					Ferric
Tape thickness (microns)	13 ± 1					
•V_t-Tape speed (mm/second)	8.15	8.15	4.075	8.15	8.15	12.225
•P-Track pitch (microns)				13.591		20.41
•8-Track angle	6 deg., 22′, 59.5″					6,23,29.4
Drum size (mm)	30 mm - 90 degree wrap angle					
Drum rotating speed (rpm)	2000		1000	2000	2000	
Writing speed (meter/second)	3.133		1.567	3.133	3.133	3.129
Head azimuth alt. tracks	± 20 degrees					

• Symbols refer to track configurations diagram

Is DAT Too Late?

Normally, you'd think the Digital Audio Tape would be a natural for a car stereo system, but look at the advantages of CDs. You have instant access to any selection on a CD without having to wait, as you would with DAT, while the tape is wound fast-forward or fast-reverse. Tape, even tape used for DAT, will eventually wear out and the spinning DAT recorder's heads (in this case rotating at 2000 rpm) will also wear out and need replacing. When you play a CD at home or in a car, nothing touches the disc's surface, so there's no "wear."

It's also no secret that a great deal of work is going on to determine the best way to make a "recordable" or "erasable" Compact Disc. If such a "readwrite" disc comes along in the near future—perhaps even at the same time that DAT machines appear—will Digital Tape Recorders have a chance against the more elegant "Recordable Compact Disc" technology? No one really knows the answer to that one, and that may be the reason why manufacturers are not rushing to be "first" with a home DAT recorder this year. There are simply too many unknowns that have nothing to do with the superiority of the R-DAT format over any previously known home audio tape recording method.

8-mm Video Tape Has Digital Audio Capability

While the members of the DAT committee deliberated on standards for DAT, digital *audio* recording on 8-mm *video* tape, has emerged as if from nowhere. It's available in the form of a tiny 8-mm VCR from Sony and in the form of a camcorder from Kodak, Canon and others.

When used strictly as a digital audio tape recording medium, the Kodak system boasts a 12-hour recording capability (six passes across the new 2-hour length of 8-mm video tape) operated at standard 8-mm speed. The Sony version, operated in its slower LP speed, can accommodate *24 hours* of continuous digital audio recording! What effect will this development have on the R-DAT system, which has taken so long to be standardized?

Despite the publicity given to this 8-mm digital audio recording "alternative," it is no real competitor to the newly established R-DAT system. For one thing, the sampling rate used in that system is only 31.5 kHz, as compared to 48.0 kHz proposed for R-DAT. This imposes a frequency response limitation with a high-end cutoff of 15 kHz. While that may be adequate for video and broadcast applications (FM's top frequency is no higher), those seeking the ultimate in audio quality will not settle for such a restricted bandwidth.

Furthermore, while the 8-mm DAT system boasts a dynamic range of 90 dB, not unlike that of CDs and the other two proposed DAT systems, in the case of the 8-mm DAT system that dynamic range is achieved with the aid of an analog noise-reduction or "companding" system. However carefully such systems are augmented, there are likely to be those audio purists who will object to even the most minimal amount of "pumping and breathing" that often accompanies such analog signal compression and expansion. The 90-dB-plus dynamic range achieved by the proposed R-DAT system, in contrast, achieves that measure of dynamic range by virture of its use of a full 16-bit linear quantization system—much like that used in standard CDs.

What R-DAT and 8-mm (video) DAT do have in common is their use of a fast-spinning rotary head. In that respect, manufacturers have gained a great deal of experience over the past few years, thanks to the popularity of home VCRs, all of which employ rotary-head technology. Another thing that R-DAT and 8-mm video/DAT have in common is the fact that even though both use very small-sized cassettes, the tape inside is of the very highest grade metal-particle or metal-evaporated type. That type of recording tape is going to be considerably more expensive than the same amount of ferric or chrome tape now used in analog audio tape recorders.

With all of these factors to consider, no one can say whether DAT will be greeted with the same enthusiasm that has made Compact Discs and CD Players the greatest success story the audio industry has experienced in many years. We'll all just have to wait and see! **ME**

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The Amiga Computer

Examining a remarkable personal computer's custom-engineered power

Amiga's 640 × 400-pixel 16-color high-resolution color graphics capability is evident here.

"Venus" shows what 32 on-screen colors can do at Amiga's lowest resolution (320 × 200). This image was created by Electronic Arts' Deluxe Paint program for the Amiga.

By Dave Powell

I was a pioneer buyer of the Commodore "Amiga" computer, enthralled by its promise and its accompanying moderate cost, $1,295 (which is even lower today) plus monitor. Having lived with the dazzling machine for some time now, here is what the machine is all about with the initial bloom off. We'll take a cosmic zoom of sorts: past the Amiga's plain-Jane exterior, down to its motherboard and special electronics, as well as some contrasts to its main graphics-oriented competitors—Apple's Macintosh and Atari's ST models, as well as IBM's Personal Computers.

Overview

The Amiga reminds me to never judge a book, person or computer by its cover. With a color monitor, CPU chassis, detached keyboard and mouse, Amiga looks like any other computer component system. The CPU chassis is plain, plastic and boxy, but more than strong enough to support a heavy color monitor. At 17″ × 13″ × 4″, it is about 30 percent smaller than an IBM PC. An 89-key detachable keyboard can slide completely beneath the CPU and save still more desk space. The keyboard's telephone-cable connector can also run back underneath the CPU section, which gives the system a spartan, uncluttered look.

The keyboard, however, is unusual. Its keys transmit signals both when they are pressed and when they are released. This lets the software use key-press durations as input (for example, to accelerate a cursor the longer a key is held down). On board are ten programmable function keys and four cursor-control keys, which can be used instead of the mouse. Two "Amiga" buttons on either side of the space bar may also be used instead of the mouse's selection buttons. Therefore, the mouse could be thrown away and all work done on the keyboard—an ability many Apple Macintosh users would kill for. And spreadsheet users will like Amiga's 13-key numeric pad (but won't be crazy about its lack of keys for arithmetic operations).

Amiga's system unit contains an almost noiseless cooling fan and a built-in 3.5-inch microfloppy drive for 880K of formatted storage. Amiga drives can read and write up to 5.6K bytes of data per revolution, and exchange data with central memory along direct-memory-access (DMA) channels. Four more external drives can be daisy-chained to Amiga's desk port, and you can mix 3.5-inch external drives ($295) with 5.25-inch drives ($395).

The system's motherboard holds a 16/32-bit MC68000 CPU, some very important coprocessor chips, and 512K of RAM storage. Half of the RAM presently serves as a write-protected control store for the Amiga's 192K operating system, which is loaded from disk. When Commodore finishes refining Amiga's operating software, and converting some "C" language routines to faster machine code, system code will be burned into ROM. This may be available to established users. However, Commodore is also providing periodic disk updates.

With Amiga's system software in RAM, most users will need another 256K. A $195 upgrade plugs into a hidden slot on the system's front for this purpose. However, this doesn't even approach tapping Amiga's

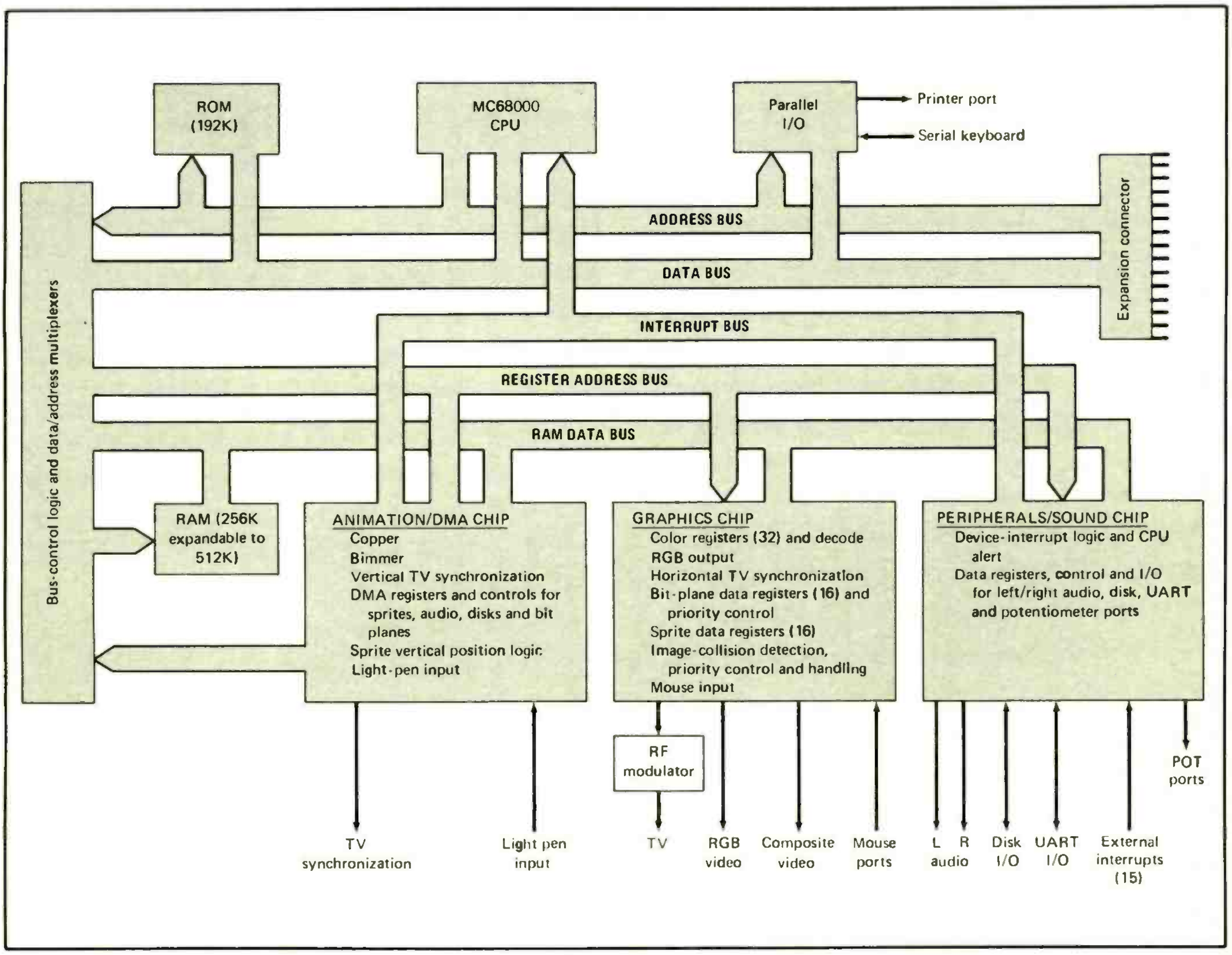


Fig. 1. Three custom chips (bottom) take over many processing tasks from the MC68000 CPU to make Amiga a fast machine, even when executing multiple tasks. These chips also share tasks. Eight 32K dynamic RAMs provide 256K of internal storage (a front-panel plug-in cartridge can double this to 256K). System architecture is divided into two sides that are joined through Bus-Control Logic and Data/Address Multiplexers. The custom-chip/display side directly accesses the 512K bytes of internal RAM. The peripheral expansion connector (upper-right) feeds into Address and Data buses on the CPU side. The CPU shares access to internal memory with the custom chips, but the up to 8 Mbytes attached to the expansion connector will be the CPU's alone. With this architectural arrangement, it is like having two computers in one.

RAM capacity, since its CPU can address 8 megabytes of main memory!

Unfortunately, there's no room inside Amiga for adding memory-upgrade or peripheral-controller boards, so Commodore will offer a separate expansion box. This will plug directly into the Amiga's system bus through a connector in the cabinet's right wall. This keeps Amiga's architecture open to enhancement. Apple's Macintosh offered no such bus access, and unfortunately, its users have had difficulty even adding such necessities as a fast hard disk.

Peripheral Interfaces

Amiga's system cabinet sports an array of peripheral connectors and ports. The system's mouse plugs into one of two identical 9-pin ports in the right wall. The second port could accept another mouse, a joystick, game paddle, light pen or drawing tablet.

On the back of the system unit are serial and parallel (Centronics) printer ports. We'll see later that they are already programmed to handle a variety of specific printers and modems. Three video ports are also available: for TV, NTSC composite, or analog/digital RGB connectors. The Amiga's analog RGB monitor ($495) can display 4,096 colors at resolutions ranging up to 640 by 400 pixels per screen.

Before attaching an NTSC monitor (or TV set equipped with an NTSC port), you'll have to buy a cable from an Amiga dealer. Similarly, to attach a conventional television receiver, you'll have to buy a TV modulator, modulator cable and TV/monitor switch box.

And although the Amiga has a built-in speaker, two standard RCA-pin audio ports will output left/right stereo to an external amplifier and speaker. (These audio ports will also come in handy when using a monitor that's not equipped with its own sound system.) Again, you'll have to buy the audio cables, but they're available through Radio Shack and other electronics suppliers. I patched some of the Amiga's music/voice demonstration programs through my stereo system, and found the sound quality as clear and noiseless as a compact-disk recording.

Multitasking

Users will notice an immediate difference between Amiga and other micros (except, to some extent, the Atari ST). That difference is full multitasking. Most microsystems—even the IBM PC/AT—perform only one task at a time, and have no innate ability to divide their attention among multiple jobs. "Shell" programs like Topview and GEM create the illusion of multitasking, but at the expense of overall system speed.

Not Amiga. Multitasking is built into its operating system and hardware, and, in my judgement, no other personal computer can compare with its productivity. Amiga could animate full-color graphics, play a multi-instrument jazz piece, upload to one disk, download from another, print a report, dial CompuServ through a modem, help you edit a document, and still let its 68000 CPU recompute several spreadsheets. You'll probably never run 50 simultaneous tasks (which Commodore engineers claim to have done), but you could edit four different documents simply by loading your word processor onto Amiga's screen four successive times.

Tasks—such as program commands, device interrupts, memory access and data I/O—are all coordinated by a library of 68000 ROM routines. Each task is assigned a priority between −128 and 127, and inserted into an execution list. Tasks are then pulled off and executed in decreasing priority. An incoming task with higher priority preempts current tasks, but these can restart later since their register and stack states are saved. Tasks with equal priorities share system resources in predetermined time slices, but during its slice, each task thinks it controls the total computer.

Amiga's motherboard (Fig. 1) is unusual since its CPU handles few system tasks. Many tasks that tie down other machines' CPUs—like peripheral I/O, sound systhesis and color graphics—are offloaded to a set of three custom VLSI chips. The Animation/DMA, Graphics and Peripheral/Sound chips offload so much work from the 68000 that most of its time need only be spent computing and logging onto Amiga's data bus.

However, it would be a mistake to think of the three custom chips as separate entities. They work together as if they were a single chip. The three-chip design was necessary, though, because they perform too many tasks to etch into one device. Broadly, the chips are responsible for the system's animation and DMA, bit-plane color graphics, and peripheral interfacing (including sound synthesis).

DMA/Animation

The Animation/DMA chip contains 25 channels of DMA that allow all three custom chips to bypass the 68000. It also includes Amiga's two most important graphics circuits: the "Copper" and "Bimmer."

The three custom chips can log onto Amiga's address and data buses, which in other micros could slow overall throughput. However, these buses are also served by 25 DMA channels. This unusually large number of independent I/O channels boosts system speed by detouring intense data traffic—for disk I/O, screen graphics and sound synthesis—around the CPU. In fact, the 68000 rarely knows when DMA transfers are occurring because the DMA channels and CPU trade off, or interleave, access to the computer's system bus.

Additional speed is achieved whenever data moves between main memory and custom-chip registers. Memory and register addresses are transmitted simultaneously along a 19-bit-wide Register-Address bus. This cuts transmission steps in half because the 68000 CPU does not have to read data and relay it to its destination.

As its name suggests, the Copper circuit coordinates traffic on Amiga's data bus. The system is so graphics-oriented that all bus activity falls into a framework dictated by CRT-scanning cycles. In the time it takes to draw one line of pixels and retrace to the next line, the Copper controls access to 230 data-bus cycles. Every other cycle is reserved for either the Copper, Bimmer or the CPU. The rest are shared among audio output, the system's eight sprite generators, memory refresh, disk I/O and screen graphics. These processes don't have to be "told" when their cycles arrive because all devices know their schedule and initiate their own action.

Any cycles the Copper and Bimmer don't use are available to the CPU. With access to alternate cycles, it can work at full speed while system DMA paths carry four channels of sound, 16 colors of low-resolution (4 of high-res) graphics and disk I/O. However, more activity than this (such as 32 colors of low-res graphics) can steal cycles from the CPU and begin to slow it.

The Copper tracks the electron beam's progress across Amiga's

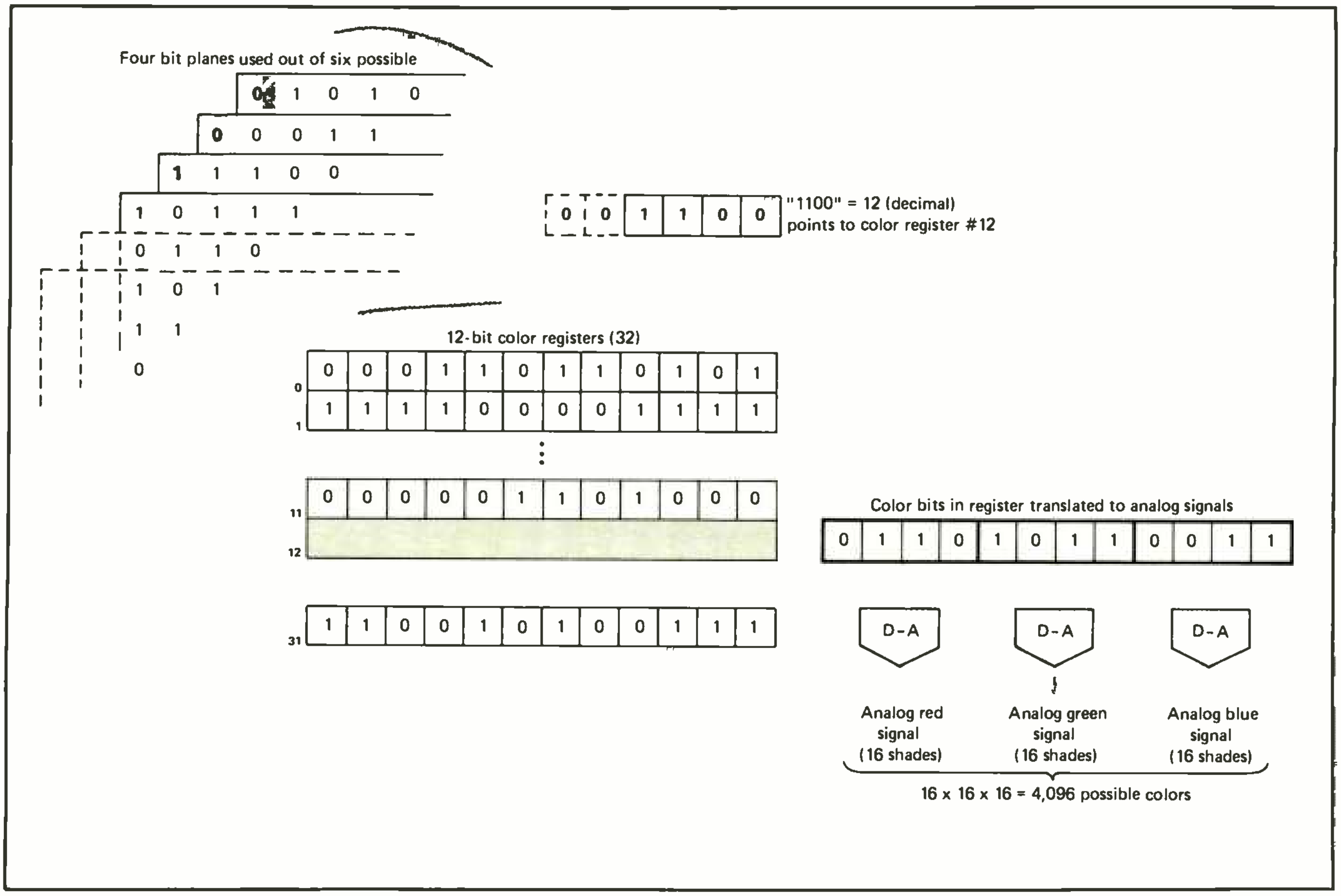


Fig. 2. Amiga defines pixel colors using stacked bit planes. Shown here is how the top-left screen pixel might be colored, using four of the system's six attached planes. The bits corresponding to this pixel read "1100," which tells the system to find the pixel's color in color register 12 (out of 32). Registers are 12 bits long—four bits each for red, green and blue. Digital-to-analog converters can therefore output each primary color at 16 intensities. These combine into 16 × 16 × 16 = 4,096 different displayable colors. Amiga's hold-and-modify graphics mode can display all 4,096 colors in a single screen.

CRT. Hence, it can also coordinate graphic and sound events with screen activity. The Copper always knows the electron beam position to within one scan line vertically and 8 high-resolution (or 4 low-resolution) pixels horizontally. This allows it, for example, to alter color palettes in midscreen and update screen memory for a location after the electron beam has passed.

Updating a graphic object's screen memory after it has been drawn permits it to be changed or moved without jumps or glitches. Again, the 68000 CPU has no concern with this. And while the Copper is waiting for the electron beam to reach a screen location, the system bus is open for the CPU and other Amiga devices.

Another Animation/DMA circuit, the "Bimmer," can move pieces of bit planes around at very high speeds, draw varied line styles, and color-fill areas. It's unusual for a personal computer to handle such tasks in hardware. Doing so, it's much faster than through software alone. Speed of light, you know, vs a disk's mechanical activity. So the Bimmer is largely responsible for the speed of Amiga graphics.

Objects are fed to the Bimmer by specifying their screen location and outline shape. The Bimmer moves them by simply repainting their shape starting at a new location. This location can change fast—for a jump across screen—or slow, for progressive motion. Since the Bimmer works with the whole screen and all bit planes, it can display and move many objects, of any size, displayed in any number of colors.

Bimmer objects could really be called Super Sprites—because that's what they are! But Amiga also offers regular, more limited, sprites (described later). These were included because they require less overhead than Bimmer-animated objects and because too many moving Bimmer objects can slow the system down. That's because the Bimmer and CPU share access to bus cycles, and when the Bimmer gets piggy, the 68000 can suffer. Still, if the system is called on to generate more than eight sprites, it will automatically call on the Bimmer for help.

If these abilities provide fast, flexible graphics, Amiga's animation routines add dazzle beyond the abilities of any other personal micro. Animation is handled by a series of calls to ROM subroutines. These can do the following:

* Create animation from sequences of graphic components. For example, a flying bird could be assembled from sequences of body, wing and tail shapes, with specified delays between shape changes.
* Move animated images across the screen by adding physical displacements after each cycle. For example, you've animated one bounce of a boy on a pogostick. He lands 10 pixels to the right of where he started. By adding a 10-pixel displacement to the beginning of each new cycle, you can make the boy bounce all the way across the screen.
* Feed "animated" data structures into sprite-display hardware for truly animated sprites.
* Restore objects and backgrounds after other objects have passed.
* Perform complete motion-control, with image changes derived from current positions, horizontal and vertical velocities and accelerations.
* Detect collisions between graphic elements and between elements and the screen edge. You can specify which types of collisions should be ignored and which followed by collision-handling routines.

If you're interested in animated graphics, you won't find a comparably priced micro with Amiga's inherent power.

Video Management

Amiga's Graphics chip produces color signals for Amiga's monitor, manages two independent displayable screens and produces eight onscreen sprites.

A key concept of Amiga graphics is the playfield. This is a bit-mapped color image which can extend beyond the limits of the screen display. By changing values in graphics registers, you can fine-scan the display around a playfield in all directions.

Pixel colors are generated a bit differently than in other micros. Normally, adjacent bits in screen memory are combined into full-word sequences, the values of which encode pixel colors.

However, in Amiga, a 640 by 400-pixel image is colored by combining separate 640 by 400-bit "planes." Amiga allows up to six such planes. They build pixel colors as shown in Fig. 2, where four planes are used. These four planes can point to any 16 of 4,096 possible colors. Similarly, five bit planes—five color bits/pixel—point to 32 colors. The latter also happens to be the number of color registers within the system. Pixels are "painted" from these registers; pixel colors are not stored as data.

This saves memory, but it also allows some interesting graphic effects. For example, changing a register's color value instantly recolors all pixels linked to it. By cycling color values through registers, you could make water in a stream seem to flow across the screen.

Amiga's bit-plane techniques offer several advantages over full-word storage of pixel-color data. One is that you can choose the number of bits of color resolution. The fewer bit planes you use, the less memory your graphics require. Area fills also become simpler because the bit planes are organized like the screen itself—one bit per pixel. And bit planes also help reduce data transfers. In systems where screen data is packed into full words, you must transfer and break down the full words, even if all bits are not being used. In the Amiga, you set up and use only as many color bit planes as you wish—even if its only a single plane for a monochrome display.

Amiga has six display options. Resolutions of 320 by 200 and 320 by 400 allow display of 32 colors. Sixteen colors can be displayed in 640 by 200 and 640 by 400 modes. The 320 by 200 and 640 by 200 displays are updated 60 times a second. However, the 320 by 400 and 640 by 400 displays are refreshed in two interlaced 200-line sets; so the total image is updated 30 times a second.

Some users have complained that interlaced images flicker (a phenomenon not unique to Amiga). Commodore's Jay Miner says the flicker disappears on a monitor with medium- or high-persistence phosphors, such as the Electrohome model. The Electrohome also accepts analog RGB signals, so it can display Amiga's entire color palette. There is, however, a tradeoff with high-persistence phosphors: rapidly moving images can leave short trails.

A fifth display option, called "hold and modify," is the star of Amiga's show. At 320 by 200 resolution, it can display *all 4,096* possible system colors. This large palette can compensate for the lower resolution, and produce photo-like graphics. Amiga uses six bit planes to build hold-and-modify images. Two of the planes tell the system how to interpret the other four. The two control bits specify whether the other four define a pixel's color, or a four-bit modification to the red, green or blue portion of the previous pixel's color value. Normally, 12 bits of memory would be required to color each hold-and-modify pixel. However, Amiga's bit-plane handling does so with only six.

Amiga benefits from its use of bit planes in another way: in a sixth display mode called "dual playfields." This divides Amiga's six color bit planes into two groups, one with priority over the other. You aren't required to have the same number of planes in each group, and they can have different resolutions and onscreen colors. This would be much harder to implement in micros where color bits are grouped together in

Where Did Amiga Come From?

The Amiga began about four years ago with a company called Hi-Toro. Four Midwestern businessmen formed Hi-Toro to build video-game systems and controllers. Their first system—Amiga's honorable ancestor—was to be an under-$400 game machine with arcade-quality graphics and sound. Hi-Toro wanted to name the product "Amica," which means "friend" in Latin. But the word was already licensed for commercial use. So Hi-Toro jumped that hurdle by simply changing the "c" to a "g." By accident, they later discovered that "Amiga" also means "friend" in Spanish.

The team Hi-Toro assembled to design Amiga promised both skill and an offbeat kind of creativity.

Hi-Toro, which changed its name to Amiga, hired a new chief executive, David Morse, away from a vice presidency with Tonka Toys. When the video-game boom, and Amiga's joystick business, soured, it was Morse who persuaded Commodore to acquire Amiga for a reported $25 million.

Hired to oversee chip designs was Jay Miner. He had been designing chips for a cardiac pacemaker manufacturer, but had previously created chips for Atari home computers and VCS game systems. Miner is now Vice President of Product Development for Commodore's Amiga division.

Glenn Keller, who worked on the Amiga's Peripherals/Sound chip, had been an oceanographic engineer for MIT. Before joining the Amiga team, he was in Scotland doing TTL logic designs and breadboards for wave-making machinery. He heard about the Amiga project through a friend in California. According to Miner, Keller left after the Amiga debut "to do construction work in the hills, I think."

Dave Dean joined Amiga as a non-degreed electronic technician, but rose within the ranks to responsibility for Amiga's Graphics chip. As with Keller, this was Dean's first experience designing a computer chip.

Ronald Nicholson, formerly with Apple, served as the team's Hardware Director. "He generated a lot of good ideas about the Animation/DMA chip, and about its unique Bimmer circuits," Miner said. "Dave Needle, a video-logic designer, also helped us a lot with the Animation chip. He had done a lot of work for video-game companies." He also worked on the initial breadboarding for the three custom chips.

"On the software side, two people made major contributions—Dale Luck and R.J. Mical." Miner noted. Luck had been designing a 68000-based graphic workstation for Hewlett-Packard when he moved to Amiga. He wrote Amiga's graphics routines and showed Miner how the Amiga's Bimmer circuits could be made to do very fast line drawing. He proved the idea with a software simulation of the Bimmer, written before the circuits were even breadboarded. This exact hardware simulator, though slow, was used extensively during the Animation/DMA chip's development.

'Mical's first name is really Robert, but we use his initials because 12 of Amiga's 60 employees are Roberts," Miner confided. "We've had to pass out nicknames to keep the Roberts straight—for example, Robert Burns is 'Kodiak'." Mical was largely responsible for the Intuition windowing system and Workbench desktop environment. "He has previously been a video-game designer, and claims he developed Intuition and Workbench without ever studying Apple's Macintosh," Miner added.

Although now part of Commodore, Amiga retains its own California headquarters. More than half of the original Amiga designers are still with the company.

words, rather than planes, because system software would have to extract and manipulate variable chunks of words.

In effect, Amiga's dual-bit-plane images are built on two separate screens that can interact in many ways. For example, one graphic adventure game uses this mode extensively. Under the user's control, a playfield containing a landscape pans behind another playfield showing a control panel with "transparent" monitor screen. The monitor playfield has priority, so the landscape looks like it is being viewed *through* the monitor. No extra programming is required to clip the landscape at the monitor's edge. That's done automatically.

Similar to playfields are Amiga's on-screen sprites—moveable bit-mapped objects superimposed over a background scene. Amiga can generate eight sprites per horizontal scan line, each with four colors (including transparency). While only 16 low-resolution pixels wide, each sprite can stretch to full-screen height. Sprite pixels are stored internally as series of 16-bit lines, plus a horizontal displacement into the screen. Sprite DMA circuits on the Graphics chip feed these lines to the display in synchrony with the electron gun. Consequently, programs can change parts of sprites above and below the current scan line. This gives Amiga sprites more "flexibility" than if they were stored and displayed as an unchangeable block (as many systems do).

System routines manage the sprites in pairs, with paired sprites using the same colors. Paired sprites can also be treated as one and be displayed using 16 colors (including transparency). The jump from 4 to 16 colors is possible because single sprites are colored using two bit planes, but combined sprite pairs have access to four.

The system assigns priorities to sprites. The result is that they can pass in front of or behind each other and the playfields.

Like the Macintosh and Atari ST, Amiga treats text as just another form of graphics. Fonts are stored in ROM or RAM as bit maps and are drawn to the screen by ROM routines. Without a text-only display mode (like the IBM PC's), Amiga software can freely mix text with graphics, define new fonts, resize text and display it at any screen resolution. The system's default fonts can display at 40 characters per line (low-res), 64 characters (on TV monitors) or 80 characters (in high-res).

You can control the starting screen position for text and text/background colors. Fonts can be displayed inversed, bold, italic, underlined and extended. Characters can also be overstruck. This would allow Amiga to display APL-language program code *including overstrikes*, though this hasn't been done yet.

I/O and Sound

The third custom chip (Peripherals/Sound) generates four voices of programmable digital sound, each with a range of nine octaves. Also on board are a device-interrupt handler and disk I/O controller.

Part of Amiga's system speed and multitasking abilities come from this chip's interrupt handler. Unlike most other micro CPUs, Amiga's 68000 CPU doesn't waste clock cycles to "ask" peripherals if they have new data. Instead, peripherals catch the 68000's attention by sending a request to the interrupt handler. This assigns priorities to interrupts and executes their interrupt routines (or, if a higher-priority task is running, logs the interrupt request into Amiga's prioritized task queue).

Also on the Peripherals/Sound chip are DMA channels for synthesized sound. These can operate under CPU control, or independently of it. So Amiga can create and output four channels of sound at the same time that screen graphics are being updated and the CPU is working on something else. One of my demo disks shows how well this multitasking works. Its realistic human voice tells what's going on while animated images run at full speed.

Sound synthesis is handled by routines in ROM and on disk. These routines are:

* Break up of text files into phenome strings, which are output as synthesized speech. These routines are available to any Amiga software, even your own BASIC programs. Amiga is the first personal computer to make voice output from any program easy.
* Lets you define attack, decay, sustain and release parameters of synthesized music. Sound tables built from these waveforms can be output directly by Amiga's DMA channels, without bothering the 68000 CPU. There's no limit to a waveform's complexity, so each channel can play chords or the combined sounds from several different instruments.
* Capture and digitize external sounds at a programmable sampling rate. This is how Amiga's most impressive music and voice effects are achieved.
* Output at any of 64 volume levels.
* Transmit signals to manipulate other Amiga tasks from within sound routines.
* Enable or disable individual sound-output channels.

Amiga's four digital sound channels are converted to analog signals and combined for output through two standard RCA stereo jacks. Thus, Amiga can feed directly into stereo amplifiers. These two jacks may also be patched into the Amiga monitor's single internal speaker using a Y cable provided. But you must put Amiga sound through a stereo system to appreciate its high quality.

The four digital sound channels can also be paired so that two channels shape (or "modulate") the other pair. This allows Amiga to control both the volume (amplitude) and rate (frequency) at which the modulated waveforms are output.

User Interface

Like the Macintosh and Atari ST, Amiga communicates with you through mouse-selected icons, drop-down menus and graphic windows into disk/data files. Its Intuition operation system displays these using a program called Workbench. This "electronic desktop" is your main tool for running programs, organizing files, specifying Amiga's human-interaction parameters and copying disks.

Presently, Intuition and Workbench are housed on two diskettes. You first enter a "Kickstart" disk (containing the AmigaDOS operating system) and follow with the Workbench disk (by the time you read this, Commodore may have transferred Kickstart to ROM on all new Amigas). System graphics not only tell you which diskette to enter and when, but also show how the diskettes should be positioned. The whole procedure is just about foolproof for new users.

It's a shame, then, that not all third-party software developers seem to be following Commodore's complete power-up procedure. Several programs I've examined are inserted *instead* of the Workbench diskette, not after it. Such programs become the system's only activity because the multi-program Workbench environment isn't running.

Many of these programs are games, which would contribute little to a desktop environment. At least one Amiga "paint package," however—Electronic Arts' Deluxe Paint —also replaces Workbench. I guess this is done to save precious money for graphics. But without Workbench, these paint packages can't exchange graphics with word-processed documents. Moreover, an artist can't print one graphic while creating another. Hopefully, the practice of bypassing Workbench won't spread. Future memory enhancements may do a lot to discourage it.

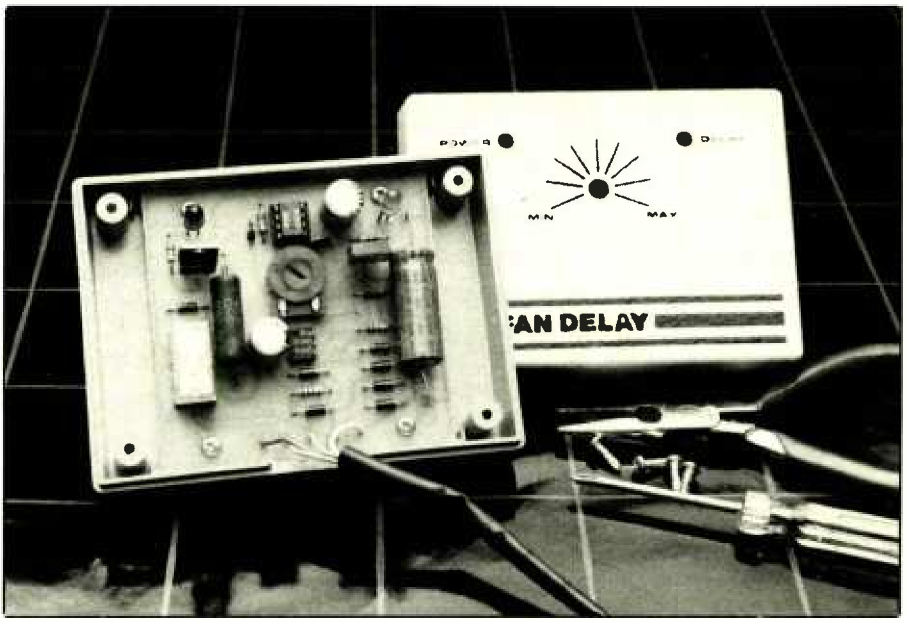
There are interesting differences between the way the Macintosh, Atari ST and Amiga use their mouse input devices. The MAC's mouse has but one button (for less user confusion). The MAC also has no cursor-control keys, so the mouse must be used for both commands and screen

(Continued on page 81)

A Fan-Delay Timer For Air Conditioning

Saves on cooling costs by purging cool air trapped in an air-conditioning system when the compressor stops

By Bill & Kathy Owen



Residential central air conditioners are usually controlled by a bimetallic thermostat whose basic design is more than 100 years old. Simple in design and virtually fail-safe in operation, this type of thermostat simultaneously switches on and off the air conditioner's compressor and fan. This causes cool air inside the system's ductwork and around the cooling coils to remain where it is. As a result, the air does not get into the areas you want to cool.

If the fan could be made to remain on for several minutes after compressor shutdown, however, the cool air could be forced into the rooms to keep them cooler for a longer period of time. Moreover, the compressor would cycle less frequently, resulting in better operating economy and less equipment wear and tear. The Fan-Delay Timer to be described here can be added to your present bimetallic thermostat to do this inexpensively.

The timer can be set so that your air-conditioning system's fan runs on for a precise period of time to maximize cooling without adversely affecting economy.

How it Works

To understand the operation of the Fan Delay Timer, let's examine how a thermostat operates. In the modern thermostat, 24 volts ac is provided by a step-down transformer inside the air-conditioning unit. Only one side of the transformer (the secondary red or return wire) is brought to the thermostat.

In the typical air-conditioning system, three other wires are brought to the thermostat. These come from the heat, compressor and fan contactors. When the thermostat connects any of these lines to the RETURN line, that part of the system is activated. Only low-power 24 volts ac is switched by the thermostat, not the full 117 volts at high power needed to power the cooling, heating and fan loads.

When the system is operated in the automatic mode, many thermostats switch on and off the fan and compressor in parallel. Hence, fan and compressor are always simultaneously switched on and off. The Fan Delay Timer keeps the fan on when the compressor cuts out, without otherwise affecting system operation.

In Fig. 1 is shown the complete schematic diagram of the Fan Delay Timer circuit. Note the routing of the Y IN and Y OUT conductors through the normally closed contacts of the relay. When relay *RY1* is energized, these normally closed contacts open, breaking the Y IN and Y OUT connection.

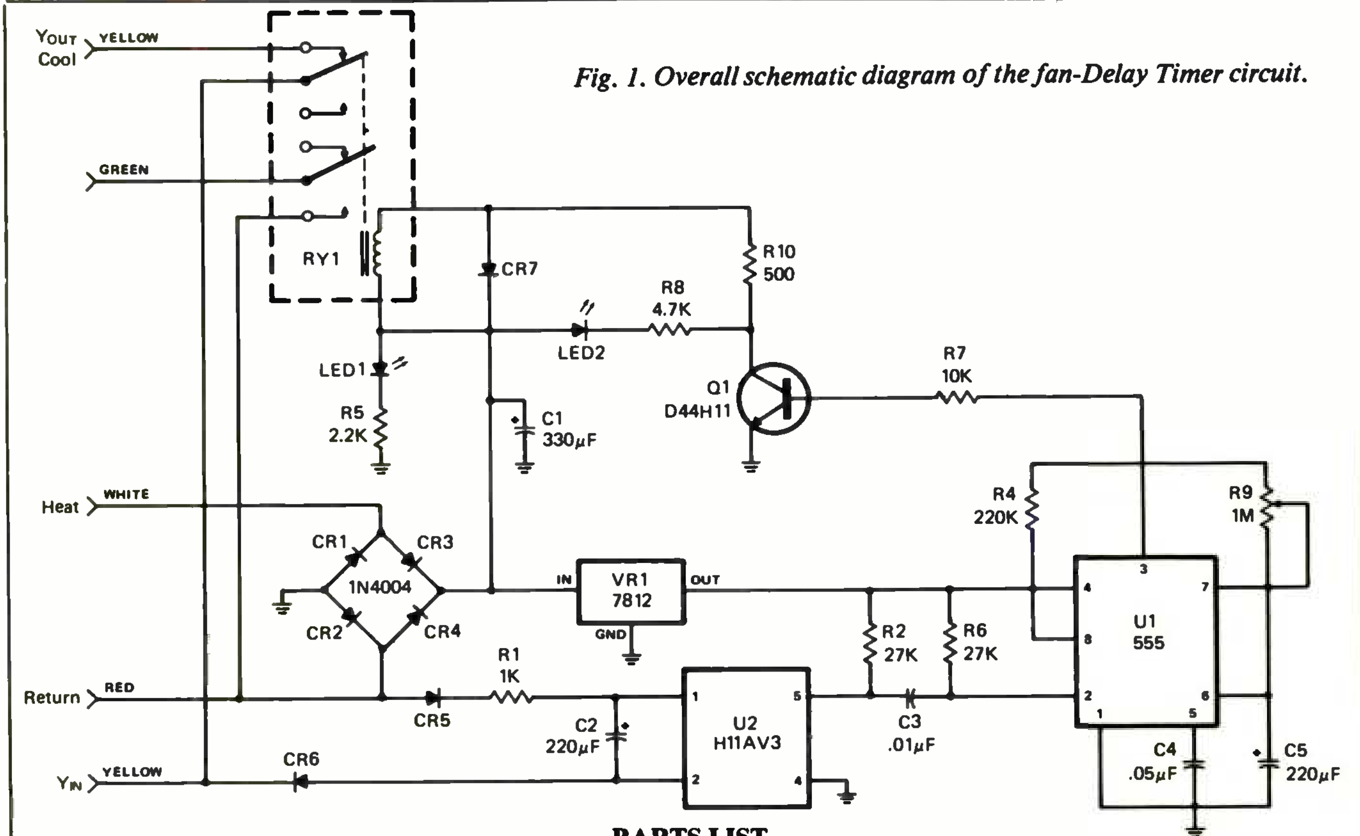
Power for the project is obtained from the RETURN and HEATING contactor conductors, where 24 volts ac is always present when heat is not being used. The 24 volts ac is rectified by *CR1* through *CR4* and filtered by *C1*, after which it is regulated by *VR1* to provide the 12 volts dc required to power the rest of the circuit. Red light-emitting diode *LED1* serves as a power-on indicator.

Time delay is provided by 555 timer *U1*, configured here as a monostable multivibrator whose timing cycle is determined by the time constant of *R4*, *R9* and *C1*. Because *R9* is a potentiometer, time delays ranging from less than 1 minute to about 10 minutes allow the system to be optimized for changing conditions.

During the time-delay period, pin 3 of *U1* is high, causing *Q1* to conduct and energize *RY1*. Current through *RY1*'s coil is limited by *R10*, and green or yellow *LED2* lights to tell you when the relay is energized and the fan delay countdown is in progress.

Every time the cooling circuit is broken and *U1* is triggered, the LED inside optocoupler *U2* senses this event. When the compressor is energized, the Y and RETURN circuits are at the same potential and no current flows through *U2*'s LED. As soon as the compressor contactor is broken, 24 volts ac is present and is rectified by

Fig. 1. Overall schematic diagram of the fan-Delay Timer circuit.



PARTS LIST

Semiconductors

CR1 thru CR7—1N4004 rectifier diode

LED1,LED2—Light-emitting diode (one red, one green)

Q1—D44H11 transistor

U1—555 timer

U2—H11AV3 optocoupler

VR1—7812 12-volt regulator

Capacitors

C1—330-μF, 40-volt electrolytic

C2,C5—220-μF, 16-volt electrolytic

C3—0.01-μF disc

C4—0.05-μF disc

Resistors (¼-watt, 5% tolerance)

R1—1,000 ohms

R2,R6—27,000 ohms

R3—Not used

R4—220,000 ohms

R5—2,200 ohms

R7—10,000 ohms

R8—4,700 ohms

R10—500 ohms, 2 watts

R9—1-Megohm flat-mount pc-type trimmer potentiometer

Miscellaneous

RY1—24-volt, dpdt pc-type miniature relay

Printed-circuit board; socket for U1; Molex Soldercons for U2 (optional; see text); suitable case; color-coded stranded hookup wire (see text); solder; etc.

Note: The following are available from NRG Electronics, P.O. Box 24138, Ft. Lauderdale, FL 33307: Etched and drilled pc board for $9.95; complete kit of all parts except cabinet for $17.95; drilled and silk-screened plastic cabinet for $7.95. Please add $2.75 P&H for each order. Florida residents, add 5% sales tax.

CR5 and *CR6* and filtered by *C2*. When *U2*'s LED lights, the optocoupler's internal phototransistor conducts and sends a negative pulse through *C3* to start *U1*'s timing cycle. The collector of *U2*'s internal phototransistor, at pin 5 of *U2*, remains low as long as the compressor contactor is open, but *C3* prevents *U1* from triggering.

Some Possible Thermostat Wiring Schemes

Fan-Delay Board	R	W	Y OUT	G	Y IN
Wire Color	**red**	**white**	**yellow**	**green**	**yellow**
Some possible	R5	4	Y6	G	
thermostat	R	W	Y	G	
terminal board	RH	W	Y	G	
markings	4	W	Y	G	
	M	H	C	F	
	RETURN	HEAT	COOL	FAN	

Construction

To make the Fan-Delay Timer as compact as possible, printed-circuit board construction is recommended. You can fabricate your own pc board, using the actual-size etching-and-drilling guide shown in Fig. 2, or purchase one ready for wiring from the source given in the Parts List.

Wiring of the board is simple and straightforward, as shown in the drawing in Fig. 3. Saving the IC for last, wire the components to the board exactly as shown. Make sure that the solid-state devices and electrolytic capacitors are properly oriented before soldering. Also, use a socket for *U1*. A socket is also recommended for *U2*, but since this is a 6-pin device, you must make a "socket" using Molex Soldercons if you cannot locate a supplier of 6-pin sockets. If you wish, however, you can simply solder *U2* directly into place. Mount the red POWER *LED1* and green or yellow DELAY *LED2* so that the bottoms of their cases are 1" above the surface of the board.

When all components have been mounted on the board, plug in *U1* and *U2*. Then remove ¼" of insulation from both ends of 12" lengths of stranded hookup wire (two yellow and one each red, white and green). Twist together the fine conductors at each end and lightly tin with solder. Then plug one end of each wire into the appropriate holes at the bottom of the board and solder into place. Follow the color-coding scheme detailed in Fig. 1 (G = green; Y IN and Y OUT = yellow; R = red; W = white).

You can house the project inside any enclosure large enough to accommodate it. The prototype shown in the lead photo was built into a 4⅜" × 3¼" × ½" plastic box. The 1½" depth of the this box provides enough clearance for the components on the board and is shallow enough to permit the domes of the LEDs to fit into holes in the top of the box to provide easy viewing from almost any angle.

Prepare the box by drilling two ⅛" holes for the LEDs and a 3/16" or ¼" hole for access to *R9*, and cut or file a slot where the two halves of the box meet to provide a means for the five

(Continued on page 87)

Fig. 2. Actual-size etching-and-drilling guide.

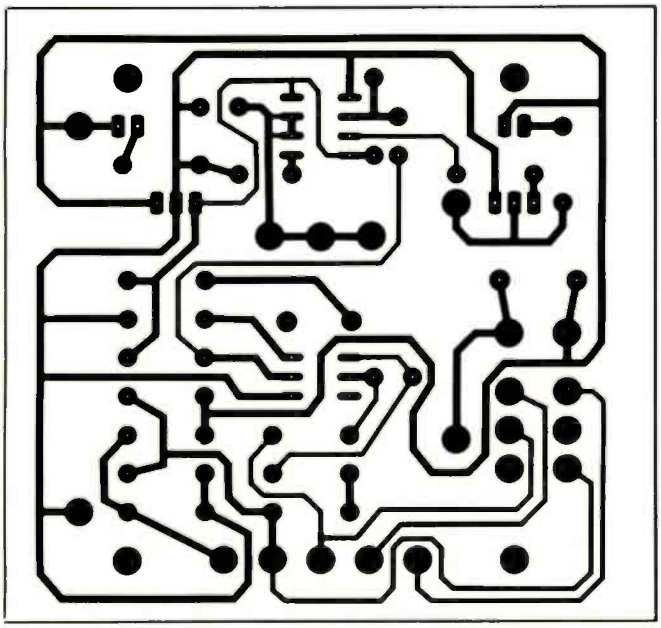
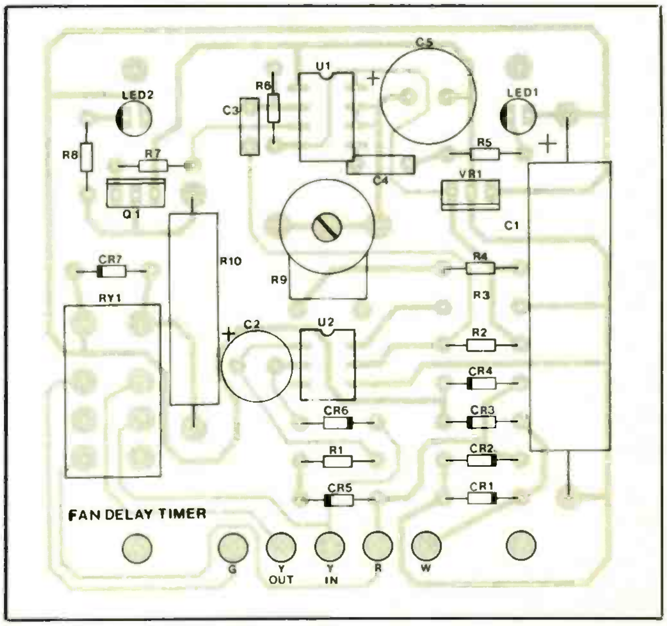


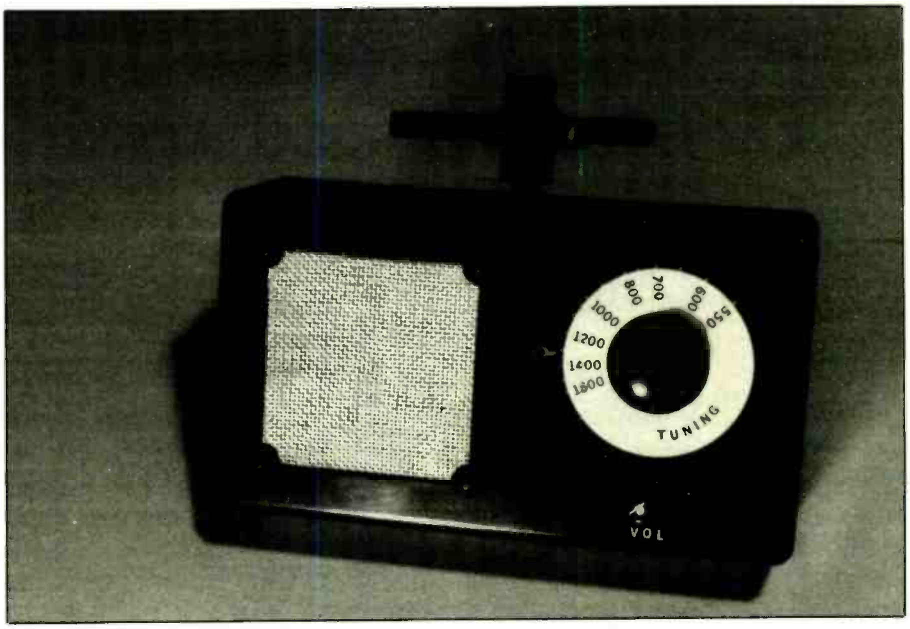
Fig. 3. The components-placement diagram.



A Radio-On-A-Chip

It's easy to build a TRF radio with a tiny IC that contains most components needed

By John T. Bailey



About 13 years ago, a tiny integrated circuit radio-on-a-chip was introduced by a British company, Ferranti. Though it looks like an ordinary three-lead TO-92 transistor, the IC, whose nomenclature is the ZN414, actually contains a 10-transistor tuned radio-frequency (TRF) circuit that provides complete amplifier, detector and agc circuitry for pulling in stations from 550 to 1600 kHz on the AM broadcast band.

External-component requirements are very simple and power requirements are modest. As a result, the ZN414 has become very popular among electronics experimenters and hobbyists all over the world. In this article, we'll tell you a bit about this unusual chip and then describe how to build a simple TRF radio around it.

About the ZN414

Shown in Fig. 1 is the block diagram of the ZN414 chip, along with the required external components. This virtually complete circuit requires only a dc power source, an audio amplifier and a speaker or earphone to make it into a complete radio. According to Ferranti, the ZN414 chip has cascaded r-f gain stages tuned by only one input LC (inductive-capacitive) network. Its selectivity is exceptional for such a tiny device, though it isn't as good as that of a superheterodyne radio.

With little more than a block diagram and Ferranti's verbal description of this chip, it's very difficult to determine how the ZN414 functions. There are, however, several things we do know about circuit operation. With regard to agc (automatic-gain-control) action, we know that chip gain is a function of the supply voltage and increases exponentially as supply voltage is increased from 1.2 to 1.6 volts. All current drawn by the chip's internal circuits passes through load resistor R_{agc}.

When the ZN414 is tuned to a strong signal, it draws more current, resulting in a greater voltage being dropped across R_{agc} and leaving less voltage for the r-f stages. Therefore, overall chip gain is reduced and agc action is achieved. The value of R_{agc} is between 470 and 1500 ohms, the lower values giving somewhat better selectivity and the higher values giving more agc action.

How it Works

Now that you know what little there is to know about the ZN414's internal circuitry and what you can expect from it, let's look at the full radio project. In Fig. 2 is shown the complete schematic diagram of the project.

Starting at the input, a high-Q (550 at 790 kHz) ferrite antenna is tuned by a single-gang variable capacitor, identified as *L1* and *C1*, respectively. This LC network directly feeds the input of ZN414 chip *IC1*, whose 4-meg-ohm input resistance doesn't load down the network. This input arrangement is the key to the excellent selectivity achieved with the ZN414.

Recommended supply potential for the ZN414 is 1.3 volts. It's essential that this voltage be reasonably constant under all operating conditions. Adequate regulation is obtained with series-connected diodes *D1* and *D2*. These diodes must be selected so that their combined drop at 1.4 mA is as close as possible to 1.3 volts. (Since

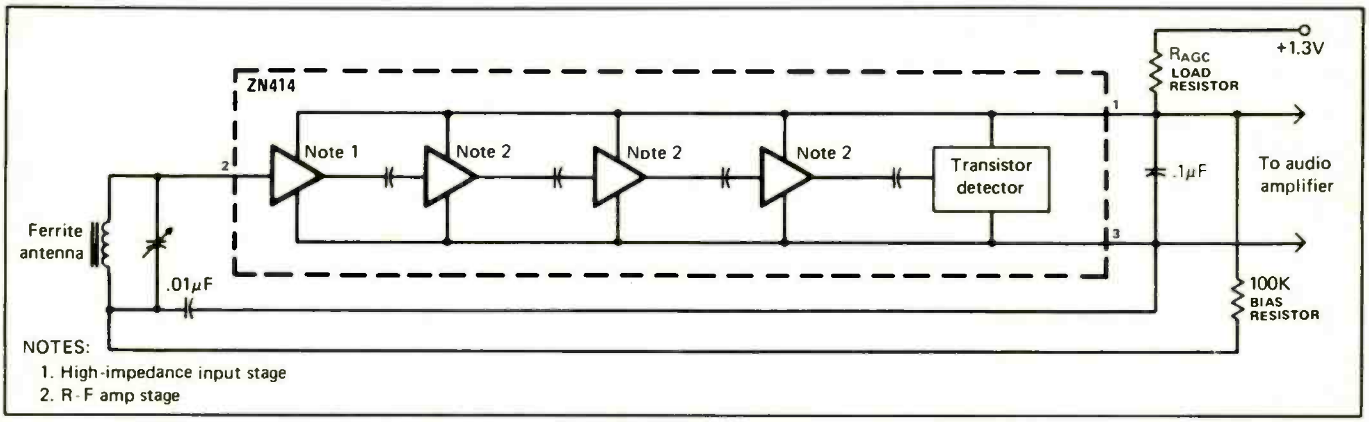
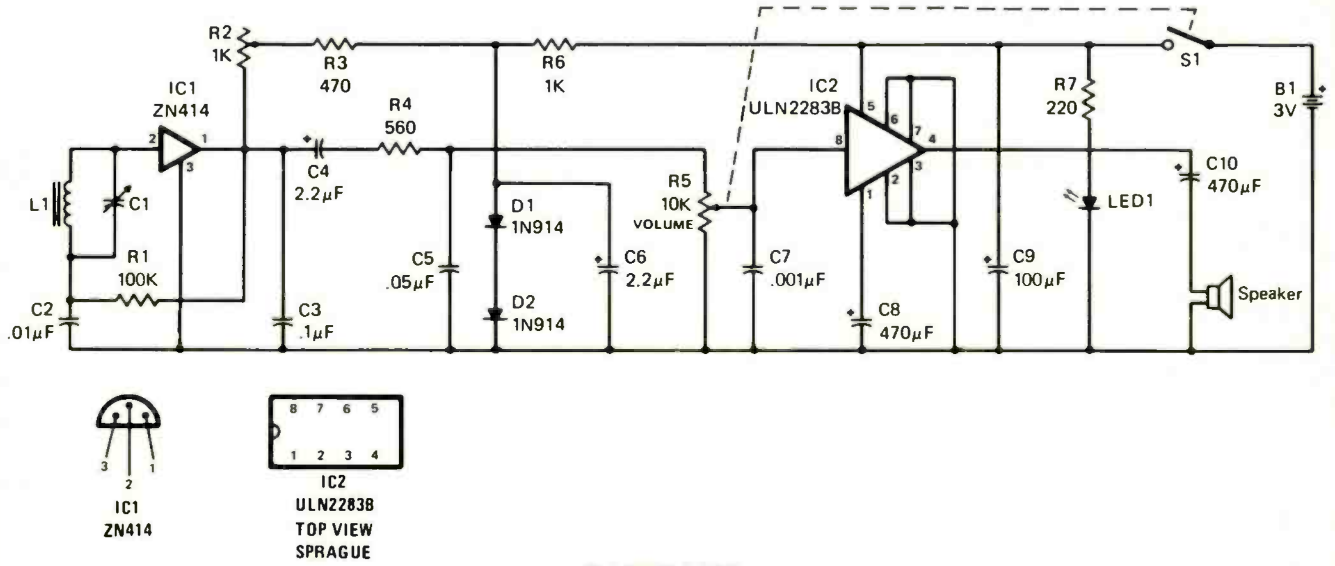


Fig. 1. Simplified diagram of the ZN414's internal circuitry, based on manufacturer's description.

Fig. 2. Complete schematic diagram of the TRF AM radio. Note that the circuit is greatly simplified by the fact that all "radio" functions are contained on the single three-lead ZN414 chip, identified here as IC1.



PARTS LIST

Semiconductors
D1,D2—1N914 diode
IC1—ZN414 radio on a chip (Ferranti)
IC2—ULN2283B IC audio amplifier (Sprague)
LED1—Light-emitting diode

Capacitors
C1—365-pF, single-gang variable
C2—0.01-μF, 50-volt disc
C3—0.1-μF, 50-volt disc
C4,C6—2.2-μF, 35-volt tantalum
C5—0.05-μF, 50-volt disc
C7—0.001-μF, 50-volt disc
C8,C10—470-μF, 10-volt electrolytic
C9—100-μF, 10-volt electrolytic

Resistors (¼-watt, 5% tolerance)
R1—100,000 ohms
R3—470 ohms
R4—560 ohms
R6—1000 ohms
R7—220 ohms
R2—1000-ohm miniature pc potentiometer
R5—10,000-ohm miniature audio-taper potentiometer with spst switch

Miscellaneous
B1—3-volt battery (two 1.5-volt C cells in series)
L1—Ferrite antenna for 365-pF capacitor (Miller No. 20001)
S1—Spst switch (part of R5)
SPKR—Miniature 8-ohm loudspeaker
Printed-circuit board; 7¾" × 4⅛" × 2⅞" plastic box (Radio Shack Cat. No. 270-232 or similar) and plastic back panel; socket for IC2; single C-cell holders (2); hollow-shaft potentiometer for antenna mount; plastic block or large setscrew-type control knob for antenna-mount adapter (see text); large setscrew-type control knob for tuning capacitor; small control knob for R5; fast-setting clear epoxy cement; plastic material for LED1 assembly; machine hardware; hookup wire; solder, etc.

Note: The ZN414 and ULN2238B ICs are availabe for $2.00 and $1.50. respectively, plus $1.50 P&H from: Circuit Specialists, Box 3047, Scottsdale, AZ 85257.

there's considerable variations among 1N914s, you may have to check through a number of them to get a suitable pair.)

Though it's possible to use a fixed resistor with a value between 470 and 1500 ohms for *R2* (which is the same as R_{agc} in Fig. 1), a potentiometer was chosen to provide a means for adjusting the radio for changing reception conditions.

At the output of *IC1* there are three important components. These are base bias resistor *R1*, decoupling/r-f bypass capacitor *C3* and agc potentiometer *R2*. These components serve as a time-constant network with a break point at about 4 kHz. Resistor *R4* and capacitor *C4* provide filtering action that minimizes r-f from reaching audio amplifier *IC2*.

Other audio amplifier chips might have been used for *IC2*, but the ULN2283B was selected because it requires very few external components and provides an output of 100 mW with a 3-volt supply. This is sufficient to drive an 8-ohm speaker.

Two 1.5-volt C cells in series provide the *B1* dc power required by the radio. The full 3 volts is used to power *IC2*. Diodes *D1* and *D2* are biased through *R6* to drop the voltage to a safe level for *IC1*. Similarly, *R7* drops enough voltage for safe operation of light-emitting diode *LED1*.

Although *IC1* draws less than 0.5 mA, *LED1*, *D1*, *D2* and *IC2* help to place a total drain of 13 mA on the battery supply at quiescence. Operating the radio at a moderate sound level increases the drain to about 25 mA, while cranking the VOLUME control *R5* all the way up draws as much as 85 mA from the battery. Obviously, then, for maximum battery life, high-energy cells should be used for the battery.

Construction

Depending on the particular speaker and variable capacitor used for *C1*, it may be necessary to modify some of the following assembly details. Before starting construction, therefore, check the "fit" of the circuit and then obtain a suitable-size plastic case in which to house the radio.

Since both r-f and audio frequencies are involved in the radio, printed-circuit construction is a virtual necessity to obtain stable operation. Fabricate the pc board using the actual-size etching-and-drilling guide in Fig. 3. Then install the components on it exactly as shown in Fig. 4, including the wires to interconnect to off-the-board components. This done, mount the pc assembly on tuning capacitor *C1* with separate machine hardware and wire the capacitor's lugs to the appropriate points in the circuit.

Mount the two C-cell holders to the speaker's frame with an appropriate bracket and machine hardware. When drilling and tapping the mounting holes in the speaker's frame, be careful to avoid getting metal particles in the voice-coil gap. If any particles do get into this area, use a small magnetized screwdriver to remove them.

The plastic case used for the prototype radio (shown in Fig. 5) is a 7¾" × 4⅜" × 2⅜" model sold by Radio Shack. It's used "backwards," and the aluminum front panel has been replaced with a nonmetallic panel, which then became the rear panel. The four bumps used as "feet" on the original back panel were filed off.

At one side of the case's panel (see lead photo), cut a square opening for the speaker with a coping saw, or drill a series of holes within the cone area to allow the sound to escape. Drill the

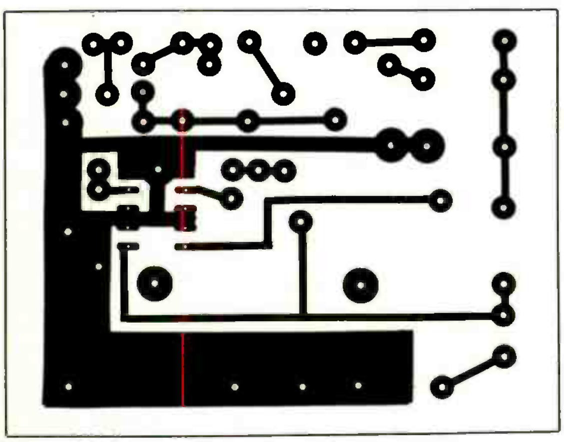


Fig. 3. The actual-size etching-and-drilling guide to use for fabricating a printed-circuit board.

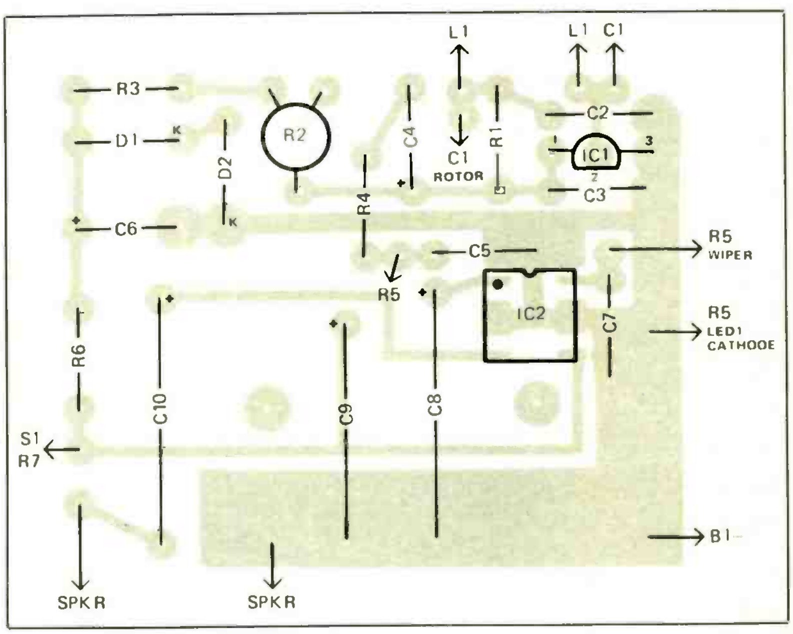


Fig. 4. Wire the pc board exactly as shown here, being careful to properly polarize and orient components before soldering their leads to the foil.

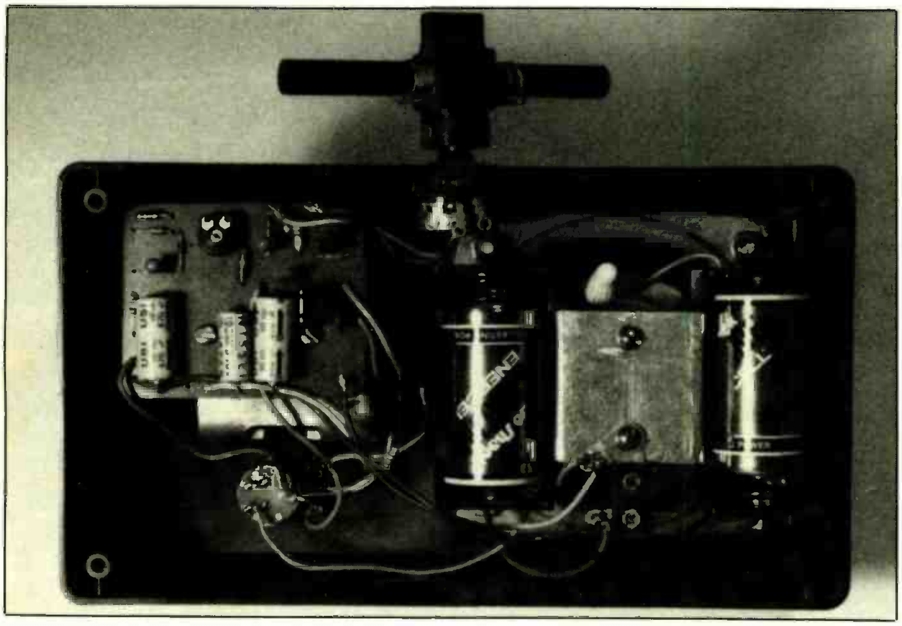


Fig. 5. Interior view of the project shows the circuit board assembly mounted on the variable capacitor with spacers. The two C cells fit into brackets mounted on the speaker, while the ferrite antenna is mounted on a hollow-shaft potentiometer installed on the top of the plastic case.

four mounting holes for the speaker. Cut a 2½"-diameter circle from the removed plastic or a separate piece of thin plastic to use for the dialplate. Drill a ¼" hole through the middle of the dialplate.

Drill mounting holes for the VOLUME control and tuning capacitor through the front of the case. Place the dialplate on the front panel, aligning its center hole with the mounting hole for the tuning capacitor. Lightly pencil the silhouette of the dialplate onto the panel. Remove the dialplate and measure ¼" out from the pencil mark toward the speaker cutout and place another mark. Drill the mounting hole for *LED1* at this point. Make this hole the same diameter as the shoulder on the LED's case.

Use a hollow-shaft potentiometer to mount the antenna. Drill the mounting hole for this pot through the top of the radio's case, and mount the pot in place. This pot serves as a means for swiveling the antenna for orienting it for best reception and has enough drag to hold it in place.

A plastic block drilled and trimmed with a file to fit over the ferrite rod and the pot's shaft, with one or two small holes drilled and tapped to accommodate setscrews secures the antenna assembly to the pot's shaft. Alternatively, you can use a modified set-screw-type plastic control knob in place of the plastic block. Prepare the knob by drilling a hole through its top, directly in line with its shaft cap. Dish out the top with a round file to conform to the shape of the ferrite rod.

Before mounting the antenna on the plastic block or control knob, remove the five-turn base-coupling winding. Pass the remaining two leads through the hole in the plastic block or knob. Use fast-setting clear epoxy to secure the ferrite rod in place. When the cement sets, route the antenna leads through the pot's hollow shaft, gently pulling on the wires to keep them from snagging or getting caught on the end of the shaft. Secure the assembly in place by tightening the setscrew(s).

After smoothing the edge of the dialplate, draw its outline on a stiff piece of white cardboard (the reverse side of an index card will do). Cut around the drawn line, and remove a 1" circle from the center of the cardboard disk to make a donut shape.

Coat the mating surfaces of the plastic dialplate and the reverse (lined) side of the cardboard donut with rubber or contact cement. When the cement has dried (contact cement has become tacky), lower the cardboard doughnut onto the disk, taking care to align the two before allowing them to meet. Then clean away all cement from the exposed area of the disk inside the cutout.

Lightly coat the shaft of a standard potentiometer with petroleum jelly or heat-sink grease. Place the dialplate assembly, cardboard-side up, on the pot, and apply a bead of the epoxy cement all around the circle where the cardboard meets the plastic disk in the center of the donut. Use only enough cement to prevent bleed to the pot's shaft when the large set-screw-type control knob is lowered onto the shaft and gently pressed into the cement. Allow the cement to fully set before removing the assembly from the pot.

To make the LED power indicator, which also serves as an index for the dial, you need a 3/16"-thick piece of clear plastic. Drill a hole through the plastic just large enough to provide a snug fit for the dome of the LED. Then cut a triangular piece of the plastic with all sides measuring ⅜", with the hole centered in the triangle. Carefully cut a shallow groove from one point to the middle of the far side. Fill the grove with white paint.

When the paint dries, press the dome end of the LED into the hole in the plastic triangle with the leads pointing away from the lined surface. Epoxy the assembly to the front panel, fitting the shoulder of the LED's case into the hole previously drilled for it. Make sure that the enameled line points directly back toward the tuning capacitor's shaft and that no epoxy cement fouls the mounting hole.

Trim to size and cement an open-weave cloth over the speaker cutout (or drilled holes) and back it with a piece of metal screening. Mount the speaker/battery assembly in place with machine hardware and the tuning capacitor/circuit-board assembly via the mounting hardware for *C1*.

Referring back to Fig. 2, interconnect all wiring from the board with the appropriate off-the-board components, paying careful attention to the polarity of the connections for the LED and C-cell supply. Insulate the connections for the LED and antenna and make sure that the LED's leads aren't shorting together.

Install the C cells into their holders, making sure they are properly polarized. Then install the small control knob on the shaft of the VOLUME control. Remove the dialplate assembly from the potentiometer and set it on *C1*'s shaft. Tighten the setscrews. (Note: If there's no flat on the shaft of the capacitor used for *C1*, carefully file one. This way, one setscrew will always "index" the dialplate should it ever have to be removed.)

Calibration & Adjustment

Turn on the radio and turn up the volume to about half way. Then slowly adjust the TUNING dial until you hear a clear station. Make a light pencil mark on the dial in line with the arrow point on the LED and note the station frequency and/or call letters. Continue doing this until the dial is filled. When the dial is filled to your satisfaction, use a dry-transfer lettering kit to give the dialplate a professionally lettered appearance. Then give the dialplate a couple of light coats of clear spray paint to protect the lettering from damage.

One of the advantages of this radio is that no critical adjustments are required, since only one LC circuit is used for tuning. Of course, *R5* (R_{agc}) can be adjusted to obtain optimum selectivity for a particular location. This adjustment is rather broad and not at all critical. Generally, it's a set-and-forget adjustment.

Using the radio is very simple. Turn it on, adjust its volume to a comfortable listening level and tune for the station you wish to hear. At start-up there's a slight delay in reception as the capacitors charge. The antenna will have to be oriented for best reception and can be positioned to null out a strong interfering station when you want to hear a weaker one on or near the same frequency. **ME**

Phone-Controlled Nite Lite

Ends fumbling in the dark when you reach to answer your telephone

By Anthony J. Caristi

When a telephone rings while you're asleep at night, you no longer need to fumble around for the instrument, probably knocking objects on your night table to the floor while doing so. The telephone-controlled light described here, dubbed the Nite Lite, will save the day (night?), automatically lighting up your night table with a lamp of your choice every time the telephone rings.

As long as the ringing continues or you keep the receiver off the hook, the lamp will remain on. Then a few seconds after you hang up, the light goes off. Everything works automatically!

The Nite Lite is so useful and easy to build, you might want to build a few to give as gifts. For a professional touch, the project can be concealed inside an existing table lamp; it won't interfere with normal operation of the lamp being used.

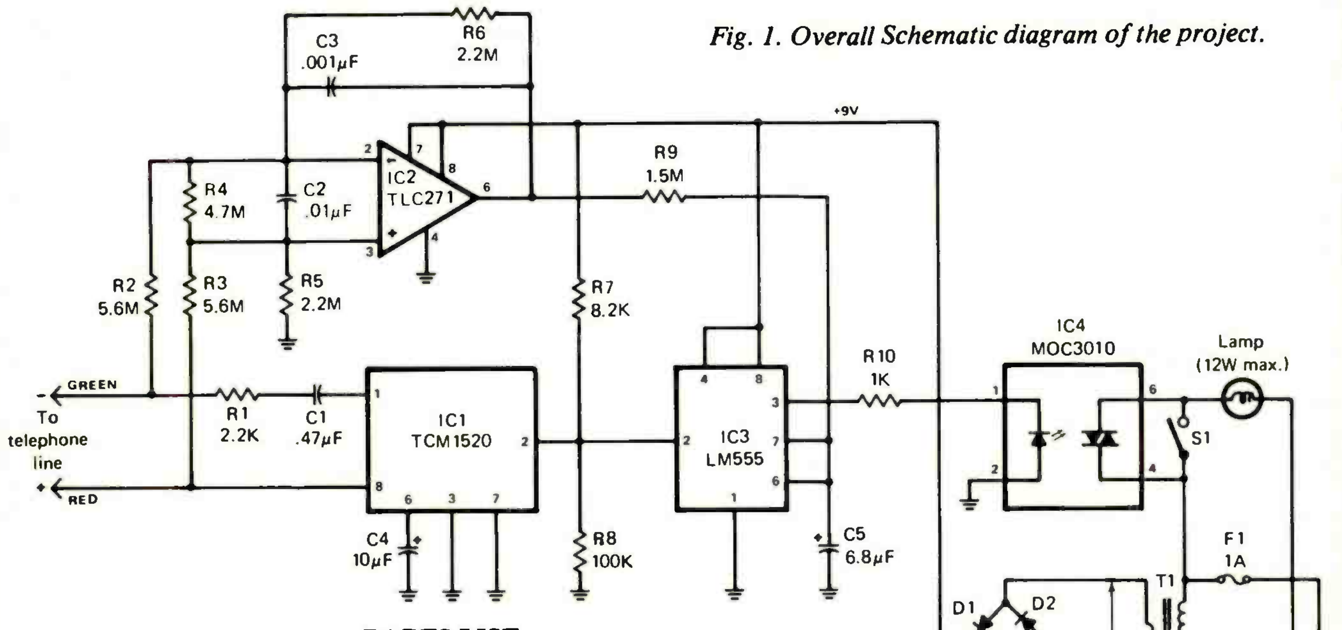
How It Works

At the heart of the Telephone Nite Lite shown schematically in Fig. 1 is telephone ring detector integrated circuit *IC1*. This specialty IC contains a bridge rectifier and regulator that are powered by the 90-volt, 20-Hz signal that appears across the telephone line when the phone rings.

A normally off switching transistor inside *IC1* is biased into conduction each time the telephone rings, causing the output of *IC1* at pin 2 to go to 0 volt. At all other times, pin 2 is biased to about 8 volts by means of a voltage divider network consisting of *R7* and *R8*.

The output of *IC1* goes to the trigger input of retriggerable one-shot multivibrator *IC3*, which has a timing cycle of about 10 seconds. Since

Fig. 1. Overall Schematic diagram of the project.



PARTS LIST

Semiconductors

D1 thru D4—1N4001 rectifier diode

IC1—TCM520AP telephone ring detector (Texas Instruments)

IC2—TLC271ACP operational amplifier (Texas Instruments)

IC3—LM555 timer

IC4—MOC 3010 optoisolator (Radio Shack Cat. No. 276-134)

Q1—2N6342 or similar 6-ampere triac and Radio Shack Cat. No. 276-1363 heat sink (optional; see text)

Capacitors

C1—0.47-μF, 200-volt ceramic or tubular

C2—0.01-μF ceramic

C3—0.001-μF ceramic

C4—10-μF, 15-volt electrolytic

C5—6.8-μF, 15-volt electrolytic

C6—1,000-μF, 15-volt electrolytic

Resistors (¼-watt, 10% tolerance)

R1—2,200 ohms

R2,R3—5.6 megohms

R4—4.7 megohms

R5,R6—2.2 megohms

R7—8,200 ohms

R8—100,000 ohms

R9—1.5 megohms

R10—1,000 ohms

R11—180 ohms (optional; see text)

Miscellaneous

F1—1-ampere slow-blow fuse

S1—Existing lamp switch (or separate spst switch; see text)

T1—6.3-volt, 300-mA transformer (Radio Shack Cat. No. 273-1384 or similar)

Suitable enclosure (see text); chassis-mount ac receptacle (optional; see text); perforated board and soldering hardware or printed-circuit board; 3-conductor line cord with plug; machine hardware; hookup wire; solder; etc.

Note: The following are available from A. Caristi, 69 White Pond Rd., Waldwick, NJ 07463: etched-and-drilled pc board for $7.50; IC1 for $4.50; IC2 for $3.00; Q1 for $3.00. Please add $1 P&H.

the normal telephone ring signal is on for 2 seconds and off for 4 seconds, *IC3* continues to be active as long as the ring signal is present. During this time, output pin 3 of *IC3* remains at about 9 volts. This 9 volts, fed through current-limiting resistor *R10*, turns on a LED inside optoisolator *IC4*. When the LED lights, it triggers into conduction a triac, also internal to *IC4*, which in turn turns on the night light connected in series with it and the ac line.

If the incoming call is not answered and ringing ceases, *C5* charges up through *R9*. Then 10 seconds after the output of *IC3* goes to 0 volt, the lamp extinguishes.

Differential amplifier *IC2* senses the – 48 volts that appears across the telephone line when the phone is on the hook. As a result, the output of *IC2* remains at 9 volts and provides the current to charge *C5* through *R9*. Answering a call causes the potential across the telephone line to drop to about 6 volts. This causes the output of *IC2* to go low, depriving *C5* of sufficient current to charge up and keeping the output of *IC3* high. Hence, the lamp remains on as long as the call is in progress. Then 10 seconds after you hang up, *C5* charges up and the lamp extinguishes.

The triac inside *IC4* can drive only low-power loads rated at up to 12 watts, which is sufficient for most night lights. If you wish to operate lamps of greater wattage, you must

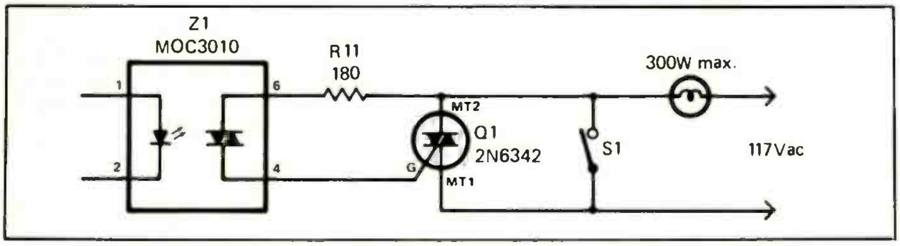


Fig. 2. Modification for high-power lamp-driver capability.

add a resistor and an external triac of sufficient current rating to safely handle the load current. This modification is shown in Fig. 2, with *Q1* identifying the external triac and *R11* the gate biasing resistor.

With the Fig. 2 modification installed, the triac inside the *IC4* optoisolator switches on and off the external triac. In turn, the latter handles the heavier current required by the load. Using the specified external triac, the project can safely switch lamps rated at up to 300 watts, which is more than adequate for any incandescent table lamp.

Construction

Owing to the circuit's relatively simple design, you can choose any method or construction that suits you. For example, you can use perforated board and appropriate soldering hardware, as shown in the lead photo, or Wire Wrap the circuit. Alternatively, you can assemble the project on a printed-circuit board. If you choose pc-board wiring, you can fabricate your own board using the actual-size etching-and-drilling guide shown in Fig. 3 or purchase one

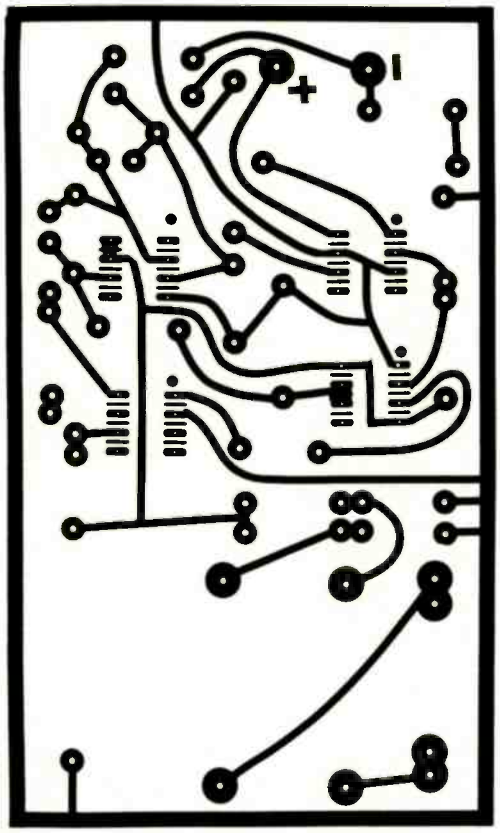


Fig. 3. Actual-size printed-circuit board etching-and-drilling guide.

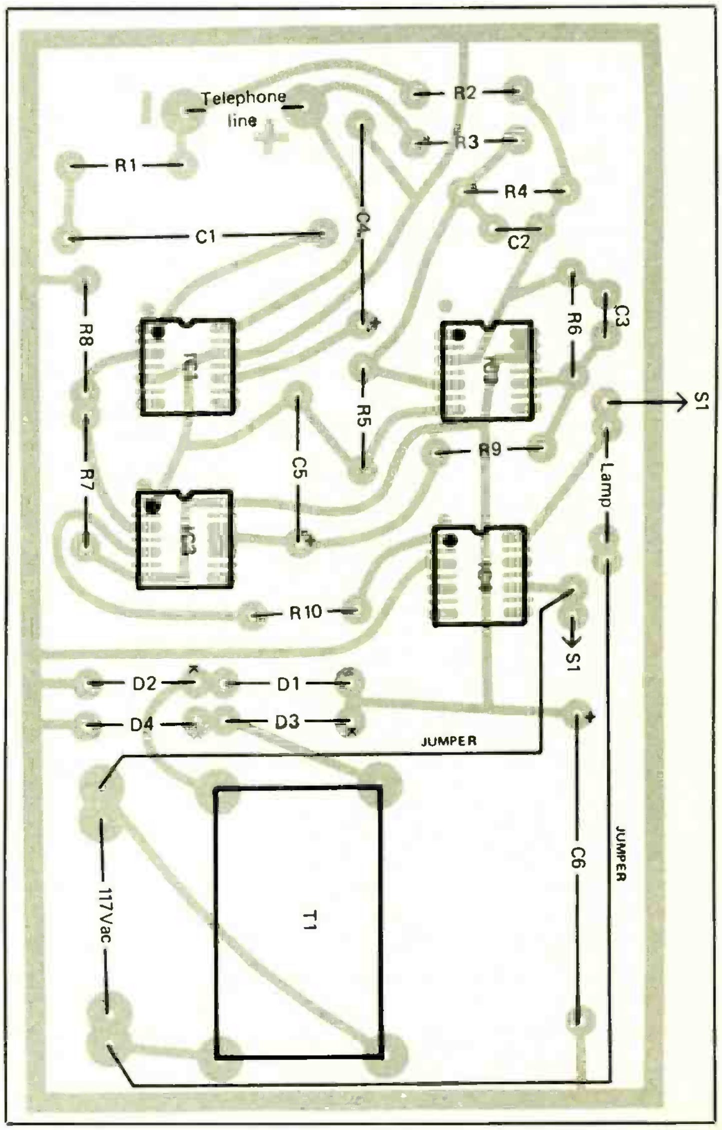


Fig. 4. Components placement and orientation diagram for pc board.

ready to wire from the source given in the Parts List.

Note that the pc guide in Fig. 3 has provisions for only the basic circuit, including a 12-watt incandescent lamp. If you plan to use the optional high-power external triac, delete the two jumper wires shown and solder *R11* to the board in place of the 12-watt lamp. Then finish wiring the circuit in accordance with Fig. 5.

Whichever wiring method you choose, Fig. 4 shows a good layout to fo''ow. Use sockets for the ICs and optoisolator. Although *IC4* has only six pins, an 8-pin DIP socket can be used (Fig. 3 has the extra holes to accommodate the socket). Pins 1 and 6 of *IC4 must* plug into pins 1 and 8, respectively, of the socket so that no pins of *IC4* plug into pins 4 and 5 of the socket. A good way to assure that none of *IC4*'s pins plug into the socket's pins 4 and 5 is to plug the ends of a short length of solid hookup wire into these socket pins to eliminate any possibility of anything else being plugged in here.

Wire the circuit board exactly as shown in Fig. 4, starting with the resistors, capacitors, IC sockets, external triac *Q1* (if used), etc., finishing up with installation of the ICs and optoisolator in their respective sockets. Make certain that you observe proper orienting of the electrolytic capacitors, diodes, ICs, optoisolator and external triac if the last is used.

Once the circuit is fully wired, mount it directly in the base of the lamp with which it is to be used. Make sure, however, that the 117-volt ac line portions of the circuit do not come in contact with any exposed metal on the lamp. If you are using the external triac, it must be equipped with a heat sink (see Parts List) or be bolted to the metal base of the lamp. The metal mounting tab is *not* electrically isolated from the leads of the triac. Therefore, it is *very* important that you use an insulating washer between triac and heat sink or ensure that the heat sink is

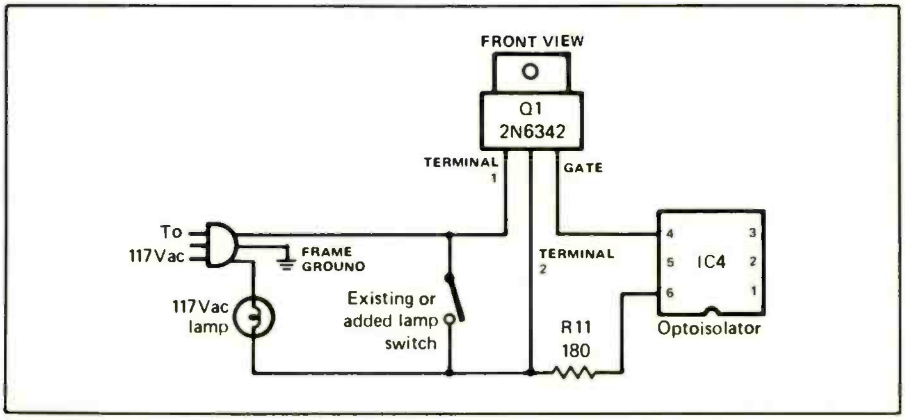


Fig. 5. Wiring details for lamps with switches that are not integral with screw base to permit the lamp to be switched on and off in the usual manner.

electrically isolated from any metal part of the lamp. (Some triacs are supplied with a mica insulator and shoulder washer that can be used to isolate the triac from the heat sink.)

To provide positive insurance against possible shock hazard, replace the lamp's two-conductor line cord with a three-conductor grounding type, wiring its green conductor to the metal frame of the lamp.

When you have finished mounting the triac and heat sink, use an ohmmeter to check for electrical isolation between the tab of the triac and the heat sink. You should obtain an infinity reading on the highest range.

If your lamp has a separate on/off switch (not integral with the bulb's screw base assembly), follow the wiring guide shown in Fig. 5, which illustrates how a separate switch is used to operate the lamp in the normal manner. If the lamp switch is integrated with the screw-base assembly, you will have to add a single-pole, single-throw (spst) switch to the lamp and set the original switch permanently to its on position.

Keep in mind, too, that since the 90-volt rms ring signal from the phone line must pass through *C1*, it is important that this capactior have a rating of at least 200 working volts. Do *not* use the low-voltage types commonly employed in solid-state circuits. If you do, the capacitor is likely to become short-circuited, in which case, *IC1* will be damaged.

As with all ancillary equipment connected to the telephone line, you should use a modular connector to tie the project to the line. This is an FCC requirement. Also, it is important that the polarity of the connection to the phone line be correct, as detailed in Fig. 1. If it is not, the project will not work. If you use a standard modular plug and cord, the red and green wires of the cord give you the correct polarity. The yellow and black wires are not used. If you have any doubt about the polarity of your telephone line, plug the cord into your modular socket and check the polarity of the red and green wires with a dc voltmeter set to measure 50 volts or more.

Checkout

Before attempting to operate your Telephone-Controlled Nite Lite, remove the ICs and optoisolator from the board and apply 117 volts ac power to the circuit via its 3-conductor line cord. With the project plugged into the ac line, avoid touching any of the wiring to *T1*'s primary, *IC4*'s socket and, if used, *Q1*. Measure the potential across *C6*; this

(Continued on page 92)

An Ion Sniffer

This hand-held unit detects relative amounts of free ions in the air

By Robert Iannini

The Ion Sniffer is a compact, sensitive instrument that detects the relative amount of free ions in the air. It can be used to indicate the output from ion generators, locate high-voltage leakage points and conductors of static electricity, check electric field gradients, and for any other application where the presence of ions or a measurement of their relative flux density is required.

About the size of a pack of king-size cigarettes, the hand-held Ion Sniffer features a sensitivity control and a separate meter and light-emitting diode that indicate relative ion flux density. It offers a choice of two grounding arrangements—one by hand contact and a much better one by hard wiring to earth ground through an optional jack. The project is low in cost, easy to build and simple to operate.

About the Circuit

The Ion Sniffer consists of basically two sections: an ion "collector" and an amplifier/display. The collector is nothing more than an ordinary telescoping whip or stiff wire antenna, which plugs into *J1* in Fig. 1. Ions collected by the antenna cause a minute current to flow into the base of *Q1*. This minute current is amplified by the Darlington circuit made up of *Q1* and *Q2* to bias on *Q3*.

When *Q3* conducts, base-to-emitter current passes through potentiometer *R3* and resistor *R2*. The setting of *R3* and the magnitude of the current flowing through *Q3*'s collector circuit, determine how far up-scale the pointer of meter *M1* will deflect when *Q3* is conducting. Hence, *R3* serves as a sensitivity control.

The meter serves as a visual indicator of the *relative* amount of ionization present in the air. It is not an absolute indicator. Light-emitting diode *LED1* in the emitter circuit of *Q3* flashes when the project is used to measure strong ion fields.

Capacitor *C1* and resistor *R1* make up an RC network whose time constant eliminates any rapid fluctuations in the ion-field intensity from causing rapid meter pointer swings. Diodes *D1* and *D2* clamp transients to prevent excessive voltage from destroying *Q1*.

Power for the Ion Sniffer is supplied by common 9-volt battery *B1*. The battery is switched on and off with *S1*, which is ganged with *R3*.

Some sort of ground is required for the Ion Sniffer to operate properly. Metallic tape around the plastic case in which the project is housed provides a convenient means by which grounding can be accomplished. Holding the tape-wrapped Ion Sniffer in your hand partially grounds it to the earth through your body. If the project is not to be held in a hand, it should be earth grounded to a water pipe or

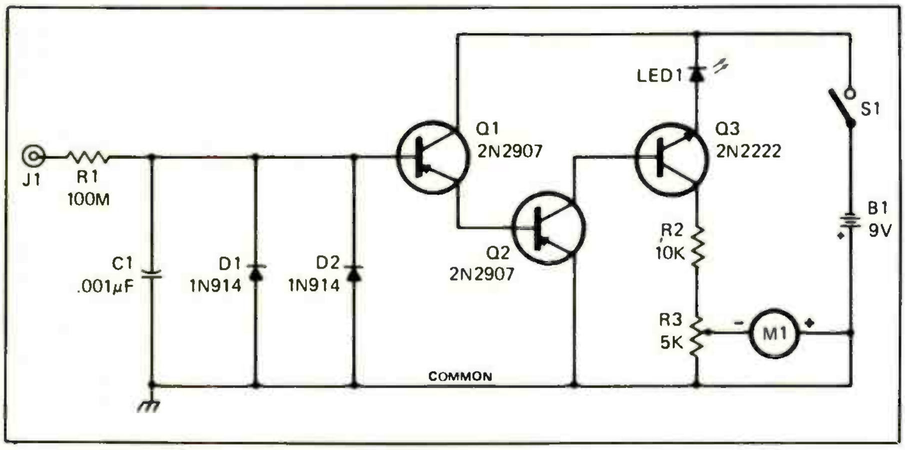


Fig. 1. The complete diagram of the Ion Sniffer.

other object that gives good grounding.

Construction

Because the Ion Sniffer's circuit is so simple, it can easily be wired together on a 2″ × 1″ piece of perforated board without having to use soldering hardware. Of course, if you are ambitious, you can design and fabricate your own printed-circuit board and use this instead of the perforated board. In either case, trim away the upper corners of the board as shown in Fig. 2.

All conductors and component leads on the top of the board in Fig. 2 are indicated by solid lines, while those on the bottom of the board are shown as broken lines. With the flat of the transistor cases facing you and the leads pointing downward, the leads are emitter, base and collector from left to right. If you orient the transistors exactly as shown, you should

PARTS LIST

B1—9-volt battery
C1—0.001-µF, 25-volt disc capacitor
D1,D2—1N914 diode
J1—Phono jack (eliminate if telescoping whip antenna is used)
LED1—Light-emitting diode
M1—Miniature 100-mA panel meter movement
Q1,Q2—2N2907 transistor
Q3—2N2222 transistor
R1—100-megohm, ½-watt resistor
R2—10,000-ohm, ¼-watt, 10% tolerance resistor
R3—5,000-ohm, linear-taper potentiometer with spst switch (see S1)
S1—Spst switch (part of R3)
Misc.—Suitable plastic enclosure (see text); perforated board (see text); snap connector for B1; small control knob for R3/S1; telescoping antenna or 12″ still wire for antenna; 10″ × ½″ foil tape; busing or grommet for LED1; double-sided foam tape; machine hardware; hookup wire, solder; etc.

Note: A complete kit of all parts, less battery and optional pin jack, is available as kit No. IOD1K from Information Unlimited, P.O. Box 716, Amherst, NH 03031.

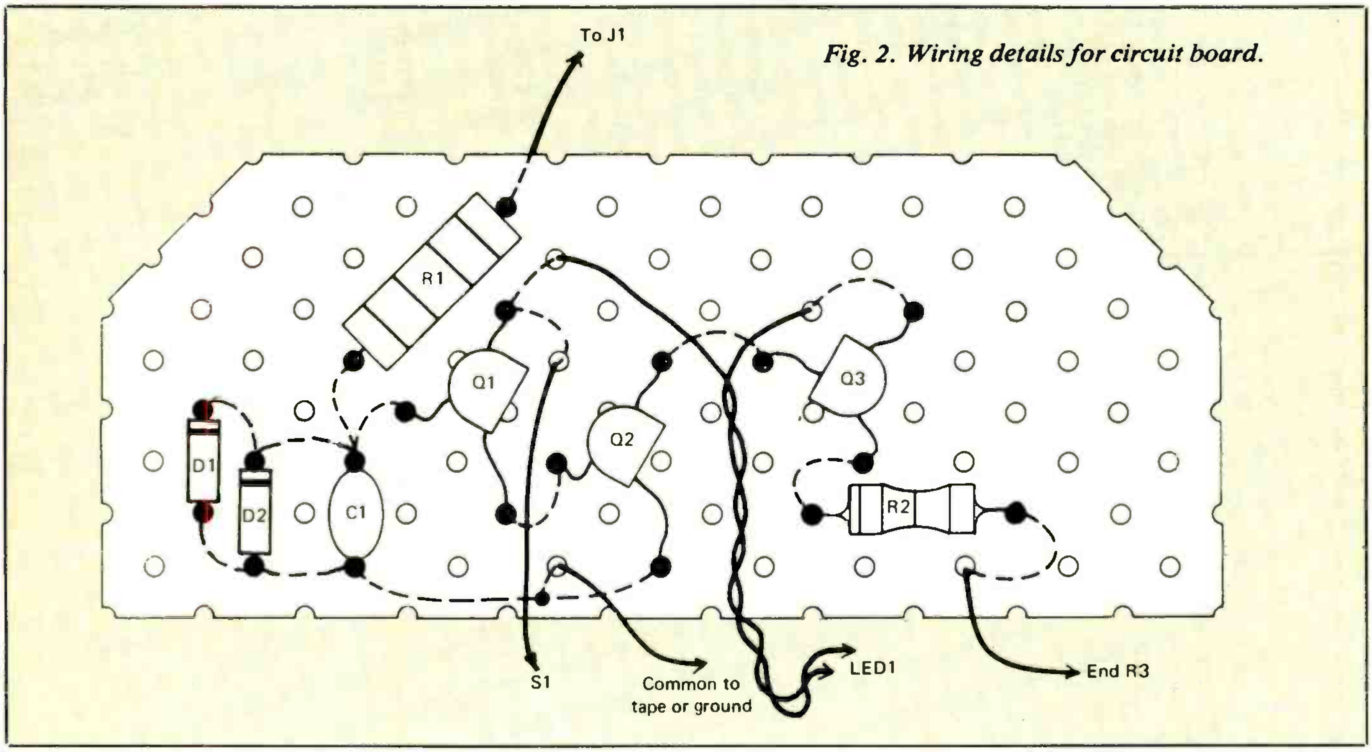


Fig. 2. Wiring details for circuit board.

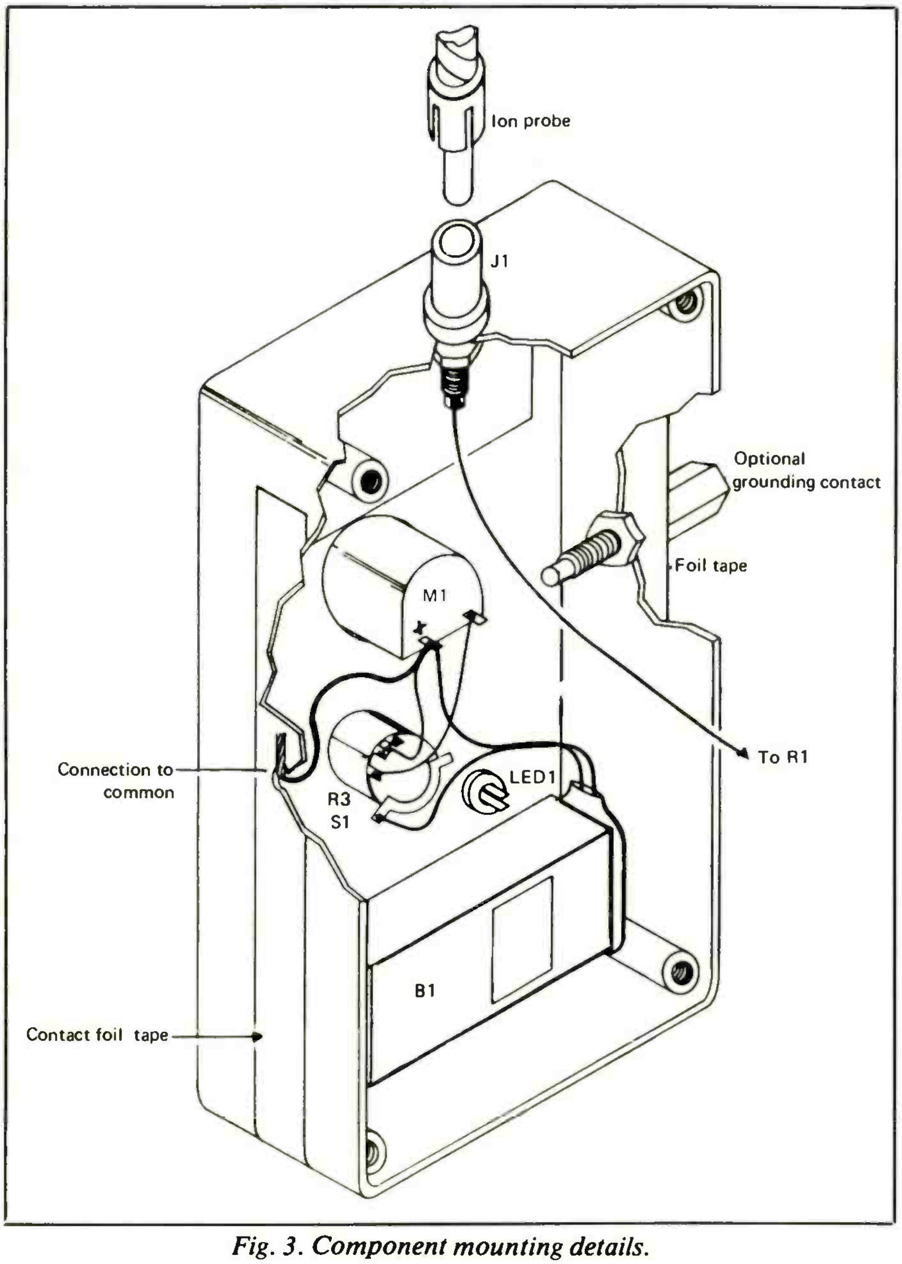


Fig. 3. Component mounting details.

have no difficulty identifying which lead is which when interconnecting the components.

Wire the circuit exactly as shown in Fig. 2. Use enough solder on all connections to assure good electrical and mechanical joints. Then solder 4″ lengths of hookup wire to the points in the circuit to which off-the-board components connect. Label each of these wires as shown. Label the LED1 wires coming from the collector of *Q1* and emitter of *Q2* as CATHODE and ANODE, respectively.

A 4½″ × 1½″ × 1″ plastic utility box is ideal for housing the project. It has ample room inside for all components, its front panel is large enough to accommodate the meter movement and sensitivity control/power switch (*R3/S1*) without crowding, and the box itself is sized for comfortable hand-held operation.

Prepare the front panel of the box as follows. Draw a light pencil line down the center of the box. Measure 1″ down from the top of the box and strike a line across the first line at this point. Drill or cut a 1″-diameter hole here for the meter movement. Measure down 1″ from the meter hole and drill a hole large enough to accommodate the mounting bushing of *R3/S1*. Off to the left and in line with the control hole or below it, drill a mounting hole for the LED, sizing it as necessary for a panel-mount bushing or small rubber grommet into which the LED can be plugged.

Drill a ¼″ hole through the top of the box for the phone jack or telescoping antenna (if you use the latter, drill a smaller hole through the bottom of the box, directly in line with that in the top, for the antenna's anchoring screw). Drill holes on opposite sides of the box for the common wire and a pin jack (the latter is optional) that contact the grounding tape. Mount the phono jack (if used).

Next, run a 10″ length of ½″-wide foil tape around the left, bottom and right outer walls of the case, centering it between the front and back edges so that it covers the holes drilled for the circuit ground (common) lead and the optional pin jack. With a punch or awl, perforate the tape through the centers of the holes.

Mount the circuit board at the top of the box, using double-sided foam tape between it and the box. The beveled corners fit between the mounting posts for the back of the box. Mount the meter movement, *R3/S1* and LED bushing or gr nmet in their respective holes. Plug the LED into the bushing or grommet. Assembly details are shown in Fig. 3.

Referring back to Fig. 1, finish wiring the circuit. Pass the free end of the circuit grounding wire through the hole in the box and foil tape and tack solder it to the latter. Then after making sure the circuit is dry, you might want to coat the entire circuit board assembly with varnish or urethane to seal it against moisture that can decrease sensitivity due to leakage. Finally, with *S1* set to off, install the battery and assemble the case.

Turn on the Ion Sniffer and rotate sensitivity control *R3* fully clockwise and note that the meter's pointer deflects slightly up-scale. This indication is due to transistor leakage; it should not be considered an indication of ions. (Note: If the meter's pointer deflects down-scale, turn off the power and transpose the connections to the outer lugs on *R3*.)

Plug the collector probe into the phono jack on the top of the project (or extend the telescoping whip antenna if you are using that instead). Again turn on power and rotate the sensitivity control knob to the fully clockwise position.

Holding the Ion Sniffer with your hand in contact with the foil tape, run a plastic comb through your hair a few times and bring it close to the ion collector (or antenna). Note that the meter's pointer deflects up-scale and the LED flashes on. The amount of meter pointer deflection and brilliance of the LED's light depend on the setting of the sensitivity control and the relative humidity of the air. The indications will be stronger under low-humidity conditions than under high-humidity conditions. If you obtain the proper results, the project is ready to be put into service.

In Conclusion

For best results, the Ion Sniffer should be hard-wired to earth ground, via the pin jack if you have included it in your project. The project will not be as sensitive or stable when used as a hand-held portable instrument but will nevertheless provide indication of moderate to strong ion fields.

Whichever way you choose to use the project, always adjust the setting of the sensitivity control to keep the pointer somewhere on the meter's scale. ME

Designing Activ e Filters

Part 2 (Conclusio 1)

A short-cut method for practical design o first-through-third-order active filters

By R. Fleischman

Last month in Part 1 of this article, we introduced you to active-filter basics and discussed how to design first-order filters. In this conclusion, we focus on second- and third-order filters.

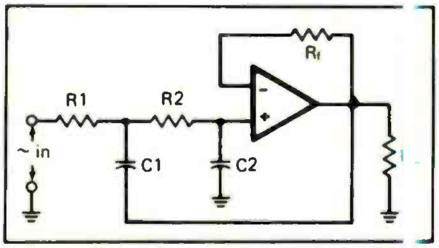


Fig. 3. A second-order, low-pa unity-gain active filter.

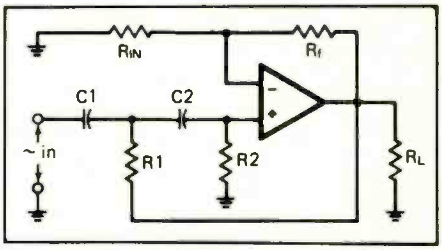


Fig. 4. A second-order, high pass unity-gain active filter.

Second-Order Filters

It should be noted that all first-order filters are Butterworth types. Second-order and beyond filters, however, allow you to choose the type of filter. You might be surprised to learn that second-order filters require only one op amp. What makes them different from first-order filters is that they have an extra resistor and capacitor. Like all second-order networks, the ultimate slope is 40 dB/decade.

The amount of "damping" a filter has determines whether it is a Butterworth, Bessel or Chebychev design. Damping is the resistive loss built into the filter to keep it under control. Critically damping a filter gives it a Butterworth characteristic, which has the flattest possible bandpass and exhibits complete freedom from overshoot. Underdamping yields the Chebychev filter, which is overly "bouncy." Overdamping gives the Bessel filter, which has a sag in the passband before cutoff.

Damping in filters is controlled by the ratio used in calculating certain component values. You don't have to compute the damping ratio. This has already been done for you by others; all you have to do is use their numbers. The damping figur s shown in the Tables are from D Lancaster's *Active Filter Cookbo* (Howard W. Sams).

• *Low-Pass Filter.* For the presen let's concentrate on the Butterwor filter, whose damping ratio is 1.41 Component values affected by th ratio depend on what kind of circu you're using. A low-pass unity-ga filter circuit is shown in Fig. 3. No in this arrangement that *C2* goes ground, while *C1* provides a path f some of the op amp's output to b fed back to the input of the filter ne work made up of *R2* and *C2*. This a rangement, not possible in a passi filter, allows you to do away with t inductor in an active filter.

With the Fig. 3 circuit, the dam ing ratio is used to determine t values of *C1* and *C2*. We'll still con pute (or scale from the reference fi ter), but this time the result will b only the starting point—not the fin value—for each capacitor. In e sence, what you'll get are the "ave age" values for *C1* and *C2*. The *act al* values of these capacitors are ca culated using the average values an the damping ratio figure.

For second-order low-pass filte only, C1 = C(2/d) and C2 = C(d/2). Here *d* is the damping ratio and *C* is the average value of the capacitor. Also, R_f = R1 + R2.

Start with the design of a second-order low-pass Butterworth filter in which F_C = 1 kHz and the values of both *R1* and *R2* are 10,000 ohms. Working from the reference filter discussed above, you know that the average values of *C1* and *C2* are both 0.16 μF. Using the actual-value formulas: C1 = 0.016(2/1.414) = 0.0226 μF; C2 = 0.016(1.414/2) = 0.0113 μF; and R_f = 10,000 + 10,000 = 20,000 (20k) ohms.

Note that C1 = 2C2. It will always be this way for a unity-gain, second-order, low-pass Butterworth filter. If you're analyzing a circuit that has already been designed, you can get the average value of *C* by taking the geometric average of the two capacitors in the circuit: C = $\sqrt{0.0226 \times 0.0113}$ = 0.016 μF. Then calculate the cutoff frequency: F_C = 1/(6.28 × 10,000 × 0.016) = 995 Hz. Note that because the average value of *C1* and *C2* (not either one alone) determines F_C, the 0.016-μF value is used in the last equation.

• *High-Pass Filter.* There are only

Table 1. Second-Order Filter Factor

Filter Type	Frequency Correction Factor High-Pass	Low-Pass	Damping
Bessel	0.785f	1.274f	1.732
Butterworth	1.000f	1.000f	1.414
Chebychev			
1 dB	1.159f	0.863f	1.045
2 dB	1.174f	0.852f	0.895
3 dB	1.189f	0.841f	0.767

*Data taken from *Active Filter Cookbook* by Don Lancaster (Howard W. Sams & Co., Inc.)

four things that make the second-order, high-pass, unity-gain filter shown in Fig. 4 different from the low-pass configuration shown in Fig. 3. Firstly, the positions of the capacitors and resistors are reversed. Secondly, you don't calculate special *C1* and *C2* values (the value of *C* obtained by scaling from the reference filter is used as is for both capacitors). Thirdly, you treat the scaled value of *R*, from the reference filter, as an "average" value, which is used along with the damping ratio to compute the final values from: R1 = R(d/2) and R2 = R(2/d). Finally, feedback resistor R_f is the average value of *R*.

Design a high-pass, unity-gain Butterworth filter in which F_C = 1 kHz and *R* = 10,000 ohms, which means that *C* must be 0.016 μF. Therefore, R1 = 10,000 × (1.414/2), R2 = 10,000 × (2/1.414), R_f = R = 10,000 ohms and C1 = C2 = 0.016 μF.

• *Chebychev Filters.* In this category is a whole family of filters. With the Chebychev filter's steep rolloff close to cutoff comes ripple throughout the passband and poorer phase-shift performance. Each member of the Chebychev family has a different combination of rolloff slope steepness versus passband ripple amplitude. The steeper the rolloff, the more ripple you have to accept.

One good thing about Chebychev filters is that you get to decide what you want. If you need a modest improvement in slope steepness, you can get it with very little ripple. On the other hand, if you want a greater increase in slope but don't mind a lot of ripple, you can get that, too.

Ripple is measured in decibels. Chebychev filters are classified by the amount of ripple they have. Thus, a 1-dB Chebychev filter has a bump that rises 1 dB above the passband; the bump in a 2-dB deisgn rises by that amount; and so on.

With the Chebychev filter, you're dealing with at least a second-order circuit. Designing the filter is simply a matter of adjusting frequency and damping to suit your needs. The formulas don't change; they're the same as those used above. The only difference is the values used for frequency and damping in calculations.

Unless you're making a Butterworth filter, the value of *F* you plug in isn't the same as F_C. You must multiply the desired F_C by the correction factor shown in Table 1. For example, if you want F_C to be 1 kHz in a second-order, low-pass 3-dB Chebychev filter, you first determine the correction factor, which is 0.841 in Table 1. Then multiply the 1-kHz F_C by the correction factor. This gives the cutoff frequency of the finished filter, which will be 1 kHz.

Note in Table 2 that each response shape has its own damping ratio. For the Butterworth filter, the damping factor is 1.414. Whenever a formula calls for a value of *d*, you'd use the 0.767 figure instead of 1.414. The high- or low-pass filter circuit itself doesn't change; it's the same as for the Butterworth filter.

Now design a low-pass, second-order 3-dB Chebychev filter in which F_C = 1 kHz and *R* = 10,000 ohms. From Table 1, F = 0.841(F_C) = 0.841 × 1000 = 841 Hz and d = 0.767. Then $C_{average}$ = 1/(6.28 × FR) = 1/(6.28 × 841 × 10,000) = 0.018 μF; C1 = 0.0189(2/0.767) = 0.0493 μF; C2 = 0.0189(0.767/2) = 0.00725 μF; R1 = R2 = 10,000 (10k) ohms; and R_f = R1 + R2 = 20,000 (20k) ohms.

Now to design a high-pass, second-order 2-dB Chebychev filter where F_C = 1 kHz. Obtain the *R* and *C* values from the reference filter. Then F = 1.174(F_C) = 1174 Hz; C1 = C2 = 1/(6.28 × 1174 × 10,000) = 0.0316 μF; R1 = 10,000 × (0.895/2) = 4475 ohms; R2 = 10,000 × (2/0.895) = 22,350 ohms; and R_f = 10,000 ohms.

Table 2. Third-Order Frequency Factors & Damping Ratios*

Section Type	Frequency High-Pass**	Factors Low-Pass**	Damping Ratio (Second-Order)
Bessel	0.753/0.688	1.328/1.454	1.447
Butterworth	1.000/1.000	1.000/1.000	1.000
Chebychev			
1 dB	2.212/1.098	0.452/0.911	0.496
2 dB	3.105/1.095	0.322/0.913	0.402
3 dB	3.344/1.092	0.299/0.916	0.326

*Data taken from *Active Filter Cookbook* by Don Lancaster (Howard W. Sams & Co., Inc.)
**The first figure in these two columns is for the first-order filter, the second for the second-order filter.

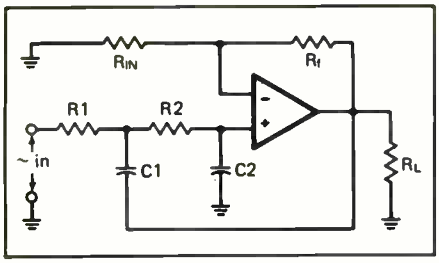


Fig. 5. A second-order, low-pass equal-component-values active filter.

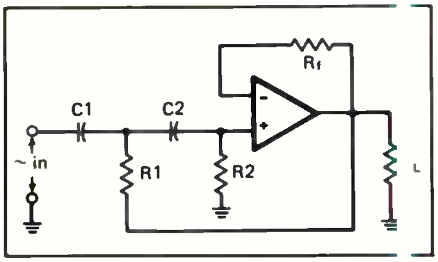


Fig. 6. A second-order, high-pass (:- tive filter.

You may have noticed that with second-order filters the unequal values of *C1* and *C2* may be difficult to find. The low- and high-pass filter ciruits shown in Figs. 5 and 6, respectively, simplify matters by allowing you to use a single value for both *C1* and *C2*. Similarly, one value of resistance does the job for both *R1* and *R2*. An important new feature of these equal-component-value circuits is that input resistor R_{in} has been added. The value of R_{in} is 39,000 (39k) ohms.

In the Fig. 5 and 6 circuits, damping is controlled by the gain of the op amp. Since the noninverting (+) input is being used, gain is $(R_f/R_{in}) + 1$. The gain needed, in turn, depends on the damping required. It's always calculated as 3 − d.

If R_f = 23,000 ohms, gain is (23,000/39,000) + 1 = about 1.59. If 1.59 = 3 − d, *d* is about 1.414, which is the required damping for a Butterworth filter. Thus, you can make a second-order, low-pass Butterworth filter in which F_c = 1 kHz by making R_f = 23,000 ohms and using the normalized values given above.

The catch is that the filter's pass-band gain will no longer be unity. It will now be 3 − d. Hence, in our last example, gain is 1.59. Since each response shape's damping value is different, each filter type must have its own unique gain. Normally, this isn't a disadvantage, since a gain of unity is seldom needed.

Using the equal-component-value circuit, design a low-pass, second-order 2-dB Chebychev filter in whi h F_c = 1.5 kHz, R1 = R2 = 10,0 0 ohms, C = 0.016 µF and R_{in} = 39,000 ohms. Given these param :- ters, C = 0.016 × (1000/1500) = 0.016 µF; d = 0.895 (from Table); and Gain = 3 − 0.895 = 2.1(. Since Gain = $(R_f/R_{in}) + 1$, plug n the known values and you have 2.1 5 = $(R_f/39{,}000) + 1$. Rearranging t e formula gives: R_f = (2.105 − 1) < 39,000 = 43,100 (43.1k) ohms.

Since the correction factor f 0.852 from Table 2 indicates adju :- ment to a lower frequency, you mı ıt raise the value of *C* or *R*. Adjusti g *R* yields R1 = R2 = 10,000/0.852 = 11,740 ohms. The final calculat d values now become: C1 = C2 = 0. 1 µF; R1 = R2 = 11,740 ohms; and f = 43,100 ohms.

Following the above steps is al it takes to design any second-order l- ter when you use the equal-comp)- nent-value circuit.

Third-Order Filters

Once you know how to design fir t- and second-order filters, designing higher-order filters is a cinch. To make a third-order filter, you just follow a first-order filter with a second-order section. The latter can be either a unity-gain or equal-component-value design. The only added complication is that you must now use a new set of frequency-correction and damping values for both filter sections. Table 2 lists the proper values to use for third-order filters.

Armed with the above information, design a third-order, high-pass 2-dB Chebychev filter in which F_c = 800 Hz. Use the equal-component-value circuit for the second-order section, and design by scaling from the reference circuit's values.

For the first-order section, the frequency factor (from Table 2) is 3.105. Hence, this section must be designed for 3.105 × 800 Hz = 2848 Hz. Assuming C = 0.016 µF and R = 10,000 ohms, rescale: R = (10,000 × 1000)/2484 = 4026 ohms.

For the second-order section, the frequency factor (again from Table 2) is 1.095. Therefore, this section must be designed for 1.095 × 800 = 876 Hz. Now assuming C = 0.016 µF and R = 10,000 ohms, scaling tells you that R = (10,000 × 1000)/876 = 11,400 ohms. Table 2 also tells you that d = 0.402. Hence, Gain = 3 − 0.402 = 2.6, which gives you 2.6 = $(R_f/39{,}000) + 1$, giving you R_f = 62,400 ohms.

(Continued on page 92)

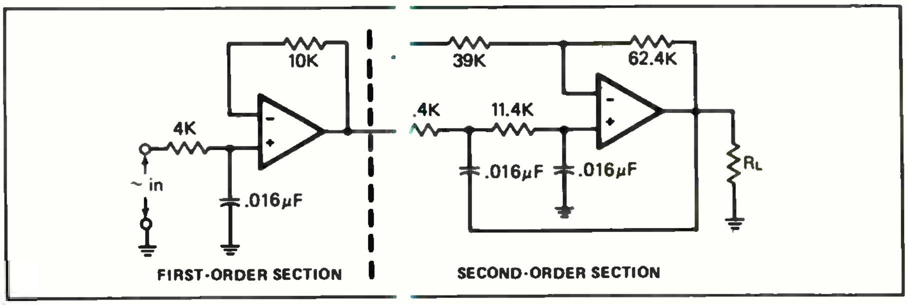


Fig. 7. A third-order, low-pass ctive filter consists of separate first- and second-order sections. Each designed independently of the other.

Relaxation Oscillators

By Forrest M. Mims III

Relaxation oscillators are common in nature and in living systems. Consider a branch hanging in a swift-moving stream. As the end of the branch is carried downstream, the tension in the branch is increased. Eventually, the tension exceeds the force of the moving water. The branch then relaxes by swinging back to its original position. The cycle is then repeated. Another example is a leaf that gradually fills with rain water. When the weight of the water exceeds the ability of the stem to hold the leaf upright, the leaf tilts over and dumps its liquid cargo. It then returns to its original position and begins collecting yet another load of water until the cycle is repeated.

On a grander scale, a lightning stroke is the visible evidence of the natural relaxation oscillator formed by a thunderstorm. The lightning stroke dissipates the electrical charge accumulated within the cloud. As the charge again builds up, another stroke occurs, and the cycle continues.

Electronic Relaxation Oscillators

The electronic analog of these natural oscillators is the relaxation oscillator, one of the most important basic electronic circuits. Most textbooks define a relaxation oscillator as a circuit that automatically switches between two stable states. Unlike sinusoidal oscillators, relaxation oscillators generate square or sawtooth waves. If the square waves are very brief in duration, they are usually called spikes.

Relaxation oscillators are used to generate repetitive pulses that can control a simple flashing light or a complex sequential logic circuit. They are also used in electronic music, laser pulse generators, television sweep circuits, and function generators to name just a few.

There are many kinds of electronic and optoelectronic relaxation oscillators. The ruby laser is one of the most interesting. When light from a flashlamp stimulates more than half of the chromium atoms within the ruby to a higher-than-normal energy level, optical amplification can occur. This happens when photons, which are emitted when excited atoms fall back to their normal energy level, stimulate additional atoms to release photons. The result is a brilliant burst of red light through one of the laser's feedback mirrors. Soon there are fewer excited than unexcited atoms, and the laser stops emitting light until light from the flashlamp stimulates additional atoms to repeat the cycle.

Most ruby lasers are excited by a flashlamp pulse lasting a few milliseconds. A close examination of the laser output during this period will reveal a series of closely-spaced spikes, demonstrating that this laser is indeed a relaxation oscillator.

The simplest purely electronic relaxation oscillators have a period determined by the values of a single charging resistor and a single capacitor. In this column several of these very simple RC relaxation oscillators will be examined. Then both hardware and software versions of digitally-synthesized relaxation oscillators will be presented.

Basic Relaxation Oscillator

Figure 1 shows a minimum configuration RC relaxation oscillator. In operation, capacitor *C1* is gradually charged through series resistor *R1*. When the voltage stored in the capacitor reaches the switching potential of an electronic switch connected across the capacitor, *C1* discharges through switch *S1* and load resistor *R2*. The circuit is said to have "relaxed." The capacitor now begins charging again until the cycle repeats, with *R1* controlling the charging time of *C1* and, hence, the circuit's frequency of oscillation.

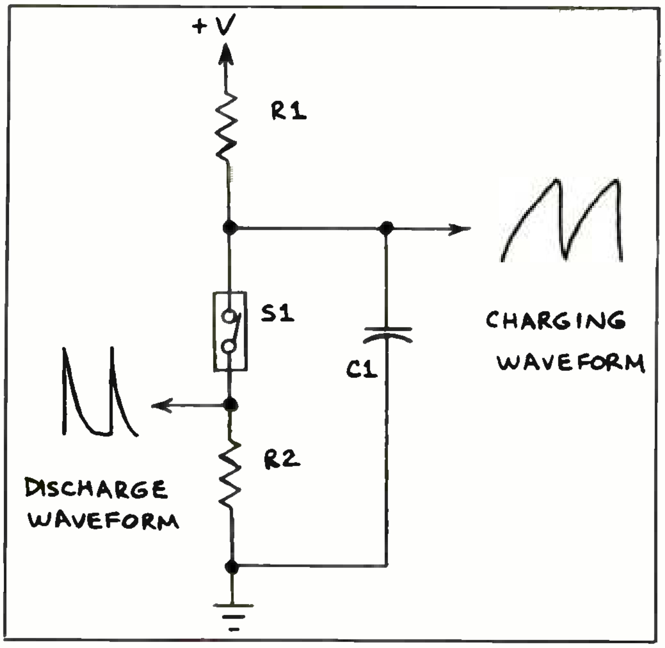
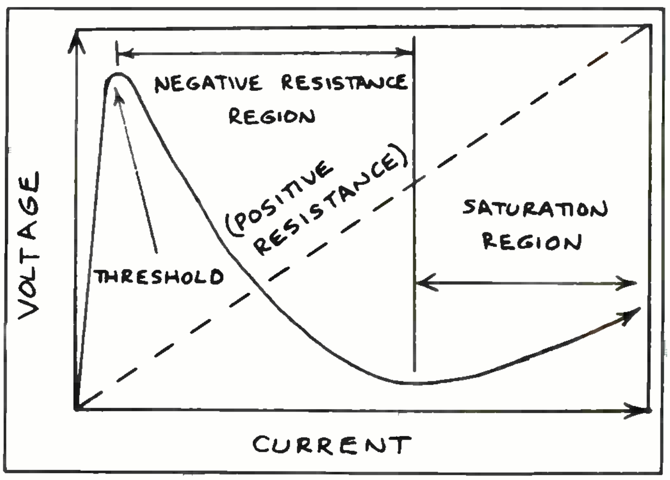


Fig. 1. Basic relaxation oscillator circuit.

Fig. 2. Negative-resistance properties.



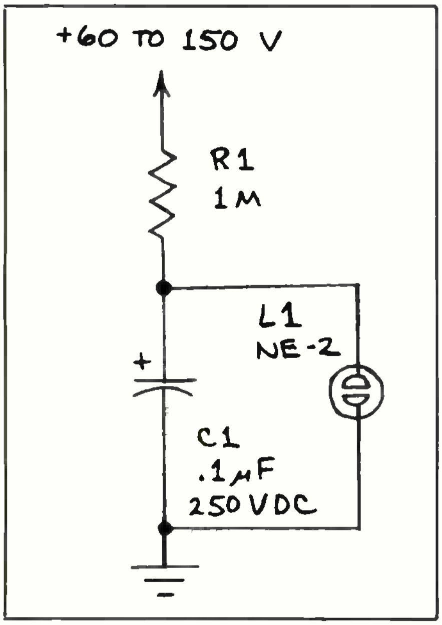


Fig. 3. Neon-lamp relaxation oscillator.

Figure 1 also shows the waveforms generated by an RC relaxation oscillator. The charging waveform, which resembles a ramp or sawtooth, is a standard capacitor charging waveform. The discharge waveform is a fast risetime spike. If the on-resistance of switching element *S1* is low, current switched through *S1* and *R2* can be as high as 10 amperes or more. If *C1* is very small in value, the duration of the spike across *R2* can be as brief as a few tens of nanoseconds (50 nanoseconds when *C1* is 0.01 microfarad).

A simple way to monitor the parameters of a relaxation oscillator is to insert a 1-ohm current-monitoring resistor between *R2* and ground. An oscilloscope probe can then be connected across the resistor. According to Ohm's law, the current through a resistor is the voltage across the resistor divided by the resistance of the resistor in ohms (I = E/R). Therefore, when *R* is 1 ohm, the current through *R* equals the voltage across *R*. In other words, a 5-volt spike across a 1-ohm current monitor means a current of 5 amperes through the resistor during the spike.

Incidentally, an oscilloscope is very helpful when adjusting most relaxation oscillators or evaluating their performance, particularly those oscillators with adjustable parameters. Simply by watching the shape of the waveform(s), it is possible to easily optimize the performance of particular oscillator circuit.

Negative Resistance

The switching device in Fig. 1 was d scribed above as turning on when the a plied voltage exceeded a certain value. Th characteristic is known as *negative r sistance*. Several classes of electronic con ponents exhibit negative resistance. No mally, their resistance is very high, but becomes very low when the potenti across the device reaches a point variou ly known as the breakdown, avalanche, c switching voltage.

Figure 2 illustrates the electrical prope ties of a typical negative resistance devic From this curve it is clear that the curre through the device remains very small a the voltage across the device is increase In other words, the resistance of the devic is very high. When the voltage reaches critical threshold point, however, the cu rent through the device rapidly increase Now the resistance of the device fal dramatically. This is the negative-r sistance region. If the forward curre through the device increases beyond a ce tain point, the device is said to be sa urated. The resistance of the device the begins to increase. Contrast this actic with that of a positive-resistance devic such as an ordinary resistor, illustrated b the dashed line in Fig. 2.

Negative resistance is a feature share by various electronic components th have little else in common. For exampl the neon glow lamp, four-layer diod SCR, and unijunction transistor all exhib negative resistance.

Neon-Lamp Oscillator

Figure 3 is the schematic diagram for th familiar neon-lamp relaxation oscillat circuit. Here, the neon lamp serves as th switching element. A typical neon lam has an ionization (turn-on) potential c about 60 volts. When the charge on C reaches this value, the gas inside the lam ionizes and provides a low-resistance pat for the charge stored in *C1*. The lam glows until the charge on *C1* falls below th point at which ionization is sustained.

The power supply for this circuit can b one or two 67.5-volt batteries or a dc-to-c converter. The latter can be made by switching a current through the 6.3-volt winding of a filament transformer. Use a 1N4004 or similar diode to transform the alternating current at the transformer's secondary to pulsating direct current. For additional information, see ***Engineer's Mini-Notebook: 555 Circuits*** (Forrest M. Mims, III, Radio Shack, 1984, p.32).

With the values shown in Fig. 3, the neon lamp will flash a few times a second. Increasing the value of *R1* or *C1* will slow the repetition rate. Several flasher circuits can be powered by the same power supply. If slightly different values for *R1* and *C1* are used, the lamps will flash at different times, creating an attention-getting effect.

Caution: Use care when operating this circuit and any circuit powered by a high voltage supply. See the caution note under the avalanche transistor oscillator circuit described below.

Four-Layer Diode Oscillator

The four-layer diode is a pnpn device that closely resembles a silicon-controlled rectifier (SCR) without a gate electrode. Normally, the device exhibits a very-high resistance. When the forward voltage across the diode exceeds a certain threshold, the diode switches on and permits a current to flow. The diode will remain switched on even when the forward voltage falls below the threshold value so long as the forward current exceeds a value called the holding current. Depending on the device, the holding current can range from 0.1 to 50 milliamperes.

A simple four-layer diode relaxation oscillator configured as an LED driver is shown schematically in Fig. 4. Depending on the setting of *R2*, this circuit will oscillate at a frequency of up to a few tens of kilohertz. In operation, *C1* charges through *R1* and *R2* until its charge reaches the avalanche voltage of *D1*. When *D1* switches on, *C1* discharges through *D1* and the LED. Then *D1* switches off and the cycle is repeated. Current pulses through the LED will have a duration of around 50 nanoseconds at up to an ampere or more.

An advantage of the Fig. 4 circuit is its extremely small size. Excluding the power supply, the entire circuit can be assembled in a space the size of a thimble. A possible

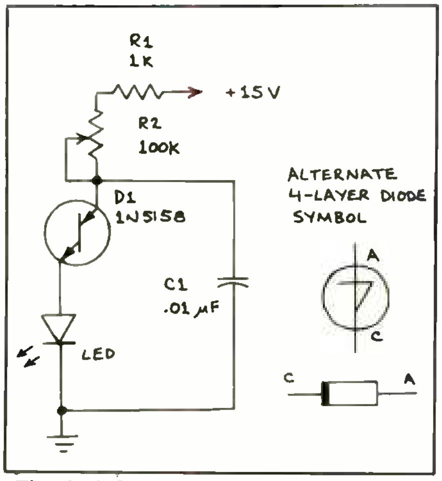


Fig. 4. A four-layer-diode relaxation oscillator.

disadvantage is that the four-layer structure of *D1* offers a somewhat higher on-resistance than that of a transistor operated in the avalanche mode. Unless the highest possible current is required, this should not normally pose a major drawback. Another possible disadvantage is that four-layer diodes can be hard to find. Many different four-layer diodes will work in this circuit. Of course the supply voltage will have to exceed the breakdown voltage of the selected diode or the circuit will fail to oscillate. I have used four-layer diodes made by Motorola, ITT and American Power Devices. You will have to contact electronics distributors that represent these companies.

SCR Oscillator

Normally, the SCR is triggered by an external pulse at its gate electrode or, in the case of the light-activated SCR (LASCR), by a flash of light. Figure 5 shows an SCR that is self-triggered and operates as a relaxation oscillator. Though the gate lead is used, the gate does not trigger the SCR in this circuit. Instead, the pnpn SCR is operated much like a four-layer diode.

In operation, *C1* charges through *R1*. When the SCR's anode-cathode breakdown voltage is reached, the device suddenly switches on and permits *C1* to discharge through itself and the LED. After *C1* is discharged, the SCR switches off, and the cycle is repeated.

When this circuit is first operated, *R2* should be set to its center point. After power is applied, *R2* should be rotated in either direction until the circuit begins to oscillate. This setting can be optimized with the help of an oscilloscope connected across *C1* or a small-value resistance between the LED and ground. The frequency of oscillation can be made variable by substituting a 100,000-ohm (100k) potentiometer for *R1*.

I have used various SCRs and LASCRs in this circuit. Since different SCRs may have differing avalanche voltages, you may have to experiment with the supply voltage to make sure the circuit will oscillate when a particular SCR is used.

UJT Oscillator

The unijunction transistor (UJT) bears little resemblance to a conventional bipolar (pnp or npn) transistor. Though both have three leads, the bipolar transistor has two pn junctions, the UJT only one. A UJT is formed from a small bar of n-type silicon. Leads attached to opposite ends of the bar are designated base 1 and 2 (B1 and B2). A third lead, the emitter (E), is attached to the side of the silicon bar near the base-2 electrode. Where the emitter joins the silicon bar a pn junction is formed.

Normally, the resistance of the silicon bar (base 1 to base 2) ranges from around 4,000 to 10,000 ohms. When the voltage applied to the emitter terminal exceeds a critical point, the emitter-to-B1 junction conducts and the resistance of the silicon bar falls to a few tens of ohms. This negative-resistance characteristic makes the UJT well-suited for relaxation-oscillator applications.

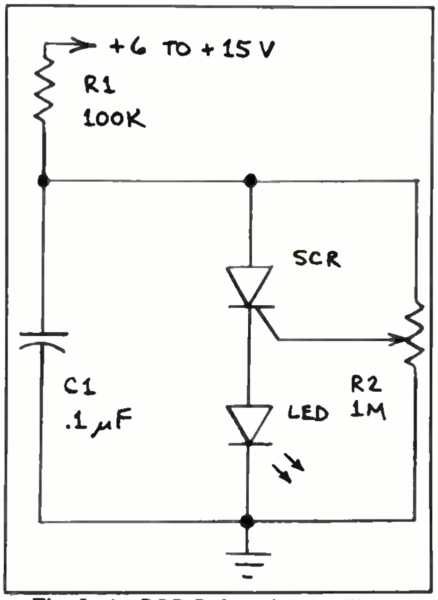


Fig. 5. An SCR Relaxation oscillator.

A simple UJT oscillator that drives a small 8-ohm speaker is shown schematically in Fig. 6. In operation, *C1* charges through *R1* until *Q1*'s emitter-to-B1 junction switches on and discharges *C1* through the speaker. The emitter-to-B1 junction then resumes its high resistance state until *C1* is again charged and the cycle repeats. The frequency of oscillation can be altered by varying *R1*.

Besides the small speaker shown in Fig. 6, the UJT oscillator can flash an LED, function as a pulse generator, actuate a relay, or trigger and SCR. By using a very-large-value capacitor for *C1*, the circuit can function as a timer having a period of half a minute or so.

Avalanche Transistor Oscillator

When the voltage across the collector-to-emitter junction of an npn transistor reaches a certain threshold, the device will switch on without the need of a base signal. What's more, it will switch so fully on that its resistance may be as little as an ohm or so. This is significantly lower than any of the solid-state negative-resistance devices described above. When a transistor is switched in this fashion, it is referred to as an avalanche transistor. Certain transistors are designed specifically for operation in the avalanche mode. Many ordinary silicon switching transistors can also be operated in the avalanche mode.

A relaxation oscillator designed around a 2N2222 transistor operated in its avalanche mode is shown schematically in Fig. 7. The avalanche (or breakdown) voltage of the 2N2222 is very close to that of the NE-2 neon lamp, which is generally around 60 volts. When the charge on *C1* reaches this value, the 2N2222 will switch on and dump the capacitor's charge through the LED. The transistor will then resume its high-resistance state until *C1* is again charged to its avalanche voltage.

Since this circuit requires a fairly high supply voltage, its practical applications are limited. Among its most important applications is service as a high-current driver

ELECTRONICS NOTEBOOK...

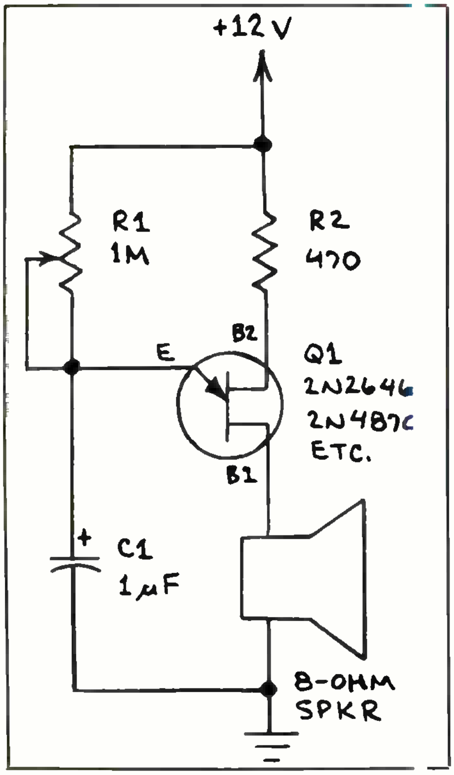


Fig. 6. A UJT relaxation oscillator.

for single-heterostructure laser diodes. These lasers emit up to several watts of near-infrared radiation when driven by current pulses having an amplitude of 10 amperes or more. These lasers cannot be operated continuously at room temperature but must be driven by pulses having a duration of no more than a few hundred nanoseconds. The circuit in Fig. 7 delivers 50-nanosecond pulses having an amplitude of up to 10 amperes at a rate of up to a few thousand hertz.

Caution: Use care when powering this circuit. Two 67.5-volt batteries in series will provide a good power source. A single 67.5-volt battery might work if the switching voltage of the 2N2222 happens to be below around 60 volts. A simple dc-to-dc converter, such as the one mentioned under the neon-lamp oscillator above, will also work. Whether a battery or dc-to-dc converter supply is used, it is important to remember that the supply voltage is capable of delivering an electrical shock. While the shock alone might not necessarily be dangerous, muscular contraction caused by the shock might cause an injury.

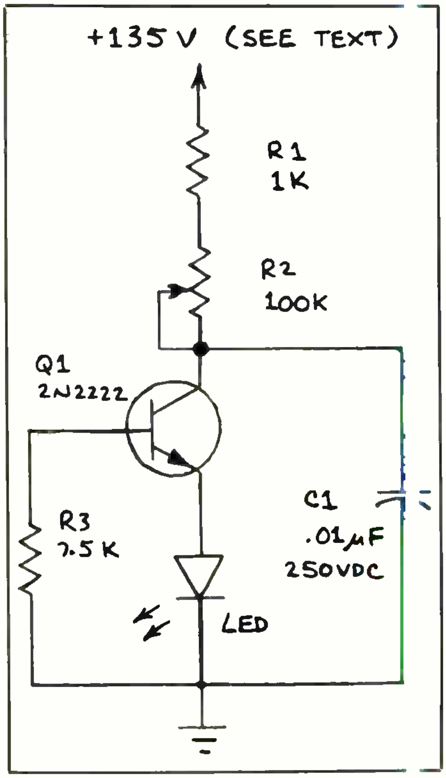


Fig. 7. An avalanche transistor relaxation oscillator.

Optoelectronic Oscillator

The circuit in Fig. 8 is included here to illustrate how negative resistance can be simulated by combining two or more components. The key to the circuit is an optoisolator. Initially, the phototransistor within the optoisolator is off. As the charge on *C1* gradually increases, current through *Q1* and the LED in the optoisolator increases. Eventually, the radiation emitted by the LED is sufficient to switch on the transistor in the optoisolator, causing *C1* to discharge, and the cycle begins anew.

The Fig. 8 circuit can be a little tricky to adjust at first. For best results, use a 1-microfarad capacitor for *C1* and set *R1* to about 5,000 ohms (5K). Then adjust *R3* until the circuit begins to oscillate. Connect an oscilloscope across *C1* to monitor oscillation. If you don't have a scope, you can verify that the circuit is working by inserting a small 8-ohm speaker between the emitter of the optoisolator transistor and ground.

Digital Logic Oscillator

A simple feedback loop can transform a

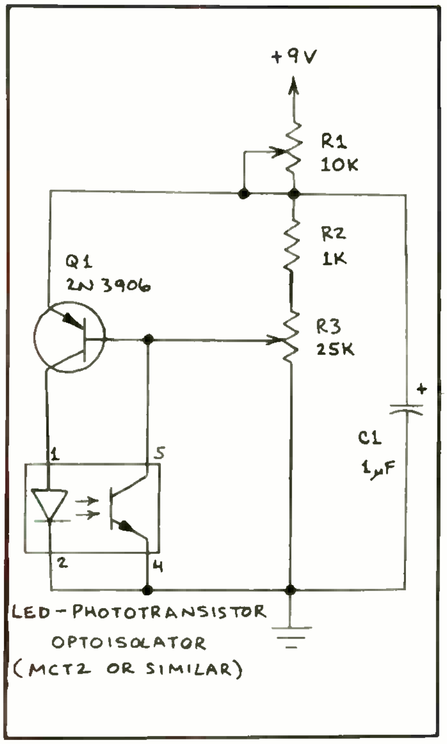


Fig. 8. An optoelectronic relaxation oscillator.

logic circuit into the digital equivalent of the relaxation oscillator. For example, consider the programmable 4-bit counter shown schematically in Fig. 9. The binary equivalent of the desired count is entered into a 4-position DIP switch. The 74193 counter advances one count for each arriving pulse from the 555 clock. The 7485 compares the count at the 74193's outputs with the desired count entered in the DIP switch. When a match occurs, the 7485 clears the 74193, and the count-compare cycle is repeated.

The clear signal from the 7485 corresponds to the threshold point of a negative-resistance switch. And the clearing of the 74193 is much like the discharging of the capacitor in the previous circuits. An added advantage of the logic circuit is that the threshold point, hence the frequency of oscillation, can be quickly adjusted to any of 16 values.

Software Oscillators

Any computer language that has a looping command permits establishment of the functional equivalent of the relaxation oscillator. For instance, consider this simple BASIC listing:

```
10 BEEP
20 GOTO 10
```

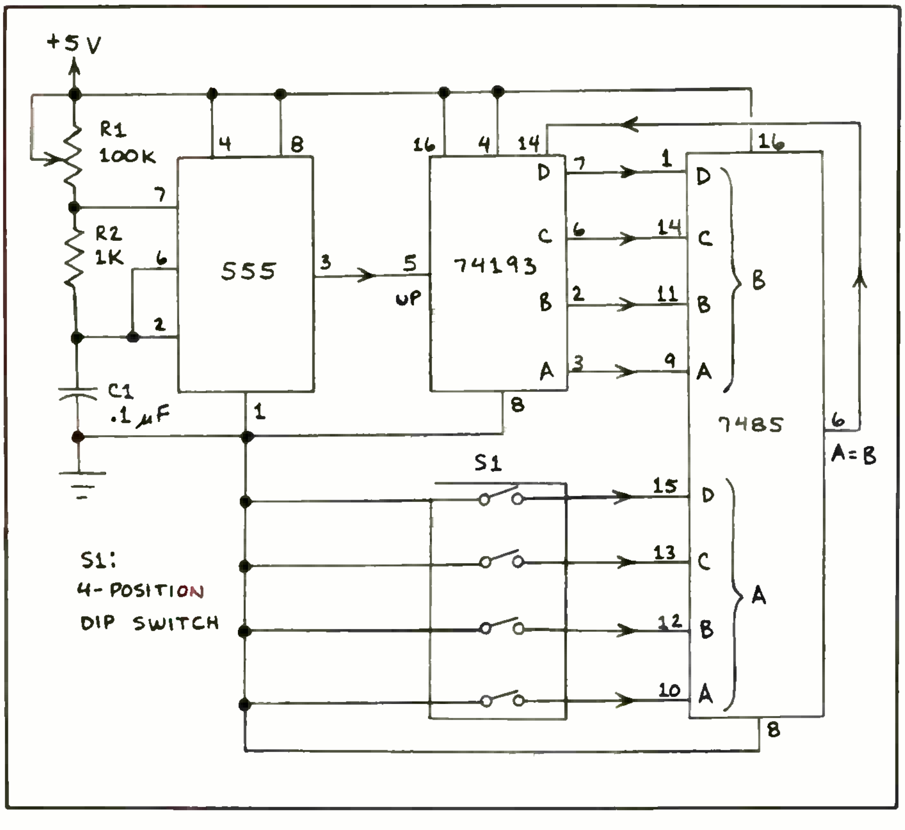
This listing will cause a computer to emit a continuous series of beeps. The program can be easily modified to alter the frequency at which the beeps occur, simulating the variation of the RC values in the circuits given above. For example, this listing permits the delay between beeps to be selected:

```
10 INPUT "ENTER DELAY BETWEEN BEEPS"
20 BEEP
30 FOR Z = 1 TO N:NEXT Z
40 GOTO 20
```

Going Further

By now, it should be apparent that relaxation oscillators play a key role in both natural and electronic systems. You can find out more about this subject and specific kinds of relaxation oscillators by referring to electronics textbooks and data sheets that describe the characteristics of various negative-resistance devices. **ME**

Fig. 9. Digital logic analogy of relaxation oscillator.



BOOKS

Understanding Computer Science an Understanding Computer Science Appl cations by Roger S. Walker. (Texas I strument Series, Howard W. Sams pul lisher. 7" × 9" soft cover. 274 and 2ε pages, respectively. $14.95 each.)

These two companion books go t gether like bread and butter. *Understan ing Computer Science* offers an in-dep look at how people use computers solve everyday problems. It covers th fundamentals of hardware and softwar programs and languages, input and ou put, data structures and resource ma agement.

This volume tells you how to instruct computer what you want it to do via pr gramming. It tells you a bit about popul programming languages and how th differ via text and sample program lis ings. Finally, it gives examples of ho software is used to operate a syste manage resources, structure data, tran late human instructions into a form t computer can understand, and analy systems to determine what resources a required to do a specific task.

The following book, *Understandi Computer Science Applications*, buil on the material presented in the previo one by showing with program exampl how to actually use computers to sol problems. Software, rather than har ware, is stressed, with applications e plained in easy-to-understand languag Parallel and serial communications, ne work communications and distribute processing, modeling and simulating sy tems, and computer graphics are exa ined.

This volume looks into some of the ap plications to which the computer is put i everyday tasks and investigates some c the changes that have been occurring as result of the computer. Example pr grams for self-study are provided alo with the text discussions.

Written in an easy-flowing style, bo volumes are designed to build unde standing in a step-by-step manne Quizzes at the end of each chapter rei force the material studied. The books a tastefully illustrated with photos, dra ings, block diagrams, etc. Two-col printing, along with liberal use of ti blocks, make for easy-on-the-eyes rea ing.

Electronic Techniques, Third Edition by R.S. Villanucci, A.W. Avtgis & W.F. Megow. (Prentice-Hall. Hard cover. 619 pages. $34.95.)

Contained in this book is a complete course in industrial design and fabrication procedures for electronic equipment. It begins with designing and machining of metal chassis, cabinets and front panels, and goes on to examine all printed-circuit board technologies currently in use. Equally important are the chapters on chassis hardware and assembly, interconnection techniques, and harness and cable fabrication.

Chapter-to-chapter continuity is maintained with the aid of a stereo amplifier example that is introduced at the beginning of the book and is gradually transformed from a concept on paper to the finished product near the end of the book. Emphasis throughout is on practical procedures employed in the manufacturing industry. The text is clearly written for easy comprehension and is lavishly illustrated with supportive photos and drawings. Since this is a learn-by-doing textbook, most chapters close with practical exercises to be performed, and there is an entire chapter devoted to projects to be built.

Power Supplies by Irving Gottlieb. (Tab Books. Soft cover. 437 pages. $15.50.)

This book offers an in-depth study of the most-often-forgotten but always indispensible part of every electronic system—the power supply. Not just a theory-oriented textbook, it is practical-applications oriented to help the reader to design and build practical power supplies for any application from computers to TV receivers to home-built projects.

The book is divided into two about equal parts. Every facet of inversion and conversion as they relate to power supplies is covered in the first half of the book. Theory, design and application of the switching-type power supply is the focus of the second half. Throughout, the clearly written text is supported with healthy doses of schematics, graphs and tables. Many schematics of actual practical power supply designs, some with parts lists or component values, are given so that the reader can assemble and put them into service, rather than having to design them from scratch.

NEW LITERATURE

Oscilloscopes Brochure. Digital storage oscilloscopes, their applications and purchase considerations are reviewed in a 12-page brochure available from Gould Inc. In addition to providing a full product line descriptions, the brochure compares digital storage scopes to tube storage scopes. For a copy of Bulletin No. 449-22, write to: Gould Recording Systems Div., 3631 Perkins Ave., Cleveland, OH 44114.

Audio/Video Products Brochure. A new line of parts, tools and service aids for audio and video tape equipment is described in an 18-page brochure from Philips ECG. The illustrated brochure contains information on audio tape and VCR test cassettes; tape repair kits and precision adjustment tools for VHS and Beta VCRs; lubricants and cleaning materials for audio and video equipment; opto sensing devices; replacement belts; and head assemblies for VCRs. The replacement-parts section cross-references by equipment manufacturer model number for belt kits and video heads and includes cross-reference charts by part numbers for individual belts, heads and sensing devices. For a free copy, write to: Philips ECG, Inc., Distributor & Special Markets Div., 100 First Ave., Waltham, MA 02254.

Protection Guide & Catalog. Electronic Specialists is now offering a new 40-page color catalog in which are described such power-line problems as noise and high-voltage spikes and the damaging and disruptive effects they can have on electronic equipment. Typical laboratory, commercial and office problems and suggested solutions are included, along with listings and complete descriptions of hundreds of protective and interference cure products. For a free copy of Catalog 851, write to: Electronic Specialists, Inc., 171 S. Main St., P.O. Box 389, Natick, MA 01760.

What To Know About Video Pamphlet. Sharp's new pocket-size, 16-page pamphlet answers the most-asked questions about TV receivers, monitors, VCRs and cameras. It is written to help the first-time buyer reach intelligent decisions when it comes to purchase video equipment. Send a SASE to: Consumer Video Brochure, Sharp Electronics Corp., Consumer Video Div., Sharp Plaza, Mahwah, NJ 07430.

CIRCLE 92 ON FREE INFORMATION CARD

Synonyms At Your Fingertips

By Art Salsberg

Webster's New World On-Line Thesaurus/Simon & Schuster Computer Software/For IBM PC Family or True Compatibles/$69.95.

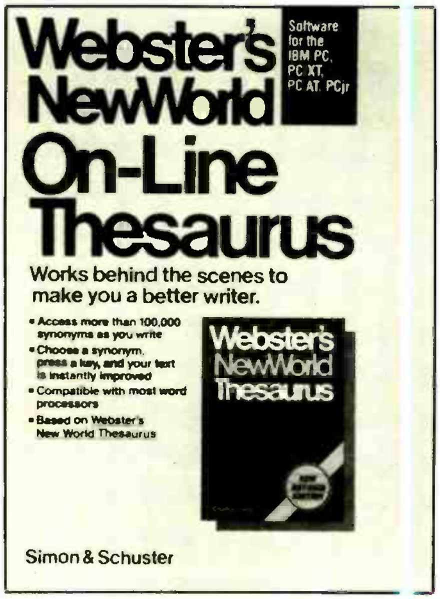
What's another word for . . . ? And that's where a thesaurus comes in handy. Having such a list of suggested synonyms available to you at the press of a key instead of leafing through a book can be a time-saver. In the case of Webster's New World On-Line Thesaurus, it is, up to a point. That point is reached when you don't use a hard disk or use a machine with dual floppies and don't have enough memory to set up a RAM disk.

Webster's thesaurus comes on two disks: a control disk and a dictionary disk. The latter must be available in a drive in order to call up the program's suggested alternative words without switching disks. Since the dictionary's data takes up almost all the space on a 360K dual-sided floppy disk, which is typically used on less-powerful IBM PC family members, you can't combine its files with a word-processing program, where the thesaurus is used most often. Adding the thesaurus to drive b: would leave too little room for saving data.

The foregoing aside, S&S claims the largest dictionary of any on-line thesaurus with 120,000 synonyms and phrases, excluding prefixed and suffixed words. It's easy to configure and is compatible with all the popular word-processing packages, such as WordStar, MicroSoft Word, Volkswriter, Bank Street Writer, MultiMate, Word Perfect, DisplayWrite, Inc. It also operates when editing text with EDLIN, Symphoney, Framework, Sidekick, ThinkTank and Word Proof, and it's easy to customize to meet special software needs.

The control disk must be loaded at every session; its 35K of data remains resident in memory until the computer is shut off. The second disk, the dictionary, must be available for a specified drive's action, as cited earlier.

Pressing Alt and function-key F10 at the same time calls up Webster's thesaurus. With the cursor anywhere within the word (or one space to the right or left of it) for which you want to see similar-meaning words, this entry key will display suggested synonyms in a window on your screen. Included in the window is the word from the word processor's text, the part of speech (verb, adjective, etc.), a list of synonyms, and references to related words, as a screen dump illustrated here shows. Also listed are the words immediately preceding and following the entry word. The user can browse through the dictionary if he wishes to or call up another window to check out the referenced related words.



Typing the first letter of whatever word one wants to call up for further reference creates a second window in which typing of the entire word will set you up for another listing of synonyms. For example, for the entry word "new," I moved the cursor to the word "recent" and

```
        B:THESAURU  PAGE 1 LINE 11  COL 15            INSERT ON
L----!----!----!----!----!----!----!----!----!----!----!--------R
                              SOFTWARE FOCUS                          <
                                                                      <
                              By Art Salsberg ─── Webster's New World Thesaurus ───
                                              nevertheless                newborn
                                              
                                              new, mod.
                          Synonyms At Your Fing  1. recent: see fresh.
                                                2. modish: see fashionable, modern.
                                                3. novel: see unusual.
                                                4. unlike: see different.
Webster's    New    World    On-Line  Thesa
Software/For  IBM  PC,  PC/XT or Tr   Co
DOS 2.0 or later:  IBM PC/AT or Tru  Com
3.0  or later:  IBM PCjr with 128K   d D
drive and 80-column display/$69.95.

    What's  another word for...?     nd ─────── Press F1 for help ───────
```

A screen printout of the first window displayed when an entry word is made.

```
        B:THESAURU  PAGE 1 LINE 11  COL 15            INSERT ON
L----!----!----!----!----!----!----!----!----!----!----!--------R
                              SOFTWARE FOCUS                          <
                                                                      <
                              By Art Salsberg ─── Webster's New World Thesaurus ───
                                              nevertheless                newborn
                                              
                                              new, mod.
                  ─────────────── Keystroke Summary ─────────────────
          Enter  : Look up Synonyms    A to Z   : Type in Word to Look Up  dern.
          F10    : Make Replacement    Esc      : "Escape" from Thesaurus
Webster   Alt-F1 : Change Options      F8       : Alternate Entries
          F2 or +: Flip Pages          F9       : Whoops!
Softwar   F3     : Display Document    Alt-F9   : Pass Through Entry key
          F4     : Note Page           Alt-F10  : Redo Scan (Phrase/Word)
DOS 2.0   F5     : Edit Word           Ctrl-F10 : Straight Type-back
    : Move Highlight
3.0  or   F7     : Retrace List        PgUp/Dn  : Browse
drive and 80-column display/$69.95.

    What's  another word for...?     nd ─────── Press F1 for help ───────
```

Pressing F1 for Help, a second window is opened that displays keystroke commands.

entered it as a substitute (Webster's requires you to confirm this). The new word was immediately substituted with a bit of magical jiggling on screen to fit it in. All well and good.

I then called up the substituted word, recent, expecting to see the word new on the list of synonyms. I was puzzled when it wasn't there. Typing one of the synonyms, modern, caused another listing of synonyms in another window to the left of the first one. But the word new still was not listed. I then chose a synonym on this list—fresh. A new synonym list for the word, fresh, did indeed include the word "new," which I restored to my word-processor text by pressing F10.

With a thesaurus book, most of these words would have been listed in one section in the first place, though there are some that have lots of references to other words that cause one to flip pages. It was all fast and easy, though, so not so terrible I thought. Automatically back in my word processor, I noted that automatic right-margin justification was not done, so there's another step to be taken. When using bit-mapped graphics displays, the program does not read a word in text for entry; the word would have to be typed in.

Color.com enables a user to change colors if you use a color-display system and prefer displaying text with colors different than the default's.

Webster's Thesurus makes good use of function keys, which are used for a variety of purposes as shown in a second screen printout window (Keystroke Summary). F9's "Whoops!" enables you to undo replacement of a word that you substituted. The Thesaurus also provides a Note Page that's brought up by pressing F4. Here you can list possible replacements for certain words, which are listed on a single page. The user can call up this page and choose a word there using highlighted selection of the word and pressing F10 to effect a text substitute. If you're browsing through the dictionary and see a welcome word you'd like to remember, you can add it to the Note Page by pressing F4 twice.

In all, this is a nice program, particularly if you have a hard disk drive where you can store it to a subdirectory. It's certainly a very useful addition to anyone's set of software tools if a lot of text writing is done. The program has its drawbacks, as noted earlier, but overall is fine if used with a hard disk or RAM drive. Even at its modest price, though, I would not recommend it for use with dual floppy drives with a PC that does not have plenty of user memory (say, at least 384K and probably much more if you use a lot of resident-memory utilities). ME

The Best Mouse Surface Around; Simulating the Human Brain Using CMOS Inverters; a New A/D Converter

By Don Lancaster

We'll begin with some updates on our previous columns. The part number on the *Hewlett-Packard* shaft encoder integrated circuit is the HCTL-2000. This dude goes by the horrendous name of a quadrature decoder counter interface IC. It automatically provides all the direction sensing, noise elimination, pulse counting and bus interfacing needed to connect a shaft encoder to a microprocessor or a personal computer.

As yet another source on piezoelectric goodies and information, check out *Piezo Electric Products*. Besides some super-quiet cooling fans that use vibrating resonant blades, they are into exotic stuff such as using piezo generators to recover electrical power from car to truck mufflers.

And some more on the SCUZZY interface. A good tutorial series is appearing in *The Computer Journal,* starting with issue #22. Also, NCR has a bunch of plug-and-go modules that will handle most of the SCSI interface firmware for you. Adaptor cards for personal computers start around $300 in single quantities. These prices are certain to drop in the near future.

As always, this is your column and you can get technical help by calling. Use the number shown in the end box. I also have lots of freebies available.

What is the penultimate mouse surface?

Several Tucson cave divers have put me onto a mouse working surface that is much better and much cheaper than just about anything else. It beats most commercial products whiskers down.

So, run down to your friendly local neighborhood divers supply house or scuba shop and pick up a square foot or two of ⅛ inch nylon wetsuit material. The cost is around a dollar per square foot and it even comes in decorator colors.

Round the corners and use the material fuzzy side up.

How does the human brain work?

That's a very good question and a very exciting one as well. There are lots of heavy-duty people doing heavy-duty studies on modeling and understanding the human mind. In fact, several firms now have ridiculously expensive emulations for supercomputers and high-end minicomputers that will model the neuron network of the brain.

What does this expensive software do to a dino supercomputer? It converts it into a model for a group of circuits that any eighth grader could throw together on a kitchen table, using parts from *Modern Electronics* advertisers, and paid for out of pocket change! So, I'll make this prediction: The next major breakthrough in artifical intelligence will not come from the artificial intelligence hotshots, nor the universities, and certainly not from the military. It will instead be done by two junior high school students whose only lifetime goal is to embarrass their science teacher.

Let's start with the basics.

The human brain seems to be made up of two basic parts. The "active" part is called a neuron, and looks and behaves suspiciously like a plain old nickel CMOS inverter. The "passive" part is called a synapse and looks and acts more or less like a penny resistor.

Neurons are rather small, being some 50 microns in length or something around 0.002 inch. There are bunches of them, ranging from a few thousand for a simple organism, up to as many as a trillion or more in humans and dolphins.

Neurons communicate with each other through the synapses. A single neuron may be connected to as many as 10,000 other neurons with as many synapses.

In computer terms, we seem to have a massively parallel, 3-D asynchronous system. It also seems to be the relative state of the neuron "interconnectedness" that is storing data rather than placing any one piece of information into any one particular place. This goes by the fancy name of "associative memory."

Some very interesting consequences of a massively parallel associative memory are that the zillions of parallel connections more than make up for the relatively slow speed of any individual device. Another consequence is that you may be able to damage or destroy part of the memory and it may recover, much in the same way that you can scratch a hologram without destroying any specific part of its image. Which may explain how stroke victims may eventually regain some abilities, even after obvious and massive brain damage.

Most often, the brain works only on a

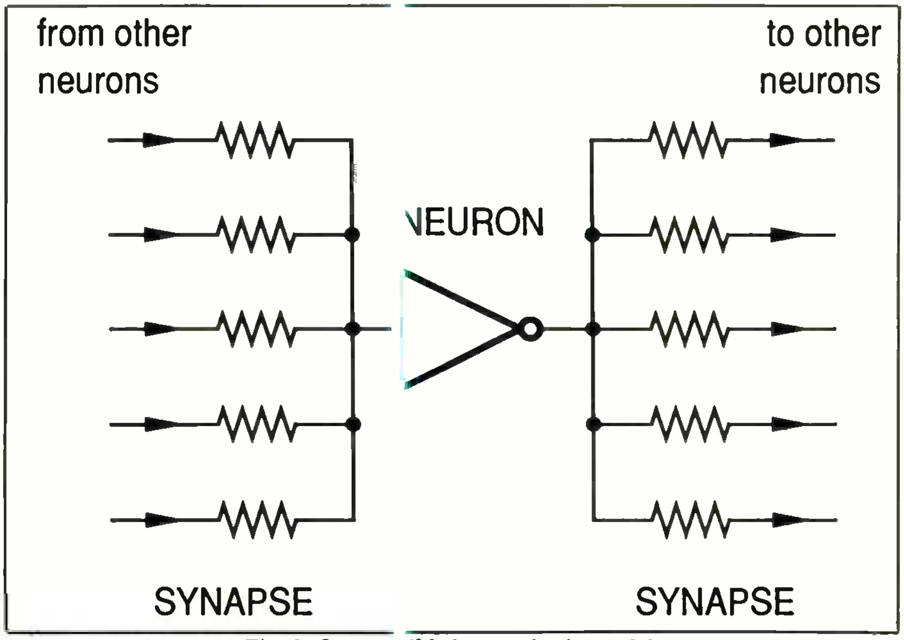


Fig. 1. One possible human-brain model.

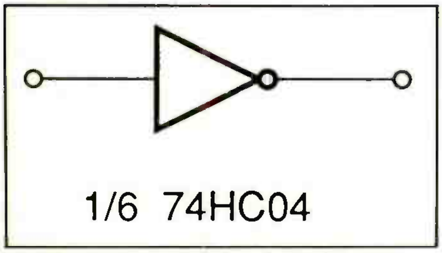


Fig. 2. A CMOS threshold detector.

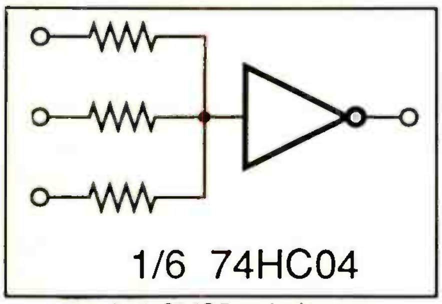


Fig. 3. A CMOS majority gate.

good solution, instead of the best of all possible solutions. You could even argue that the best possible solution to a problem is often both obsessive and energy inefficient. And nature would be on your side.

There's a very famous computer problem called the "traveling salesman routine." In it, a salesman has to visit all the cities on his route. Naturally, he only wants to go a minimum distance to do so. For more than a few dozen cities, the problem solution takes forever, even for supercomputers using the newest algorithms. There's all sorts of uses for this sort of thing, ranging from telephone calls to, unfortunately, star wars.

Here's the neat part: A kitchen table full of resistors and logic gates modeled in a neuron net can solve the same traveling salesman problem that would take a supercomputer months to do. And it does so in a millisecond or less!

The only little gotcha is that the neuron net will come up with a only very good solution, instead of the best possible one. But who cares? Certainly not the traveling salesman.

There's even a new name for human brain modeling and studies. Instead of software and firmware, we now have—*wetware.*

How can we model the brain?

Figure 1 shows part of a neuron net model. For a neuron, we can use a plain old CMOS inverter, say ⅙ of a 74HC04. We'll stick with a +5-volt dc supply, since this seems to be the in thing to do. For a synapse, we'll use plain old resistors. These will often be in the 4.7k to 470k range.

A real neutral net works something like this: Currents routed through several synapse connections will "fire" a neuron if the currents get strong enough. The "fired" neuron pulse is then passed on to yet other neurons through extensive synapse interconnections.

In some instances, the time rate of firing will change with stimulus intensity. For instance, the color red might fire the red sensors in the eye at a higher rate than the blue or green sensors. In others, synapse pulses have to build up or accumulate until they are strong enough to fire a neuron. Chemical changes are most likely involved, similar to the charging and discharging of a battery. Calcium seems to play an important role. The "interconnectedness" of the neural net will then decide what "thinking" action is to take place.

Probably the best way to start off on all this is with some reading of what others have done and are up to. In particular, check out the May issue of Science 86, and the March 24, 1986 and more recent issues of *EE Times.* For a related subject, check out the April 11, 1986 issue of *Science,* where the complete genetic code for the red, blue, and green vision sensors has been fully cracked for the first time.

There's lots of reasons why you might like to study neuron nets. Firstoff, they are fascinating in themselves and can give you anything from a quick school report to a lifetime of dedicated study.

Second, they can be profitable key to new software that can handle "fuzzy" data that gives today's programs fits. Things such as speech recognition, robotic vision, mailing list cleaners, spelling correctors, and, of course, chess. Plus a great heaping bunch of new applications presently unthunk of.

Third, eventually we will have some way of real-time interacting with the human brain, literally being able to network brilliance, in addition to being able to write

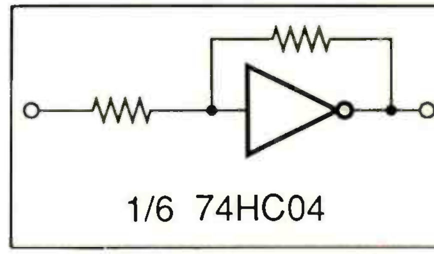


Fig. 4. A CMOS linear amplifier.

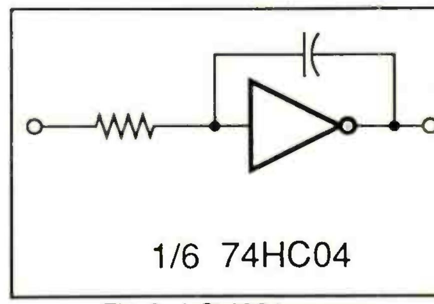


Fig. 5. A CMOS integrator.

"wetware patches" that can "cure" certain forms of mental illness.

Besides, think how much money you could earn by selling little blue boxes to used car salesmen that have three buttons on them marked "enters lot," "gets interested," and "closes sale"?

What can a "neuron" logic inverter do?

You don't have to have an exact model of a neuron or a synapse to study massively parallel 3-D computer architectures that use extensive feedback. Even with plain old CMOS inverters and plain old resistors, you might be able to come up with new ways to thinking and new ways of doing things.

But what can you do with a CMOS inverter? The correct answer, of course, is just about anything. Let's look at a few quick examples.

In Fig. 2, we can use the inverter itself as a threshold detector. Anything less than half the supply voltage drives the output low, while anything more than half the supply voltage drives the output high. Thus, by summing currents above a given threshold would actually "fire" your inverter.

In Fig. 3, the CMOS inverter behaves as a majority gate. The output will go low only if two of the three resistors are positive. Put another way, your neuron fires only if the Ohm's Law voltage produced by net currents from all inputs exceeds the magic "half way up" threshold.

In Fig. 4, we have a linear amplifier that we build by feeding back the inverter's output to its own input. This forms an operational amplifier. The gain in this case equals the ratio of the output resistor to the input resistor. You can extend this to just about anything a "real" op-amp can do. Additional inputs will be summed. Extra resistors from the input to +5 volts or ground will bias the output off-center. With enough bias, you can get half-wave or even full-wave rectification.

Figure 5 is an example of an integrator. The capacitor will build up a charge that represents the past history of input currents. For instance, if the capacitor is first discharged and the input is made positive, you will get an output that starts at the positive supply and linearly ramps downward. One use is for square wave to triangle wave conversion.

A regenerator, or snap-action circuit is shown in Fig. 6. Here we use positive feedback to create hysteresis. This circuit is also called a Schmitt trigger. Use this circuit to change a slowly changing and weak input into a "wall-to-wall" higher power output.

Figs. 5 and 6 can be combined to produce a square-wave generator. Do you see how?

Figure 7 is a pulse or edge detector. A single pulse is output every time the input is suddenly brought low.

Finally, Fig. 8 shows how to build a latching memory by connecting two inverters back to back. If one inverter's input is high, it holds the other one low, and vice-versa. And that, of course, is what leads to all of electronic memory.

For more details on gates and inverters, check into both volumes of my *Micro Cookbooks*.

Just as you cannot predict what a car will do by thoroughly studying only its carburetor, the performance of massively parallel inverter-resistor networks will behave differently than the individual circuits studied alone. The magic stuff starts happening when you connect everything to everything else and then let the feedback rip. And therein lies the excitement of some leading-edge research you can do on your own.

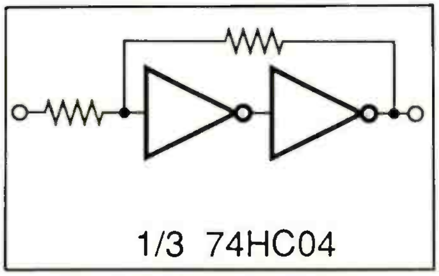


Fig. 6. A CMOS regenerator.

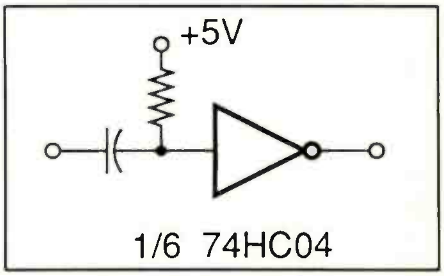


Fig. 7. A CMOS pulser.

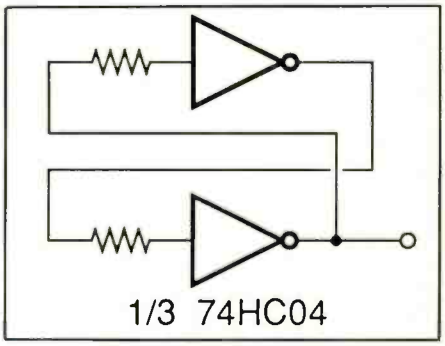


Fig. 8. CMOS memory.

Show me a "neuron" A/D converter

Figure 9 is my adaption of a circuit proposed by John Hopefield of AT&T. It represents a "brand new" way of doing analog to digital, or A/D, conversion. No clocks are needed, no capacitors, nor any precision time or frequency references; yet the circuit needs far fewer inverters than you would use for the usual brute-force or "flash" converter.

Hopefield's theory says that one-way neuron nets work is by seeking minimum energy states. So he set up a feedback network that, through massive feedback, sets up not one but 16 possible "locally minimum" energy states. Each of these states represents one level of a four-bit A/D converter.

The input CMOS inverter acts as an inverting linear amplifier with a gain of somewhat less than one. This unloads, or buffers, the input and changes the outputs to "true" rather than complement values. The gain is less than one so that the inverter still has some drive at both the low and high ends.

The bottom CMOS inverter is our "8" detector. Anything below level eight leaves this inverter low, while anything equal to or above level eight sets this bit high.

The next higher CMOS inverter is our "4" detector. If there were no "synapse" feedback from the 8 output, this detector would go high above level four. But if the

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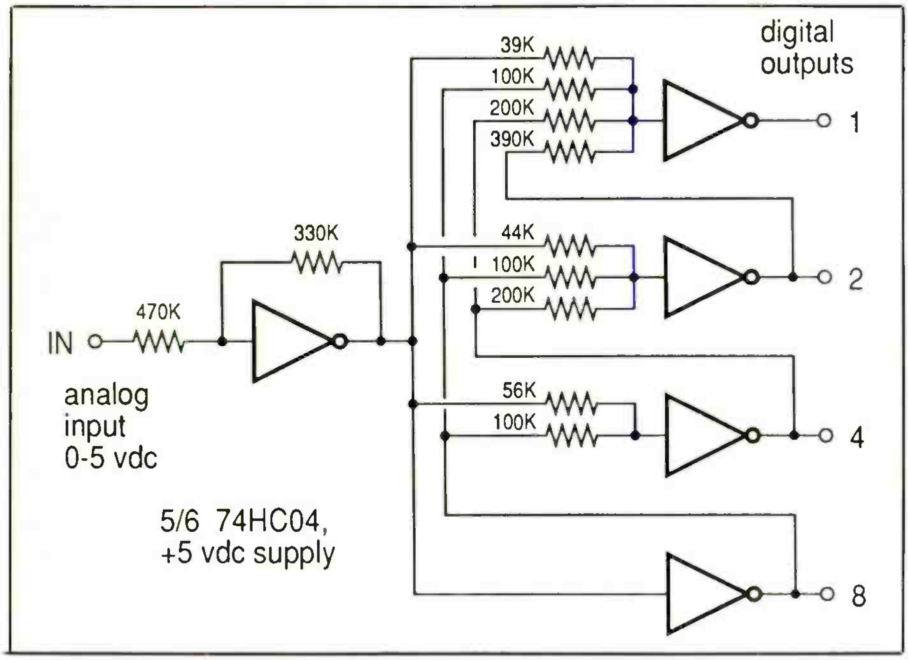

Fig. 9. A novel "neuron-like" A/D converter.

input level is above level 8, then 8 levels worth of current are resistively subtracted from it. Thus, the "4" output will go high for levels 4, 5, 6 and 7. It will seperately go high for levels 12, 13, 14, and 15.

The "2" detector has two feedback paths, one from the "4" and one from the "8" outputs. Follow the bouncing ball, and you will find this output going high for counts 2, 3, 6, 7, 10, 11, 14 and 15.

Finally, the "1" detector has three feedback paths at its input that subtract 2, 4, or 8 levels as needed. The "1" output will be high only on input levels 1, 3, 5, 7, 9, 11, 13, or 15.

What good is this circuit? If in fact, this turns out to be an accurate model of how the brain "thinks," then we are probably looking at an all-time winner. Right now, you have a simple, easily understood, and cheap way of handling a limited-resolution A/D converter with nothing but CMOS inverters and resistors. There's lots of times when you might like to have a simple "volume-control" input to a digital project, for which this circuit is nearly ideal.

You can easily extend the concept to more bits, but you eventually will need lots of very precise value resistors, so today's "heavyweight" A/D conversion schemes have nothing to fear.

How about a new contest?

OK. A free *SAMS* book to the first 10 *Modern Electronics* hardware hackers that come up with some interesting and useful "neuron" circuits that use nothing but CMOS inverters, resistors, and capacitors to simulate something in possibly the same way the human brain does.

As with the earlier contests, the overall winner gets an all-expense paid tinaja quest for two (FOB Thatcher, AZ) and maybe some cash-type money if the idea is good enough for a *Modern Electronics* article. So, take off your thinking cap and show me how to simulate it. Send you entries directly to me. ME

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First impressions: Toshiba's Model T1100 Laptop Computer; Epson's Model LQ-1000 Dot-Matrix Printer; New England Software's "Graph-in-the-Box" Graphics Software

By Eric Grevstad

Before you rush out and buy an IBM PC Convertible, check out the standard equipment of the Toshiba Model T1100 PC Convertible-compatible laptop computer.

Dateline, April 10—The IBM PC Convertible came out a week ago, and a friend of mine at a business computing magazine has already lost count of the press releases pouring in from companies rushing their programs onto 3.5-inch disks. Both they and IBM deserve a "What took you so long?", but the new portable is good news. It's the first IBM for which there were clones before there was an original—the 80C88, microfloppy, and LCD recipe goes back to the Data General/One in September 1984—but it's here at last. Laptops are legitimate. Now we can stop worrying about the market and get down to fixing IBM's mistakes.

And there are mistakes, once you stop marveling at Big Blue's genuinely good decision to include a second disk drive with the machine at a fair price ($1,995). The lack of an external 5.25-inch drive or cable to tap a desktop floppy is a brutal way to promote the new 3.5-inch standard, forcing owners of existing software to buy a 3.5-inch drive ($395) for their PCs while the Convertible and its two drives stand idle. Charging $95 for DOS is a cruel joke, and ignoring parallel or serial ports—without costly interfaces, the Convertible connects to nothing on earth but its thermal matrix printer—is IBM tyranny in the classic style.

Drawbacks like these are why other PC-compatible laptops will coexist with the autograph model, though they'll have to cut prices to do it. Some months ago (November 1985), I flunked the Kaypro 2000 for its invisible LCD and lack of a parallel port. I've now tried the Toshiba T1100, a newer mix of the recipe at the same $1,995 price, and am much more impressed. Except for its wildly awkward function keys and numeric keypad, the T1100 deserves to outsell the IBM.

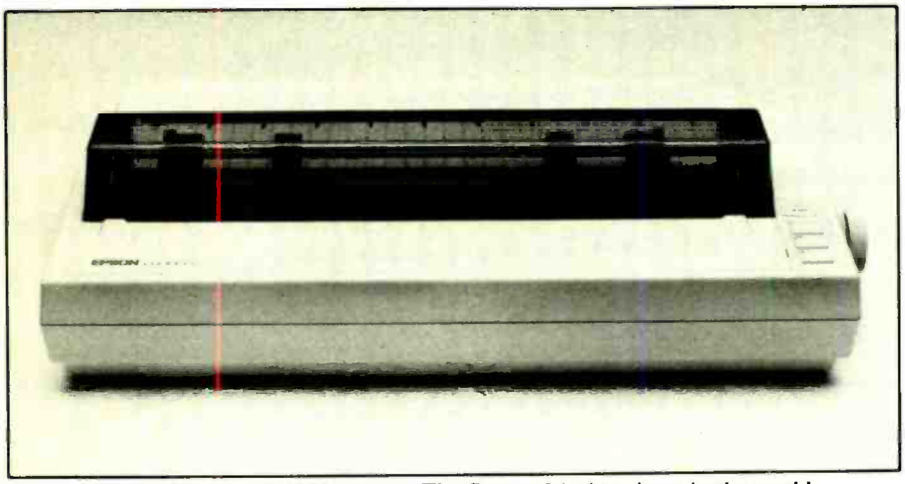
Ignore IBM, Save $1,000

The Toshiba and IBM have a lot in common: an 80C88 processor, 720K microfloppies (though Toshiba has one built-in drive to IBM's two), and a tiltable 25 by 80 LCD that's fully compatible with PC (200 by 640) graphics software. The T1100 display will give you a headache in dim rooms or dark alleys, but in any decent light it's the best non-backlit LCD I've seen.

There's plenty of angle and contrast adjustment (though the contrast dial is lethally close to the on-off switch), and Toshiba MS-DOS 2.11 includes a memory-resident utility called CHAT ("change attributes") which lets you tap Shift-Alt to tinker with palettes if your color software shows black on black. CHAT sometimes took two taps—SideKick was first opaque, then revealed "Select by pressing a," then another try brought "highlighted letter"—but one too many made blank vertical lines. (Full-screen views of Framework II graphs stayed solid black even with CHAT, but I encountered no other LCD obstacles.)

If you dislike LCDs for desk work, an RGB color or composite monochrome monitor plugs into the Toshiba's rear video port. Flip the switch anytime, even while taking off with SubLogic's Jet, and the T1100 toggles between the LCD and CRT, doing what the PC Convertible can't do without a $325 adapter. If you'd like to put a file on paper, there's the parallel port that both Kaypro and IBM forgot (IBM offers a parallel/serial card for $195; Toshiba has a serial port, clock, and 300-baud modem for $249).

IBM includes a second microfloppy drive; Toshiba counters with 512K instead of 256K standard RAM. The external drive port fits either a second battery-powered 3.5-inch unit ($499) or the 5.25-inch drive I tested ($529) that uses the laptop's ac adapter. Flipping a switch to use the full-sized unit as drive A instead of B, I could run everything from self-



Epson's Model LQ-1000 printer: The flattest 24-pin printer in the world.

booting graphics games to PC-DOS 2.10 and 3.10, though the latter two systems couldn't read the Toshiba's own MS-DOS 2.11 formatted microfloppies. The hard-shelled 720K disks proved fast, quiet (unlike Kaypro's), and generally adorable.

All told, I'd urge a good look at a Toshiba with the optional serial/modem card and the $99 card and cable that lets it access your desktop's 5.25-inch drive; that system costs $2,343, compared to $3,450 for a PC Convertible with comparable memory, video, and printer ports (but a 1,200- instead of 300-baud modem). The one thing that might scare you is the keyboard. It's a good one, with excellent typing feel (though my model's space bar started to wiggle and squeak after four hours' pounding on it), but the function-key block has been turned 90 degrees and stuck above the top row; F9 backwards through F1, lying above F10 through F2.

I adapted to that, but I hate the numeric keypad—not a square pad at all, but two (odd and even) rows, 1 to 9 above 2 to 10. For number entry, a mock keypad in the Tandy Model 100 tradition would be superior; as for the cursor arrows and End, PgDn, Home, and PgUp keys (in that order), they drove me back to WordStar's cursor commands.

A Slim Printer

Since this is the first time I've put a company (Toshiba) in back-to-back columns, I'll cancel the favor by saying I've found a 24-pin dot-matrix printer that's even nicer than the P321 I reviewed last month. It's from archrival and printer king Epson, which has brought the appeal of its two-year-old LQ-1500 down to consumer instead of corporate budgets with two new models, identical except for width: the 80-column LQ-800 ($799) and 136-column LQ-1000 ($995).

The other 24-pin printers I've seen have been big, heavy machines with massive printheads, but I pulled the LQ-1000 out of its box with one hand. It's only four inches tall, perfectly smooth and flat, and the usual Epson pale beige. It looks like a giant bar of soap.

Besides parallel and serial interfaces and DIP switches for a few default settings, the LQ-1000 has few controls to fuss over—just on-line, form feed, and line feed buttons. Instead of keying in formatting codes as with recent Epsons' SelecType feature, you simply push the form feed or line feed buttons (with the printer on-line) to move between quality and draft printing. It's not a lot of flexibility—software escape sequences, including an all-purpose code that triggers almost any combination of features depending on the decimal value you enter, provide that—but it's all most users need. If you want double-width italics, superscripts, or other dot-matrix shenanigans, a first-class manual details the software commands.

As with other 24-pin units, the small pins of the LQ-1000 actually make slightly worse or wavy-looking draft text than trusty 9-pin models. Still, the draft copy is legible enough, and pica and elite averaged a healthy 100 characters per second (cps) by my watch. Correspondence output (49 cps pica, 56 cps elite and proportional) looked sensational, perhaps a shade lighter than the P321's but with crisply formed characters. I'm going to have to break down and start applying the words "letter-quality" to today's matrix printers.

On the down side, the LQ-1000 didn't seem as solidly built as older Epsons: the hinged front cover fit well but there was a lot of play in the paper release lever, and the machine was definitely noisy, making a hearty *ka-thunk* at each carriage return

The Epson LQ-1000 shifts from draft pica,
or draft elite with underlining or whatever,
to letter-quality pica text or
to letter-quality elite text in conventional
or proportional spacing, a winning feature.
Nevertheless, I prepare my correspondence
in great big italics! Yippee!

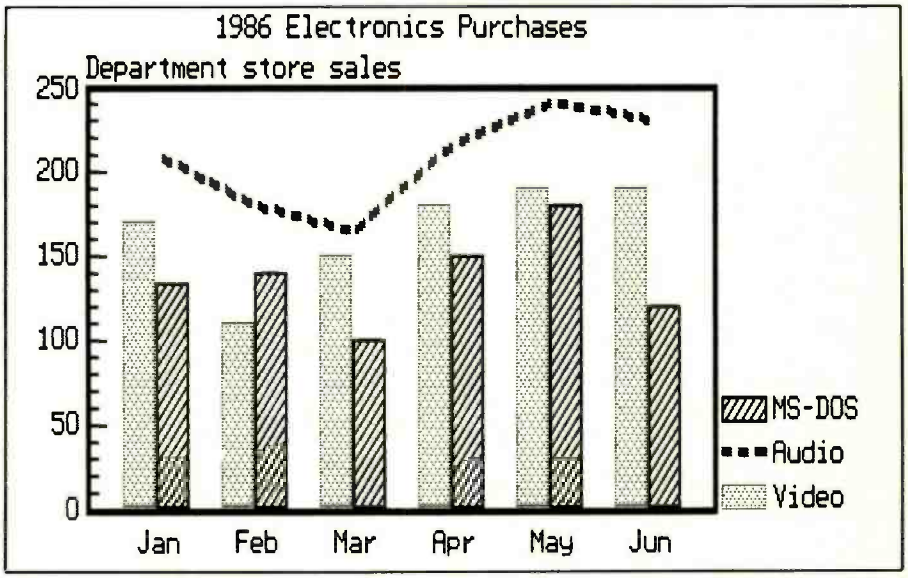
Sample: Playing around with Epson's print qualities.

and such a racket when first turned on that I thought I'd left some packing material jammed in the mechanism. It distracted me so I almost forgot my traditional gripe about having to pay for a tractor feed ($49.95 and $59.95 for the narrow and wide models; sheet feeders are $129.95 and $169.95).

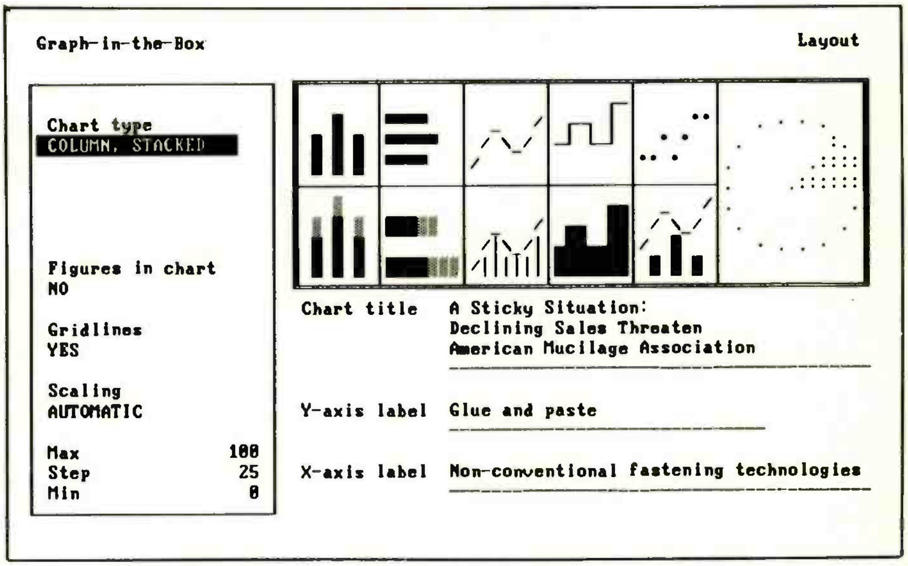
Every Story Tells a Picture

Why does my Apple-owning dad lust after Lotus? What's one reason I like Framework II? Instant graphics, the ability to select a few spreadsheet columns, tap a key, and see a chart. The convenience can become habit-forming, but what if your spreadsheet (such as Multiplan) doesn't do graphics? What if you're typing tabbed columns of numbers with a word processor? What if you're mildly batty and crave a chart of memory and disk bytes from a DOS CHKDSK report?

If so, you'll go beserk over Graph-in-the-Box, a Swedish import from New England Software (the price, $97.60, has something to do with converting from krona). The cute name says as much as I could: it's a graphics program which loads into memory like SideKick (I loaded both with no collisions, though Graph-in-the-Box takes a sizable 127K), then pops up to capture and graph any data on your screen. It works with Multiplan, WordStar, or any ASCII software, though I had a spectacular Op Art crash



Fancy spreadsheet? No, Graph-in-the-Box and numbers typed with my word processor.



Graph-in-the-Box layout screen lets you change graph styles with a push of the space bar.

with graphics-oriented Framework II.

After pressing Alt-G, you use the cursor arrows to highlight one or more columns of numbers on screen, then press Enter—and, in a twinkling, there's a rather bland column chart (labeled "Graph A," "Graph B," and so on), ready for you to make changes or additions from Box's layout and data screens. The former lets you tab and space through selections of column or horizontal bar (separate or stacked), line or step (filled or blank), scattered point, or pie charts, or mix formats (putting a trend line, for example, above some columns). There are ample color or crosshatching pattern choices; charts can hold up to 500 values and be saved to disk in proprietary or DIF (data interchange format).

Until you give its Erase command, Box keeps the current data in memory, letting you capture and add other data to the same chart—even if you've switched to a different application to do it. You can capture text and stick it into the label and title areas instead of retyping. A setup utility lets you configure the program (copy-protected, but installable on a hard disk) for IBM, Epson, HP, or Facit printers and plotters and IBM (regular or EGA), Hercules, AST, and Tecmar graphics boards.

Graph-in-the-Box isn't as loaded with features as standalone graphics programs, and it won't turn WordStar into integrated software in the sense of putting a graph in the middle of a document. But it's fast (except for drawing pie charts and holding down the arrow keys during data capture), flexible, and its menus and capture abilities are fun and easy to use. For anyone who relies on a word processor or simple spreadsheet but would like an occasional chart, it nearly eliminates the chore of importing or entering graphics program data. I can't wait to show it to my dad. **ME**

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CIRCLE 32 ON FREE INFORMATION CARD

Monitoring Central America From Guatemala

By Glenn Hauser

Earlier this year, we spent some time in Guatemala, researching the radio scene there and in neighboring countries. Information to follow should correct and update that to be found in traditional reference works. Times and days are UTC.

Belize. The new Voice of America relay was testing on 1530 kHz, heard briefly at 0115 with announcements in English and Spanish; no location was given, but we know it was Belize, from the southern town of Punta Gorda. Unfortunately, this station will override the main Spanish-speaking U.S. mediumwave station to be heard in Central America, Radio Panamericana, KGBT, Harlingen, Texas.

El Salvador. Although not very distant, due to the mountainous terrain, we were still surprised to pick up several FM and TV stations from here without external antennas. San Salvador FM outlets follow an actual or nominal 0.8-MHz spacing, just like in the U.S. Many others were probably masked by nearby Guatemala City stations.

91.3, "Stereo-Club 91.3" or "91.3 FM," with music of yesterday, today and always; seems to be 24 hours.

92.3, unidentified station but definitely Salvadorian; could be nominal 92.1.

92.9, "Estereo-Sagitario," with jingles promoting romantic music format; off at 0600.

99.3, "Metro-Estereo," stronger than the others and with a live DJ, call is YSEW, sometimes just "EW" or "W"; rocker throwing in tapes complete with IDs of Miami and Los Angeles FM stations; on past 0600 (local midnight). Also audible on 99.5, perhaps a relay transmitter; note that on mediumwave, adjacent-channel relays are customary.

100.1, "ABC-FM Estereo," so apparently the onetime mediumwave station YSABC still survives on FM.

101.1, "Estereo-Amor, KW, 100.9," so is YSKW, definitely off-frequency; off after midnight.

102.5, "La Femenina," live (male) DJ said would be on until 3 a.m. (0900 UTC), at least Saturday night/Sunday morning.

103.3, unidentified classical music outlet, heard in the morning but not in the evening.

104.1, "Radio Cadena YSKL," includes missing-person announcements, off at 0600, and also audible on 104.3—relay?

Television channels 2, 4 and 6 were visible, but not channel 8. Although calls are assigned, such as YSR-TV on channel 2, they do not seem to be used. Channel 2 is "TV-Dos"; Saturday night closed at 0525 UTC; Sunday morning signed on at 1436. Has a nice jingle, "Sonria—esta con el 2" (smile—you're with Two). Both it and channel 4 sometimes put up full-length color bars for a few seconds during commercial breaks. Channel 4 signed on at 1500; their ID is a 4 in a circle. Channel-6 audio seems to be off-set-minus, better on 87.70 MHz than 87.80; carried a long speech, probably by Pres. Duarte.

Although Radio El Salvador occasionally activates shortwave, the only regular shortwave transmissions from this country are unintentional harmonics. "Ondas Orientales," San Miguel, has been heard previously in North America on 2310 kHz; now it's confirmed on 2300, the fundamental having moved from 1155 to 1150. Another one to try for is "XW, Novedades"; i.e., YSXW, Usulutan on 2680 kHz, twice 1340.

Honduras. Harmonics and split-frequency mediumwave stations were of special interest here, but one "normal" outlet was notable for its strength, exceeding that of Guatemalan 90-meter-band stations except Radio Cultural, 3300. That's Radio Luz y Vida, 3250 in the early evening; perhaps they are directional westward.

Around 1300 UTC, Radio Danli was audible on 2740, two times 1370. It's near the Nicaraguan border as is El Paraiso. We also heard Danli last year while in Costa Rica. A foreign harmonic audible on the 2 MHz band in the daytime indicates considerable power. That's the case with Radio Actualidad, Santa Barbara, on 2840, heard around 1800 (local noon); if it didn't sign off so early, 0100, it would doubtless be heard farther afield. San Pedro Sula is the location of two more, Radio El Mundo on 2675, also a regular in the evenings on approx. 1338 kHz; and Estrella de Oro on 2560, twice 1280, with a program until 0200 produced by Radio Transmundial (TWR).

The splits included Radio El Paraiso, on 1165, "la voz del cafe"; and Radio Latina, 1255, also in El Paraiso, both heard evenings. A third station in that town is actually on 1130 rather than listed 1110, Radio Progreso.

Mexico. A rim-shotter for Merida, Yucatan, Radio Uman, on 1270 kHz put a harmonic on 2540; another harmonic, on 2940 at 1312 surprisingly came from distant XEHI, Ciudad Miguel Aleman, Tamaulipas. A regular split in the evening was XEUD, "Canal 136" on 1363 kHz from Tuxtla Gutierrez, Chiapas.

Guatemala. So much was observed from Guatemala itself that we can only summarize here. First, the FM dial in Guatemala City is packed with stations, contrary to what you might gather from reference books which deliberately omit FM data. This is not all academic, either—these are in sporadic-E DX range of much of the U.S., from South Carolina through most of Texas, with the optimum distance being along the Gulf Coast, and some of them, especially the lower frequencies, are regularly heard by DX listeners. Mixed together are low-power links duplicating AM stations in mono, and higher-powered originating FM stereo stations, many of them also related to AM stations and usually automated. Sometimes the "real" FM stations mask the signals in Guatemala City itself of the links.

88.1, "Fabu-Estereo," probably the leading FM station in the country; it was originally an offshoot of "La Fabulosa," but is now owned by another member of the same family. Closes around midnight (0600 UTC). Claims to be Central America's first stereo station.

88.8, "La Fabulosa," part of the Emisoras Unidas network, parallel 670, mono.

89.6, "Radio Centroamericana," parallel 1510, mono—a rarity, a private commercial, yet cultural and educational outlet, with its own gymnasium and anti-smoking campaign. For being so offbeat, it's boycotted by the local ad agencies.

91.9, "Estereo-Saturno," mostly music, 24 hours.

92.5, "Radio Continental," parallel 970, mono.

93.0, "Radio Nuevo Mundo," parallel 880, mono. Though one of the best-known Guatemalan mediumwave outlets, thanks to a favorable frequency and power, its studios in downtown Guatemala City on Sixth Avenue are in a dingy walk-up, its once proud neon sign burnt out.

93.7, "Estereo-Amor". This is one of several stations with a regular hour of marimba music, in this case at 0500. Contrary to what you might expect, most stations do not like to broadcast marimba music, and relegate it to hours when it'll do the least commercial damage. The former government apparently required a certain amount of marimba music.

94.1, "Radio Sonora," parallel 1180, mono.

94.4, "Radio Rumbos," low modulation, parallel 1210 and 2420, 24 hours.

94.9, "FM-95," a rocker.

96.2, "Radio Nuevo Mundo," apparently a relay associated with 93.0. Announced as 96.1.

96.85, "Radio Progreso," parallel 580, mono.

97.6, "Radio Emperador," parallel 910, mono.

98.1, "Super-Stereo," rock in English; also "Doble S" until 0700. Call is TGSD.

98.6, "Radio Mundial," parallel 700, mono; associated with Emperador.

98.9, "FM-Globo," romantic music in stereo, until 0700.

100.1, "La Voz de Guatemala," government station in mono parallel 1000 kHz, capable of separate programming but actually duplicating 640 kHz and 107.0 MHz.

100.7, "Radio Cultural," missionary outlet well-known from shortwave on 3300 kHz. During the day it's separate from that and 730 kHz, but from late afternoon until 0630 they duplicate. Taped announcements claim 100.5 MHz. Mixture of classical music and gospel. Has one of the most elaborate studios in the city, including a huge room originally intended for TV production. Like many, but not all FM stations, it has the main transmitter on a nearby mountain, and a backup transmitter at the studio. Oh yes—there's an English segment of gospel programming in the evening. The station itself is ambivalent about whether this is for listeners abroad or nearby English-speaking residents. Although not announced, a weak transmitter is active on 5955 kHz, to hold the license for that frequency.

101.5, "Estereo 101," more rock in English.

102.1, "Classy 102," romantic music in Spanish.

102.6, "Super-Radio," parallel 760, mono. Poor modulation, on both.

102.9, "Metro-Stereo," romantic music in English, 24 hours.

103.7, "La Voz de la Buena Musica," 24 hours, stereo.

104.4, "Radio Tic-Tac," parallel 1360, mono, off at 0500.

104.7, "Radio Faro Aviateca," classical and jazz, no longer related to the airline but can't change the name without legal expenses; stereo, echoey announce chamber. Has given up its former mediumwave outlet of 1540, but is thinking about adding shortwave. Goes off before 0600.

105.5, "Union Radio," Adventist station in stereo partly dual 1328; irregular schedule. Hopes to reactivate shortwave on 6090, but Adventist World Radio has shifted its major shortwave focus to Radio Lira, Costa Rica.

106.0, "Radio Poderosa," parallel 1120, and indeed really powerful at our hotel, with spurs audible on 105.2 and 106.7; mono.

107.0, "La Voz de Guatemala," TGW, parallel 640, 1000, 100.1, mono. Many educational and cultural programs, marimba in the studio. Shortwave on 6180 and 9760 is very irregular. Unlike neighboring countries, Guatemalan stations do *not* play the national anthem at sign-on or sign-off—with the exception of this government station.

107.5, "Stereo 108," romantic music 24 hours.

In addition, there's a background-music service (no IDs) on 86.0 MHz. When the fabulous stations above 88 MHz are audible, check for this, too, if you have a Japanese-FM-band receiver and not too much channel 6 interference.

We also gathered some miscellaneous FM information from outside Guatemala City. Audible at Panajachel, on the shore of beautiful Lake Atitlan, was "Reu-Estereo" on 96.5, an automated station in Retalhuleu, also called "FM-96"; signed off at 0400; romantic music. A station heard with a strong signal in Antigua, but apparently not located there, was "Stereo-Jet" on 96.95 (sometimes better on 97.0, sometimes 96.9), announced as 96.9. The 1590-kHz station in Chaimaltenango announced that there would soon be a 104-MHz FM station there. That could be a rounded frequency, or in this country, not.

In Santiago Atitlan, we saw the studio building of La Voz de Atitlan, and townfolk told us it was currently active, but during a two-day period in the area, we never heard it on 2390 kHz, just Radio Huayacocotla, Mexico. However, there was a weak, unstable carrier in the daytime varying around 2413 kHz.

In Guatemala city, the clandestine Radio Caiman frequencies of 7470 and 9960 were extremely strong; in other parts of the country they were weak and fading. This tends to confirm reports that this station broadcasts from Guatemala City. However, we could find no one there who even admitted to knowing about it, except for the DXers we met, who had also been unable to locate it precisely. On the other hand, La Voz del CID, on 9940 and 6305, was weak and fading both in the city and the parts of the country we visited. This would not rule out a location around Coban, or elsewhere in Central America.

We were pleased to confirm that some of the harmonics heard in the U.S. from Guatemala also stand out on the local dial, Radio Ciros on 1700 (2 × 850), and Radio Rumbos on 2420 (2 × 1210). In Chichicastenango, we also heard Radio Quiche, Santa Cruz on 1770 (3 × 590), Radio Sur, Escuintla, on 1840 (2 × 920) around sundown, and on 2320 (2 × 1160), La Voz Evangelica, Morales, Izabal, signing off at 2359. A non-harmonic but interesting signal was that of TGN, Radio Cultural, on 2570 kHz, a mixing product of 3300 minus 730 kHz. Also, on about 1680 kHz, a beacon with the strangely appropriate callsign of HILL, which we doubt came all the way from Boston.

Those contemplating a visit to Guatemala may want to contact members of the Guatemala DX Club, Apartado 583, Guatemala. We're especially indebted to Carlos Zipfel, Edgar Oliva, and Oscar Ramirez for their hospitality. They also publish an occasional bulletin in Spanish, "Radiactividad DX." ME

 (from page 33)

(A) Multitasking in action. On power-up, the system displays only the upper-left window of system files. Double-clicking the mouse button on an icon opens another window to reveal the icon's sub-files. In this example, the three windows on the right show the contents of the System, Utilities and Demos Drawers. Bottom-center, two windows are running two copies of a single graphics-demo program simultaneously.

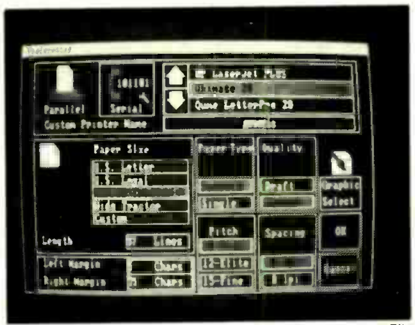
(A)

While they run, the window at bottom-left runs a different demo program. Just behind and above the demos, a Command Line Interface (CLI) gives a window into Amiga's MS-DOS-like operating system. While the demos are running, the CLI window is being used to rename a disk file.

(B) Selecting the Workbench Preference icon displays the access panel for all user-controlled system characteristics. By dragging the carat character around the center panel, you can center displays on the monitor screen. The devices (or "gadgets") around the panel's edge, clockwise from center, set key-repeat delay and speed, mouse-cursor speed, mouse double-clicking timing, implement printer specifications, edit/redraw the mouse pointer, change Workbench's four screen colors, add the CLI icon to the Workbench, set characters per displayed line, select a communications baud rate, adjust the internal calendar/clock, and save all Preferences to disk.

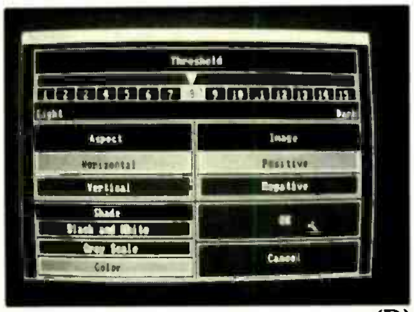
(B)

(C) When you select the Change Printer gadget in the Preferences control panel, this Printer Control panel appears. Its gadgets select driver routines for specific printer models, serial/parallel output, paper type, print quality, margins, character spacing and pitch.



(C)

(D) Selecting the Graphics Select gadget in the Printer Control panel calls up another panel that controls graphic output to black-and-white and color printers. For example, gadgets under the heading "Shade" let you set Amiga to print graphics in full-color, continuous gray scale, or black and white. If you are printing black and white only, the Threshold slider at the top of the screen lets you specify which range of colors will print as black and which as white.



(D)

positioning. This proved especially frustrating for writers, who were forced to position text using the mouse. Many MAC programs added cumbersome command-key sequences to get around this drawback.

Atari gave its mouse two buttons. The right one is reserved for use by application software, so the ST machine *itself* is still a one-button system. Fortunately, it has cursor-control keys. However, there's another quirk. In the MAC you point to a menu title and click the mouse button to reveal its list of commands. Atari ST menu selection is less controllable. Its menus drop down automatically when touched by the mouse pointer, without any button-pressing on your part. Users who like to work fast may frequently trigger unwanted menus, which they must retract by moving the mouse pointer off the menus and clicking.

I believe the Amiga's two-button mouse is better integrated into its user interface. Both buttons are used, but their roles remain consistent whether you are working with the system itself or with an application program. Also, the way the buttons operate eliminates accidentally triggered menus.

The mouse's Selection button (left) picks icons or items that will be acted upon. If you press this button while pointing to a disk icon, the icon will become "active" and the system will offer menus and commands appropriate to that type of object.

The Menu button (right), while held down, displays the list of available menus across the top of the screen. Still pressing the Menu button, you move the mouse cursor to a menu title, and its command list automatically drops into view. You slide the mouse cursor down this list, and select a command by releasing the menu button.

Menu commands can even have their own submenus, which pop into view as the mouse cursor passes. Neither the MAC nor the Atari ST allow this command nesting. So if I were developing or using a complex program with many command levels, I'd prefer the Amiga environment.

Both the MAC and ST are essentially mouse bound. You can move the cursor and execute *some* commands by keying in short control codes. However, Amiga isn't tied to its mouse. Two "Amiga Keys" flanking the keyboard's space bar can substitute for the two mouse buttons. The Amiga Keys, the Shift key and the four cursor-control keys can also move the cursor at both high and low speeds.

Workbench Workings

When you select a program icon (called a "tool") with the mouse, a window opens within which the program runs. When you open a "project" such as a world-processing document, created by a tool, a window opens onto the project and Amiga also loads the tool that created it. Every window opened is a "virtual terminal," with full access to all system resources. You can open as many windows as Amiga's memory permits. Multitasking also enables "extended selections" in which you work on several projects in the order they are opened. You could, for instance, open three spreadsheets, which the system would work on in the order they were selected.

But only one window has highest priority. You select which one by "clicking" the mouse cursor on it. You can then enter data, select from that window's menu options, and receive system messages pertaining to the window's processes. Processes in other windows don't stop. They continue to run until they finish or need attention.

As with the Macintosh and Atari ST, windows opened onto the Workbench desktop can be moved, shrunk, expanded, overlapped and shuffled—just like papers on a desk. Scroll bars help you scan a window's contents, when there's too much to show at once. And as with any program, double-clicking the mouse button over the Workbench icon itself opens a window into its files. These show up as seven (or eight) icons:

* Preferences
* System Drawer
* Utilities
* Demos
* Empty Drawer
* Clock
* Trashcan
* CLI (optional)

Preferences is the most complex of them all. Like similar options on the Macintosh and Atari ST, Preferences lets you change system settings and set peripheral configurations via a nested series of on-screen "control panels."

The main panel lets you click or slide various types of "gadgets" to set and change:

* Key-repeat delay and speed
* Mouse-cursor travel speed
* Mouse button (double click) sensitivity
* Internal date/time
* Serial communications rate (110, 300, 1200, 2400, 4800, 9600 or 19,200 baud)
* Characters per screen line
* CLI, the system's Command Line Interface (described later)
* Display positioning (horizontal and vertical screen adjustment)
* Workbench display colors
* Printer configuration
* The on-screen pointer

When selected, the printer-configuration and on-screen pointer gadgets open their own control panels. The on-screen-pointer panel lets you alter the Workbench pointer, or create a new one, and works like the Workbench's icon editor.

The printer panel lets you select among the models for which Amiga is preconfigured. To date, these include the Alphacom Alphapro 101; Brother HR-15XL; Commodore MPS1000; Diablo 630; Advantage D25 and C-150; Epson JX-80; HP Laserjet and Laserjet Plus; Okimate 20; and Qume LetterPro 20. You can also identify other printers as serial or parallel and add them to this list.

You can also set some output parameters through the printer panel, including cut/continuous paper, paper length, tractor width, lines per page, lines per inch, margins, draft/letter quality, typeface and type size. In addition, I would have liked gadgets for transmitting carriage-return and line-feed signals. Without these, you may have to set some switches inside your printer to get it on-line.

The printer panel's last gadget, Graphic Select, opens a third panel for controlling graphic printing. This panel lets you choose black-and-white, gray-scale halftone or full-color output. The Amiga can output 15 shades of gray (plus white), and a slider gadget lets you control which ones will register as black in a black-and-white printout. Images can also be output as positive or negative.

Every Preferences control panel includes a Save gadget, which will store your new settings on your current system disk. Each disk stores its own Preferences settings, so they can differ between applications. Also part of every Preference control panel is a Cancel gadget, for returning to the preceding panel.

The Workbench System-Drawer icon opens to reveal three files:

* Disk Copy, for duplicating diskettes
* IconEd, for redesigning or creating new Workbench icons
* Initialize, for erasing and reformatting diskettes

Similarly, the Utilities icon window reveals:

* Notepad, a 10-page text processor for jotting notes without leaving your current program
* Calculator, for impromptu arithmetic calculations

Demo files include:

* Dots, which fills its window with random colored dots
* Lines, which displays a constantly-changing colored line that bounces all around its windows
* Boxes, which draws a random series of colored boxes

Workbench's Empty Drawer icon may be copied, renamed, and used to collect files you want kept together. For example, an "Art Drawer" could hold a paint program, libraries of brush designs, text-font files, and any pictures you wish to save.

A Clock icon's window displays an analog clock face (with second hand) driven by the Amiga's internal clock. This clock can be switched to a smaller digital version.

Trashcan is a holding file for things you want to delete from disk. By pointing to an icon and "dragging" it onto the Trashcan, you sim-

Pin	Amiga	RS-232	HAYES®	Description
1	GND	GND		Frame Ground
2	TXD	TXD	TXD	Transmit Data
3	RXD	RXD	RXD	Receive Data
4	RTS	RTS		Request To Send
5	CTS	CTS	CTS	Clear To Send
6	DSR	DSR	DSR	Data Set Ready
7	GND	GND	GND	System Ground
8	CD	CD	CD	Carrier Detect
9				
10				
11				
12		S.SD	SI	
13		S.CTS		
14	−5V	S.TXD		−5 Volts Power (50 mA)
15	AUD0	TXC		Audio Out of Amiga
16	AUD1	S.RXD		Audio Into Amiga
17	EB	RXC		Buffered Port Clock
18	INT2			Interrupt Line to Amiga
19		S.RTS		
20	DTR	DTR	DTR	Data Terminal Ready
21	+5V	SQD		+5 Volts Power (100 mA)
22		RI	RI	
23	+12V	SS		+12 Volts Power (50 mA)
24	C2	TXC1		3.58-MHz Clock
25	RESB			Buffered System Reset

Amiga's serial interface can create problems for careless hardware developers. Its 25-pin connector follows RS-232 standards for pins 1 through 11 but departs from the standard on pins 12 through 25. Designers should pay particular attention to pins 14, 21, and 23, which carry −5, +5 and +12 volts, respectively. These should be connected only if the hardware requires and expects them.

ply copy it into the Trashcan's window. You can recover the file (drag its icon back out) at any time *until* you select the Workbench's Empty Trash command.

For Iconophobics

Amiga won't force you to use desktop metaphors, icons or windows if you really don't want to. A CLI (Command Line Interface) icon shows on the Workbench only if you request it through Preferences, as described earlier. CLI bypasses Workbench, and goes directly to the AmigaDOS operating system.

If you like the IBM PC operating system, you'll welcome AmigaDOS' system commands for transferring, duplicating, renaming, deleting and running programs and data files; directing input/output; and examining directories. Amiga-DOS commands can even do comparisons, branch and loop, so you can write programs to guide Amiga's operations automatically. And if you attach a high-capacity hard disk to Amiga, you'll probably use CLI a lot for building and maintaining large, hierarchical file structures. (However, this can also be done iconically by nesting drawer icons within each other.)

But even in CLI mode, Amiga's multitasking sets it apart from the IBM PC. You can open as many independent CLI windows as you want, run different programs and even interrogate and work with different disks at once.

Eventually, it is expected that Amiga will be able to run IBM PC software, too. Commodore has announced two approaches to PC compatibility. One would be an under-$100 program that translates commands from PC software and emulates the PC's response. It would load and execute PC programs either from Amiga's 5.25-inch or 3.5-inch disk drives. The latter would be able to run programs for compatibles like the Data General/One. When demonstrated, this software-only emulation proved a bit slow in calculation-intensive jobs like spreadsheets.

Commodore has also announced a $500 Trump Card hardware upgrade, which accelerates the process with a library of often-used PC-DOS BIOS routines. This should at least help Amiga run spreadsheets as fast as the PC. However, I'm still skeptical that the Amiga buyer will want to sacrifice its graphic/sound talents for a PC's boring green screen.

Comparisons & Conclusions

For my money, Amiga is the most well-rounded existing example of a next-generation, 68000-based, personal computer. The Amiga (with 7.8-MHz CPU) seems slightly speedier than the Atari ST (with 8-MHz 68000) or even the 6-MHz IBM PC/AT, and runs rings around the 4.77-MHz IBM PC or 7-MHz Macintosh. Theoretically, the MAC could have been as fast as the Atari ST or Amiga. However, the Amiga's (and to some extent, the Atari's) special chips and DMA buses offload so much processing from their CPUs that there's no contest. (For sheer speed, however, even Amiga can't beat the Pinnacle, a less well-known micro with a 12-MHz 68000 CPU.)

Color graphics is the second important point of comparison. The MAC offers no color at present. The Atari ST can match Amiga's 640 by 400 screen resolution, but only on the ST's monochrome monitor. A separate color monitor produces 320 by 200-pixel images with 16 colors out of 512, or 640 by 200 screens with 4 colors out of 512. Hardly a match for Amiga.

The IBM PC's Enchanced Graphics Adapter (EGA) card comes in around, or a bit below, the Atari ST's performance, and quite a bit below Amiga's. EGA resolutions range from 320 by 200 to 640 by 350 and display up to 16 out of 64 colors. This is, perhaps, an unfair comparison, since the IBM PC isn't a 68000-CPU-based machine.

The Atari 520ST is amazingly inexpensive, costing $999 (suggested retail) for a bundled CPU, RGB monitor, 500K floppy drive, mouse and system software. (At press time, Atari announced its 1040ST, with 1 megabyte of internal RAM, and costing $1,200 when bundled with a color monitor. Atari now plans to sell the 520ST components through mass-market channels, such as large department stores.)

Amiga costs a bit more—$1,295 for the CPU section, $495 for the RGB monitor, and $195 for the 256K RAM upgrade. The total ($1,985 manufacturer's suggested retail price) still undercuts the cost of a monochrome Macintosh. Some dealers are effectively reducing Amiga's price by bundling extra hardware and software with each system sold. More dealers will do this, since the dealer's cost per Amiga ($1,281 for the above configuration) leaves a $700 margin for reductions.

I think the above comparisons add up to a good overall price/performance ratio that favors the Amiga. But specs alone won't guarantee sales success. Witness the fate of Mindset, an impressive color system with built-in IBM PC compatibility. It failed as a personal/small-business product, and found small success as a dedicated graphics system.

I think this could also happen to Amiga if Commodore ignores its obvious strengths and concentrates on selling to the Lotus 1-2-3 crowd. Commodore has made the system's graphics and sound *so good* that THAT'S what users will be driven to buy. And those who buy will probably have good uses for Amiga's sound and/or graphics in their work. So Amiga's best reception will likely be in schools, ad agencies, architectural firms, TV studios, cable networks, film studios, the theater and in professional music, as well as creative at-home "enthusiasts."

Commodore seems to understand this. A company spokesperson said: "The system's future—especially as a business system—will depend on future software. To concentrate on the business market right now may prove a misallocation of resources." So it's no surprise that of the first four peripherals Commodore plans to announce, only one—the model 1680 modem (list $295)—is a general business tool. The others are the:

* Model 1300 GenLock device (list $250), for interfacing Amiga with professional video equipment
* Model 1500 Amiga Live Framegrabber (price TBA), for capturing video images into central memory for processing
* Model 1400 MIDI interface (list $50), for connecting Amiga to professional music synthesizers, instruments and equipment.

At these prices, many amateurs will probably get their first chance to paint and jam like the pros.

Similarly, early Amiga software—from both Commodore and third parties—targets educational and creative applications. A rush of educational packages includes Reading Adventure, U.S. Geography Adventure, World Geography Adventure, The Americas, American History Adventure, How a Bill Becomes a Law and Vocabulary Adventure. And creative products such as Deluxe Paint, Animator, Musicraft, Graphicraft, Video Construction Set, Deluxe Music Construction Set and Concertcraft will be the reason many people buy Amiga. I believe packages like these (and hardware like Commodore's GenLock and Framegrabber) will be the keystone products Amiga will need to carve out its market niches.

Lotus 1-2-3 was responsible for much of the IBM PC's success in business markets. And the Macintosh floundered for quite some time before products like Jazz, Filevision and PageMaker helped define its successful markets. Amiga, too, will probably flounder a bit until users can assemble complete educational and creative systems from available hardware and software.

Other Amiga software available, or soon to be released at this writing, include:

* Amiga BASIC (Microsoft)
* Textcraft (Arktronics)
* WACK software tool kit (Commodore)
* IBM PC cross-development package and Transformer PC emulator (Commodore)
* CalCraft (Commodore)
* Rags to Riches—ledger, receivables and payables—(Chang Labs)
* Maximillian—integrated word processor, spreadsheet, business charts and communications—(Tardis Software)
* VIP Professional (VIP Technologies' 1-2-3 clone)
* Enable (The Software Group).

Even if you're not familiar with existing "desktop metaphor" systems, you'll find Amiga easy to use. It provides color and open architecture (which the MAC doesn't), windowing and true multitasking (which have to be jury-rigged into an IBM PC), and more extensive color capabilities than either the IBM PC or Atari ST. All of this is courtesy of some pretty sophisticated electronics inside Amiga's plain plastic shell.

Last but not least is the financial wherewithall of a company. To the buyer it means the difference between everlasting (five years?) company support for its machine or joining a computer survival group as Sinclair/Timex and TI99/4 owners have been forced to do. Commodore is not IBM or Apple in this respect, so the buyer's risk is greater. Nonetheless, the Amiga deserves to succeed in the marketplace. I've never seen such fantastic video sights or heard such wonderful sounds from any other computer in its price range. **ME**

Build An Air-Conditioner Fan-Motor Control *(from page 36)*

wires that go to the thermostat to exit. If you are using a metal box, however, route the wires through a rubber-grommet-lined hole. Then use a dry-transfer lettering kit to label the LEDs and *R9*'s access hole as shown in the lead photo.

Installation & Adjustment

Before attempting to install the Fan Delay Timer, disconnect power from your air-conditioning system at the circuit breaker panel or at the unit itself. If you do not know how to do this, get help from someone who does.

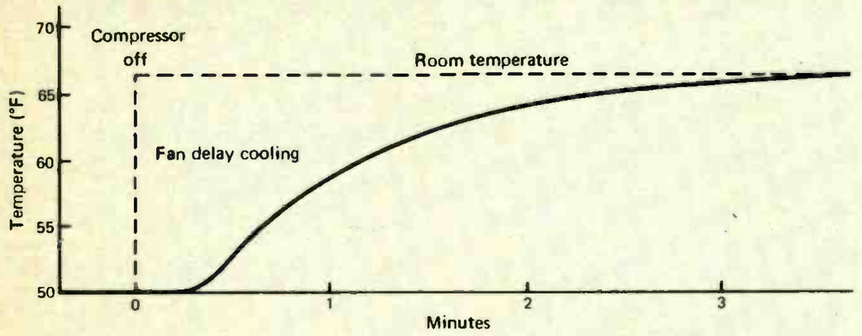
Remove the cover from the thermostat and then the thermostat itself from its mounting base to gain access to the points where the wiring connects to it. Keep in mind that wire insulation color coding may not always be helpful. Therefore, always follow the labeling on the thermostat.

When you are sure which wire is which, disconnect the compressor wire (usually yellow) from the thermostat, and splice it to the yellow Y IN wire from the project. Connect the project's yellow Y OUT wire to the thermostat mounting base terminal. Leave all other wiring from the air-conditioning system to the thermostat as is. Add the Fan-Delay Timer wires to the appropriate contacts on the thermostat's terminal board.

Mount the project on the wall near the thermostat and return power to the air-conditioning system. At this point, the red POWER indicator LED should be on.

Cycle the compressor and adjust *R9* for the desired fan-delay period. Do not set this period to have the fan run beyond the point at which the air entering the room is no longer colder than that in the room. If you do, this may cause more moisture than necessary to enter the room, resulting in a lowering of the comfort index. As the outside temperature changes, you may find it necessary to reset the Fan-Delay Timer's control to maintain maximum efficiency. **ME**

Cost Analysis



Shown in the graph is a plot of the rise in air temperature measured at an air-conditioning vent during and after compressor operation. Note that it takes more than 3 minutes for the temperature inside the air conditioner to equalize with room temperature. This 3 minutes roughly equates to 1 minute of compressor on-time. Consider now that a typical air-conditioning system might cycle on and off three times per hour, or 72 times per day. Assuming a typical month to contain 30 days, during this period, the system would cycle 2160 times. If the system were run for six 30-day months, it would cycle 12,960 times.

For a medium-sized house, the cost of running an air-conditioning system is about 60 cents per hour, or 1 cent per minute. From this, you can calculate the saving if you were to use the Fan-Delay Timer described in the main article. If the compressor ran only 1 minute in each cycle, at the end of 12,960 cycles, the cost would be $129.60 (about $130). the cost of operating only the fan would be $15 over the same period of time, resulting in a savings of $130 − $15 = $115.

Now consider that you can build the Fan Delay Timer at a cost of only about $25. This being the case, your net saving over the six-month period would be $115 − $25 = $90. Hence, the project would pay for itself shortly after it's put into service.

Your actual savings would depend on the type of air-conditioning system with which you use the project. Though the above cost analysis is fairly typical, results can vary widely.

EDITORIAL • • • *(from page 4)*

pulled a 40% share! Fourteen percent of respondents noted that they plan to buy a hard-disk drive, while 15% indicated they already own one.

In response to a question on "Computer Applications Mostly Used," 46.8% of respondents indicated that it was for Professional or Business purposes, 61.5% for Hobby, 43.0% for Education, and 26.2% for Entertainment. (The total exceeds 100% due to multiple uses, of course.)

Toting up all the plan-to-buy responses, MODERN ELECTRONICS readers are expected to spend more than $34-million in the next 12 months on computer hardware!

In line with the large electronics/computer professional readership we have, 59.5% indicate they specify/influence/authorize company purchases of electronic and/or computer equipment. Your influence on purchases of electronics and computer equipment extends beyond this, too, to personal advice given to friends, neighbors and others who, as you know, seek out your counsel when they learn that you're an "expert." Thirty-six percent of respondents not surprisingly indicated they gave buying advice to ten or more people in the past 12 months, for example.

As you can see from this brief overview of our 1986 Study, you are certainly very special people with enormous talent and energy, contributing actively to our technologically advanced life. And having fun doing it.

Art Salsberg

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A Phone-Activated Light *(from page 49)*

should be about 9 volts, with positive on the + side of the capacitor. If you obtain the correct reading, disconnect ac power from the project and allow sufficient time for the charge to bleed off *C6*. Otherwise, troubleshoot the circuit and correct the problem before proceeding.

You can check operation of *IC2* by plugging it into its socket and connecting the project to the telephone line via the modular cable. With ac applied to the project, the potential between pin 6 of *IC2* and circuit ground should be about 8 volts dc when the telephone is on the hook. Lift the handset off the hook and once again measure the voltage at pin 6; it should now be about 2 volts or less. If you do not obtain this response, check the polarity of your telephone line, making sure that the negative side feeds to *R2*. Then check the wiring of the *IC2* circuit.

Power down the project and wait for the charge to bleed off *C6*. Then plug *IC3* and *IC4* into their respective sockets and reapply line power. With your telephone on the hook, momentarily short pin 2 of *IC3* to circuit ground and note that the lamp turns on and remains on for about 10 seconds and then extinguishes.

Power down the project and once again wait until the charge bleeds off *C6*. Then plug *IC1* into its socket and reapply line power. Call a friend and have him or her call back and hang up after one or two rings. The lamp should go on at the first ring and remain on for about 10 seconds after ringing stops. If everything works okay, call your friend back and tell him or her about your new circuit! **ME**

Active Filters *(from page 58)*

The schematic diagram of the circuit just designed, with component values indicated, is shown in Fig. 7.

More Information

In this article, we've discussed practical design approaches to first-, second- and third-order Bessel, Butterworth and Chebychev active filters on a more or less elementary level. Topics not covered include: filters beyond the third-order; filters with response shapes between those discussed; bandpass filters; filters with variable cutoff frequencies; and use of filters as crossover networks in audio systems. If you wish to learn about these and much more, there are a number of books to which you can refer. Two good ones are Don Lancaster's *Active-Filter Cookbook* and W.G. Jung's *Audio Op-Amp Applications*, both published by Howard W. Sams. **ME**

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